



CASE STUDY

## Solid waste management system for small island developing states

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### ABSTRACT

**BACKGROUND AND OBJECTIVES:** Solid waste management which entails the generation, storage, collection, transportation, processing, treatment and disposal of waste products is regarded as a challenge to many countries worldwide. The focus and methods vary in all territories given the wide range of factors which influence waste management. Small Island Developing States face unique challenges which are influenced by their peculiar physical, economic, social, political and institutional characteristic. Consequently, they require a solid waste management system tailored to their unique requirements.

**METHODS:** Qualitative and quantitative data were gathered between February and November 2019 from various primary and secondary sources using the following instruments and techniques: literature review of reports, news articles, legislation, journals and case studies; on-site observations; and administering questionnaires in the study area in October 2019. The study area comprised 3 communities which were representative of the waste management district, and were selected using the purposive sampling method, while the sample size of 0.3% of the households in the study area was selected randomly by administering questionnaires to anonymous respondents in arbitrary households in the communities. Using descriptive methods, data was tallied and grouped, then the content analysed to determine patterns, to answer questions to the problems and to determine relationships and themes. Findings were summarised, simplified and presented in formats such as graphs and tables and written descriptive accounts.

**FINDINGS:** Solid waste management affects all countries irrespective of their level of development. The focal point varies across societies. Small Island Developing States have a unique challenge posed by their particular characteristics. Given that each territory has a peculiar mix of factors, any solid waste management system derived must be exclusive to each. There is no single, ideal system which can be proposed. Whatever the system decided upon, it must encompass the socioeconomic, cultural, economic, legislative, institutional and environmental context of the territory, but most of all it must be accepted by the majority of stakeholders.

**CONCLUSION:** A solid waste management system must be unique to each area, given that there are many dynamic variables which affect the system. Consequently, the system derived from this study can only be applied in its entirety to the study area. Other areas with similar characteristics can lend examples from the study area.

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## INTRODUCTION

Solid waste management (SWM) is a critical infrastructural service which is integral to urban and environmental management worldwide (Sarkar and Singh, 2015). Like most other infrastructural services, it has come into sharp focus, since people are affected by the adverse impacts such as water and air pollution or overflowing landfills, forcing the responsible parties to address the problems of increased waste generation (Seadon 2010). In 2016, global annual waste generation was 2.01 billion tonnes of waste and, driven by rapid urbanisation and growing populations, the quantum is expected to increase to 3.4 billion tonnes over the next 30 years as indicated in the World Bank Report "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050" (Kaza et al., 2018). The same authors purport that SWM is critical for sustainable, healthy, and inclusive cities and communities and so, is highly important. Notwithstanding its importance, developing nations, much like their developed counterparts experience challenges in implementing a SWM system given its very dynamic nature. Di Maria et al. (2017) emphasize the strong correlation between the SWM system and the economic context of a society. They compared the Umbria region in Italy and the West Bank in Palestine to contrast solid waste management in developed and developing countries. They concluded that in developed countries, an adequate legal and economic framework, economic sustainability and political stability were vital for successful solid waste management, while political instability, inadequate awareness and inadequate economic revenues resulted in poor SWM in the developing country. Guerrero et al. (2013) state that solid waste management is a challenge for authorities in developing countries mainly due to increased waste generation. Although an effective SWMS is important in promoting healthy communities, the myriad of issues faced by developing countries cause this notion to be neglected (UNEP, 2018). The challenges faced by Small Island Developing States (SIDS) are unique because they have the distinctive characteristic of not only being geographically small but also having physical and topographic constraints coupled with peculiar economic, social, political and institutional characteristics which greatly hinder their ability to establish and implement sustainable waste disposal options (Agamuthu and Herat, 2014). Mohee et al.

(2015) observed that SWM is an ongoing problem in SIDS mainly due to the continuous increase in waste generation and the lack of effective and sustainable waste management strategies. As their lifestyles and economies continue to improve, their consumption and waste disposal patterns will continue to change radically (Shah et al., 2019). Institutional limitations defined as a lack of policies and strategies on behalf of the government to promote SWM approaches are one of the main challenges of SIDS (Mohee et al., 2015). Some implications to developing countries of not having a system of enforcing legislations for solid waste management are the creation of an environment which enables open dumping and open burning of waste, the failure to implement best practices such as segregation and take-back obligations on recyclables and the inability to collect revenue through taxes or charges (Bundhoo, 2018). Hence, they constantly endeavour to derive creative solutions to their SWM problems. Therefore, a study to assess the institutional, legislative, economic and physical context of SIDS and examine current global best practices in SWM was conducted under the broad headings of waste generation, waste collection, waste treatment/disposal and waste management. The aim of this study was to derive and propose a solid waste management system which will address the problems of municipal (household) waste management in SIDS such as the lack of physical space for landfills and lack of adequate regulatory, legislative, socioeconomic, institutional and technical frameworks to foster effective waste management. The aforementioned issues resulted in environmental issues such as: increasing levels of imported non-biodegradable goods, decreasing water quality and overexploitation of natural resources (UNEP, 2019). Research was conducted in the waste management district of Gros Islet in Saint Lucia in 2019.

## MATERIALS AND METHODS

### *Study area description*

The waste management district of Gros Islet is 1 of 11 in Saint Lucia in the North America (SLSWMA, 2016). It registered population expansion of 20.8% and shows trends for favourable population expansion (CSOSL, 2011). It is located north of the capital city of Castries and offers commercial, touristic, residential, industrial, institutional and recreational services to the entire island. Therefore, it requires a suitable

SWMS which caters to these characteristics. In that regard, the study population comprising 3 representative communities from the district was selected. The communities are representative of the broad socioeconomic and physical development levels in the island i.e. suburban, urban and rural based on empirical observation and literature review. *Redit* is a suburbanised residential area which is planned/organized, has paved streets, all structures enjoy street/curb frontage and a stable population of medium to high socio-economic class. It is located along the major road linking Gros Islet town to the capital -Castries City. *Gros Islet town* is the municipality head and an urban settlement with high population density, mixed socioeconomic groups and mixed residential and commercial activity and dynamic population where not all structures enjoy street frontage and are linked via footpaths. Although urbanised, development was haphazard/unplanned in certain sections. *Monchy* is a predominantly residential, rural area which displays potential for population increase in the near future as evidenced by the recently observed rise in advertisements for land for sale in the area as well as statistics from the Department of Physical Planning in Saint Lucia.

*Monchy* also has varied socioeconomic groups and is a mixed land use community located away from major thoroughfares. Not all structures enjoy curb front or even motorable access. Fig. 1 illustrates the location of the study area in Gros Islet District in the island of Saint Lucia at coordinates 13.9094° N and 60.9789° W, showing the communities of *Monchy*, *Redit* and *Gros Islet Town* from which the study population was selected.

#### Study design and data collection

Data was collected between February and November 2019 from a variety of primary and secondary sources of not older than 10 years. This helped to identify a study area and population, to determine the current SWM practices and situation in the study area, as well as to discover global best practices in waste management which could be applied to the study area. This included collection of information on the institutional, legislative, economic and physical context of waste management from desktop and literature reviews of reports, news articles, legislation journals and case studies, and where possible, on-site observation. The study population was selected using purposive sampling

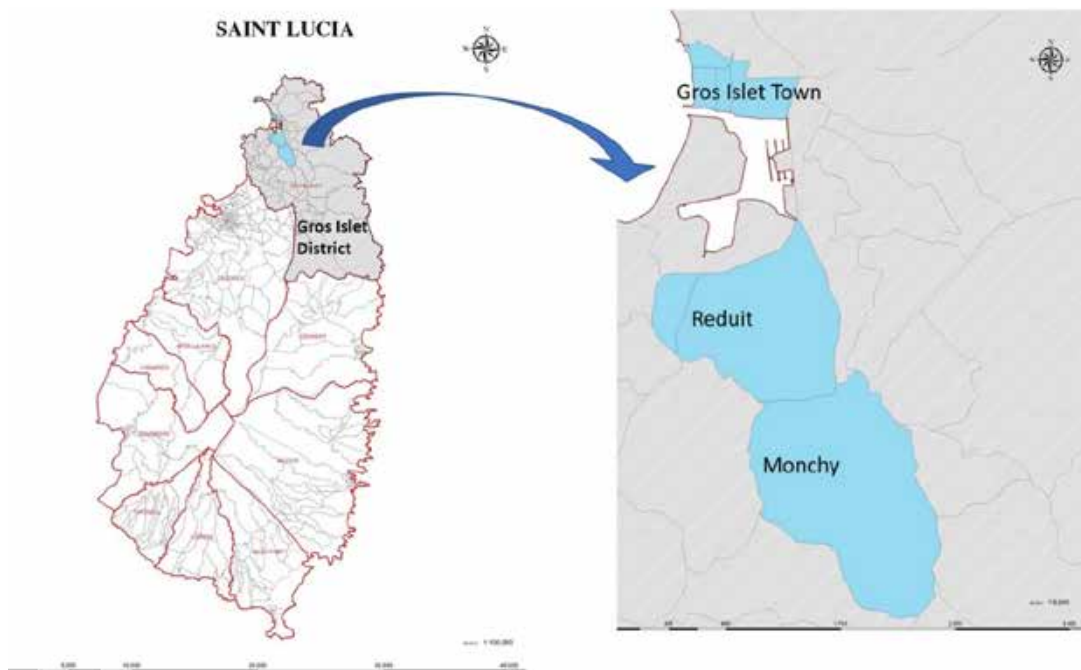


Fig. 1: Geographic location of the study area in district of Gros Islet in the island of Saint Lucia

(Gay *et al.*, 2009) since the subjects were selected from 3 different communities which were representative of the physical and economic development categories of the entire district. Questionnaires were randomly distributed in the study area in August 2019 to gather socioeconomic data on respondents (such as age, gender, education level, sector of employment, etc.), to discover respondents' perspectives, prejudices, limitations and attitudes to waste generation, collection, disposal, treatment and management. They comprised 2 open-ended, 11 closed-ended and 7 mixed questions. The mixed questions offered respondents a list of options including the "OTHER" option to allow them to express answers which may not have been in the list provided. They were administered in-person to 31 arbitrary households. Thirty of them were completed and returned. The unreturned questionnaire was not considered in the analysis. That is, 1 each from 10 households in each of the 3 communities studied. This constitutes approximately 0.3% of households in the study area or 0.1% of households per community. Although the sample size was small, responses were generally consistent among respondents. It should be noted that all United States Federal Government norms and ethics for conducting research involving human subjects as stipulated by the Institutional Review Board (IRB) were adhered to. Notwithstanding attempts to be fair in selecting a sample, sampling bias defined by Gay *et al.* (2009) as a sampling error caused by the researcher when some aspect of the sampling creates a bias in the data, may present itself. Some sources may be in the disparity in the microculture of the communities selected because the main criteria for selection of the sample were the predominant land use and level of urbanization. Consequently, practices and perspectives which would be affected by the culture of the community e.g. those based on the relationship among neighbours, the design of the community or socioeconomic status may be lost. Even so, any potential disparity is anticipated to have negligible effects on the results of the study.

#### *Data analysis*

The main variables analysed included the method of disposal, frequency of disposal, quantity of waste disposed, type of waste, administrative and social system and resident perspective on the aforementioned variables. Next, key strategies in

descriptive data analysis for qualitative data were applied. These included analysing the content; identifying themes and patterns; asking key questions to understand the problem or context; organisational review to understand the organisation and aspects relevant to the problem; noting antecedents and consequences; displaying findings in a summarised, simplified, meaningful format such as charts, graphs, concept maps, figures, etc. and finally, stating what is missing or noting the questions for which no answer was found. From the findings gaps were identified and became the basis for recommendations which were used to propose a SWM system for the study area.

#### **RESULTS AND DISCUSSION**

Solid waste management in the district is not homogenous and is characterized by many challenges (SLSWMA, 2016). The Annual report of 2014/2015 (most recently published) indicated that the SLSWMA offers free, twice weekly, municipal solid waste collection and once monthly bulk waste collection to all communities on the island with the help of contracted waste haulers who gather waste curbside where possible, in communal bins or at collection point service where households cannot be accessed by the collection vehicle. All waste is disposed of at the national landfill. (SLSWMA, 2016). At the time of this study, SWM practices did not cater for segregation of waste at the source. Therefore, all waste was disposed of together. Several small businesses currently engage in material recovery but there is no approved framework for their operations, so activities are not standardised (SLSWMA, 2012 as cited in Te-HsinTsai, 2013). Generally, more females (60%) participated in the study, in which persons aged 51 and older accounted for most respondents. This occurred because at the time that responses were collected in Reduit, the persons available to respond were retirees. This however is not representative of the willingness to respond or the demographic character of the sample or study area. Most respondents (30%) had attained primary education as the highest level, however, persons had attained varying levels including university education. The employment characteristics were varied. i.e. public/ private sectors, self-employed, technical /administrative, managerial /non-managerial personnel. Retired persons accounted for 23% of

respondents. There were marked difference between the results for the 3 communities studied, supporting claims that SMW challenges very even between urban and rural areas (De Medina-Salas *et al.*, 2020).

**Waste generation**

Most studies focus on the treatment and disposal of waste since the impacts of poor disposal are more immediately experienced. However, the amount of waste generated is as important as the disposal or treatment (Singh, *et al.*, 2018). Fortunately, emerging concepts of resource-efficiency and resource-recovery have shifted that focus (Lehman, 2010). Respondents ranked their communities as very clean in relation to waste management on a scale of 1 to 10. Forty-seven percent ascribed values of 10 or 8, while 20% ranked it at 9. There was no obvious

relationship between the perceived cleanliness and education level attained or gender of respondents based on responses to the questions asked. However, male response was outstanding ranking cleanliness at 8 and 7, while females gave ratings of 10, 9, 6 and 4 (Fig. 2).

Using an average plastic grocery shopping bag with a capacity of 2-3 gallons (4-5 kg.) as a point of reference, respondents quantified the number of bags of household waste generated per week (Fig. 3). 47% of respondents disposed of approximately 4-7 bags of waste, while 43% disposed of 1-3 bags. The remainder disposed of 8-10 bags. Monchy stood out in the category of 1-3 bags per household while Gros Islet town did in the category 4-7 bags. UNEP (2019) revealed that the average SIDS inhabitant generates approximately 2.3 kg of waste per day while the

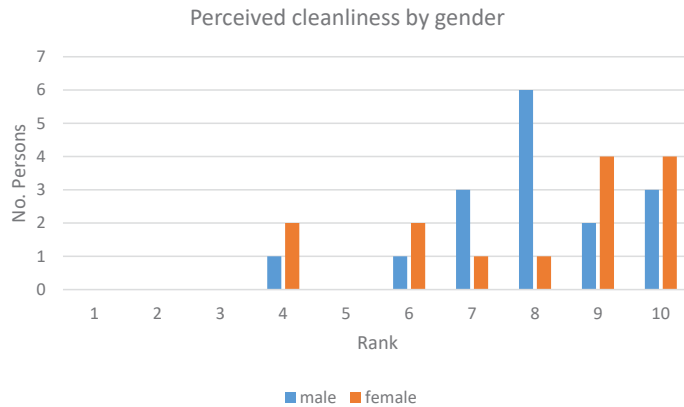


Fig. 2: Ranking community cleanliness by gender

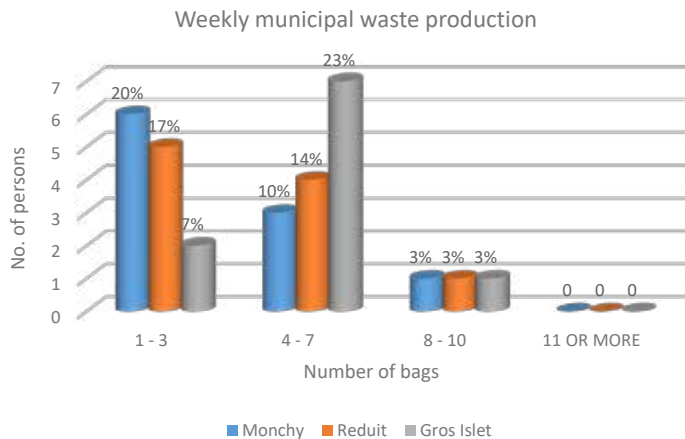


Fig. 3: Weekly municipal waste generation by community

global average is 1.55 kg.

The study did not consider the number of persons in the household, nor if the respondent was the head of the household. 37% of the respondents indicated that their consumption habits/patterns had changed to reduce the amount of household waste generated. Of these, 46% were 51 years and older and only 27% had attained university education as the highest level. Of those who had changed, 73% were from Gros Islet town. None of them were from Monchy (Table 1).

Finally, the comparison of responses by education level revealed that 37% of respondents who had not made any change had attained primary education as the highest means of formal education (Fig. 4).

The availability of free municipal waste collection service further exacerbated the issue of waste generation since it is convenient for residents to simply

place their waste at the roadside for collection, at only the cost of carrying the trash out. Responses displayed in Table 1 indicate that there was little to no effort to reduce the quantity of waste generated through changed consumption habits. This observation is consistent with the SLSWMA (2018) report which confirmed that residential waste represents the largest component of the waste stream; and underscores the need for education and awareness-building initiatives. It should also be noted, that organic waste generally accounts for a higher percentage of the total waste generated (SLSWMA, 2018). Residents of Gros Islet town seemed to realize that waste generation could be better managed and were taking steps to do so through changed consumption patterns. This may be due to the urban nature of Gros Islet town where space constraints may have awoken respondents'

Table 1: Changed consumption patterns

Total number of responses						
Category		Yes	%	No	%	Total
Age (years)	21-30	0	0	3	16	3
	31-40	2	18	3	16	5
	41-50	4	36	4	21	8
	51 +	5	46	9	47	14
Sub-total		11		19		30
Education level	PRIMARY	2	18	7	37	9
	SEC	1	9.5	4	21	5
	TEC/VOC	4	36	4	21	8
	UNI	3	27	2	10.5	5
	OTHER	1	9.5	2	10.5	3
Sub-total		11		19		30
Community	Monchy	0	0	10	53	10
	Reduit	3	27	7	37	10
	Gros Islet	8	73	2	10	10
Sub-total		11		19		30

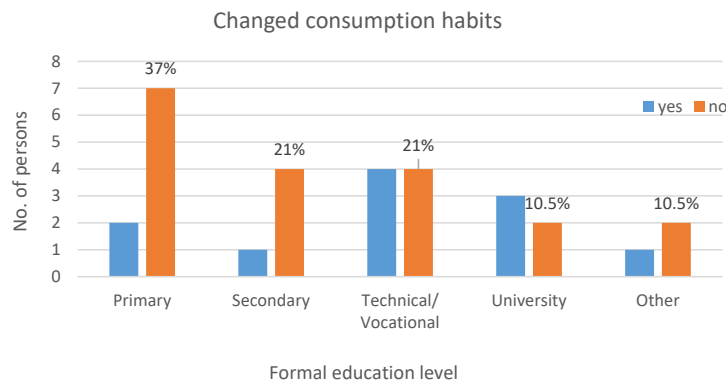


Fig. 4: Changed consumption habits by education level

awareness to the need for management of the limited land resource. It was noticeable however, that Gros Islet town recorded the greatest amount of waste generated, with most respondents indicating that they discarded on average 4-7 bags of trash per house per week. Thus, despite them having taken steps to change consumption patterns to reduce waste generation, they were still high emitters. UNEP (2019) identified the increasing rate of urbanization as a determinant of the need for well managed urban waste SWMS. The residents of Monchy, on the other hand, take no direct action to reduce the amount of waste which they generate. Residents indicated a willingness to effect changes which would help improve SWM in Saint Lucia among which were composting, repurposing waste, segregation/sorting, change in products, recycling, lifestyle changes e.g. less shopping and cooking, reduce consumption, whatever is enforced by the government. This reveals therefore that though they may have not taken major action, they were willing to minimize waste generation. Consequently, the limitations of the current system as it relates to waste generation include the lack of sustainable options for dealing with organics, green waste, and recyclable materials; the existence of a system which favors waste generation, unsustainable SWM practices and environmental pollution; waste generation is coupled with urbanization and population growth; and the failure of SLSWMA to formulate and implement policy and regulations relating to waste reduction, waste diversion and effective material recovery. There are several global initiatives which can be applied to improve the existing system. Ghosh (2016) recognised the need for sustainable SWM in China and India given the rapid population growth and the high volumes of waste generated and thus, proposed that the authority reduce the volume of waste disposed of in landfills e.g. through collection by door-to-door services or in communal containers as well as use of informal waste recyclers which played an important role in recovering recyclables. Various treatment options including incineration, composting, pyrolysis, industrial recycle and reuse, recycle and reuse to achieve the reduction of waste to landfills were identified Ghosh (2016). The German government experienced a shortage of landfill capacity coupled with the need to curb its use of natural resources and energy, so it promoted the "circular economy" which comprises waste separation, treatment and recycling

of waste to close substance cycles, thereby favouring sustainability. This it achieved through a programme of public sector measures which outlines existing and potential waste prevention measures at all levels. It focuses on waste prevention strategies and incentives along with advice, information and awareness-raising measures, and research and development projects (BMU, 2018). Japan disseminated a waste reduction policy based on the 3Rs namely reduce, reuse and recycle. The plan emphasized the need for a sustainable lifestyle by urging citizens and businesses to separate their waste at source. This philosophy was instilled in citizens and advocated through a gradual and phased approach. The policy was backed up with environmental education as well as concrete steps including increasingly rigorous separation rules, quality checks and sanctions. These components were further enhanced by the introduction of technological resources such as a mixture of disposal facilities and innovative civil engineering (Jones, 2015). The preceding examples illustrate the importance of environmental education supported by the relevant technologies and socioeconomic framework in addressing SWM issues. Diaz (2017) emphasized the need for rigorous environmental education in developing countries as a solution to the problems of waste management.

#### *Waste storage, collection and transportation*

All respondents confirmed that their community benefitted from garbage collection service, which they used and described as good. This service is offered with the help of contracted waste haulers who collect waste curbside where possible, via communal bins or collection points where households could not be accessed by the collection vehicle (SLSWMA, 2016). The service is also "good" because SLSWMA engages contractors and other major stakeholders in sensitization activities (SLSWMA, 2016). Residents attributed adequacy of service to various factors including "frequency of collection" which accounted for 22% of answers, "reliability" i.e. whether garbage was collected on collection days, which accounted for 19%, no charge for collection according to 13% and for 12% it was punctuality of collection (Fig. 5). Nonetheless, the service was not homogenous.

Nine percent of persons indicated that there were other factors which influenced their rating of service provided. Among them was unreliability of



**Solid waste management system**

collection evident through the change in collection schedules and irregular collection times/ days; decreased quality of service arising from the more sporadic nature of collection compared with past service; failure to collect bulk waste and green waste; the breakdown of trucks resulting in non-collection of waste; and a need for improvement in the service generally. An illustration of the factors affecting rank by community is presented in Fig. 6.

Monchy was most affected by unreliability in collection i.e. waste was not always collected on scheduled days. Monthly reports from the SLSWMA reflect breakdown of collection vehicles, delays at the landfill and high volumes of waste which exceed the capacity of the trucks for collection as some

reasons for non-collection. Gros Islet town and Reduit however, cited frequency of collection as an issue and this may be due to the volume of waste generated, thereby necessitating more frequent collection to clear the waste. The Authority confirmed that these 2 communities generate high volumes of green waste and organic waste and lack the space to store these between collection days (SLSWMA, 2018). Additionally, Gros Islet town is the municipal head for the district and as such, tends to be prioritized in decision-making matters. Reduit is a stable community, whose population comprises primarily older, affluent families who have an organized homeowner’s association and consequently are better able to take collective action to address issues within the community. Monchy on the

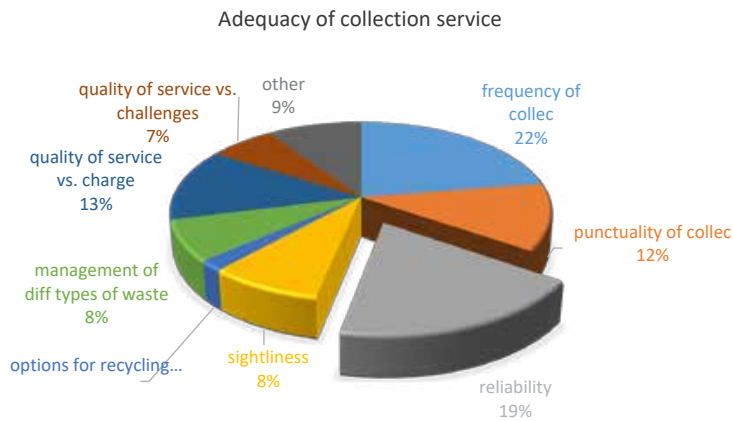


Fig. 5: Factors affecting residents rank of adequacy of garbage collection service

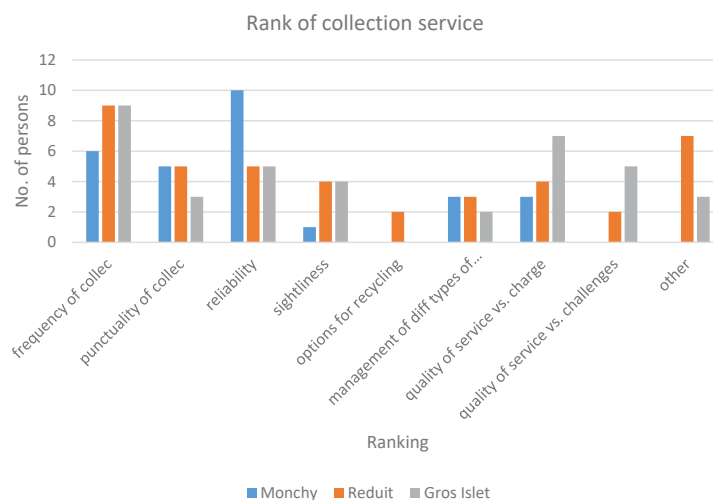


Fig. 6: Factors affecting ranking of service by community



other hand is more rural, less stable and characterized by constantly a changing population. Some participants (40%) indicated that they were willing to pay for improved garbage collection services, although females were less inclined to do so. Respondents from Gros Islet town were more willing to pay while those from Monchy were least willing. Given the foregoing, it was observed that several needs must be addressed to improve collection, storage and transportation in the study area. They were: source sorting of various streams of waste to allow for more efficient collection; provision of compatible infrastructure to enhance collection since the physical environment does not cater for trucks to collect waste at the curb for each household; a proper system and technology for storage and collection to minimize mismanagement between collection days; improved collection technology and system (e.g. the use of proper containers; enhanced education on appropriate practices; introduction of measures which are compatible with the characteristics of each community such as door to door collection, communal bins, incentives and/or sanctions, etc.; and formulation, implementation and enforcement of policies and regulations guiding waste collection for all stakeholders. A possible solution to the problem of waste collection was identified in a public-private-partnership (PPP) between locals and the municipal government in Managua, Nicaragua in which locals formed a cooperative called 'Manos Unidas' and collected waste from areas which are inaccessible by garbage trucks, cleaned the community and collected garbage from residents for a small fee, rather than inappropriate disposal and littering can serve as an applicable practice in the study area. The initiative helped the society respond to several developmental challenges such as poverty reduction, environmental protection, reduction of infant mortality, etc. Members of the communities enjoy a clean, healthy and safe environment while the waste collectors have a stable source of employment. This partnership thus solved two (2) social issues. (MGV Producciones, 2011). Another possible solution was found in the example where Jamaica improved service in 18 communities by means World Bank financing for results-based financing (RBF), waste collection infrastructure investments and community involvement. The initiative called Super 18, involved the provision of trucks, bins, etc. in the most vulnerable areas and generated job creation by introducing environmental wardens from the

communities to educate community members, to enforce waste collection and separation practices as well as to hold regular stakeholder meetings in each community as a means to engage members in the project and build trust. Consequently, it contributed to a crime prevention and reduction programme (Burrowes, 2017) and enhanced service delivery (The World Bank, 2019). Thus, authorities must be innovative in addressing SWM challenges.

#### *Waste processing, disposal/treatment*

Despite enjoying good collection service, nearly half of respondents indicated that they used other forms of waste disposal. Of those who do, the majority (50%) were from Reduit, followed by Gros Islet town and finally Monchy. There was a noticeable link between education level and use of alternative forms of garbage disposal when many residents with university education indicated that they used alternative methods in addition to the municipal collection service (Fig. 7).

The methods used however, were not dependent on education level i.e. some university graduates engaged in unsustainable methods such as burning while some primary school graduates practiced composting. This indicated that though respondents were cognizant of the need for utilizing alternative methods of waste disposal they may not sufficiently educated on sustainable practices. As it related to the quantity generated and disposed of, Monchy disposed of less waste through the municipal collection service. This can be attributed to the fact cadastral records from the Department of Physical Planning indicated that many households have more yard space to engage in composting, separating and open burning. This contrasts with Gros Islet town where respondents disposed of higher volumes via the municipal services. The residential lots in the community are generally smaller in area, more densely developed with little to no yard space, and neighbors are in closer proximity. Therefore, there is limited space to practice alternative forms of disposal/treatment. Another reason may be that Monchy is less urban, inhabitants can have backyard gardens and produce some of their own food, there are fewer fast-food restaurants and commercial activities, and thus generally generate less waste than the town of Gros Islet which is more urban. The younger respondents indicated that they generally disposed of less garbage (Fig. 8). This may be because they are away

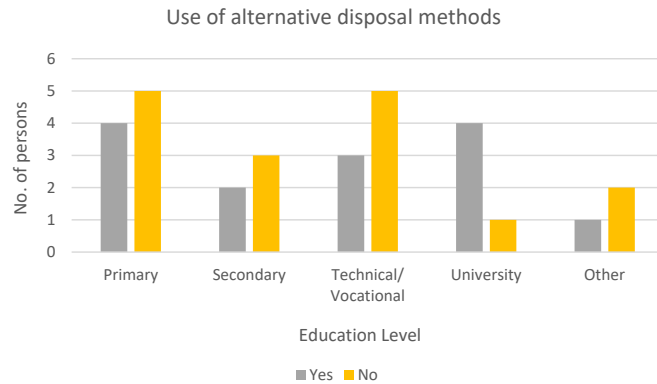


Fig. 7: Use of alternative garbage disposal options by education level

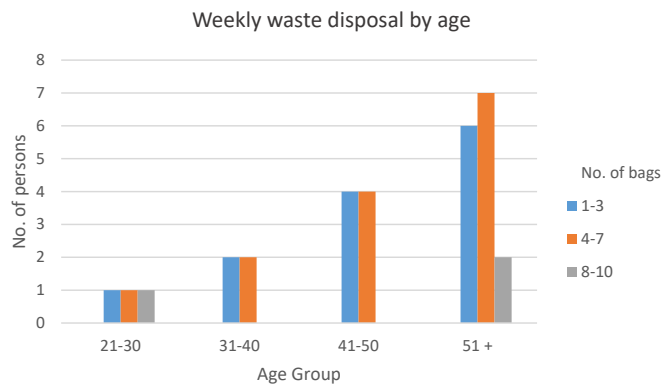


Fig. 8: Quantity of garbage disposed by age

from home more, eat out more, cook less and have different lifestyles than their older counterparts.

Some shortcomings of the current waste disposal system comprise, a non-communitarian attitude to waste disposal among residents whose only concern was individual wellbeing; need for education on environmentally friendly disposal practices; need for a system of monitoring and enforcement including incentives, against illegal and indiscriminate dumping; need for a system (inclusive of policies and regulations) to allow for alternative and sustainable disposal/treatment methods; existing landfills to be properly maintained; need for resources (for all stakeholders in the sector) to accomplish all the aforementioned initiatives. This is supported by [Grigorova et al. \(2017\)](#) who concluded that the increased quantity of the waste products of varied origin has driven the need for revolutionary SWM technologies particularly those focused on treatment and disposal methods. [Liikanen et al. \(2018\)](#) studied São Paulo, Brazil to discover

alternative treatment alternatives for MSW to reduce the volume of waste to landfills. They found that a progressive, stepped approach which built up on implemented methods was best.

#### Waste management services

Attitudes towards waste management are important. Females in the study area were less willing to pay to improve waste collection services. Moreover, they believed that their current practices were good and did not need to be changed. [Ocean Conservancy \(2019\)](#) emphasises the cross-cutting role of women in the waste management sector as consumers, recyclers, informal workers, etc. Participants from Gros Islet town were most willing to pay a fee while Monchy residents were least willing. This may be owed to the fact that Gros Islet town suffers the impacts of receiving lots of visitors who further exacerbate problems of the high volumes of waste generated, and consequently, needing disposal. Monchy on the other hand does not

receive visitors as frequently, and, given the land space residents practice alternate forms of waste disposal. As such, waste collection and disposal /treatment are less problematic for them. This factor (payment to improve service) was considered in the context that residents do not currently pay a fee and consequently may feel that the government is obligated to provide this free service. An alarming factor is that residents continue to engage in illegal dumping and indiscriminate littering despite the free service offered. It raised concerns of what their reaction will be if fees are imposed for collection service. Overall residents of Monchy showed more willingness to change their current waste management practices, and Redit showed less. The reasons indicated were similar and included concern for the environment (25%), concern for family well-being (22%) and benefits to them (24%). Other reasons presented were, their current practices were adequate, and wished to contribute to the common good of the community (Fig. 9).

Fear of fines and sanctions was seldom identified as a reason for changing disposal practices. This may be reflective of poor enforcement of existing regulations or a lack of enabling legislation which results in residents having little to no concern about punitive actions. Policy, legislation and government priority also play a major role in the sustainability of WMS (Henry et al. 2017). Residents of the study area were willing to try alternative methods of SWM but were concerned about the inconvenience of the new methods. This revealed that any proposal must consider awareness building

and culture change so that residents understand how lifestyle change could improve their circumstances and not necessarily be a negative thing. It also highlighted the need for public participation and involvement in decision making to ensure success (Chang and Pires, 2015). The SLSWMA engages in continuous public awareness activities to educate residents. However, this has not resulted in the requisite attitudinal change on a wide scale. This indicated that education alone is inadequate. This strengthens the need for supporting policy as supported by Guerrero et al. (2013) who state that adequate legislation is needed to ensure the effectiveness of solid waste management policy. Germany's successful recycling programme is attributed to appropriate policy coupled with the establishment of necessary systems of monitoring and enforcement (Nelles, et al., 2016). Respondents indicated willingness to make changes to improve waste management in their community (Fig. 10) and some remarked that they were already taking alternative action such as carry waste to recycling depot and cleaning their environs. Others stated that they would do whatever is enforced (by government) while yet other commented that they like the convenience of current practices and that whatever options are offered should not be too time consuming.

SLSWMA has power to elaborate policy and regulations to institutionalize SWM based on reduction, reuse, recycling, recovery and separation, however, it had not done so at the time of the study. Brassaw (2017) indicated that Germany's Waste

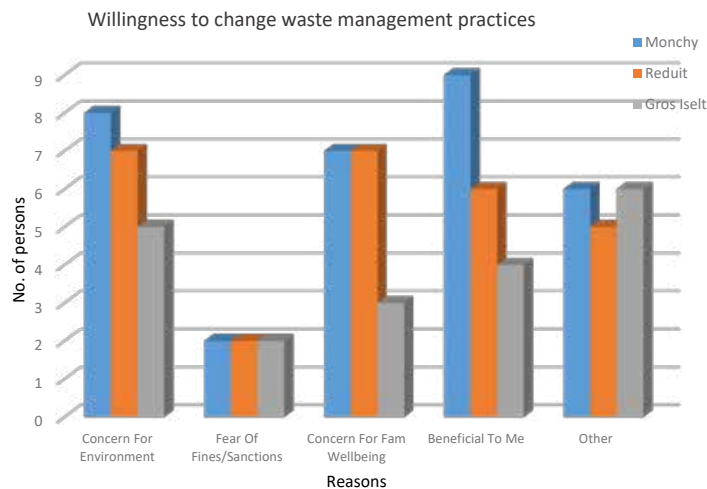


Fig. 9: Reasons impacting willingness to change waste management practices

### Changes for improved waste management

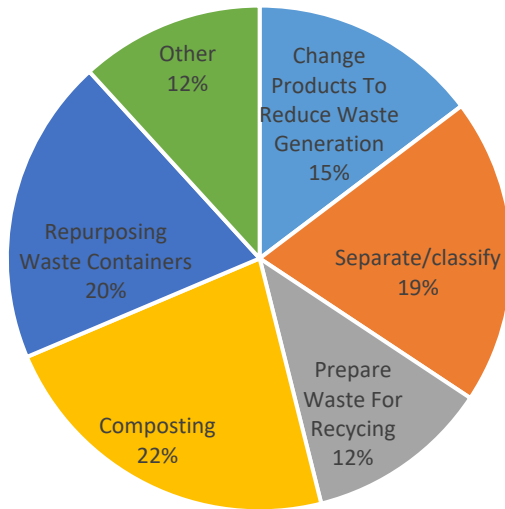


Fig. 10: Changes respondent willing to make for improved waste management in Saint Lucia

Management and Renewable Energy Programs are very successful because of strong government policy and citizens embracing recycling. Notwithstanding the lack of legislative instruments, SLSWMA continued its attempts to operate the disposal facilities according to international standards, attempting to apply best practices to prevent harm to human and environmental health (SLSWMA, 2016). It is however severely limited by a lack of resources, inadequate legislation/policy, and challenges in the environment, which is common to waste managers in developing countries. The current waste management services therefore suffers deficiencies such as the lack of waste management approaches appropriate for all age, gender and socioeconomic groups; lack of an education plan which promotes the positives of waste management such as economic and environmental benefits; lack of initiatives/approaches which adequately balance proper waste management with the residents' convenience; lack of a comprehensive management system and strategy which clearly identifies roles, responsibilities, resources, monitoring and enforcement activities, etc.; lack of capacity of the SLSWMA to effectively and efficiently implement and govern the current SWM system, and possibly the newly proposed one. Moreover, SLSWMA alone cannot address the existing deficiencies in the system. Willmott and Graci (2012) acknowledged the importance of collaborative

approaches to management and decision-making, to address problems too complex to be effectively resolved by independent action. Their research focused on providing an answer to governance and management issues as a means of improving operations, waste related behaviour, education and awareness matters, knowledge and network sharing and overall increased institutional capacity.

### CONCLUSION

Solid waste management is a global issue which affects all countries and so, must be urgently addressed since the impacts are wide-ranging and far-reaching. Many countries are seeking practical solutions, especially SIDS whose peculiar mix of physical and socioeconomic characteristics exacerbate their challenges. Although this research aimed to present a SWM system which could become a model for other SIDS, it was noted that SWM is a very dynamic activity and is influenced by multiple variables which differ for each territory. Consequently, each territory requires a system which is unique to its mix of characteristics. In the case of the study area the main requirements were resources (physical, technical, human and economic), environmental education and institutional strengthening. This was derived from assessment of the existing system as it relates to the socioeconomic and cultural framework, legislative and policy framework, institutional framework, and the environmental characteristics. Many of the deficiencies of the SLSWMA could be addressed by investing the requisite financial resources or implementing innovative measures such as sharing management activities with community organizations or establishing PPPs. The resultant framework would then have to be supported by widespread environmental education for all stakeholders, as well as the appropriate legislative and policy framework to result in changed behaviours. The researchers realized that the existing deficiencies in the SWMS in the study area are mammoth in scope and cannot all be addressed at once. Consequently, it identified the top actions which could be immediately implemented in order to address the SWM problem in the short to medium term. These are, the conduct of a legislative review inclusive of the requisite policies, regulations and amended legislation to establish an adequate legislative framework for effective SWM. Next would be the preparation of a comprehensive Solid Waste

Management Strategy since this will underpin many of the other actions needed. Thirdly, there would be need for widespread public environmental education and sensitization on the proposed solid waste management system, the role of the various actors, benefits to be derived, goals to be achieved and the actions to be implemented. An important activity would be the implementation of actions to change the perception of residents of the Waste Management Sector and associated professions such as waste haulers, pickers and material recovery crews, to make them more attractive and socially acceptable, while highlighting their importance. Finally, would be the creation of a sense of pride, belonging, stewardship and shared responsibility among residents, to their communities and environment. This study concluded that it is the responsibility of each society to assess its existing context and propose a system which will address its exclusive situation. Consequently, there is no existing SWMS which can be taken and applied directly to any other territory, however, certain components or practices can be borrowed, modified and applied to the unique context of the intended area.

#### AUTHOR CONTRIBUTIONS

J. Weekes is the main author who conducted on-site research, collated and interpreted data, analysed findings and prepared the manuscript. J.C. Musa, K. Malavé and C. Morales helped in the literature review, editing and data analysis.

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#### CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

#### ABBREVIATIONS

<i>BMU</i>	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
<i>collec</i>	Collection
<i>CSOSL</i>	Central Statistics Office of Saint Lucia
<i>diff</i>	Different
<i>e.g.</i>	For example
<i>etc.</i>	Etcetera
<i>i.e.</i>	That is
<i>IRB</i>	Institutional Review Board
<i>Fig.</i>	Figure
<i>Kg.</i>	Kilograms
<i>MGV Producciones</i>	María Gabriela Vega Producciones
<i>MSW</i>	Municipal solid waste
<i>No.</i>	Number
<i>PPP</i>	Public private partnerships
<i>RBF</i>	Results-based financing
<i>SIDS</i>	Small island developing states
<i>SLSWMA</i>	Saint Lucia Solid Waste Management Authority
<i>SWM</i>	Solid waste management
<i>UNEP</i>	United Nations Environment Programme
<i>vs.</i>	Versus
<i>%</i>	Percent

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