Financial, Institutional, Environmental, Technical, and Social Evaluation of Waste Management in Tamale Metropolis

Commented [BGZ1]: Assessing the Sustainability of Waste Management Practices in Tamale Metropolis: A Comprehensive Financial, Institutional, Environmental, Technical and Social Factors.

Abstract

The safe and productive use of solid and liquid waste implied in Tamale Metropolis was deemed necessary following the discriminatory use of this waste in urban and peri-urban as a result of the soaring price of inorganic fertilizer which was not affordable to farmers, especially in the peri-urban communities. Collaboration with farmers, opinion leaders, government institutions (EPA, District Assemblies, MoFA, and MoH), compost factories, NGOs, Public toilet operators, etc. A questionnaire checklist on thematic areas and expected interviews were conducted. Collaboration of these stakeholders in sanitation has been constrained to water or treated or untreated wastewater and organic waste (including human/animal excreta) in small-scale agricultural production. The objective of using FIETS in monitoring is to determine the financial, technical, and institutional capabilities, and social acceptance of producers, users, and institutions concerned with the management of waste in the Metropolis. Geographical Positioning System (GPS) was used to take locations of waste collection points (public toilets markets), disposal sites, and compost preparation sites. The contributions of the institutions concerning financial, institutional capacity, environmental awareness, technical capability, and social acceptance were ranked from 5-highest to 1-lowest and presented in web diagrams and interpreted. Focus Group Discussion (FGD) and Household questionnaire administration. The result of the monitoring indicates that institutions of the transformation that UPA, water, and sanitation will undergo, thus helping to influence policy or by-laws of the Metropolis. Successful management of biodegradable waste requires collaboration across various sectors. By working together, governments, businesses, educational institutions, NGOs, and individuals can create a sustainable waste management system that benefits the environment and reduces landfill use.

Commented [BGZ2]: Provide five Keywords.

1. Introduction

There is increasing recognition of the complexity underlying WASH conditions in developing countries. This paper explores the complexity by assessing the vulnerability of poor WASH conditions using a qualitative approach in Tamale Metropolis. Financial, institutional, environmental, technical, and social (FIETS) tool was used to evaluate groups or organizations in waste management. It involves resources in the understanding and skills in waste management, fostering a holistic approach to various facets of a project or initiative. Disposal methods, such as open dumping or incineration, that result in air, soil, and water pollution were considered. Also waste management practices, such as recycling and composting, mitigate these environmental impacts by reducing the volume of waste and minimizing pollution.

The government of Ghana has played a crucial role in promoting sustainable waste management through its policies and regulations with international cooperation being very essential. Ghana is a member in signing global agreements and partnerships to drive progress towards sustainable waste management practices. Public education and awareness campaigns of the public about the importance of waste reduction, recycling, and proper disposal are critical enough to have been intensive in Northern Ghana but have not resulted in good outcomes of achieving sustainable waste management. The sustainability of waste management achieved by reducing waste generation, maximizing recycling and resource recovery, minimizing environmental impact, ensuring social equity, and promoting economic viability is effectively measured using the FIEST tool.

Transportation plays a crucial role in waste management, influencing costs, efficiency, and environmental sustainability. Technological advancements impact waste management by enabling more efficient sorting, recycling, and disposal methods and innovations such as smart sensors, data analytics, and automation enhance waste collection routes, optimize resource utilization, and reduce environmental impact. Urban farming takes advantage of its proximity to market, transport, and other urban infrastructure to provide food for the city and sustain the livelihoods of urban and peri-urban dwellers. It employs more than 60% of the local urban population. It is an informal activity not supported by law but in practice is regulated to a certain extent by state institutions, traditional rulers, farmers, and national and international non-governmental organisations.

For decades due to the high cost of inorganic fertilizers peri-unban farmers in Tamale Metropolis, faecal sludge (FS), and other biodegradable waste for urban agriculture were not composted, which posed health hazards and environmental inconvenience. Recycled waste for urban agriculture not only improves household food and income security but also helps to improve sanitation in the cities (Rhyner, et al., 2017). Tamale Metropolis and other districts in Northern Ghana that are fast-growing are faced with daunting challenges of both liquid and solid waste with environmental challenges. Rapid population growth, exacerbated by the unplanned development system and institutional conflicts, are factors contributing to

bottlenecks in urban agriculture and agriculture in general in Tamale. Differences in stakeholders' waste management institutions remain resolved through the interactions of various governance systems.

Waste generation in Tamale Metropolis increases from 150 tonnes a day in 2006 to 810 tonnes in 2010 (TaMA, 2010). About 810 tonnes (of between 20-50% by weight) of waste is generated daily in the Metropolis and only 216 tonnes are hauled, a backlog of 594 tonnes uncollected. Faecal sludge, municipal biodegradable waste, agricultural waste and agro-industries.

Faecal sludge (FS), agricultural by-products (e.g. Shea butter slurry), municipal waste, and agricultural waste are the major waste management concerns in the metropolis/districts. In the absence and high cost of fertilizers, farmers apply fresh untreated forms of this waste on their farms (Rhyner, et al., 2017). In the event of unexpected rains, the applied wastes are either washed into streams or residential areas thus raising environmental concerns. This poses a major concern to environmentalists, institutions, and communities and where the waste is applied. Major challenges in the reuse of urban waste drying and sorting the waste that reduces the negative perception by the public and authorities in the use of waste for agriculture, and an appropriate technology for co-composting waste that is safe and environmentally friendly.

Governments implement laws encouraging or mandating the separation of biodegradable waste from non-biodegradable waste, providing composting guidelines, and providing incentives for recycling (Wei, et al. (2017). Separating biodegradable waste from non-biodegradable items improves recycling rates and reduces landfill waste (Velvizhi, et. al., 2020; Bharadwaj, Yadav, & Varshney, 2015).

The Metropolitan, Municipalities, and Districts Assemblies provide waste management infrastructure for waste collection, dumping sites, and training in processing biodegradable waste into composting. They educate citizens on the benefits of waste reuse and segregating biodegradable waste and the importance of composting. The Assemblies are then in charge of introducing separate bins for biodegradable waste and arranging regular pickups. They ensure that households and businesses comply with waste segregation practices through regular checks and penalties for non-compliance.

Successful management of biodegradable waste requires collaboration across various sectors. By working together, governments, businesses, educational institutions, NGOs, and individuals can create a sustainable waste management system that benefits the environment and reduces landfill use.

There is therefore the need to evaluate the interconnected root causes resulting in poor water and sanitation conditions and the impact strategies used by institutions to address various aspects of waste generation, disposal, and environmental impact. The objectives of the study are to evaluate the Dutch-WASH FIETS Tool in communities and to foster a culture of hygiene essential to WASH practices that have become an integral part of the daily life of the people these include:

- Productive and hygienic use of biodegradable organic waste
- The importance of clean water, proper sanitation, and good hygiene practices.

- The behaviours that prevent the spread of diseases, such as handwashing and safe food preparation.
- Use of improved infrastructure (toilets, dry-beds etc.), training and access to clean water and sanitation facilities.

2. Instituting FIEST Tool

The financial impact of waste management is significant for both public and non-public institutions to effectively manage waste involves costs associated with collection, transportation, treatment, and disposal. These costs vary depending on the waste type, the methods used for disposal, and the efficiency of the systems in place (Alzamora, and Barros, 2020: Jouhara, et al., 2017).

Waste management has both direct and indirect financial impacts, it requires substantial investment and operational costs. Effective waste management provides economic benefits through resource recovery and environmental protection. Financial concepts diminish dependency on external subsidies, based on the principle of "local finance first", which has led to the strengthening of "in-country" structural finance. Strategies such as business approaches & private sector involvement, innovative financing, mobilize government budgets;

Institutional impact on waste management is how institutions, including businesses, and entities, influence the management and regulate waste. These institutions play a critical role in shaping waste management practices, policies, and outcomes. They have a profound impact on waste management by shaping policies, funding infrastructure, advancing technology, educating the public, enforcing regulations, and promoting collaboration among stakeholders (Rodić, and Wilson, 2017: Serge, and Simatele, 2020). Effective institutional involvement is crucial for developing and maintaining sustainable waste management systems. Ensure systems that ensure institutions, policies, and procedures at the local and national level are functional to meet the (long-term) demand of users of water and sanitation services. Integrating WASH policies with Civil Society Organisations (CSOs) in close collaboration with local stakeholders working as capacity builders, and facilitators.

Environmental impact on waste management is the influence of environmental factors on the methods, effectiveness, and challenges of managing waste. Environmental conditions and concerns play a crucial role in shaping waste management practices. The environment has a significant impact on waste management by influencing the methods used, the effectiveness of waste processing, and the challenges faced in managing waste (McAllister, 2015; Guerrero, et al., 2013). Environmental factors must be carefully considered in the planning and operation of waste management systems to ensure sustainable, effective, and minimize harm to the natural environment that will ensure the long-term availability of natural resources and a healthy environment.

Technological sustainability is achieved by applying locally appropriate technologies, which are context-specific, affordable, and demand-driven. The technological impact on waste management is profound, as advancements in technology have significantly improved the efficiency, sustainability, and effectiveness of waste management practices. Technology has a transformative impact on waste management, making processes more efficient, sustainable,

and environmentally friendly. From waste collection to recycling, energy recovery, and pollution control, technological advancements continue to improve how waste is managed, helping to reduce environmental impact and promote a circular economy.

Social sustainability is based on demand-driven and needs-based interventions sensitive to local and cultural incentives and focuses specifically on women as change agents. The sustainability of waste management refers to practices and strategies that minimize the environmental, social, and economic impacts of waste (Ahluwalia and Patel, 2018). Sustainable waste management seeks to reduce the amount of waste generated, maximize resource recovery, and minimize the harmful effects of waste on the environment and human health. Sustainability of waste management is achieved by reducing waste generation, maximizing recycling and resource recovery, minimizing environmental impact, ensuring social equity, and promoting economic viability (Ludwig, et al., 2012). By integrating these principles, waste management systems can contribute to a healthier environment, stronger communities, and a more sustainable future (Rhyner, et al., 2017).

Recycled waste in cities for agriculture not only improves agriculture and household security but also helps to improve sanitation in the cities. For decades due to the high cost of inorganic fertilizers peri-unban farmers in Tamale used faecal sludge (FS), and a very limited amount of agricultural and urban waste. These materials are not decomposed before application to the field posing health hazards and environmental inconvenience.

2.1 Sources of Municipal Biodegradable Waste

Municipal biodegradable waste in Tamale Metropolis may be categorised into faecal (solid and liquid), agro-industrial, municipal (household and market), and agricultural wastes.

Faecal Sludge (FS): Faecal sludge is applied fresh from public toilets by either spreading, in pits, or dried without treatment in farms in most communities (Hassall, et al., 2011). The dried FS is then redistributed in the field. However, in the event of unexpected rains, the applied wastes are washed into streams and residential thus raising environmental concerns. The practice of applying fresh urban waste to farmlands is a major concern not only to environmentalists and institutions but also to members of the communities in the neighbourhood. The challenges in the use of municipal waste include drying and sorting waste and reducing the negative perception by the public of the use of municipal waste for agriculture. Appropriate technology for co-composting FS and other municipal biodegradables has been developed for farmers and some farmers are trained in the application of the technology. Faecal sludge is a rich source of organic matter and plant nutrients such as nitrogen, phosphorus, and potassium. The application of co-compost needs to be monitored and the innovations developed with the FIETS tool.

Communities in Northern Ghana have experienced rapid increases in population, spatial expansion, and economic activity. In addition, to many developmental challenges, related to water and land, this situation has brought about an unprecedented amount of waste generation. In Tamale and other metropolitan and urban centers in Ghana, the use of organic solid waste has a long history. In the Tamale metropolis, there are about 115 public toilets scattered across

communities (Figure 1). 80% of the population depends on public toilets or other illegal modes of toilets. The type of facilities across the metropolis range from Aqua Privy, Water Closets, Kumasi Ventilated Improved Pit (KVIP), and Ventilated Improved Pit (VIP). Thus faecal sludge waste generation has increased from 150 tonnes a day in 2006 to currently over 810 tonnes.

Municipal waste: Generally, the increase in waste in Metropolitan/Municipal areas from households and market areas (Hassall, et al., 2011) is due to the inadequate supply of skips, and irregular collection of waste. The use of the Integrated Solid Waste Management (ISWM) Model, proper management of the landfill, and adequate sourcing of the waste management institutions have reduced the municipal waste menace in the metropolis (Issahaku, Nyame, and Brimah, 2014).

Residents of the Tamale Metropolis receive waste management services from the Metropolitan Waste Management Department which works in partnership with Zoomlion Ghana Limited, a private waste management company in Ghana. Before the privatization of waste management in 2006, the Metropolitan Waste Management Department was the sole body responsible for waste in the metropolis.

Open burning of municipal waste is common (76%) of solid waste management for those who treated their waste in Tamale. This could be due to easy access to land where households can openly dump their waste and burn it in their backyard. Few others (24%) buried their waste in their backyard.

The presence of private waste management and waste management equipment in Tamale Metropolis has brought improved waste management services to about 70% (Adongo, et. al., 2015). This has brought about improved cleaning of the principal streets, lorry parks, dredging of gutters, door-to-door services, provision of dust bins in public places, and addition of more community containers with frequent collection in Tamale. Municipal Solid Waste in Tamale at present is managed through the communal container system, door-to-door collection services, street litter bin system, and community dumps.

Household size is an important tool to predict the generation rate of municipal waste in the municipality, in addition to other social and economic parameters. Based on the findings, there is regular supervision and monitoring of municipal waste collection by sanitation institutions (Issahaku, Nyame, and Brimah, 2014)

Agro-industrial waste: Large quantities of the shea butter slurry are generated daily in the Tamale metropolis and its peri-urban communities because of the demand for the shea butter by the pharmaceutical and cosmetics industries (locally and internationally) (Hassall, et al., 2011). There are about forty-five (45) small-scale shea-butter processing centers and about 10 large-scale factories in Tamale Metropolis, Tolon, Kumbungu, and Savelugu Districts, generating about 820.2m^3 of the slurry every month.

The proliferation of commercial and light industrial activities within the residential areas is another environmental problem facing the township. Therefore, if the situation is left

unchecked it can result in the outbreak of communicable diseases such as cholera, and typhoid and this will affect people exposed to these unsanitary conditions. Based on this, the business model is being developed to help remedy the problem enumerated above of TaMA in the Northern Region.

Facilities managed by private individuals are in better condition in terms of sanitation and infrastructure than the ones owned and managed by the government. The poor management of the government facilities is attributed to political interference.

Agricultural Waste: Agricultural wastes are non-product outputs of the production and processing of agricultural products that may contain material that can benefit man but whose economic values are less than the cost of collection, transportation, and processing for beneficial use. Estimates of agricultural waste arising are rare, but they are generally thought of as contributing a significant proportion of the total waste matter in communities. Agricultural development is usually accompanied by wastes from the irrational application of intensive farming methods and the abuse of chemicals used in cultivation, remarkably affecting rural environments in particular and the global environment in general (Hassall, et al., 2011).

However, the management of agricultural waste is not adequately met in Tamale hence the need to ensure the treatment of this waste at the local by composting to ensure that all pathogens in the waste are destroyed. This will reduce the pollution levels in the streams (Duque-Acevedo et. al, 2020).

There is an increasing concern about the environmental effect of the disposal of agricultural waste on land. The land is the main area of agricultural waste disposal and remains the best approach in many areas in Ghana as well as in many countries (Obi, et. al., 2016). Agricultural waste discharge is required to meet water quality criteria established by the public institutions in Ghana. Traditionally, some crop residues have been used as domestic fuel, animal fodder, roof thatching, soil mulching are very insignificant, (Hassall, et al., 2011; Duque-Acevedo et. al, 2020) the rest are burnt or washed into streams/rivers. The limited and/or improper management of the same has created an urgent need to devise strategies for their timely utilization and valorisation, for agricultural sustainability and human food and health security.

The safe and productive use of solid and liquid waste implies using rainwater or treated or untreated wastewater and organic waste (including human/animal excreta) in small-scale agricultural production. The purpose is to enhance resilient urban development by creating synergies between sectors, stimulating short cycles (of water and nutrients) and adding value in the sanitation chain, securing household consumption and improving nutrition, and facilitating changes in perception and policies to further stimulate this paradigm change.

The focus of the study is on the issue of safe and productive use of water, including household grey wastewater, and organic wastes, including human excreta in urban and peri-urban agriculture (UPA). Traditional reuse methods for faecal sludge are very common in the peri-urban areas of the Tamale Metropolis. Wastewater is being used by various urban farmers in the city, farming around the central drain as well as dams and wells. With the growth of the city, the importance of managing municipal solid wastes to avoid environmental degradation

and public health risks has gained in significance, especially where population density is high. Although informal recycling activities for waste materials are widespread, the treatment and use of biodegradable organic fractions are still very limited.

A survey revealed two large commercial rice mills operating in Tamale, because of the considerable rice production in Northern Ghana, with the resulting abundance of rice straw and husk. The nutrient contents of both products are similar. However, rice straw has faster decomposition (3 months), compared to the husk (over 5 months). At present, in the study area, these materials are either left in the fields for animals to feed on or burnt during the dry season.

Composting products would be further used to improve the fertility and productivity **of** the soils for increased food production. Business opportunities for small-scale entrepreneurs in composting are also exciting since the raw materials are readily available and the demand for finished products is high.

The impacts of integrated planning, efficiency improvement, data analysis, and environmental impact assessment of institutions in waste management in Tamale Metropolis using the FIETS tool, for integrated environmental and waste management planning, in addressing waste management. FIETS was introduced by the Dutch WASH Alliance as a tool to evaluate or monitor the sustainability of their WASH programs. FIETS is used to evaluate the below sustainability framework in Tamale Metropolis.

Social acceptance in the use of co-compost especially with faecal sludge as a component is has been observed by commercial co-composters (Small DeCOs) as financially beneficial environmental acceptance. The acceptability of co-compost by farmers to the use of waste for crop production sets a breakthrough for the use of waste as a business in municipalities. Institutional collaboration with waste disposal agencies is very vital to the access and use of waste in UPA. The policy forum in Tamale has helped to address accessibility to municipal waste without hindrance, hence the safe use of UPA. Survey results were further discussed regarding the availability of co-composting sources in the selected districts and their potential as organic fertilisers.

3. Methodology

The study was carried out in the Tamale Metropolis and Sangnarigu District, where many public and private institutions including non-governmental organisations are engaged in waste management and reuse. These institutions are also responsible for environmental sanity and waste disposal in the districts. In the districts are the Environmental Protection Agency (EPA) and Tamale Metropolitan Assembly (TaMA), ZOOMLION, CLIP, SIMLI AID, WUZDA, DeCO, and URBANET, concerned with the safety reuse of waste for agriculture.

Geographical Positioning System (GPS) was used to take locations of waste collection points public toilets (Figure 1), disposal sites, and compost preparation sites. The contributions of the institutions concerning financial, institutional capacity, environmental awareness, technical capability, and social acceptance were ranked from 5-highest to 1-lowest and presented in web diagrams and interpreted. Focus Group Discussion (FGD) and Household questionnaire administration

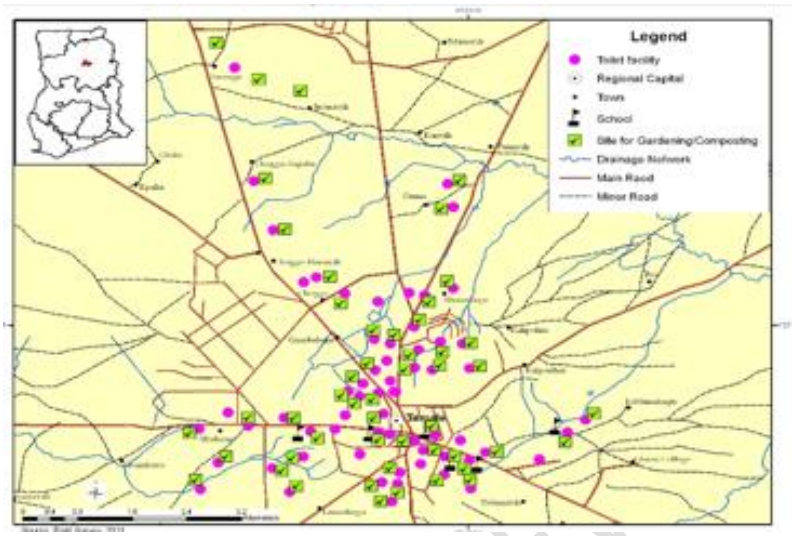

Figure 1: Map of Tamale Metropolitan Assembly and Sangnarigu District
(Source: Raymond T, 2018)

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4. Results and Discussions

The financial, institutional, environmental, technological, and sustainable impact on waste management is significant for both public and non-public institutions to manage municipal waste effectively involving costs associated with collection, transportation, treatment, and disposal. Biodegradable municipal waste in a municipality not only improves urban agricultural yields but also improves sanitation in areas.

In the Tamale Metropolis, vegetable and cereal farmers have used untreated solid and liquid waste for agriculture, affecting most water bodies through surface runoff. Faecal sludge is the fertilizer source and is increasing for cereal crop production. The annual increasing price and most of the times difficult source of fertilizer Liquid waste from septic tanks is used in watering vegetables especially getting to the end of rains which start from late October. We used to apply without composting but co-compost has an added technical advantage to what we already know. The realisation of Institutions that waste for agriculture helps in cleaning the environment and improves crop production has enabled us to get waste-free now without intimidation. Added advantage two to three times cropping before co-compost is applied

SIMLI AID, WUZDA, URBANET, and CLIP are non-governmental organisations affiliated with Dutch-WASH benefits some funding to undergo Dutch-WASH programs involves costs associated with collection, transportation, treatment, and disposal are constraints in the disposal and monitoring of municipal waste as such their presence in the study communities were involvement of farmers with appropriate technologies (drying beds, sorting and co-composting) reduces the financial constraints on the limited budget and resources of public institutions.

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Table 1: FIEST INSTITUTIONAL RANKING

	URBANET	CLIP	MoFA	EPA	Zoom-Lion	WUZDA	SIMLI AID	DeCO
Financial	4.8	4.7	1.7	1.4	5.0	3.3	4.5	4.7
Institutional	1.3	3.5	2.3	1.3	2.0	2.3	1.3	3.6
Environmental	3.8	3.4	3.3	2.3	4.0	4.0	4.5	2.0
Technical	2.3	2.5	3.2	4.7	2.3	2.7	3.7	3.7
Social	4.7	4.3	2.0	2.7	2.0	3.7	3.0	2.0

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FIETS analysis also shows that social acceptance of co-compost from waste has resulted in high yields of crops (vegetables and cereals) and hence promising businesses in the waste chain especially in co-compost production and also the abundant availability of the raw material for co-composting. Due to the use of wastewater and not composted soil amendment for vegetable production, consumers and buyers were convinced of the vegetables produced. This resulted in high financial loss and serious environmental effects because the positive change in perception of waste use has improved the financial outcome of vegetable products. Institutional arrangement (MoFA and EPA) was not very good but recent policy recommendations have improved institutional relations leading to better collaboration in waste management in the Tamale Metropolis.

4.1 URBANET and CLIP

The use of faecal sludge and municipal waste in the URBANET and CLIP communities' project areas is frequent. It was therefore necessary to construct drying beds for the faecal sludge which form the base of co-compost. The social acceptance of faecal sludge in these communities is high and therefore needed technical knowledge in the designing, construction and composting training. The provision of faecal sludge dryers improved the method of drying and has a positive effect on the environment, social acceptance, and financial status in the ranking (Figures 1 and 2).

FIETS interviews indicate that social acceptance of manure from waste (faecal sludge) is high about 85% of farmers in vegetables and cereals cultivation. This was also observed in the business operation in the waste chain especially in co-compost and the also the abundant available of the raw material for co-composting.URBANET and CLIP works in over 20 communities basically on agriculture practices, and water and sanitation.

It is observed from the study that funding for their activities in the communities is not a challenge due to Dutch-WASH support as a result financial ranking was high 4.8 and 4.7 respectively. Social rankings were also high due to the acceptance of the innovation introduced because they were already familiar with them. This was measured in terms of willingness to participate in communal works during WASH programs.

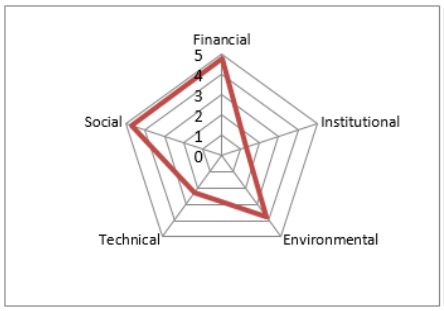

Figure 1: URBANET WEB

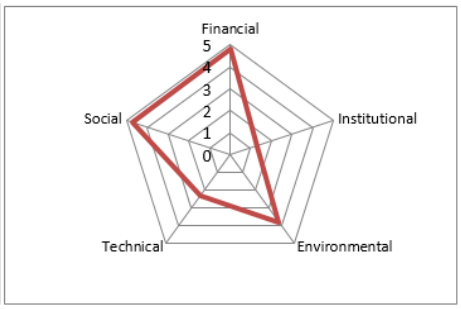

Figure 2: CLIP WEB

Environmental ranking in the two communities was observed to be an average (3.8 and 3.4 respectively). The environment was generally found to be clean of biodegradable materials because of the restriction of open defecation with only scattered used polythene bags. Institutional collaboration was observed to be poor which led to low institutional and technological rankings.

Plate 1: Mixing Composting Materials

Plate 2: Farmers in Training

Plate 3: Maturing Co-compost

4.2 Ministry of Food and Agriculture and Environmental Protection Agency

Ministry of Food and Agriculture (MoFA) and Environmental Protection Agency (EPA) public institutions (Figures 3 and 4) whose source of funds is from Ghana Government budgetary allocation which is very inadequate. While MoFA is responsible for food and agriculture in the communities, EPA communities are not effectively monitored. Inclusion of public schools with their curriculum integrated to include lessons on waste management and composting as part of their science and environmental studies. Setting up compost bins in schools for cafeteria waste and the compost used for school gardens (Mpuangnan, Mhlongo, & Govender, 2023).

The lack of finances has serious environmental effects due to lack of monitoring and because a positive change in the perception of waste use has improved the financial outcome of vegetable products. However, with the recent policy recommendation, improved institutional relations now exist leading to better collaboration in waste management in the Tamale Metropolis.

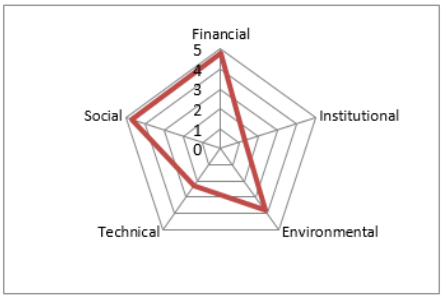

Figure 3: MoFA - WEB

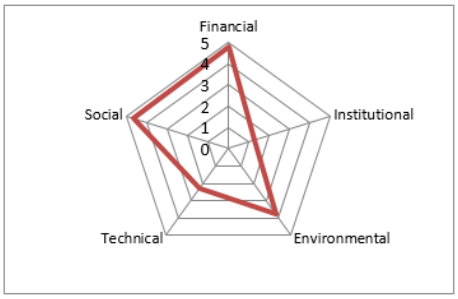

FIGURE 4: EPA - WEB

These institutions have no funding they depend on government subventions. These institutions are not also members of the Dutch-WASH consortium and hence have little collaboration with institutions in WASH. The institutions also have limited knowledge in converting waste into compost.

4.3 ZoomLion and DeCO

Zoomlion is a business waste management company into clears, cleans, and processing of waste in the Metropolitan center and peri-urban communities to the dumping site in Tamale at Gublahi. ZoomLion is financially and environmentally ranked high even though it did not operate in the selected communities. The social ranking was however high even though it did not operate in the communities officially because these communities depend on biodegradable waste for their farming operation. The low ranking in institutional and technical especially in the reuse of waste in the communities (Figure 5).

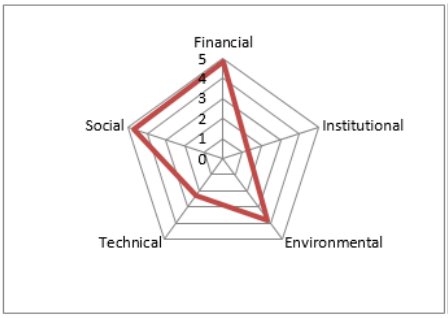

Figure 5: ZoomLion - WEB

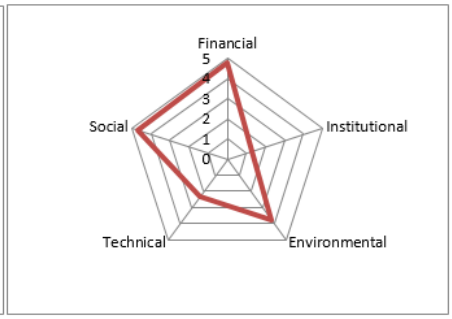

Figure 6: DeCO - WEB

DeCO is a business company in the manufacture and distribution of soil amendments to farmers in Northern Ghana to augment the unreliable supply, costly and distribution of inorganic

fertilizers to farmers, have relatively high ranking in the technicalities in wastes also a business institution, transforms biodegradable waste to compost for farmers to purchase. The high financial status of these institutions has not resulted direct impact in the technological, environmental, and social in its operational communities (Figure 6). DeCO is a member of Dutch-WASH consortium and has close collaboration with institution in the consortium.

4.4 WUZDA and Simli Aid

WUZDA and Simli Aid are non-governmental and members Dutch-WASH consortium in Tamale They access some funding from Dutch-WASH. The major activities in their command communities are reducing open-defecation by providing toilet household facilities (Ecosan Toilets) and environmental water and sanitation.

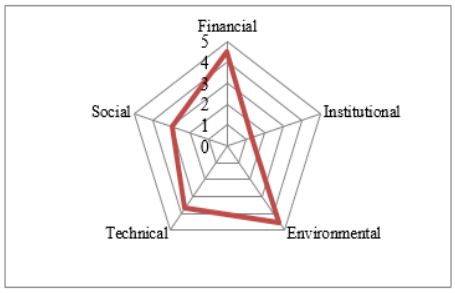

Figure 7: WUZDA WEB

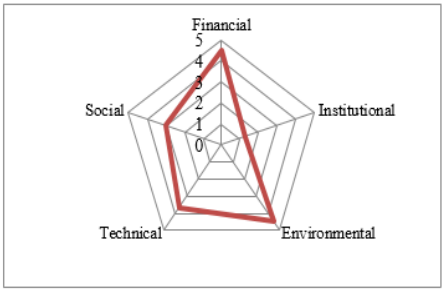

Figure 8: Simli Aid WEB

Financial support from Dutch-WASH had impacted progressively the monitoring activities of WUZDA and Simli Aid in their activities. However, with the recent policy recommendation, improved institutional relations now exist leading to better collaboration in waste management in the Tamale Metropolis.

Drying of faecal sludge used to be done by public toilet keepers apart from the illegal dumping in farmers' fields. The provision of faecal sludge dryers has improved the method of drying have has a positive effect on the environment, social acceptance, and financial status of dryers.

Conclusion

It may be concluded from the above study that collaboration among stakeholders in water and sanitation high rankings in the financial, institutional, environmental, technical, and social (FIETS) will be achieved and more sustainable. With appropriate technology, municipal waste can easily be transformed into a co-compost which will not only serve as a waste management system but also improving agricultural production.

The collaboration between institutions, public education, and training of waste water vegetable farmers and buyers improved the public's negative perception of agricultural produce from waste.

The idea of using waste (water and biodegradable) for crop production in urban communities, especially home gardens is a better alternative and less costly inorganic fertilizers commonly use. The use of wastewater for crop production especially vegetables is good but institutions

should endevour to appropriately develop wastewater filter beds to reduce the level of toxicity in wastewater for irrigation. Smart Waste Management Systems may be used to monitor waste levels, optimize collection routes, and improve recycling efficiency. Universities and research institutions can also innovate methods for converting biodegradable waste into compost. This will improve the quality of vegetable produced with wastewater and the quality of runoff after irrigation in urban areas.

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