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The Zero-Waste City: Case study of port louis, mauritius

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A B S T R A C T

Climate change is a global phenomenon that is expected to affect cities around the world to differing degrees and scales. Developing and emerging cities have a range of challenges to deal with in responding to climate change while aspiring to leap frog outdated approaches. It will be important for these cities to undertake well informed and strategic approaches to respond to climate change in urban planning; both in adaptation and mitigation. However, the two do not always complement each other and focusing on one area may be counterproductive overall. Literature also shows that it is also important to understand that adaptation and mitigation strategies in low income cities need to focus on social and economic issues along with environmental measures. This paper seeks to investigate how waste management can offer an extra dimension where urban policies can contribute to move towards a net-zero carbon city. Through a focus on waste minimisation there are a range of mitigation options available that are associated with reducing the wastage of energy, materials, and water. This paper outlines the findings of an assessment of technological, environmental, institutional and socio-economic opportunities and challenges related to a 'Zero Waste' pathway for one small emerging African city; Port Louis, the capital city of the island of Mauritius. The findings of this study seek to inform policy makers to implement 'Zero Waste' policies and approaches in Mauritius.

Keywords: sustainable development; zero-waste city; port louis; urban metabolism

Introduction

The Intergovernmental Panel on Climate Change [1] defines climate change as a term that encompasses any change in climate which could be attributed to natural causes or even human activity [1]. One prominent aspect of climate change is global warming [2], and it has been shown that greenhouse gases (GHG) emission is among the most important contributors of global warming [3]. Adaptation and mitigation strategies to climate change do not always complement each other on the road to sustainable development, hence leading to an imbalance in focus which can be counterproductive [4, 5]. Waste management is one such developmental aspect of emerging cities that have been posing a major hurdle towards sustainable development [6].

While Urban Regenerative measures are often tailored to planning and design, one aspect often lacks in sustainable urban design methodologies; material flows in regard to input and outputs [7]. showcases this in the Extended Metabolism Model, and underlines waste as a key dimension. Furthermore, the waste sector is a major contributor to global warming, with methane emission being the most important GHG [8]. These authors highlighted that methane accounts for up to thirty-five times the potency of carbon dioxide as a greenhouse gas over a century.

Tackling this emission from waste will undoubtedly reduce the contribution of this dimension of a city for GHGs. Zaman and Lehmann [9] pointed out that managing waste in cities is among the most tedious issues that sustainable city designs must tackle. These authors further posited that the 'Zero Waste' concept can help to curb the impact of waste on GHG emissions. The "Zero waste" is defined as a systemic approach towards products and process design and managing whereby aiming at avoiding and eliminating waste generation [10]. Moreover, such a concept also promotes resources recovery and can help emerging cities design and implement proper policy for a 'zero waste' sustainable city [11]. Several factors affect the implementation of the 'Zero-Waste' concept in cities [12, 13].

This paper outlines the findings of an assessment of socio-economic, political/institutional and technological opportunities that are related to a 'Zero Waste' pathway for one small emerging African city; Port Louis, the capital city of the island of Mauritius. The findings of this study seek to inform policy makers to implement 'Zero Waste' policies and approaches in small emerging African cities.

Background

Concept of the zero-waste city

Rapid urbanisation and inexorable mass movement of people towards urban areas create an unsustainable setup. It is expected that by 2050 the world population will reach 9.5 billion with more than 66 % living in cities [14]. More people means more consumption, and this leads to generation of more wastes [15]. Worldbank [16] report on urban development highlighted that municipal solid waste (MSW) generated in 2010 was 1.3 billion tonnes per year and by 2050, this Figure is expected to reach 2.2 billion tonnes per year. Moreover, for the same time frame per capita waste generation rates will increase from 1.2 to 1.42 kg per person per day [16]. These rates vary greatly depending on the region and size of the cities (Table 1).

Table 1. Waste Generation Projections for 2025 by region (Source: [16])

Region	Current Available Data			Projections for 2025			
	Total Urban Population (millions)	Urban Waste Generation		Projected Population		Projected Urban Waste	
		Per Capita (kg/capita/day)	Total (tons/day)	Total Population (millions)	Urban Population (millions)	Per Capita (kg/capita/day)	Total (tons/day)
AFR	260	0.65	169,119	1,152	518	0.85	441,840
EAP	777	0.95	738,958	2,124	1,229	1.5	1,865,379
ECA	227	1.1	254,389	339	239	1.5	354,810
LCR	399	1.1	437,545	681	466	1.6	728,392
MENA	162	1.1	173,545	379	257	1.43	369,320
OECD	729	2.2	1,566,286	1,031	842	2.1	1,742,417
SAR	426	0.45	192,410	1,938	734	0.77	567,545
Total	2,980	1.2	3,532,252	7,644	4,285	1.4	6,069,703

Understanding how natural resources are being used at local level provides the most important scale for assessing resources management [17]. Such management of resources ensures that human population live within the limits of the region's supporting system in terms of social, economic and ecosystem level. This calls for a reliable and valid method to measure and assess sustainability frameworks [17]. Several methods of sustainability prevail in literature such as the ten indicators of the European Common indicators, the sixty-three indicators of the Global City Indicators Program and fifteen indicators for the Urban Metabolism Framework among others. One Indicator which caters for the Zero Waste City is the Finnish Sustainable Communities network (FISU) which promote members to cut on their emissions and consumption of natural resources.

However, Zaman and Lehmann [12] pointed out that it is very difficult to design sustainable cities, especially in the case of huge metropolitan areas. The same dilemma awaits emerging cities [18]. Nonetheless, there is still a window of opportunity to manage the relatively lower waste load generated and eventually pave the way towards a zero-waste city paradigm. The zero-waste city is one which minutely control all the pathways of goods from conception to collection of refuse in order to minimise waste load collected [13]. The term "zero waste" was first coined by Dr. P.Palmer in 1973 during his work on recovery of resources from chemicals [19]. Such a model of waste management involves a circular flow of materials as opposed to the conventional linear method (Figure 1) [19]. There is thus needing to shift from conventional waste management to a more rigorous waste control method which aims at eliminating all wastes from the city environment. The salient feature of the cyclical model of waste management lies in the fact that here the waste generated at the end of an urban metabolic process is used as the raw material in another urban metabolic process [20].

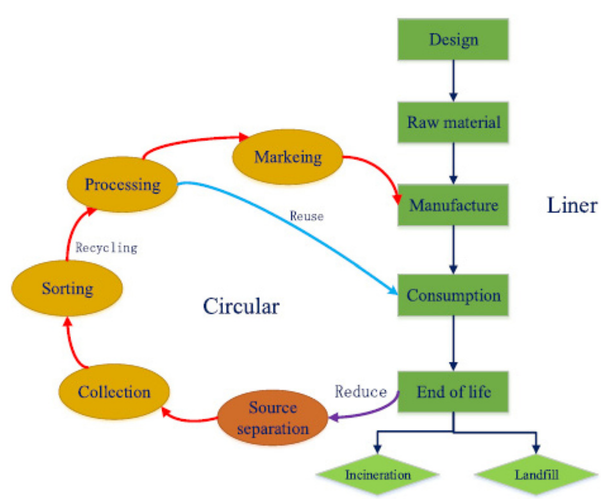

Figure 1. Linear and Cyclical resource flows (Source:[19]).

The Zero Waste management systems consist of several dimensions that are dynamic and interrelated [12]. These dimensions include the socio-economic attributes of the city, its political agendas, the environmental concerns and characteristics together with the technological attributes of the city (Figure 2). All these spheres consist of dimensions that are associated with key drivers as described by [12] (Figure 3).

The social dimension of the Zero Waste City concerns consumption behaviour, while the economic aspect deals with cost-benefit aspect of engaging onto the zero-waste pathway. Political dimension involves policy and regulation in waste management while the technological dimension of the project concerns the efficiency and technology involved in waste management change. Moreover, the strategies to deal with any impacts fall under the environmental dimension [9].

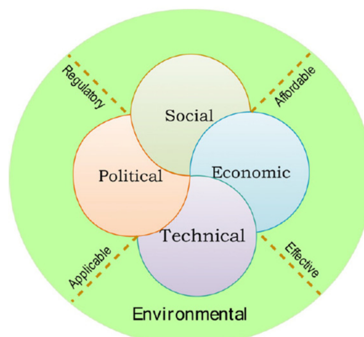

Figure 2. Spheres of the Zero Waste city (Source:[9]).

Figure 3. Drivers for transforming current cities into zero waste cities (Source:[12]).

Socio-economic and political dimensions

This dimension concerns sustainable consumption and behaviour. According to Zaman and Lehmann [12] such a dimension includes three indicators; i) collaborative consumption, ii) behaviour change and iii) sustainable living. Collaborative consumption offers a relatively new trend of socially enriched economy which not only contribute positively to sustainable development but also promote stronger community ties [21]. Examples of such consumption pattern includes car-pooling and co-housing. [22] argued that collaborative consumption supplements the inadequacies of resource efficiency and technological innovations in reducing the use of natural resources. Business models aiming principally at consumerism is no longer an option. However, although there is a movement towards 'greening' supply chains as first step towards sustainable consumption, the surge in demands outpace 'greening' innovations [23]. This calls for a change in consumption behaviour from a consumerism dimension to a more sustainable approach [12, 23, 24].

Newman [25] brought into the limelight the concept of sustainable urban ecosystem as a self-renewing, self-regulating and zero waste city. Dizdaroglu [26] further extrapolated on the concept of sustainable ecosystem and postulated that sustainability depends on a '*balanced interaction between human activities and natural resources*'. This author further proposed key sustainable development principles to strengthen this balance. One such approach is through sustainable land use and urban design for enhanced liveability, introduction of green technologies to curb energy consumption, decrease GHG emissions through regulation of transport and to promote a greening of the environment. Another pathway focuses on effective environment protection policies through effective waste management [26].

This dimension on waste management focuses on the role of policy makers and financing institutions [18]. Weak institutional framework seems to be a major hurdle towards proper waste management in emerging and developing countries [18]. This dimension has key drivers in the form of policies for environment protection and waste management including public awareness [10, 27-29], cultural issues [18] and funding of waste management protocols [28, 30].

This dimension of zero waste city links to the cost benefit analysis and taxation of zero waste pathways [9]. Greyson [28] argued that the incremental approach by gradually reducing the impacts of an environmental issue is no longer an effective way of curbing the waste issue. This author warned about this concept being used by several cities and organisations and eventually leading to a lesser waste city instead of a zero waste one. Furthermore, he posited that the concept of zero waste city is being viewed as unachievable in the wake of current economic practices. For instance, economic growth is seen as having a negative impact on sustainability and when a city opts for sustainability approach, economic growth fails due to over-burdening of the system with regulations [28]. There is a need to review the economic system in place and make the pathway towards zero waste a plausible one.

Technological dimension

Singh et al. [31] posit that the concept of Zero Waste urges producers and consumers to move towards sustainable attitudes. These authors further stipulate that one approach towards tackling waste is through Zero Waste Manufacturing (ZWM). Through this concept novel technologies are being applied to promote recycling and reusability of wastes generated from other manufacturing processes. The importance of technologies as a focal point into a pathway towards zero waste has been highlighted by [29]. The author highlighted the need to implement new technologies in waste management systems to prevent loss of resources through thermal treatment and landfilling. The technology dimension of the zero waste city concerns composting, anaerobic digestion and also incineration and landfilling [9]. Certain studies hail recycling as being an essential component towards effective waste management [32-35] while Leach et al. [36] point out that incineration or digestion technologies have lesser impact on the environment than recycling. Such contradictory findings promote further probe into effectiveness of technologies involve towards the zero-waste city. Another aspect that highlight the impact of electronics on the pathway towards a zero-waste paradigm is the concept of electronic waste. Overconsumption of electronics and shorter lifecycles of electronics leads to generation of substantial amount of electronic waste (E-waste) which has increased dramatically in recent years [37]. Such waste can lead to proliferation of toxic electrical and electronic waste which become more consequent for small cities [19]. However, there exist a market for good quality, second-hand electronic and electrical equipment in developing countries. This opens argument for exporting scrap electronic and electrical equipment to these countries [38].

Port Louis

Port Louis lies in the North West part of the island and extends over a total area of 46.7 km^2. It is bounded by the Indian Ocean and a mountain range. Port Louis is also a port city and the capital of Mauritius with a population of 149,194 [39]. This number soar during weekdays owing predominately to the large number of commuters that work in the city [40]. The City of Port Louis positions itself to welcome an urban regeneration [41]. Pathways of regeneration has been researched by Allam [42-44]where the author posits 3 key dimensions when smartly regenerating an existing city. Figure 4 highlights the dimensions of Metabolism, Culture, Governance as key components to smart a city.

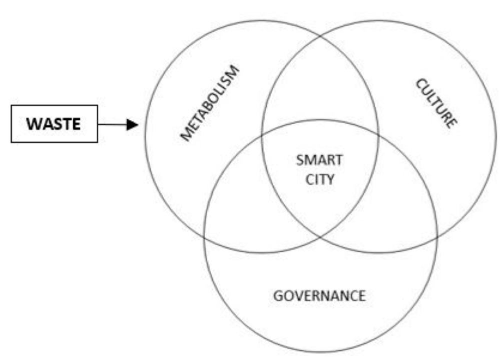

Figure 4. Smart Framework for Port Louis. Adapted from [42].

From a waste perspective, the waste dimension be a subset of the Metabolism dimension (Figure 4). It is to be noted that there is insignificant waste segregation at source and the amount of waste generated keeps on increasing every year. Waste management in Mauritius follows a linear model involving collection, transport to processing plant and eventually disposal at landfills [45]. This author also highlighted that 6,308 tonnes of municipal wastes are collected monthly from Port Louis and transported to a transfer station before eventually being directed to landfills. The waste profile for Port Louis follows the same general trend for other cities with organic waste being the major chunk of collected garbage (Figure 5).

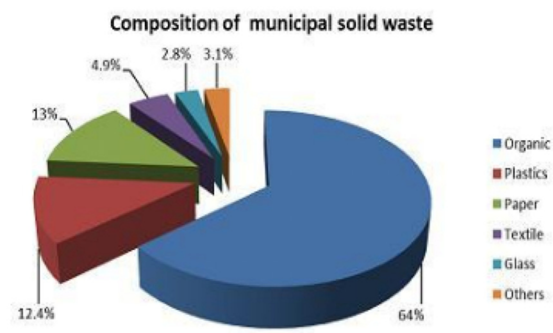

Figure 5. Composition of solid municipal waste of Port Louis (Source: Ministry of Environment, sustainable development, and disaster and beach management).

Waste as a Subset of Urban Metabolism

The Extended Metabolism Model [7] underlines, in Figure 6, the upgrading of the livability dimension within cities without compromising the resources for future generations. The concept of assigning a metabolic component to cities has first been coined by Wolman [46] which principally englobes the input of resources and managing the wastes generated with as little impact as possible on the city. Moreover, the model of viewing cities as biological entities has its origins within the work of Tjallingii [47] who draws lines of similitudes between cities and ecosystems. Newman's model strengthens upon these two dimensions but lays emphasis on upgrading livability and growth opportunities for the urban population.

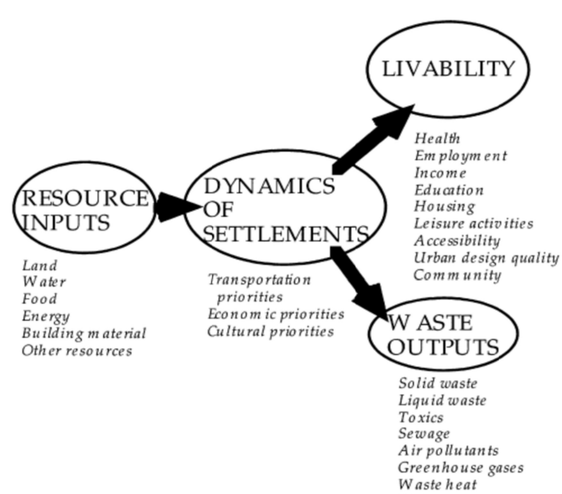

Figure. 6. The extended metabolism model of human settlements (Source:[7]).

The extended metabolism model has an inherent underlying principle that links inputs to outputs like any biological system. Resources that get in will eventually come out as waste products similar to the law of thermodynamics on conservation of energy. Decker [48] further extrapolate on the concept of cities metabolising raw materials with generations of wastes while a few years later Kennedy [49] defined the metabolic processes within cities as the summation of the technical, social and economic processes occurring within cities resulting in growth, energy production and waste elimination. However, Newman [7] underlies the factor of entropy in such a model in a sense that to manage waste generated, there needs to have further input of extra energy, but he also stresses on the fact that this defeats the purpose of sustainability. To circumvent the entropy factor, Newman [7] proposes a rigorous reduction in resources input.

One hallmark feature of Newman's model is that cities is entirely scrutinized as a biological entity with prime focus being upon human growth in terms of availability of opportunities [7]. Such a bold underlying principle lays the onus on livability, hence providing the nerve that links the environmental dimension of urban sustainability with that of economic and social dimensions.

Discussion

One principle component of the Zero Waste pathway is linked intricately to consumption behaviour of people [9, 12, 13]. According to the Ministry of Environment and Sustainable Development (MESD) (2013) Sustainable Consumption and Production (SCP) is a tool that can be used to promote more responsible consumption pattern. It is defined as a holistic approach that aims at curbing the detrimental impacts of uncontrolled consumption and production systems while laying emphasis on promoting quality living conditions. Such an approach focuses on efficient management of resources throughout product/service life cycle. From a waste management perspective, SCP promotes reuse and recycling of valuable resources within waste flow and is expected to:- i) upgrade quality of life without compromising on environmental integrity, ii) enhance economic growth through more responsible pattern of consumption, iii) focusing on greener life cycle of services and products and iv) preventing the 'rebound' effect whereby efficiency gains can be neutralised by a resurgence in consumption [50]. This approach from the Ministry shows that there is commitment at the highest administrative level to proceed towards a more responsible attitude for a Zero Waste pathway.

To put words into action, the Government of Mauritius introduced the Sustainable Public Procurement (SPP) which aims at making public expenditure more sustainable in terms of social, environmental and economic policies [50]. SPP has been introduced by United Nations Environment Programme (UNEP) in 2009 and in 2011, Mauritius joined in as a pilot country for implementing SPP policies. The focus is on seven products/services:- i) paper and printing, ii) IT devices, iii) cleaning products and services, iv) office and classroom furniture, v) vehicles, vi) food and catering services and vii) construction work. Port Louis being the main administrative centre of the island host the national assembly and the prime minister's office together with other ministries and public services such as hospital and social security services. These public departments are already gaining from SPP but this approach could also be adopted by private companies as well as local authorities such as municipalities.

In fact, Walker and Jones [51] highlighted the robustness of a similar concept called Sustainable Supply Chain Management (SCM) in the private sector. According to these authors, SCP allows private companies to be more environment conscious. Incentives could be provided to such companies that are involved in SCM. In Mauritius, there are incentives for companies that want to set up smart cities. For instance, these companies are exempted from several financial burdens such as: i) income tax for a period of eight years, ii) land transfer tax and registration duty, iii) land conversion tax, iv) value added tax, v) customs duty and vi) 'morcellement' tax [52]. The same strategy could be adopted for companies that are involved in attitudes pertaining to zero waste pathway like waste segregation at source and SCM.

From an institutional perspective, the legal framework for waste management in Mauritius consists of the Environment Protection Act [53] and the Local Government Act (LGA). The former act was introduced in 2002 and amended in 2008 while the LGA was introduced in 2011. However, on a zero-waste pathway, there is need for further support through additional legal frameworks. One such example is the Zero Waste SA Act (2004) introduced in Australia which provide legal support so that people can upgrade their good practices in terms of recycling and waste elimination at home, work and industry [54]. One key aspect of this legislation was the complete ban of plastic shopping bags in a bid to avoid waste generation.

Atasu [37] proposed 'take-back' legislation to cope with E-waste. This practice involves activities which is linked to end of life management of electronics [37]. Two examples stand forth as torchbearer in dealing with E-waste; i) the Waste Electrical and Electronic Equipment (WEEE) directive as enacted by the European Union [37] and ii) the Specified Home Appliance Recycling (SHAR) introduced in Japan which lays the onus of recycling of electronic goods on the producers [55]. In Mauritius, there is no such legislative, but some good practices do exist. As at 2013, Mauritius imported an average of 20 million batteries annually while the mobile telephone devices amounted to 1.14 million. These Figures represent a potential danger of release of toxic chemicals in the ecosystem [50]. The Mauritius Telecom and several non-governmental organisation (NGOs) such as Mission Verte, BEM Ltd and Rotary Club of Port Louis initiated actions that promoted collection of used mobile phones and batteries. Boxes for collection are placed at strategic places including supermarkets, shops. Post offices together with public and private buildings throughout the Island. Once collected, these E-wastes are directed towards local and international recycling companies based on international regulations. Moreover, Rajesh [38] postulated that although E-waste can be seen as quite cumbersome for developed countries, there exist a market for scrap electronic and electrical waste in developing countries. This opens avenues for further studies in the possibility of Port Louis being a hub for recycling and exporting E-waste.

Municipalities are called to play the key role towards sustainable development on the zero-waste pathway [56]. Solid waste management (SWM) for Port Louis is under the direct control of municipality of Port Louis but is restricted to collection and transport to a transfer station. According to Jhingut [45], from the transfer station, the waste is then disposed of at Mare Chicose landfill. This author pointed out that Port Louis and its suburbs generate an average of 6,308 tonnes of solid waste monthly with 64 % being of organic origin, 13% paper and 12.4% plastic wastes. However, only 7% of the collected waste are used for recycling and composting. Furthermore, as at 2014, a composting facility implemented at La Chaumiere was operating at only 61% of its capacity [45]. There is, thus, significant potential to extend this Figure to a much higher percentage. In a previous study Susty and Venkannah [57] proposed anaerobic digestion (AD) of the organic component of municipal waste. These authors postulate that such an approach will lead to a reduction by 25% of the total waste disposed at Mare Chicose while decreasing the annual carbon dioxide emission by 28,720 tonnes. Moreover, the biogas liberated can be used as a source of renewable energy while the digestate remaining still holds composting properties. Moreover, as recommended by Wiel et al. (2012), 'cradle to cradle' standpoint could be adopted by industries. This concept is a radical approach to sustainability in which products are recycled at the end of the lifecycles but without any loss in quality [58]. Port Louis being the only trade port of the island, it is the seat of many industries. Promoting the concept of 'cradle to cradle' through the right legal frameworks might be one aspect of taking industrial complexes on-board this endeavour of zero-waste.

It is essential that all stakeholders within the city take active part on the pathway towards sustainable waste management [59]. He identified twelve different stakeholders within the city ranging from NGO to political Figures and including the senior citizens and school children among others, where the findings highlighted the dimension of cooperation and civic responsibilities of each stakeholder towards adopting effective sustainable waste management attitudes. For instance, academia has the responsibility to infuse the paradigm shift towards a more responsible attitude in connection with consumption pattern and waste management while politician can include sustainable waste management in their agenda and push the same for municipalities. All these recommendations fit well with the need of Port Louis on a zero-waste pathway.

Recommendations for Port Louis

Based on the above discussion the following key recommendations are proposed for policy makers for the city of Port Louis:

1. Consolidate sustainable consumption practices for public and parastatal bodies.
2. Promote sustainable supply chain management in private companies.
3. Offer financial incentives such as tax exemptions for companies adopting zero waste practice.
4. Implement effective policy for dealing with E-waste in terms of collection, sorting, processing and exporting towards potential markets for such goods.
5. Promote sensitisation campaigns to promote attitudes and good practices like at source waste segregation.
6. Implement more effective waste segregation approach to maximise potential for recycling, recovering, anaerobic digestion and composting.
7. Maximise use of existing technologies and introduce new ones for better composting, anaerobic digestion and recycling/recovering of solid municipal wastes.

Conclusion

This study investigated key indicators in sustainable waste management from a socio-economic, political/ institutional and technological standpoint that might affect the potential application of a zero-waste concept in the city of Port Louis. Although several ongoing good practices have been noticed in terms of policies for coping with solid municipal waste, there is still room for further improvement. These improvements are in the form of a complete paradigm shift in connection with consumption patterns, further responsibilities on stakeholders, manufactures and suppliers of goods for the city of Port Louis, enhanced and more rigorous legislations pertaining directly to the zero-waste concept and an introduction of state of the art technologies for better 'cradle to cradle' management of solid municipal wastes. Moreover, as showcased by Allam [44] fiscal incentives could be introduced to encourage the private sector to take part in this endeavour, falling into the public domain. Logistics facilities for waste segregation at source must be setup to ensure maximisation of outputs through waste recovery, recycling, composting and anaerobic digestion. While this is a preliminary study of the incumbent issue of sustainable waste management through a zero-waste concept for one small emerging African city, there are highlighted avenues to explore to achieve this target. One limitation of this study is that the findings cannot be extrapolated to other emerging African cities because the 'one size fits all attitude' for sustainable development is not effective. This is because each city has its own socio-economic, political and technological dimensions. Moreover, as with all change, there is need to develop a proper framework to ensure viability and sustainability of such an approach for waste management, especially through in-depth cost-benefit analyses.

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References

[1] IPCC, *Climate Change 2007: Impacts, Adaptation and Vulnerability*, New York, NY, 2007.

[2] A. Menzel, T.H. Sparks, N. Estrella, E. Koch, A. Aasa, R. Ahas, K. Alm- Kübler, P. Bissolli, O.G. Braslavská, A. Briede, and F.M. Chmielewski, *European phenological response to climate change matches the warming pattern*, Glob. Change Biol 12 (2006), pp. 1969-1976.

[3] S. Solomon, G.K. Plattner, R. Knutti, and P. Friedlingstein, *Irreversible climate change due to carbon dioxide emissions*, Proceedings of the national academy of sciences 106 (2009), pp. 1704-1709.

[4] S. Kane, and J.F. Shogren, *Linking adaptation and mitigation in climate change policy*, Clim. Change 45 (2000), pp. 75-102.

[5] H.H. Dang, A. Michaelowa, and D.D. Tuan, *Synergy of adaptation and mitigation strategies in the context of sustainable development: the case of Vietnam*, Clim. Policy 3 (2003), pp. s81-s96.

[6] L.A. Guerrero, G. Maas, and W. Hogland, *Solid waste management challenges for cities in developing*

countries, Wast manag. 33 (2013), pp. 220-232.

[7] P.W. Newman, *Sustainability and cities: extending the metabolism model*, Landscape and Urban Plann. 44 (1999), pp. 219-226.

[8] M. LaGiglia, P. Legarreta, A. Vanamoli, and L. Wang, *Promoting Net-Zero Emissions From The Waste Sector in Latin America through NAMAs*, 2014.

[9] A.U. Zaman, and S. Lehmann, *Urban growth and waste management optimization towards 'zero waste city'* City, Cult. and Soc. 2 (2011), pp. 177-187.

[10] C.Y. Young, S.P. Ni, and K.S. Fan, *Working towards a zero waste environment in Taiwan* Waste Manag. & Res. 28 (2010), pp. 236-244.

[11] N. Matete, and C. Trois, *Towards zero waste in emerging countries- A South African experience*, Waste Manag. 28 (2008), pp. 1480-1492.

[12] A.U. Zaman, and S. Lehmann, *The zero waste index: a performance measurement tool for waste management systems in a 'zero waste city'*, J. of Clean Prod. 50 (2013), pp. 123-132.

[13] A.U. Zaman, *A comprehensive review of the development of zero waste management: lessons learned and guidelines*, J. of Clean Prod. 91 (2015).

[14] United Nations, *World Urbanization Prospects: The 2014 Revision, Highlights. Department of Economic and Social Affairs* Population Division, United Nations (2014).

[15] D.N. Ogbonna, G.T. Amangabara, and T.O. Ekere, *Urban solid waste generation in Port Harcourt metropolis and its implications for waste management*, Manag. of Environ. Qual: An Int. J. 18 (2007), pp. 71-88.

[16] Worldbank, *What a Waste: A Global Review of Solid Waste Management* Urban Development Series Knowledge Papers, 2012.

[17] M.L. Graymore, N.G. Sipe, and R.E. Rickson, *Regional sustainability: How useful are current tools of sustainability assessment at the regional scale?* , Ecol. Econ. 67 (2008), pp. 362-372.

[18] D.C. Wilson, *Development drivers for waste management* Waste Manag. & Res. 25 (2007), pp. 198-207.

[19] Q. Song, J. Li, and X. Zeng, *Minimizing the increasing solid waste through zero waste strategy*, J. of Appl. Math. 104 (2015), pp. 199-210.

[20] T. Curran, and I.D. Williams, *A zero waste vision for industrial networks in Europe*, J. of Hazard. Mater. 207 (2012), pp. 3-7.

[21] R. Botsman, and R. Rogers, *What's mine is yours: how collaborative consumption is changing the way we live*, Vol. 2, Collins, London, 2011.

[22] K. Leismann, M. Schmitt, H. Rohn, and C. Baedeker, *Collaborative consumption: towards a resource-saving consumption culture*, Res. 2 (2013), pp. 184-203.

[23] N. M. P. Bocken, and S. W. Short, *Towards a sufficiency-driven business model: Experiences and opportunities*, Environ. Innov. and Soc. Trans. 18 (2016), pp. 41-61.

[24] A. Silva, M. Rosano, L. Stocker, and L. Gorissen, *From waste to sustainable materials management: Three case studies of the transition journey*, Waste Manag. 61 (2017), pp. 547-557.

[25] P.W. Newman, and I. Jennings, *Cities as Sustainable Ecosystems: Principles and Practices*, Island Press, Washington, DC., 2008.

[26] D. Dizdaroglu, *Developing micro-level urban ecosystem indicators for sustainability assessment*, Environ. Impact Assess. Rev. 54 (2015), pp. 119-124.

[27] M. Colon, and B. Fawcett, *Community-based household waste management: Lessons learnt from EXNORA's 'zero waste management'scheme in two South Indian cities*, Habitat Int. 30 (2006), pp. 916-931.

[28] J. Greyson, *An economic instrument for zero waste, economic growth and sustainability*, J. of Clean Prod. 15

(2007), pp. 1382-1390.

[29] A.U. Zaman, *Measuring waste management performance using the 'Zero Waste Index': the case of Adelaide, Australia*, J. of Clean Prod. 66 (2014), pp. 407-419.

[30] P.S. Phillips, T. Tudor, H. Bird, and M. Bates, *A critical review of a key waste strategy initiative in England: Zero waste places projects 2008 −2009*, Res., Conserv. and Recyc. 55 (2011), pp. 335-343.

[31] S. Singh, S. Ramakrishna, and M.K. Gupta, *Towards zero waste manufacturing: A multidisciplinary review* j. of clean Prod. 168 (2017), pp. 1230-1243.

[32] F. Ackerman, *Cost-effective recycling*, Rethin. the Waste hierarchy (2005), pp. 22-34.

[33] O.F. Kofoworola, *Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria*, Wast Manag. 27 (2007).

[34] H. Merrild, A. Damgaard, and T.H. Christensen, *Life cycle assessment of waste paper management: the importance of technology data and system boundaries in assessing recycling and incineration*, Res., Conserv. and Recyc. 52 (2008), pp. 1391-1398.

[35] W. Qian, R. Burritt, and G. Monroe, *Environmental management accounting in local government: A case of waste management* Accoun., Audit. & Accountab Journal 24 (2011), pp. 93-128.

[36] M.A. Leach, A. Bauen, and N.J.D. Lucas, *A systems approach to materials flow in sustainable cities: A case study of paper*, J. of Environ. Plann. and Manag. 40 (1997).

[37] A. Atasu, Ö. Özdemir, and L. N. Van Wassenhove, *Stakeholder perspectives on E-waste take-back legislation*, Prod. and Oper. Manag. 22 (2013), pp. 382-396.

[38] A. Rajesh Ejiogu, *E-waste economics: a Nigerian perspective* Management. of Environ. Qual.: An Int. J. 24 (2013), pp. 199-213.

[39] Ministry of Finance and Economic Development, *Annual Digest of Statistics 2015*, in *Government of Mauritius*, 2016.

[40] S.C. Fowdur, and S.D. Rughooputh, *Evaluation of Congestion Relief Proposals in a Capital City*, J. of Appl. Math. 2012 (2012).

[41] A. Groëme-Harmon, *Gaëtan Siew: Ramener jusqu'à 5 000 jeunes vivre à Port-Louis*, (2018).

[42] Z. Allam, *Building a conceptual framework for Smarting an existing city in Mauritius: The case of Port Louis.*, J. of Biourban. 4 (2017), pp. 103-121.

[43] Z. Allam, and P. Newman, *Redefining the Smart City: Culture, Metabolism & Governance*, Smart Cities 1 (2018), pp. 4-25.

[44] Z. Allam, and P. Newman, *Economically Incentivising Smart Urban Regeneration. Case Study of Port Louis, Mauritius*, Smart Cities 1 (2018), pp. 53-74.

[45] N. Jhighut, *Implementing source separation of household waste in Mauritius* The J. of the Inst. of Engrg. Mauritius 2016 (2016).

[46] A. Wolman, *The metabolism of cities*, Scie. Amer. 213 (1965), pp. 179-190.

[47] S.P. Tjallingii, *Strategies for Ecologically Sound Urban Development*, Backhuys Publishers, Leiden, 1995.

[48] H. Decker, S. Elliott, S.F. A., D.R. Blake, and F. Sherwood Rowland, *Energy and material flow through the urban econsystem*, Ann. Rev. Energy Environ. 25 (2000), pp. 685-740.

[49] C. Kennedy, J. Cuddihy, and J. Engel-Yan, *The changing metabolism of cities*, J. of Indust. Ecol. 11 (2007).

[50] Ministry of Social Security and Sustainable Development, *Sustainable Consumption and Production: Best Practices in Mauritius*, Goverment of Mauritius, 2013.

[51] H. Walker, and N. Jones, *Sustainable supply chain management across the UK private sector* Supply Chain Manag.: An Int J. 17 (2012), pp. 15-28.

[52] Board of Investment., *Smart Cities-Smart Mauritius-Building Intelligent, Innovative and Sustainable Cities of the Future*, 2016.

[53] D.C. Department Of The Army Washington, *Administration Trip Books*, Defense Technical Information Center, 1998.

[54] ZWSA., *Zero Waste SA has transitioned to a new agency called Green Industries SA*, in *Government of South Australia*, 2017.

[55] N. Tojo, *Extended producer responsibility as a driver for design change-utopia or reality?* , The Int. Inst. for Indust. Environ. Econ. (2004).

[56] G. Zotos, A. Karagiannidis, S. Zampetoglou, A. Malamakis, I.S. Antonopoulos, S. Kontogianni, and G. Tchobanoglous, *Developing a holistic strategy for integrated waste management within municipal planning: Challenges, policies, solutions and perspectives for Hellenic municipalities in the zero-waste, low-cost direction* Waste manag. 29 (2009), pp. 1686-1692.

[57] A. Susty, and S. Venkannah, *Use of biomass from municipal solid waste as a Source of renewable energy in Mauritius* The J. of the Inst. of Engrg. Mauritius (2011).

[58] A.V.D. Wiel, B. Bossink, and E. Masurel, *Reverse logistics for waste reduction in cradle-to-cradle-oriented firms: waste management strategies in the Dutch metal industry*, Int J. of Technol Manag 60 (2012), pp. 96-113.

[59] K. Joseph, *Stakeholder participation for sustainable waste management*, Habitat Int. 30 (2006), pp. 863-871.