



Towards integrated, and sustainable municipal solid waste management system in Shashemane city administration, Ethiopia

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ARTICLE INFO

Keywords:

Environmental quality
Municipal solid waste management
Public health
Shashamane
Sustainable waste management

ABSTRACT

Solid waste generation is attested to be unavoidable product of human activities. Sustainable management of such waste is a pressing challenge faced in many developing countries today. The study was motivated by the fast growing population and the inefficient waste management system threatening the public health and the image of Shashemane city in Ethiopia. The objectives of the study were: to explore the existing household solid waste management practices, to examine the current governance system of municipal solid waste management, to investigate the contemporary challenges and opportunities of municipal solid waste management, and forward integrated and sustainable municipal solid waste management system for Shashemane city. Data were collected from sampled households, key informants, focus groups, and the city's environment. Data were analyzed by employing quantitative and qualitative methods. 94.8 % of the respondents opined that the solid waste generated in their city is organic in nature (Ash, and sweeps; leftover food, and vegetable peels; paper, and cardboards; green leaves, and grass; and cattle dung). 96.7 % of respondent households opined that they have temporary waste storage in their yards and trash bags were asserted to be widely used (87.6 %) in handling the trash in the courtyard. The waste sorting and recovering practices among the residents is very low and is certainly the major cause for inefficient and unsustainable management system of municipal solid waste in Shashemane city. Generally, a grand mean of 2.23 confirmed the absence of good governance in municipal solid waste management system in Shashemane city. Moreover, the significant proportion of responses (≥ 50 %) for each of the nine principles of good governance as either poor or very poor asserted governance failure of the municipal solid waste management system in Shashemane city. The results of the study confirmed that low public awareness on waste management; inadequate collection capacity; poor integration and coordination of stakeholders; environmentally unsound dump site; and illegal dumping by key stakeholders are the major challenges underpinning the unsustainable municipal solid waste management in the city. It is recommended that Shashemane city must adopt integrated sustainable municipal solid waste management system to substantially enhance the waste management service in the city leading to ultimate advancement of public health and environmental quality.

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<https://doi.org/10.1016/j.heliyon.2023.e21865>

Received 25 August 2023; Received in revised form 28 October 2023; Accepted 30 October 2023

Available online 4 November 2023

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1. Introduction

The current global municipal solid waste generation figure is asserted to be about 2.01 billion tons per year and it is expected to rise to 3.4 billion in 2050 [1,2]. Globally, solid waste management cost is affirmed to rise to about \$375.5 billion in 2025 [3]. Solid waste generation is attested to be unavoidable product of human activities while sustainable management of such waste is a pressing challenge faced in many developing countries today [4–8]. Solid waste management is asserted to be a multidimensional issue that incorporates political, institutional, social, environmental, and economic aspects [9–12]. Improving solid waste management in developing countries is affirmed to require efforts to raise public awareness, increase funding, build expertise, and invest in infrastructure [1,3,9,10,13,14].

Major constraints of solid waste management in developing countries are affirmed to include: infrastructural challenges; budgetary constraints; inadequate service coverage and operational inefficiencies of services; ineffective technologies and equipment; inadequate landfill disposal; and limited utilization of waste reduction activities [1,9,15–19]. Lack of collaboration and collective efforts among the key actors are attested to underpin the problems of municipal solid waste management in developing economies of our contemporary world. In other words, the field of municipal solid waste management in developing countries is affirmed to be affected by numerous administrative, financial and technical constraints that hinder the delivery of sustainable outcomes in MSWM [20,21]. More importantly, many problems in the cities and towns of the global South are attested to be often associated with a weak or inadequate municipal solid waste management system underpinning severe direct and indirect environmental and public health issues at every stage of waste collection, handling, treatment, and disposal. In other words, inadequate and weak municipal solid waste management is attested to result in indiscriminate dumping of waste on the streets, open spaces, and water bodies [22–24].

[20] attest that institutional change is necessary to address the administrative, technical, and operational constraints on municipal solid waste management practices in developing countries. One of the challenges facing countries worldwide is the need for more sustainable and smart waste management (WM) solutions, and the Internet of things (IoT) technologies are asserted to significantly improve the overall waste management process and its logistics [25,26]. [27] affirm that the role of the private sector is essential for attaining the sector's sustainability. Sustainable integrated municipal solid waste management is recommended in our contemporary world as sustainable strategy to address issues of municipal solid waste management in developing countries [22,28–32]. As a comprehensive strategy, integrated municipal solid waste (IMSW) management incorporates several waste management techniques, such as waste reduction, recycling, composting, and controlled disposal [33–39]. Scholars of sustainable integrated municipal solid waste management affirm that there is a need to educate, train, support, and empower informal stakeholders within recycling value chains, as they are important contributing parts of society that positively add to economic growth and ultimately to the efforts of transitioning towards a circular economy [40–47]. A circular city (CC) is attested to promote circular economy (CE) principles, and efficient urban solid waste management strategies are affirmed to be essential for promoting a CE at the municipal level [48–52].

Interventions on solid waste management in developing countries are attested to include: improvements to service operations, technology, and accessibility; utilization of recycling initiatives and improvements in disposal; and landfill creation [9,15,53–56]. The environmental management measures affirmed to be effective in managing solid waste in developing countries include: economic instruments; regulatory instruments; and suasive instruments [13,53,57,58].

Previous studies conducted in Ethiopian cities, and towns asserted that they face serious environmental contamination and health risks underpinned by poorly developed municipal solid waste management system and governance failure [12,13]. Moreover, the existing waste management problems were affirmed to be associated with low awareness of inhabitants, and lack of resources [59–61]. Generally, their waste management system was attested to be faced with numerous challenges due to the huge amount of waste generation beyond the collection capacity of the towns [13,15,59,60]. More importantly, the current municipal solid waste management system in Ethiopia was characterized by the 3 I's (Irregular, inadequate, and inefficient) which denote sporadic and inconsistent collection, low coverage, technical frailties, and lack of enforcement of laws, respectively [1].

Shashamane town in Ethiopia has been exhibiting an accelerated economic growth and rapid urbanization in recent years while no attention is given to integrated and sustainable municipal solid waste management system [1,5,12,62]. In other words, there were no comprehensive studies on waste management practices, challenges, and opportunities in the city to underpin the integrated and sustainable municipal solid waste management system. Despite the absence of comprehensive studies on municipal solid waste management issues in the city, the information from some studies and the city municipality reveals that different kinds of municipal solid waste types are generated from households, industries, institutions, commercial firms and open market dealers [5,12,62,63]. Among these solid waste types generated are organic and inorganic, all of which have been detrimental to environmental quality and threatening to human health [5,12,62]. This study focused on municipal solid waste management issues in Shashemene city with the purpose of recommending integrated, and sustainable municipal solid waste management system. To this end, the general objective of the study was to assess municipal solid waste management issues of the town, and recommend integrated, and sustainable solid waste management system for Shashemene City. The specific objectives of the study were: to explore urban households' solid waste management practices; to examine governance of municipal solid waste management in the town; to investigate challenges of municipal solid waste management in the town; to explore existing opportunities of municipal solid waste management in the city; and to recommend integrated, and sustainable solid waste management system.

2. Conceptual framework of the study

The study adapted the Integrated Sustainable Solid Waste Management (ISWM) framework. ISWM is affirmed to distinguish three important components in solid waste management and recycling systems. The three components include: technological (technical)

component, sustainability aspect (social, political, institutional, financial, economic and environmental aspects) and the stakeholder component. In other words, solid waste can be managed effectively and efficiently by involving all the above components [1,3,5,10]. The main goal of the framework is to support decision-makers, stakeholders and planners to handle the system in an economically and environmentally sound way [1,5]. The framework allows studies of complex and multi-dimensional systems in an integrated way and provides a new and modern perspective for further development (Fig. 1). Moreover, the ISWM systems combine waste streams, waste collection and treatment and disposal methods, with the objective of achieving environmental benefits, economic optimization and societal acceptability [1,5]. The most sustainable waste management practices affirmed by scholars are waste reduction and waste recycling (Anshassi et al., 2021). Material source reduction is attested to be at the highest management hierarchy used globally by many local governments to determine best management approaches [1,64]. Moreover, effective waste recycling is attested to ultimately lead to waste reduction [1,3,5]. It is possible to recycle completely a waste product only when the production and marketing processes themselves have integrated the target of 100 % recycling as the ultimate goal of the design of the value chain, making it possible to generate money from the recycling activity itself (and allowing the recycling activity to not just be an end of chain cost) [3].

3. Methodology

3.1. Description of the study area

Shashemene city is bordered by Arsi Negelle in the North, Hawassa in the South, AlabaKulito in the West, and Dodola in the East [65]. Shashemene is a city in the West Arsi Zone, Oromia Region, Ethiopia, and a separate district [65,66] (Fanta & Megento, 2018; Gemedo et al., 2020). Geographically, the city is located between 7° 9'50"N and 7° 18'17"N latitude and between 38,°31'43"E and 38, °41'58"E longitude (Fig. 2) in the middle of the great Ethiopian Rift Valley Region with a distance of about 250 km to South of the capital city of Ethiopia Finfinnee (Addis Ababa) [5,62,65–69].

Cities in Ethiopia are asserted to have the following organizational scheme: city, sub-city, woreda, kebele. Sub-city is the term for a district within a bigger Ethiopian city. Shashemene consists of eight sub-cities, namely Arada, Abosto, Burka Gudina, Alelu, Kuyera, Awasho, Bulchana, and Dida Boke [5,12,62,65,66].

Topographically, Shashemene is affirmed to flat with slope rarely exceeding 3 % particularly along river courses. The slope is asserted to generally decrease from southeast towards the northwest. This is asserted to be underpinned by the presence of hill and uplands in the southeastern border of the town. The average elevation of the town is reported to be about 1940. Larger areal coverage of the town is reported to have flat topography with a slope less than 5 % except areas along Essa and Gogeti streams. In other words, the area along Essa and Gogeti streams is attested to have an average slope of 12 % and 9 % respectively. The town is asserted to have an ample of land for future urban development activities [5].

With regard to the climate of the town, the climate condition of the city administration is affirmed to fall into three climatic zones namely the highland (Dega), temperate (woinadega) and the lowland (Kolla) climate condition. It is attested to have an altitude ranging from 1672 to 2722 m above the sea level experiencing a temperature value between 12 to 28 °C. The town's mean annual rainfall for years is reported to be 1735.8 mm [5,12,70].

With regard to human population, the population of the town is affirmed to be increasing rapidly from time to time with annual growth rate of 5.4 %. The total population of the town in 2020 was projected to be 279,814, of whom 141,150 were males and 138,665 were females [68,71]. It is probably the most ethnically mixed town in the region as it composes more than 14 ethnic groups [5,65].

With regard to the economic condition of the town, Shashemene town is characterized with the hinterlands economy characterized by agriculture and non-agriculture economic activities. In other words, the economy of the town is attested to be dependent on trade and agriculture. For instance, trade, which had been a source of economy for years, is affirmed to still contributing a lot for the economy of the town. In other words, scholars claim that starting from the ancient period, the town is known for its main route to long distance trade, which passes through the center of the town. Moreover, the city's strategic location is attested to make it an international highway route connecting Ethiopia with neighboring Kenya. It is located within the Great Rift Valley system and is close to the lake and holiday resorts of Hawassa town, Langano and the Shala-Abiyata Park [62]. Scholars also attest that agriculture is still

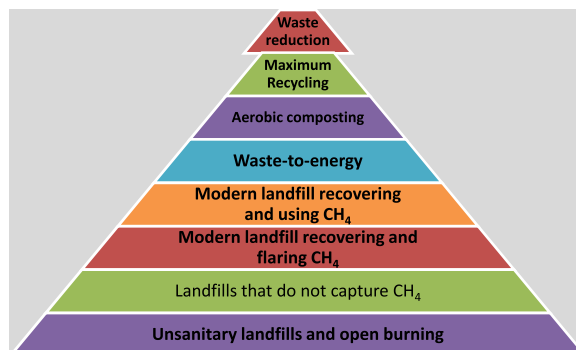


Fig. 1. Hierarchy of Integrated Sustainable Solid Waste Management System (Source: Authors elaboration based on literature review).

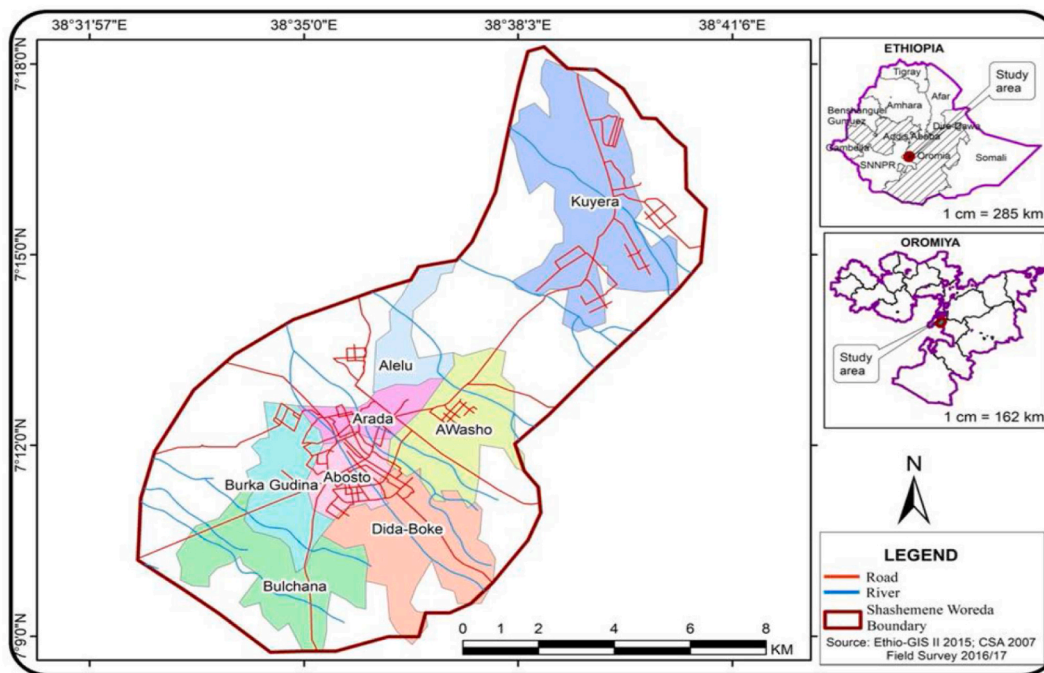


Fig. 2. Geographical location Map of Shashemene City (Source: Ethio-GIS:CSA2007Field Survey 2016/2017).

considered as a major source of economy for the majority of the town's residence. For instance, cereal crops are reported to constitute much of the agricultural production in and around the town. Service and transport sectors are also affirmed to be among the contributors of the town's economy even though the contribution is affirmed to be low [5,12,65].

With regard to sanitation and Solid Waste Management situation of the town, scholars assert that there are multiple issues of sanitary situation and waste management systems underpinned by rapid population growth and city's expansion. According to Ref. [5], still there exist critical sanitary and waste management problems even though there have been newly constructed vacuum tankers, wells and garbage containers in the city. For instance, liquid and solid wastes were confirmed to be being disposed in open space and no treatment involved [5,12,62,63]. Solid waste management services in Shashemene city is affirmed to be not keeping up with the city's expansion, population increase and development. The capacity of micro and small enterprises (MSEs) engaged in solid waste management and the amount of waste generated in the city is attested to show a large gap. The practice of informal waste disposal to open fields, limited door-to-door waste collection services, limited segregation and composting efforts, awareness level and limited efforts to reduce waste by most inhabitants are asserted to call for the municipality to revise its waste management infrastructure and service delivery efforts [63].

3.2. Research design, and sampling procedures

The study adopted a mixed research design combining descriptive research design (for quantitative research), and exploratory research design (for qualitative research). Moreover, it employed a mixed research approach integrating quantitative and qualitative approaches of data collection, and analysis.

With regard to sampling procedures, and methods, the study employed both non-probability, and probability sampling techniques in different sampling stages. First, Shashemene town was selected purposively as the purpose of the study was to assess municipal solid waste management issues, and recommend integrated, and sustainable municipal solid waste management strategy. At the second stage, the villages of the town were clustered into two, based on the geographic distribution and age of settlement (i.e. old and new settlement areas). Then, from each cluster, one representative village was picked using random/lottery sampling technique. Accordingly, Awasho and Burqa Gudina were selected representing new and old settlement areas, respectively. The actual number of survey respondents (sample size) was then determined using the sample size determination formula [72]:

$$n = \frac{N}{1 + N(e^2)}$$

where;

n = designates the sample size the study uses;

N = designates total number of households

e = designates maximum variability or margin of error 8 %;
 1 = designates the probability of the event occurring. Therefore;

$$n = \frac{N}{1 + N(e)^2}$$

Sample size determination aimed at selecting part of the population from which information was drawn to form conclusions about the entire population. By applying the above formula:

$$n = \frac{7627}{1 + 7627(0.08)^2} = 153 \text{ households}$$

n = 153 households.

Accordingly, 153 households were selected for household survey from the two villages (75 from Awasho and 78 from Burka Gudina) (Table 1). Regarding qualitative data collection, purposive sampling technique was employed to select participants for focus group discussion, and key informant interview.

3.3. Data types, and sources; methods of data collection, and methods of data analysis

Data Types and Sources: With regard to data types, and sources, both secondary and primary data were utilized for the purpose of the study. Accordingly, secondary data were collected from secondary sources while primary data were collected from primary sources. The sources of primary data were sampled households, focused groups, key informants, and micro business groups. On the other hand, the secondary data were acquired from secondary sources like national documents, town-specific socio-economic studies, reports and records of the past.

Methods of Data Collection: With regard to methods of data collection, the study employed household survey questionnaire, focus group discussion, key informant interview, and personal observation to collect the primary data from the primary sources. Accordingly, interview schedule/household questionnaire was employed to collect data from sampled 153 households. Moreover, guiding checklists were used to collect complementary qualitative data through focus group discussions (8 focus group discussions), key informant interview (10 key informants), and personal observation. In addition to the primary data, additional data were collected from different secondary sources to complement the primary data. Accordingly, municipal reports, town based surveys (published & unpublished) and, national and regional related documents were reviewed. The secondary data from all these sources were then correlated with data obtained from other sources, and so substantiated the reliability and validity of the research result.

Methods of Data Analysis: With regard to methods of data analysis, the study employed both quantitative and qualitative methods of data analysis. Accordingly, the study employed simple descriptive statistics (percentage, frequency, and mean) to analyze quantitative data collected through household survey questionnaire assisted by SPSS software (Version 21).

The qualitative data collected through focus group discussion, key informant interview, and personal observation were analyzed through narrations, and thematic content analysis. The major criteria underpinning the application of thematic content analysis were: transparency, maximizing validity, maximizing reliability, comparative analysis, and reflexive approach in the process of analysis [73]. Accordingly, the responses from the key informant interviews, and focus group discussions were recorded both electronically, and by hand on the notebook as some of the participants preferred not to be recorded by any audiovisual tools. Moreover, relevant environmental events were recorded through audiovisual tools and hand during participant observation and transect walk sessions. As the number of key informant interviews is manually manageable and the researchers were familiar with the data, no software was employed to analyze the qualitative data. The application of thematic content analysis technique in this study to analyze the qualitative data involved the following six steps [73]: Step one: Reading and Re-reading the recorded qualitative data to be familiar with the content; Step two: Organizing the qualitative data by questions; Step three: Coding the data into exhaustive, mutually exclusive, and specified categories or themes; Step four: Reviewing and revising the coding system; Step five: Looking for patterns across categories or themes; and. Step six: Summarizing findings, and recognizing limitations of the data.

4. Results

This part of the research paper presents the practices of solid waste management, governance of urban solid waste management system, challenges of municipal urban solid waste management, and opportunities of municipal urban solid waste management based on quantitative and qualitative information generated from the collected data.

Table 1
 Sample household population distribution by village.

Sr.No	Name of Village	Total Households	Sample Households
1	Awasho	3739	75
2	Burka Gudina	3888	78
	Total	7627	153

4.1. Solid waste management practices in Shashamane town

With regard to urban solid waste generation in Shashemene town, the results indicated that 94.8 % of the respondents opined that the solid waste generated in their town is organic in nature (Ash, and sweeps; leftover food, and vegetable peels; paper, and cardboards; green leaves, and grass; and cattle dung) (See Table 2). This indicates that most of the urban solid waste generated in Shashemene town is organic by nature. This complies with many previous studies which asserted that majority of the municipal solid wastes in African cities and towns are organic by nature.

According to Shashamane city waste management study report, the major waste generators are residential quarters, commercial establishments and public service institutions, followed by industry, transport and agriculture sectors. It is generally understood that urban waste generation depends on many factors among which the major is the number of household members, the type of consumable goods and the season. The rapidly growing urban population, the increasing income of the household and the changing life style of the residents in Shashamane city were attested to tremendously increase the waste generation since last couple of decades. Moreover, the key informants, and the discussants of the focus group discussions asserted that being the hub for numerous towns in central Ethiopia, shashemene city has intensely encountered with increasing urban waste management problems since last two decades.

Respondents were also asked about their solid waste collection, handling and transportation practices in their town. In residential areas, respondents opined that they use different types of storage strategies such as plastic bags, baskets, and trash bags locally known as 'medaberia'. Others were affirmed to use trash pits, bury or burn the household generated wastes regularly. With regard to solid waste storage practices, they attested that they simply put their garbage into the storage materials, and collectors pick it up, the next time coming. According to the findings of the household survey, 96.7 % of respondent households opined that they have temporary waste storage in their yards and trash bags were asserted to be widely used (87.6 %) in handling the trash in the courtyard. 79.7 % of the respondent opined that they do practice sorting solid waste at source mainly to reuse the sorted material as fuel/cooking, fertilizer, and animal feed (Table 3). This gives implication that the practice is not underpinned by knowledge/awareness of sustainable solid waste management approach.

It was also affirmed by the focus group discussants and the key informants that the solid waste generated by residential quarters was formally collected in two different ways: house-to-house and curbside collection which is employed by private micro-enterprise groups and municipal utility units, respectively. According to the waste management survey conducted in Shashemene city, three major actors were attested to perform the formal waste collection service in the city: the municipality, the microenterprise business groups, and formally organized community groups. The microenterprise and community groups were asserted to collect municipal solid waste from residential quarters and streets, while the municipality was affirmed to be responsible mainly for picking and transporting waste-packed steel containers to the final dump site. It was also confirmed during the study that the existing waste collection capacity by these institutions is much less than the municipal solid waste generated in the city. According to the data from the municipality, there were 38 steel containers, each with a storage capacity of 8m³, based in different locations of the city. The same information source discloses that 11 of these containers were functioning completely and others (13) were operating under capacity at the time of the study.

According to Shashamane city municipal solid waste management report, 60 % of the overall waste generated in the town was affirmed to be collected and moved to open dumpsites with the help of two trucks and other means. This meant that only 85,177.98 kg of waste, out of the total 141,963.3 kg generated every day was collected and conveyed to open dumpsite. However, the remaining 40 % or 56,785.32 kg of municipal solid waste generated every day in the city was attested to be scattered all over along streets, on open fields, in flood drains, and on riverbanks.

The ever-increasing demand for a clean environment and the inadequacy of solid waste management services has underpinned the increase in informal waste collectors in Shashamane town. Despite the ongoing scholarly debate about the role and contribution of informal waste collectors, it was observed that the informal groups lack full knowledge of environmental sanitation and operate outrageously in an illegal and distractive manner. According to the household survey data, 73.9 % of the respondents opined that they do have access to solid waste management services of which 88.4 % were done by business groups, 6.3 % by community groups, and 5.3 % by the city municipality (Table 4).

The household survey result shows that most trash collectors recur within 7 days, while many others reappear within 8–15 days. Notably others unveiled that these folks are hardly available, and in most case show up after a month or so. The worse of all is that waste collected by this informal groups is dumped anywhere open space is found, which in most case is river streams or drain canals and bridges. The piles of garbage observed through personal observation in roadside drains, alongside riverbanks and under the

Table 2
Perceived Types of Urban solid waste generated in Shashemene town.

Sr.No	Type of solid waste generated	Frequency	Percentage
1	Ash & sweeps	48	31.4
2	Left Over foods & vegetable peels	53	34.6
3	Plastic bags & bottles	6	3.9
4	Paper & cardboards	13	8.5
5	Empty tins, metal scraps & bottles	2	1.3
6	Green leaves & grass	26	17.0
7	Cattle dung	5	3.3
	Total	153	100.0

Table 3
Temporary waste storage, materials used, and practice of sorting municipal solid waste.

Practice of Municipal Solid Waste management	Yes (%)	No(%)
Temporary Storage	96.7	3.3
Use of trash bags	87.6	12.4
Sorting of solid waste at source	79.7	20.3

bridges have perfectly solidified the aforementioned assertions from the respondent household survey results. Besides, the response of households participated in the survey also supports this fact, as 71.2 % of the respondents attested that they do not know the exact destination of the waste carried off from their courtyard. Sadly, a considerable number of community members in Shashamane city do not consider the illegal dumping of waste as a problem and, the environmental issue is not a priority at all. A vast majority (79.1 %) of household survey participants have, indeed, articulated that the waste disposal is a problem in their locality which, however, is about the physical impression or the aesthetic aspect only (Table 4).

With regard to urban solid waste recovery and disposal practices in Shashemene city, the household survey result shows that the actual number of household practicing the reuse and recycling of waste are quite low, though many claim they are knowledgeable about. The most commonly reused or recycled waste materials reported by the household were metal scraps, glass bottles, organic wastes and textiles. Lack of knowledge and absence of working capital were reported as the two major reasons for most residents not to practice the recycling of waste. In general, the waste sorting and recovering practices among the residents is very low and is certainly the major cause for inefficient, and unsustainable management system of municipal solid waste in Shashemene city.

4.2. Governance of municipal solid waste management system in Shashamane City

The governance of municipal solid waste management was analyzed from the perspective of the nine principles of good governance, and the results of the analysis are presented hereunder:

- 1. Accountability:** A considerable number of respondents (71.9 %) rated the practice of accountability in the waste management system of Shashemene city as either poor or very poor.
- 2. Legality:** A considerable number of respondents (64.7 %) rated the practice of legality in the waste management system of Shashemene city as either poor or very poor.
- 3. Impartiality:** More than half proportion of the respondents (56.2 %) rated the practice of impartiality in the waste management system of Shashemene city as either poor or very poor.
- 4. Transparency:** A considerable number of respondents (68.6 %) rated the practice of transparency in the waste management system of Shashemene city as either poor or very poor.
- 5. Participation:** More than half proportion of the respondents (58.8 %) rated the practice of participation in the waste management system of Shashemene city as either poor or very poor.
- 6. Coordination:** A considerable number of respondents (63.4 %) rated the practice of coordination in the waste management system of Shashemene city as either poor or very poor.
- 7. Effectiveness:** A considerable number of respondents (62 %) rated the effectiveness of the waste management system in Shashemene city as either poor or very poor.
- 8. Education/Awareness:** More than half proportion of the respondents (52.3 %) rated the practice of education/awareness in the waste management system of Shashemene city as either poor or very poor.
- 9. Subsidiarity:** A considerable number of respondents (73.8 %) rated the practice of subsidiarity in the waste management system of Shashemene city as either poor or very poor (See Table 5).

Generally, a grand mean of 2.23 (Table 5) confirmed the absence of good governance in solid waste management system in Shashemene city. Moreover, the significant proportion of responses (≥ 50 %) for each of the nine principles of good governance as either poor or very poor asserted governance failure of the municipal solid waste management system in Shashemene city. In other words, the municipal solid waste governance system was generally rated as poor and ineffective in realizing the intended objective of the municipal solid waste management services. The governance failure in municipal solid waste management system of Shashemene city was also asserted by the qualitative information from the key informants, and the focus group discussants who affirmed that there is governance failure in municipal solid waste

Table 4
Municipal solid Waste as a problem, and Perception on Exact Destination of Waste Collected.

Practice of Municipal Solid Waste management	Yes(%)	No(%)	
Is municipal solid waste a problem in your city?	79.1	20.9	
Perception on exact destination of waste collected, and transported	28.8	71.2	
Waste Collected from home by	Business groups (%)	Community groups (%)	City Municipality (%)
	88.4	6.3	5.3

Table 5
Households' perspective on governance of solid waste management in Shashemene.

Good governance principle	Rating in Percentage					Mean
	Very poor	Poor	Fair	Good	Very good	
Accountability	24.8	47.1	23.5	4.6	0	2.0784
Legality	28.8	35.9	28.1	7.2	0	2.1373
Impartiality	15.7	40.5	32.7	11.1	0	2.3922
Transparency	24.8	43.8	20.9	9.8	0.7	2.1765
Participation	16.3	42.5	31.4	9.2	0.6	2.3529
Coordination	21.6	41.8	30.1	5.8	0.7	2.2222
Effectiveness	25.5	36.5	30.1	7.2	0.7	2.2092
Education/Awareness	15	37.3	32	11.1	4.6	2.5294
Subsidiarity	33.3	40.5	21.6	4.6	0	1.9346
Grand Mean						2.23

E management sector in the city. Interestingly, the participants of the research had, therefore, suggested different but complementary solutions that they think can improve the municipal solid waste management system in the city. The major among these suggestions were: increasing public awareness, placing adequate waste containers, capacity building training and education for all at all levels, organizing regular clean up campaigns, enhancing community participation, increasing municipality engagement, supporting and strengthening house-to-house collection, strengthening waste management micro-enterprise, making the operation inclusive, engaging private sectors, synergizing stakeholders' efforts on solid waste management, and enforcing rules and regulations. The participants had also affirmed that increasing the involvement of private sector and enhancing public-private-partnership are indispensable measures to curb the existing poor waste management situation of the town in integrated and sustainable manner.

The research participants (the key informants, and the focus group discussants) also emphasized that waste management does not involve only services related to waste and infrastructure. In other words, they attested that it involves: people (their behavior and interaction); finance; legal; and all other aspects that are quite often overlooked, and neglected. Previous studies conducted in different cities, and towns in Ethiopia have shown that municipal solid waste management system in Ethiopia is generally poor and entangled with many operational challenges, among which solid waste governance is the major. Sadly, despite having the most important policies and legislations in place in relation to environmental protection and urban waste management in Ethiopia, the municipal solid waste management system in most of the towns in Ethiopia, including Shashamane City are attested to be overlooked and in a critical condition.

4.3. Challenges of municipal solid waste management in Shashamane City

The quantitative and qualitative analyses of the collected data affirmed the following challenges of municipal solid waste management in Shashemene City:

- 1. Wrong Perceptions of Stakeholders about The Responsibility of Solid Waste Management:** The first and foremost challenge of municipal solid waste management in Shashamane town was the wrong perception among all stakeholders about the responsibility of solid waste management in Shashemene city. According to the household survey result, more proportion (47.1 %) of the interviewees perceived that the responsibility of household waste management is for children. 24.2 % of the respondents attributed the responsibility to mothers while 20.9 % of the respondents opined that the responsibility belongs to house workers. Others (7.8 %) still think that waste collection and disposal is the responsibility of the municipality only. The above-mentioned attitude towards the responsibility of waste management in Shashemene city was also reflected by the participants of focus group discussions in the city implying that municipal solid waste management is not given due attention as an environmental challenge.
- 2. Weak Municipality's Waste Collection Capacity:** The second challenge of municipal solid waste management identified in Shashemene City was the weak municipality's waste collection capacity. According to the waste management study report of Shashamane City, the municipality's collection capacity was only 45.96 % or 67.7m³/c/day of the total waste generated. The majority of the respondent households (85 %) opined that there are no waste containers in their neighborhood to let them empty their packed trash bags. The data from secondary sources, focus group discussions, key informant interviews, and personal observation also show that the existing numbers of waste containers were not only inadequate but also some were not in service. Besides, the containers were confirmed to be distributed unevenly across the sub-cities and localities clearly showing that some parts of the town did not get the container service at all. As a result, residents were forced to relay their waste to illegal waste collectors, contributing to illegal and unsafe dumps. Sadly, about 54 % of the municipal solid waste was affirmed to be dispersed all over the town uncontrolled and unhealthy. The municipality report further reveals that the solid wastes that were dumped in open space, backyards, and in the river banks were much more than wastes formally collected and dumped in the existing assigned dumpsites.
- 3. Absence of Market for Wasted Materials:** The third challenge identified was the absence of a market for wasted materials. 35.9 % of the household survey respondents opined that there is a demand but for only some types of waste such as cattle manure, metal scraps, cardboard, and glass bottles. Urban gardeners and farmers, injera/bread makers, and informal dealers (Koraliyos and

Liwach) mainly seek the cited waste types. The above assertion was also confirmed through focus group discussion, key informant interviews, and personal observation.

4. **Urban Residents' Poor Culture of Reusing and Recycling Waste:** The fourth challenge identified was urban resident's poor culture of reusing and recycling waste. The survey data indicated that 56.9 % of the respondents opined that they have a culture of reusing and recycling a portion of the waste generated. However, this is an insignificant quantity and for limited waste types like cattle manure, metal scraps, paper, and woody stuff. The above assertion was also confirmed during the focus group discussion, key informant interview, and personal observation.
5. **Poor Governance of Solid Waste Management System:** the fifth challenge identified was the poor waste governance system. Generally, a grand mean of 2.23 (Table 3) confirmed the absence of good governance in the solid waste management system in Shashemene City. Moreover, the significant proportion of responses ($\geq 50\%$) for each of the nine principles of good governance as either poor or very poor asserted governance failure of the municipal solid waste management system in Shashemene city. The poor governance of the solid waste management system in the city was also affirmed through focus group discussions and key informant interviews. For instance, the involvement of the community and the private sector in the waste management processes was asserted to be minimal. According to the participants of the focus group discussion, and the key informants, good governance of urban solid waste management demands the active participation of all stakeholders, sound institutional arrangements, and proactive policies in place, each with distinct roles and responsibilities within the system.

The secondary information from the secondary sources reveals that there are several policies, strategies, and proclamations issued by the Federal Government of Ethiopia about urban solid waste management, hygiene and sanitation promotion, and environmental protection. For instance, the Ethiopian constitution (articles 43, 44, and 92) indicates the right of the people to live in a safe environment, the need to promote sustainable development, and the responsibility of the government to ensure consultation and safeguard the environment from damage and destruction. Besides, numerous national proclamations have been endorsed in the past couple of decades to frame environmental protection and ensure a safe and suitable environment. The documents reviewed indicated that the existing human resources in the municipality unit are seriously constrained by the inadequacy of appropriate personnel, both in number and expertise.

4.4. Opportunities of municipal solid waste management in Shashamane City

Based on the qualitative information generated from the qualitative data analysis from focus group discussion, key informant interview, and personal observation, the following opportunities were identified in Shashemene town:

1. **Public willingness to pay for the service:** One of the opportunities of municipal solid waste management in Shashemene City identified was the public willingness to pay for the service. All the key informants and the discussants of the focus group discussion attest that the public in Shashemene City is willing to pay for municipal solid waste management in their environment.
2. **Existence of traditional waste recycling practices:** One of the opportunities for municipal solid waste management in Shashemene City identified was as the existence of traditional waste recycling practices in Shashemene City. All the key informants and the discussants of the focus group discussion affirm that the existence of traditional waste recycling practices in Shashemene City can be utilized by supporting the practices with modern recycling technologies which will contribute to a sustainable municipal solid waste management system in the city.
3. **High rate of unemployment in the city:** One of the opportunities of municipal solid waste management in Shashemene city identified was the high rate of unemployment in Shashemene city. All the key informants and the discussants of the focus group discussion assert that the high rate of unemployment in Shashemene city can be utilized as a good opportunity since the unemployed persons can be organized into different groups and involved as stakeholders of sustainable municipal solid waste management system in Shashemene city.
4. **Existence of Municipal Solid Waste Management Strategy in Shashemene City:** One of the opportunities of municipal solid waste management in Shashemene City identified was the existence of a municipal solid waste management strategy in Shashemene City. All the key informants and the discussants of the focus group discussion assert that the existence of a municipal solid waste management strategy in the city can be considered a good opportunity as it gives clear direction, and focus towards a sustainable, and integrated management system of municipal solid waste in the city.
5. **Existence of Good Political Will to Improve Management of Municipal Solid Wastes in Shashemene City:** One of the opportunities of municipal solid waste management in Shashemene City identified was the existence of good political will to improve the management of municipal solid wastes in Shashemene City. All the key informants and the discussants of the focus group discussion affirm that the existence of good political will to improve the management of municipal solid wastes in Shashemene City can be considered as one opportunity since the local government in the municipality is one of the key stakeholders underpinning the foreseen integrated, and sustainable management of municipal solid waste management system in Shashemene City.
6. **Existence of Governmental and Non-Governmental Organizations Supporting Municipal Solid Waste Management in Shashemene City:** One of the opportunities of municipal solid waste management in Shashemene City identified was the existence of governmental and non-governmental organizations supporting municipal solid waste management in Shashemene City. All the key informants and the discussants of the focus group discussion attest that the existence of governmental and non-governmental organizations supporting municipal solid waste management in Shashemene city can be considered as one opportunity since different resources are required for a sustainable and integrated management system of municipal solid waste management.

5. Discussion

5.1. Practices of municipal solid waste management

The findings of the study reveal that most of the municipal solid waste generated in Shashemene city (94.8 %) had an organic nature. This complies with the findings of other studies which affirm that most of the municipal solid wastes generated in developing countries are organic. Three major actors were attested to perform the formal waste collection service in Shashemene city: the municipality, the microenterprise business groups, and formally organized community groups. 60 % of the overall municipal solid waste generated in Shashemene city was affirmed to be collected and moved to open dumpsites while 40 % of it was attested to be scattered all over along streets, on open fields, in flood drains, and riverbanks. The actual number of households practicing the reuse and recycling of waste was attested to be quite low in Shashemene city though many claim they are knowledgeable about reusing, and recycling of municipal solid waste. The most commonly reused or recycled waste materials reported by the household were metal scraps, glass bottles, organic wastes, and textiles. 73.9 % of the respondents opined that they do have access to solid waste management services of which 88.4 % were done by business groups, 6.3 % by community groups, and 5.4 % by the city municipality.

The aforementioned findings imply that the waste generation, collection, reuse, recycling, and disposal practices in Shashemene city had many problems as poor management practices of municipal solid waste management were demonstrated. In other words, the best practices of integrated and sustainable solid waste management underpinned by the municipal solid waste management hierarchy of waste reduction, maximum recycling, aerobic composting, waste-to-energy, modern landfill recovering and using CH₄, modern landfill recovering and flaring CH₄, landfills that do not capture CH₄, and unsanitary landfills and open burning were missed from the demonstrated municipal solid waste management practices in Shashemene city. This implies that there is an urgent need to shift the municipal solid waste management practices in Shashemene City to integrated and sustainable municipal solid waste management practices underpinned by the modern municipal solid waste management hierarchy.

Municipal solid waste management (MSWM) is affirmed to be a multidisciplinary activity that includes administrative activities and solid waste management practices such as the control of waste generation, storage, collection, transfer and transport, processing, and disposal of solid waste [74,75].

The municipal solid waste generation in different cities and towns of Ethiopia was attested to show an average municipal solid waste generation rate ranging from 0.25 to 0.49 kg/capita/day. Furthermore, residents, commercials, institutions, industries, hotels, and street sweepings are affirmed to be the major sources of solid waste generation in urban areas of Ethiopia [75]. This was also found to be true for Shashemene City. While the municipal solid waste collection practice in Shashemene City was confirmed to be extremely poor, proper solid waste collection is attested to be important for the protection of public health, safety, and environmental quality [18, 75]. Despite its importance to a healthy and aesthetically pleasing environment, solid waste management in most African cities and towns is affirmed to remain highly unsatisfactory [4,14,75]. Partnerships involving NGOs, CBOs, and communities are affirmed as new modernizing agents to upgrade solid waste management systems in developing countries. Moreover, there is an urgent need for the public must be educated about the value of a clean environment so that the related costs are appreciated [14].

Approximately 30–60 % of the waste generated is attested to be left uncollected in urban areas of developing countries [75]. The finding of the study which confirmed that 40 % of the municipal solid waste in Shashemene city is scattered everywhere in the city implies that there are significant environmental risks underpinned by the scattered municipal solid waste in the city. The environmental risks underpinned by the scattered municipal solid wastes in cities, and towns are attested to be composed of dangerous materials (non-biodegradables and hazardous materials) that will stay for hundreds of years in the environment [60,75].

Solid waste separation at the source is asserted to have a crucial advantage in encouraging reuse and recycling strategies in urban areas [75]. Composting is attested to be the treatment option that, with few exceptions, best fits within the limited resources available in cities of developing nations. In other words, there is an urgent need to raise awareness for promoting composting on a large scale in cities and towns of developing countries where the most portion of the municipal solid waste generated is organic [4,74,76].

Open dumping (unplanned dumping of waste without consideration for environmental protection and public health) is affirmed to be the most common method of waste disposal in Africa, with open burning coming close as another regularly used mechanism to eliminate waste [54,75]. Sustainable municipal solid waste management (MSWM) strategies, such as waste prevention, reduction, reuse, recycling, and waste-to-energy practices, are affirmed to be weak in least-developed countries like Ethiopia [1,75]. The most sustainable waste management practices affirmed so far are waste reduction and waste recycling [3]. Contrary to this, the illegal open burning and dumping of solid waste are common practices in many developing countries [75]. This is affirmed to be particularly true for cities, and towns in Ethiopia.

5.2. Challenges, and opportunities of municipal solid waste management

Wrong perceptions of stakeholders about the responsibility of solid waste management, weak municipality's waste collection capacity, absence of a market for wasted materials, urban residents' poor culture of reusing and recycling wastes, and poor governance of municipal solid waste management system were confirmed as the existing challenges of municipal solid waste management in Shashemene city.

Public willingness to pay for the service, the existence of traditional waste recycling practices, the high rate of unemployment in the city, the existence of municipal solid waste management strategy in shashemene city, existence of good political will to improve the management of municipal solid wastes in shashemene city, and the existence of governmental and non-governmental organizations supporting municipal solid waste management in shashemene city were affirmed as the existing opportunities of municipal solid waste

management in Shashemene city.

Scholars of sustainable municipal solid waste management affirm that weaknesses in Solid Waste Management (SWM) in most urban centers in the least developed countries have over the years been attributed to financial and administrative capacity constraints of municipalities [9,16,76–80]. Lack of awareness of the benefits of sustainable management of municipal solid waste is asserted as one of the pressing challenges of municipal solid waste management in least-developed countries [11,16,55,59,61,75]. [3], and [75] attest that the main challenges to the effective management of solid waste in our contemporary world are the increasing volumes of waste underpinned by the faster rate of generation and the high cost of waste management. Lack of proper planning for waste management services is also affirmed as one of the pressing challenges [3,81–85]. Lack of policy enforcement, weak capacity, public awareness, and minimal cooperation among stakeholders was also attested as the main challenges of municipal solid waste management in least-developed countries [1,4,8,13,17,58,75,81,85].

[15,86] affirm that the willingness of residents in urban areas to pay for municipal solid waste management services is one of the opportunities for promoting sustainable municipal solid waste management in least-developed countries. Similar to the aforementioned attestation, residents of Shashemene town also showed a willingness to pay for municipal solid waste management in their city. Generally, addressing the multifaceted challenges of municipal solid waste management in Shashemene City, and capitalizing on the existing opportunities at local, regional, national, and international levels for the same will certainly make Shashemene City livable in the years to come.

5.3. *Towards integrated and sustainable municipal solid waste management system*

Integrated Solid Waste Management (ISWM) is affirmed to typically involve waste reduction, recycling, recovery, treatment, and disposal of waste to achieve operational efficiency, enhance community well-being, and mitigate environmental risk [10,18,64].

According to Ref. [3], integrated solid waste management (ISWM) is a complete waste production, collection, composting recycling, and disposal system. An efficient ISWM system is attested to consider how to reduce, reuse, recycle, and manage waste to protect human health and the natural environment. Moreover, it is affirmed to involve evaluating local conditions and needs thereby choosing, mixing, and applying the most suitable solid waste management activities according to the condition [2,3,76,78,87,88]. [53] attest that economic instruments (EIs), regulatory instruments (RIs), and suasive instruments (SIs) must be employed simultaneously to efficiently and effectively manage municipal solid waste management in developing countries.

Cities and towns in Ethiopia are expected to start realistic, integrated, and sustainable management of municipal solid wastes [1]. attests that waste segregation bins with at least three different colors (green for biodegradable, yellow for non-biodegradable mixed wastes, and red for recyclable wastes) must be provided for every household with different colors that can be easily understood. This is particularly relevant for urban households in Shashemene City. Interestingly, he recommended realistic actions between 2021, and 2035 with feasible action plans for Ethiopian cities, and towns to enable them to adopt the integrated sustainable municipal solid waste management system. In our case, we assert that Shashemene City must become a livable city in 2030 which is the final year to achieve the new goals of sustainable development for the urban development sector. Accordingly, we dare to assert that the integrated and sustainable solid waste management system underpinned by the municipal solid waste management hierarchy of waste reduction, maximum recycling, aerobic composting, waste-to-energy, modern landfill recovering and using CH₄, modern landfill recovering and flaring CH₄, landfills that do not capture CH₄, and unsanitary landfills and open burning is vital to address the pressing challenge of municipal solid waste management in Shshashemene city.

6. Conclusions and recommendations

94.8 % of the respondents opined that the solid waste generated in their town is organic (Ash, and sweeps; leftover food, and vegetable peels; paper, and cardboard; green leaves, and grass; and cattle dung). 96.7 % of respondent households opined that they have temporary waste storage in their yards and trash bags were asserted to be widely used (87.6 %) in handling the trash in the courtyard. The waste sorting and recovery practices among the residents are very low and are certainly the major cause of the inefficient and unsustainable management system of municipal solid waste in Shashemene City. A grand mean of 2.23 confirmed the governance failure in municipal solid waste management in Shashemene city.

Wrong perceptions of stakeholders about the responsibility of solid waste management, weak municipality's waste collection capacity, absence of a market for wasted materials, urban residents' poor culture of reusing and recycling wastes, and poor governance of municipal solid waste management system were confirmed as the existing challenges of municipal solid waste management in Shashemene city. Public willingness to pay for the service, existence of traditional waste recycling practices, high rate of unemployment in the city, availability of characteristically high organic solid wastes in the city, existence of municipal solid waste management strategy in hashemite city, existence of good political will to improve management of municipal solid wastes in shashemene city, and existence of governmental and non-governmental organizations supporting municipal solid waste management in shashemene city were affirmed as the existing opportunities of municipal solid waste management in Shashemene city.

Based on the findings of the study the following recommendations are forwarded for an integrated and sustainable management system of municipal solid waste in Shashemene City in the years to come:

- The existing waste management policies and strategies should be revisited, and realistically enforced to make the city livable for citizens;
- Good governance should be practiced to address governance-related challenges of municipal solid waste management in the city;

- Advocacy and engagement should be promoted since integrated sustainable municipal solid waste management is the responsibility of all stakeholders at different levels;
- Stakeholders' Partnership must be strengthened since different types of resources are required for promoting integrated, and sustainable municipal solid waste management;
- Institutional capacity should be built and strengthened since integrated, and sustainable municipal solid waste management is underpinned by effective, and efficient institutions responsible for planning, implementing, and coordinating solid waste management services in the city;
- Microenterprises should be established, and engaged in waste management to address simultaneously the economic, and environmental issues of the city; Training must be organized for different microenterprises to enable them to participate in sustainable municipal solid waste strategies like waste reduction, recycling, and composting;
- Environmental education should be given regularly to residents of the city to make them aware of the negative effects of poor municipal solid waste management in the city;
- Community participation and empowerment in municipal solid waste management initiatives should be improved to raise awareness through socialization, public campaigns, and education;
- Waste segregation bins with at least three different colors (green for biodegradable, yellow for non-biodegradable mixed wastes, and red for recyclable wastes) should be provided to urban households to let them segregate wastes at the source to be managed similarly at different streets, and central containers in the sub-cities;
- The Municipal solid waste management services should be improved in the city since this underpins the motivation, and cooperation of residents, and other stakeholders to participate in all activities of integrated, and sustainable management of municipal solid waste management in the city;
- Corporate Social Responsibility programs for private companies should be utilized to address the financial constraints in municipal solid waste management practices;
- Regulations on service charges should be standardized, and an average figure that takes into account the income of the majority should be set for municipal solid waste management services;
- Sustainable landfill strategies should be practiced in only areas mapped by geographic information system technologies;
- Economic instruments (EIs), regulatory instruments (RIs), and suasive instruments (SIs) must be employed simultaneously to efficiently and effectively manage municipal solid waste management in Shashemene City; and
- Monitoring, evaluation, and research on municipal solid waste management should be introduced and strengthened to sustainably address the emerging challenges in the city.

Data availability statement

Data associated with our study had not been deposited into a publicly available repository, and data will be made available on request.

CRediT authorship contribution statement

Senbet Elmo Derdera: Writing – original draft, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Gemechu Shale Ogato:** Writing – review & editing, Supervision, Software, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

We would like to express our sincere gratitude to all those who took part and unreservedly contributed to the success of this research. We also sincerely thank residents and all other stakeholders who faithfully provided the primary and secondary data for the study. Our special thanks also go to anonymous reviewers and editors of this journal for their efficient and effective management of the review and publication process of this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e21865>.

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