PRINT ISSN 1119-8362
Electronic ISSN 2659-1499

Full-text Available Online at
https://www.ajol.info/index.php/jasem
https://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 28 (8) 2359-2365 August 2024

Evaluation of Cost-Benefit Valuation of Solid Waste Minimization at Vingunguti in Dar es Salaam City, Tanzania

***[1]MAPUNDA, AS; [1]KIMWAGA, RJ; [2]KASSUWI, SA**

**[1]Department of Water Resources Engineering, P. O. Box 35131 Dar es Salaam, Tanzania*
[2]Department of Molecular Biology and Biotechnology, P. O. Box 35179 Dar es Salaam, Tanzania

*Corresponding Author Email: abdonmapunda@gmail.com; *mapunda2000@yahoo.com*
**ORCID ID: https://orcid.org/0009-0006-2725-3456*
**Tel: +255715464941*

Co-Authors Email: *rkimwaga2007@yahoo.com; kasshaab@gmail.com*

ABSTRACT: An increasing rate of urbanization and unprecedented rising human population growth challenges solid waste management. In developing countries, such challenges are exacerbated by the presence of inefficient infrastructure. Hence, the objective of this paper was to evaluate the cost-benefit valuation of solid waste minimization at Vingunguti ward in Dar es Salaam City, Tanzania, using appropriate standard methods of data collection involving documentary review and focused group discussion. The type of data for cost-benefit valuation on solid waste minimization at source (household) excluded transfer stations and landfill costs and benefits. Analysis of cash outflow and inflow of private sector engagement on solid waste minimization at the household level delivered positive net present value. Such results can only be realized if and only if the monthly refuse charge per household is paid as required, which happen rarely. Sensitivity analysis at a rate of 8±2 delivered positive net present value in both scenarios. The findings signal refuse charges policy reviews, hence removing solid waste piling in the streets of Dar es Salaam City, Tanzania.

DOI: https://dx.doi.org/10.4314/jasem.v28i8.12

Cite this Article as: MAPUNDA, A. S; KIMWAGA, R. J; KASSUWI, S. A (2024). Evaluation of Cost-Benefit Valuation of Solid Waste Minimization at Vingunguti in Dar es Salaam City, Tanzania. *J. Appl. Sci. Environ. Manage.* 28 (8) 2359-2365

Dates: Received: 04 June 2024; Revised: 27 June 2024; Accepted: 11 July 2024 Published: 05 August 2024

Keywords: Cost-benefit analysis; Household waste management; Solid waste minimization

Globally, about 2.01 billion tons of waste are generated daily (Barua and Hossain, 2021; Maalouf *et al*., 2020; Maalouf and Mavropoulos, 2023; Noor *et al*., 2020; K. D. Sharma and Jain, 2020). These unintended by-products of most processes and activities in human livelihood are projected to reach 3.80 billion tons, with a large contribution from developing countries by 2050 (Chen *et al*., 2020; Popp, 2020). Studies show that per day per capita waste generation in high-income countries is 19%, far below 40% in low- and middle-income countries (Mir *et al*., 2021). Unprecedented exponential human population growth, rapid urbanization, rising cultural diversity, unique urban feeding habits, and changing lifestyles are driving factors for the rising quantities of municipal solid wastes in developing countries, including Tanzania. While the average rate of solid waste generation is 0.47 kg/capita/day (Aryampa *et al*., 2019) across East Africa Community countries, the region's low-income earners generate 0.26 kg/capita/day (Aryampa *et al*., 2019; Wang *et al*., 2021) compared to high-income earner generation capacity of 0.78 kg/capita/day (Aryampa *et al*., 2019; Nyampundu *et al*., 2020; Wang *et al*., 2021). Across all cities in the region, Dar es Salaam exceptionality is on the fact that, the city's rate of population growth

*Corresponding Author Email: abdonmapunda@gmail.com; *mapunda2000@yahoo.com*
**ORCID ID: https://orcid.org/0009-0006-2725-3456*
**Tel: +255715464941*

and rising income, greatly correlates with increasing solid waste generation (Aryampa *et al*., 2019). In developing countries context, in particular, sub-Saharan Africa including Tanzania, increasing municipal solid waste in the street is linked to unsorted solid waste at source, social/cultural taboos, citizen's attitudes, poor waste assessment, inadequate management strategies, unorganized informal sector on waste management, unplanned fiscal and poor implementation of government policies on waste management (Mapunda *et al*., 2023; Rebehy *et al*., 2023; Sotamenou *et al*., 2019). As such, greatly influences the costs of managing wastes along the system. According to (Association, 2024), the global direct cost of waste management is expected to be $640.3 billion in 2050 from $361 billion in 2020. Such huge financial figures can be decreased to about $108.5 billion annually through the adoption of the circular economy model (Adeleke *et al*., 2021; Association, 2024). In such an economic model, decoupling economic growth and waste generation favour waste avoidance, full waste management practices, and sustainable business practices (Adeleke *et al*., 2021; Chakraborty, 2023; Seah and Addo-Fordwuor, 2021). The effectiveness and efficiency of these practices require a mindset change on turning rubbish commercial resources (Brien, 2023; Levidow and Raman, 2019); hence subscribe to demand and supply principles (Brien, 2023; Herron *et al*., 2021). This value proposition approach is an urgent strategy in municipal solid waste management systems. Hence the article has proposed monetization of solid waste minimization at sources. In a large section of the global inhabitants, the costs or benefits of solid waste management systems are affected by the characteristics and nature of the waste stream (Abdel-Shafy and Mansour, 2018; Kaza *et al*., 2018; Kumar and Samadder, 2017; Muthuraman and Ramaswamy, 2019). Generally, the aforementioned factors that lead to increasing municipal solid wastes in the streets have strong impacts on institutional factors (i.e., laws and policies), social factors (i.e., population pyramid, residential, commercial, and industrial sectors), and financial factors (i.e., government revenues and user fees), economic factors (i.e., job creation and enhancement of public interest) (Iyamu *et al*., 2020). In the same vein, the MSWM system is linked to environmental factors (i.e., aesthetics and reduced level of pollution and contamination of soil, air, and water but also greenhouse gas emissions). Nonetheless, it is the same factors that constitute the benefits and costs of MSWM (Badgett and Milbrandt, 2021; Karaca and Tleuken, 2023). Further MSWM cost analysis delivers two categories of costs, namely cost of investment and cost of operation (Paes *et al*., 2020; B. K. Sharma and Chandel, 2021). While the cost of operations is handled by private companies hired for MSWM, the infrastructure investment cost is beard by the central government (Fairchilds, 2019). This scholarly article's innovativeness is on the discounted cash flow (cost-benefit valuation) MSWM feasibility model to test the idea of turning waste into commercially marketable products. Therefore, the objective of this paper was to evaluate the cost-benefit valuation of solid waste minimization at Vingunguti ward in Dar es Salaam City, Tanzania.

MATERIALS AND METHODS

Study Areas: This study was conducted at Vingunguti, an administrative ward in Ilala Municipality of Dar es Salaam city, Tanzania. The city of Dar es Salaam is found at latitude 6^{o} 37′ 20.4212″S and longitude 39^{o} 8′ 42.0144″E at about 24 meters above sea level. Vingunguti is an industrial area whose activities are highly influenced by maritime, commercial, and international gateway characteristics of Dar es Salaam port, on the western coast of the Indian Ocean in the East Africa region. The ward is home to about 66,342 people (NBS 2022) (Figure 1), most of them being industrial workers. Vingunguti exhibits City characteristics of an average of 172 millimeters of rainfall annually, with a maximum and minimum temperature of 29.5^{o}C and 21.7^{o}C respectively. The ward is among the city areas with the highest rate of informal jobs in almost whole unplanned areas hence informal settlement, as such no wonder leading for solid waste generations since year 2002 (Mapunda *et al*., 2023).

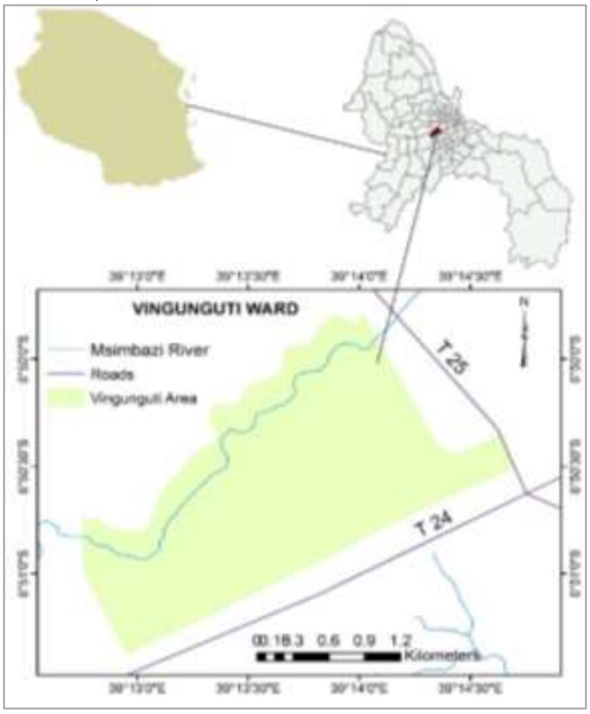

Fig. 1: Map of the Study Area (Source: author's creation)

Data Sources and Preparations: The cost and benefit input variables for this study were extracted from various documents such as the Tanzania National Bureau of Statistics (NBS), Bank of Tanzania (BOT), and Ilala Municipal Council reports and local government bylaws. Such documentary extracts involved monetizing cost input variables (local government by-laws enforcement, container facilities, collection costs per day, administration cost, cost of safety gear provisions, and landfill tipping fee). Further monetization in Tanzania Shillings (TZS) involved benefit input variables (household refuse charges and sale of recyclable materials). Such price tag exercise on each variable was triangulated with field focus group discussion (FGD) data in the case study area of Vingunguti ward in Ilala Municipality.

Solid Waste Minimization Costs Variables: Further data preparation involved the computation of closely related costs, from private waste collection contractors' perspective. As such, each main input variables were observed to be influenced by several sub-variables as displayed in Table 1.

Solid Waste Minimization Benefit Variables: As it is in cost elements for solid waste minimization at source (Table 1), the benefits generated from the exercise of minimizing solid waste at sources are influenced by sub-variables (Table 2).

Table 1: Cost Variables and Sub-variables for Solid Waste Minimization at Sources

Factors	Variables	Sub-Variables
Local Government By-Law		
	Contents of the Law	Conference Facility; Stationaries; Facilitation and Stakeholders Engagement; and Purchasing of the Printed of the By-Law
	Community Awareness	Public Announcement (PA); Facilitation and stakeholder engagement; Transport and Logistics; and Advertising Materials.
Situational Factors		
	Container Cost	Collection Point containers; Household Containers; and Plastic bags
	Collection Cost per Day	Number of Compactor Truck; Vehicle Cost per Trip; Number of Trips per Day; Dumping Charges per Ton; Personnel Per Compactor Truck; Cost of Loading per Person per Day; Population per Ward; and Waste Generation per Ward per Day
	Administration Cost	Salaries for Loaders, Driver, and Supervisor; Premises Rental Fee; Office Utilities (Electricity, Water, Insurance, policies, Premiums, Legal, Accounting and Consultancy Fees); Office Supplies and Equipment.
	Safety Gears	Hand Gloves; Eye Goggles; Hearing Protection Equipment; Hard Helmets; Breathing Apparatus; Fire Extinguishers; and Safety Boots.
	Landfill Tipping	Landfill Tipping Fee

Table 2: Benefit Variables and Sub-Variables for Solid Waste Minimization at Source

Variables	Sub-Variables
Household Refuse Charges	Household Numbers; and Refuse Charges per Household
Sale of Recyclable Materials	The population at Vingunguti Ward; Weight Estimate of Non-Plastic Recyclables; Price of Non-Plastic Recyclables; Percentage of Population Using Plastic Bottled Water; Weight of Each Non-Water Plastic Bottle; Weight Estimate of Recyclable Plastics; Price of Recyclable Plastics

Discounted Values: In cost-benefit evaluation using discounted cash flow modeling such as net present value (NPV), the application of a discount rate is necessary for determining the present value of future cash flows(Anastasia and Nikolay, 2021; Carmichael, 2017). In such computation, the most preferred model is the weighted average cost of capital (WACC) (Equation 1). In the context of this study, the computation of the discounting factor (Equation 2) applies 8 percent, the Bank of Tanzania discounting rate.

$$WACC = \frac{D}{D+E}(1+T_m)K_d + K_e * \frac{E}{D+E} \quad (1)$$

$$DF = \frac{1}{(1+r)^n} \quad (2)$$

Where; D is the cost of debt, E is the cost of equity, K_d is the weighted average cost of debt, K_e is the weighted average cost of equity, T_m is the marginal tax rate; DF: discounting factor; r is the interest/discount rate; n is the number of compounding years.

Net Present Values: Availability of costs and benefits computed over time, discounted to the present value enables computation of net present value (NPV). NPV modelling facilitates the understanding of the difference between present value benefits and present value costs, over the project's lifetime($Equation$ 3). The rule of thumb is that net present value (NPV) greater than zero justifies economic benefits than economic costs (Banerjee 2015). Conversely, an NPV less than zero signals a high possibility of losses, meaning the cost value is higher than the benefit (Maravas and Pantouvakis 2018).

$$NPV = \sum_{t=0}^{t} PV\ (Benefits - Costs) \quad (3)$$

Where: NPV: Net present values from time t, to n^{th} time; PV: Present values of SW Minimization at time t Benefits: The sum of all benefits (all financial inflows) due to SW Minimization; Costs: The sum of all costs (all financial outflows) due to SW Minimization

Sensitivity Analysis: Sensitivity analysis is the measure of model fitness and output variation is attributed to input variable variations (Pianosi *et al*. 2016).

The wide application of sensitivity analysis in physical science research such as solid waste management is attributed to some of the reasons such as uncertainty assessment, robustness assessment of results, model calibration, and diagnostic evaluation (Pianosi *et al.*, 2016; Hadley 2011). In this study, the cost of lending (interest rate) is considered an influential input variable, thus a choice for the sensitivity analysis test.

RESULTS AND DISCUSSION

In the following sections, the model input variables, CBA model formulation and sensitivity analysis results are presented and discussed.

Input Variables for Solid Waste Minimization Model: Analysis of the field data (Table 1) in Spreadsheet delivered model input variable in Table 3.

These financial findings formed inputs for the CBA Model for Solid Waste Minimization at Source. In this study, the monetary cost-benefit analysis of the central government on landfill and transfer station construction wasn't part of this research. While landfills and transfer stations are built by the central government, the burden of making the streets and household settings clean from solid waste is overloading the municipal council (Adedara *et al.*, 2023; Azimi *et al.*, 2020; Manya *et al*., 2017). As such, piles of waste are observed on most streets across many cities in emerging and developing economies, monetizing solid waste management activities is likely to attract more practitioners. Nonetheless, In the practical sense, the idea of understanding, the costs and benefits analysis that integrate landfills, transfer stations, and households as central solid waste calls for more research.

Table 3: Input Variables for Solid Waste Minimization Model

Variables	Unit	Value
Contents of the Law	TZS	7,840,000
Community Awareness	TZS	3,120,000
Container Cost	TZS	9,753,600.00
Collection Cost per Day per year	TZS	479,376,237.60
Administration Cost	TZS	33,132,000.00
Safety Gears	TZS	13,200,000.00
Landfill Tipping	TZS	21,600,000.00
Household Refuse Charges	TZS	759,024,000.00
Sale of Recyclable Materials	TZS	574,212,448.22

The Cost Benefit Analysis Model: The study using the data in Table 3 as an input in the CBA Model framework for a five-year contract awarded to the Solid Waste Minimization services at source, delivered results presented in Table 4. The Model formulation and computation applied the Bank of Tanzania interest rate of 8%, the results displayed a positive Net Present Value (NPV). From the model results (Table 4), the positive NPV is an indicator that solid waste minimization is a financially viable business.

While the household setting has in most cases viewed as a central factor in solid waste generation (Alwedyan, 2022; Struk and Boďa, 2022; Zhao *et al.*, 2021), approaching the same factor and its roles in the context of solid waste minimization is profoundly significant in solid waste management strategy (Zhao *et al.*, 2021). The make-up of households as the source of solid waste minimization involves solid waste awareness, contextually the understanding of waste values hence sorting techniques, reduce, reuse, and recycle (3R) approaches. Application of the 3R approaches at the household level has proved to minimize the amount of waste taken to the dumpsite (Moh, 2017). However, what has not been worked on effectively is the monetization aspects of such municipal waste reduction strategies, which this paper presented up to feasibility analysis.

Table 4: Cost Benefit Analysis Model

Year	Inflation Rate	**Period**	**Cost**	**Benefit**	**Discounting Factor**	**Discounted Cost**	**Discounted Benefit**	**Present Value (PV)**
2022	0.0435	0	24,708,949.94	57,995,785.50	1.00	24,708,949.94	57,995,785.50	33,286,835.56
2023	0.0404	1	22,948,082.24	53,862,752.51	0.93	21,248,224.30	49,872,918.99	28,624,694.69
2024	0.0404	2	22,948,082.24	53,862,752.51	0.86	19,674,281.76	46,178,628.69	26,504,346.94
2025	0.0403	3	22,891,280.06	53,729,428.86	0.79	18,171,836.15	42,652,152.92	24,480,316.78
2026	0.0401	4	22,777,675.69	53,462,781.57	0.74	16,742,271.61	39,296,740.47	22,554,468.86
								135,450,662.83

Sensitivity Analysis: In testing the model fitness, this CBA study considered an interest rate as the variable of effect in a sensitivity analysis. The computation of sensitivity analysis using an interest rate of 8±2 %, both rates delivered TZS 131067893.4 at 6 percent, TZS 135450662.8 at 8 percent, and 140163347.6 at 10 percent respectively. Both resulted in positive NPV. As such, using the variables in this research the solid waste minimization project is a viable business, if and only if refuse charges are collected accordingly.

Conclusion: The study engaged in an evaluation of the cost-benefit valuation of solid waste minimization at source, the case of Vingunguti ward in Dar es Salaam city, Tanzania displayed viable business. The results show that monetizing solid waste management at the Local Government (Municipal) level has multiple benefits beyond monetary, such as employment creation perspectives to income generation activities. In the practical sense, the idea of understanding the costs and benefits analysis that integrates landfills, transfer stations, and households as a central solid waste calls for more research. From this research the CBA using a discounted cash flow approach has delivered a positive net present value (NPV) shows the solid waste minimization business is more beneficial to both the government and the community, at large.

Declaration of Conflict of Interest: The authors declare no conflict of interest

Data Availability Statement: Data are available upon request from the first author or corresponding author.

REFERENCE

Abdel-Shafy, HI; Mansour MSM (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egypt. J. Pet.* 27: (4). 1275–1290

Adedara, ML; Taiwo, R; Bork, H-R (2023). Municipal Solid Waste Collection and Coverage Rates in Sub-Saharan African Countries: A Comprehensive Systematic Review and Meta-Analysis. *Waste.* 1: (2). 389–413

Adeleke, O; Akinlabi, S; Jen T-C; Dunmade, I (2021). Towards sustainability in municipal solid waste management in South Africa: a survey of challenges and prospects. *Trans. R. Soc. South. Afr.* 76: (1). 53–66

Alwedyan, S (2022). The urban household solid waste generating factors and composition study—A case study: Irbid City–Jordan. *J. Environ. Qual Manage.* 31: (4). 235–248

Anastasia, BK; Nikolay, K (2021). Conceptual Problems in the Use of Risk-Adjusted Discount Rate for Risky Negative Cash Flows. *Корпоративные Финансы.* 15: (1). 67–76

Aryampa, S; Maheshwari, B; Sabiiti, E; Bateganya, NL; Bukenya, B (2019). Status of waste management in the East African Cities: Understanding the drivers of waste generation, collection and disposal and their impacts on Kampala City's sustainability. *Sustain.* 11: (19). 5523

Association, ISW (2024). *Global waste management outlook 2024: beyond an age of waste, turning rubbish into a resource.*

Azimi, AN; Dente, SMR; Hashimoto, S (2020). Social life-cycle assessment of household waste management system in Kabul City. *Sustain.* 12: (8). 3217

Badgett, A; Milbrandt, A (2021). Food waste disposal and utilization in the United States: A spatial cost benefit analysis. *J. Clean. Prod.* 314. 128057

Banerjee, S (2015). Contravention between NPV & IRR Due to Timing of Cash Flows: A Case of Capital Budgeting Decision of an Oil Refinery Company. *Am. J. Theor. Appl. Bus.* 1: (2). 48–52

Barua, P; Hossain, N (2021). Waste to energy: an overview by global perspective. *Adv. Technol. Convers. Waste. Fuel. Chem.* 1–49

Brien, JD (2023). Recycling Is Rubbish: Reinvent, Realign. and Restructure US Material Management. *Tex. Environ. L. J.* 53. 97

Carmichael, DG (2017). Adjustments within discount rates to cater for uncertainty—Guidelines. *The Eng. Econ.* 62: (4). 322–335

Chakraborty, S (2023). Trade and Management of Waste. In *Green Circular Economy: A New Paradigm for Sustainable Development.* Springer. 145–166

Chen, DM-C; Bodirsky, BL; Krueger, T; Mishra, A; Popp, A (2020). The world's growing municipal solid waste: trends and impacts. *Environ. Res. Lett.* 15: (7). 74021

Fairchilds, CC (2019). *Poverty and charity in Aix-en-Provence.* JHU Press. 1640-1789

Hadley, D (2011). Sensitivity analysis within cost benefit analysis. *Policy.* 17: 397–407

Herron, M; Jones, DS; Roös, PB; Allam, Z (2021). Creating revenue out of green waste: New perspectives for municipal organic waste harvesting in Geelong, Australia. *Geogr. Environ. Sustain.* 14: (1). 91–105

Iyamu, HO; Anda, M; Ho, G (2020). A review of municipal solid waste management in the BRIC and high-income countries: A thematic framework for low-income countries. *Habitat Int.* 95. 102097

Karaca, F; Tleuken, A (2023). Reforming Construction Waste Management for Circular Economy in Kazakhstan: A Cost–Benefit Analysis of Upgrading Construction and Demolition Waste Recycling Centres. *Recycl.* 9: (1). 2

Kaza, S; Yao, L; Bhada-Tata, P; Van Woerden, F (2018). *What a waste 2.0: a global snapshot of solid waste management to 2050*. World Bank Publications.

Kumar, A; Samadder, SR (2017). A review on technological options of waste to energy for effective management of municipal solid waste. *Waste Manage.* 69. 407–422

Levidow, L; Raman, S (2019). Metamorphosing waste as a resource: Scaling waste management by ecomodernist means. *Geoforum.* 98. 108–122

Maalouf, A; Mavropoulos, A (2023). Re-assessing global municipal solid waste generation. *Waste Manage. Res.* 41: (4). 936–947

Maalouf, A; Mavropoulos, A; El-Fadel, M (2020). Global municipal solid waste infrastructure: Delivery and forecast of uncontrolled disposal. *Waste Manage. Res.* 38: (9). 1028–1036

Manya, CMS; Leta, S; Khan, MM (2017). Assessment of municipal solid waste management practices in Juba city, South Sudan, challenges and practical considerations: A review. *J. Environ. Sci. Toxicol. Food. Technol.* 11: (10). 13–25

Mapunda, AS; Kimwaga, RJ; Kassuwi, S (2023). Analysis of Drivers of Solid Waste Minimization at Source in Dar es Salaam City , Tanzania. Int. J. Res. Eng. Sci. 11: (10). 22–52

Maravas, A; Pantouvakis, J-P (2018). A New Approach to Studying Net Present Value and the Internal Rate of Return of Engineering Projects under Uncertainty with Three-Dimensional Graphs. *Adv. Civ. Eng.* 1: (2018). 6108680

Mir, IS; Cheema, PPS; Singh, SP (2021). Implementation analysis of solid waste management in Ludhiana city of Punjab. *Environ. Chall.* 2. 100023

Moh, Y (2017). Solid waste management transformation and future challenges of source separation and recycling practice in Malaysia. *Resour. Conserv. Recycl.* 116. 1–14

Muthuraman, L; Ramaswamy, S (2019). *Solid Waste Management*. MJP Publisher

Noor, T; Javid, A; Hussain, A; Bukhari, SM; Ali, W; Akmal, M; et al. (2020). Types, sources and management of urban wastes. In *Urban ecology*. Elsevier. 239–263

Nyampundu, K; Mwegoha, WJS; Millanzi, WC (2020). Sustainable solid waste management Measures in Tanzania: An exploratory descriptive case study among vendors at Majengo market in Dodoma City. *BMC Publ. Health.* 20: (1). 1–16 https://doi.org/10.1186/s12889-020-08670-0

Paes, MX; de Medeiros, GA; Mancini, SD; Bortoleto, AP; de Oliveira, JAP; Kulay, LA (2020). Municipal solid waste management: Integrated analysis of environmental and economic indicators based on life cycle assessment. *J. Clean. Prod.* 254.

119848

Pianosi, F; Beven, K; Freer, J; Hall, JW; Rougier, J; Stephenson, DB; et al. (2016). Sensitivity analysis of environmental models: A systematic review with practical workflow. *Environ. Model. Softw. 79.* 214–232 https://doi.org/10.1016/j.envsoft.2016.02.008

Popp, A (2020). The world ' s growing municipal solid waste : trends and impacts Recent citations The world ' s growing municipal solid waste : trends and impacts. *Environ. Res. Lett.* 15. 13

Rebehy, PCPW; Junior, APS; Ometto, AR; de Freitas Espinoza, D; Rossi, E; Novi, JC (2023). Municipal solid waste management (MSWM) in Brazil: Drivers and best practices towards to circular economy based on European Union and BSI. *J. Clean. Prod.* 401. 136591

Seah, S; Addo-Fordwuor, D (2021). Roles and strategies of the local government in municipal solid waste management in Ghana: Implications for environmental sustainability. *World Environ.* 11: (1). 26–39

Sharma, BK; Chandel, MK (2021). Life cycle cost analysis of municipal solid waste management scenarios for Mumbai, India. *Waste Manage. 124.* 293–302.

Sharma, KD; Jain, S (2020). Municipal solid waste generation, composition, and management: the global scenario. *Soc. Responsib. J.* 16: (6). 917–948

Sotamenou, J; De Jaeger, S; Rousseau, S (2019). Drivers of legal and illegal solid waste disposal in the Global South-The case of households in Yaoundé (Cameroon). *J. Environ. Manage.* 240. 321–330

Struk, M; Boa, M (2022). Factors influencing performance in municipal solid waste management–A case study of Czech municipalities. *Waste Manage.* 139. 227–249

ang, Y; Shi, Y; Zhou, J; Zhao, J; Maraseni, T; Qian, G (2021). Implementation effect of municipal solid waste mandatory sorting policy in Shanghai. *J. Environ. Manage.* 298. 113512

Zhao, Y; Diunugala, HP; Mombeuil, C (2021). Factors affecting household solid waste generation and management in Sri Lanka: an empirical study. *Environ. Monit. Assess.* 193: (12). 838