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Abstract.
This study is a third piece in a series of 10. It can be subdivided into: (i) identification of waste generators at the subject university; (ii) establishing background information on Solid-Waste-Management (SWM) system, from the service providers' point of view; (iii) observation and examination of current SWM practices; (iv) assessment of compliance of SWM practices with SWM laws and regulations; and (v) SWOT analysis. Main instruments, employed by the study, were limited to: document analysis; regular physical site visits and non-participant observations; questionnaire; and interviews. Besides maps, still photographs, and a flow chart diagram, were generated. Issues on: Universities and their role in achieving sustainability; Waste scavengers/pickers; Potential dangers of uncontrolled waste dumpsite; Socio-cultural barriers; and Financial assistance for SWM projects, were also elaborated on. Numerous barriers, to effective SWM, at the university, were reported; lack of readily available and sufficient allocation of financial resources, was identified as the most serious barrier. On the other hand, the both departments, responsible for SWM, have declared, that they have been stretched, indeed, to perform their duty, and they are just doing their very best, under the circumstances. The study also revealed that: the current SWM system, at the university, is largely unacceptable, as it is characterized as: (a) of inferior quality and accessibility of SWM; (b) inefficient; (c) of poor legitimacy and social acceptability; (d) potentially damaging to health and Environmental sustainability; and (e) financially incapable. In particular, this study has justified that on overall, the open and uncontrolled waste dumpsite, at the university, is making all: environmental pollution, health impacts, and safety violation, highly probable. People students, residing near the dumpsite, and waste scavengers, as well as ecosystems of the Kesses Dam complex and the Sosiani River, and ground water of Rift Valley Basin, are facing impending threat, from the open and uncontrolled dumpsite. The study also points out on the deficiencies/gaps, that need to be bridged, to meet the legal obligations, towards SWM, as there is a gross non-compliance with the legal SWM provisions (both: international and national). Results of the SWOT analysis, points out, that it is necessary to maximize both: strengths and opportunities, minimize the external threats, transform the identified weaknesses into strengths, and to take advantage of opportunities, along with minimizing both: internal weaknesses and external threats. In this regard, several tailored recommendations, were offered, including: on the actual operations (at both: a long-term and short-term scale); and on Social involvement, in WM. Besides, areas for further research were identified. The findings of this study will be used as a baseline, in further development of a tailored integrated SWM model/system, for the university. The study is, hopefully, also contributes (in its small way) to the body of knowledge on the subject matter.

Keywords: SWM, SWOT analysis, waste pickers, dumpsite, littering, ISWA, UN.
contributed to the problem of SWM, in most-developing-nations (Al-Khatib et al., 2010; Manaf et al., 2009; Saeed et al., 2009). In addition, Guerrero et al. (2013), identified some challenges, associated with SWM, as: increasing-generation of waste; burden, posed on municipal-budget, as a result of high-costs of waste-management; lack of understanding over a diversity of factors, that affect the different stages of waste-management; and linkages, necessary to enable the entire waste-handling-system functioning.

Globally, according to Shanghai-Manual (2012), the waste-sector is a significant contributor to greenhouse-gases (GHG)-emissions, accountable for approximately 5% of the global GHG-budget, with total-emissions of approximately 1,300 metric-tons of CO$_2$-equivalent, as reported by the Intergovernmental-Panels on Climate-Change (IPCC). In particular, solid-waste disposal sites release landfill-gases, such as: Methane (CH$_4$); Biogenic-carbon-dioxide (CO$_2$); Non methane-volatile organic-compounds (NMVOCs); Small amounts of nitrous-oxide (N$_2$O), nitrogen-oxides (NOx) and carbon-monoxide (CO). Methane is 21 times more potent than carbon-dioxide, aggravating problems, related to Global-warming.

Besides, inadequate-SWM-practices can lead to impacts on human-health, living-resources, and the environment, including: water-contamination, rodents and insect-attraction, and flooding, due to blocked-drainage (Starovoytova, 2018a; Ferronato et al., 2017; Ziraba et al., 2016; Hashemi et al., 2014; Oguntoyinbo, 2012; Cocarta et al., 2009; Beigl et al., 2008; USEPA, 2002). Impacts on human-health include: infection-transmission, physical-injury, non-communicable-diseases, and emotional and psychological-effects. In particular, pollutants from landfill, can increase the risk of cancer, birth-defects, reproductive-disorders, and respiratory-diseases (Porta et al., 2009). In addition, inadequate-SWM-systems, do substantially increase management and disposal-costs (UNEP, 2009a; Klundert & Anschutz, 2001).

Uncontrolled SW-disposal is still remains a pressing-environmental-issue, necessitating more research.

### 1.2. Universities and their role in achieving sustainability.

A period, between 2005 and 2014, was named, by the United-Nations, as a Decade for Education for Sustainable-Development. Education is also central to UNEP’s mandate of “inspiring, informing, and enabling nations and peoples to improve their quality of life, without compromising that of future-generations.” Education has also been described as humanity’s best-hope, and most-effective means, in the quest to achieve sustainable-development (UNEP, 2013).

The terms ‘sustainability’ and ‘sustainable-development’ have been used interchangeably; however, there are some distinctions (Langat, 2016):

Sustainability is the ultimate goal or destination. Exactly what defines the state of being, of what is sustainable (whether it be a society, logging, fishing, etc.), is informed by science, but ultimately depends on personal values and world-views. To achieve a state of environmental sustainability, a framework, or process, is needed. Certain conditions have to be met, and steps in the process toward sustainability have to be made. The framework of sustainable-development is the means for achieving sustainability.

So, in short, ‘sustainability’ refers to the goal, and ‘sustainable-development’ is the path, or framework, to achieve it.

On the other hand, Universities are the providers of the highest-level of recognized, structured education, in any country. Given the ascribed role of Universities in society, and the prevailing environmental and sustainability challenges, Universities are coming under increasing pressure to engage with, and respond to, climate-change, and other sustainable-development issues, and the associated risks and opportunities (M’Gonigle & Starke, 2006; Filho, 2000). Universities, hence, have a special responsibility to help define, and also to exemplify best-practice. Yet, when it comes to the University’s own operations, there is frequently a significant disconnect, particularly in developing countries; Kenya is not an exception. For instance, evidence shows that many universities are struggling with the concept and agenda of university greening; achievements to date have been scattered and unsystematic (Sharp, 2002). Besides, according to Langat (2016), Kenyan public universities are faced with a problem of waste management, energy use and conservation, water use, and management, toxic wastes, hospital wastes and radioactive waste management, air and noise pollution, and other critical environmental concerns, which negatively affect environmental sustainability.

To meet sustainability challenge requires a detailed understanding of the particulars of the university’s activities, as well as its environmental impacts (the key-areas for intervention, in relation to environmental aspects). According to UNEP (2013), ‘environmental aspects’ are identified as elements of an organization’s activities, products, or services, which can interact with the environment, for example energy consumption or waste generation.

Institutions of higher learning (universities), being autonomous, by nature (Armijo de Vega et al., 2003) should be given utmost attention, as regards WM. Since they, by their very nature, have the capacity to accommodate innovative WM practices, which would trickle to other communities, after being properly-
institutionalized. For-example, studies by Zilahy & Husingh (2009); and Velazquez et al. (2006), have revealed the-key-roles that universities can play, when promoting sustainable-programs, in-society.

Several-studies have also-been-conducted on WM, in educational institutions. For-example: Nagawiecki (2009) undertook a-waste-study at the-University of Idaho, USA; Smyth (2010), at the-Prince-George-campus, of-the-University of Northern-British-Columbia (UNBC); Chukwunonye (2015), conducted a-case-study of-the-University of Wolverhampton, UK; Ongondo & Williams (2011) researched on the-use and disposal of mobile-phones, among university-students in five-UK-universities; Hodoval et al. (2009), at the-University of Florida; Crigger et al. (2017), at the-Chapman-University; Armijo de Vega et al. (2003), at Mexican-universities; Bailey et al. (2015), at the-University of West-Indies, Cave-Hill-Campus, Barbados; Gequinto (2017), in-select state-universities, in-Philippines; Coker et al. (2017), at private-Nigerian-universities; and Dery (2014), in-two-Ghanaian-universities, among-others. Besides, Zhang (2011) examined the-greening of universities, through sustainable-WM. In-Kenya, in-particular, Aseto (2016), examined waste-management in the-university of Nairobi, (UoN), the-largest-public-university of Kenya; Gakungu (2012) undertook a-study on SWM, in-public Technical-Training Institutions, in-Kenya; Kiprop (2008), conducted research on waste, at the-Catholic University of East-Africa; and Mwilu (2006), researched the-matter, with emphasis towards Sustainability.

The-studies, reviewed, laid more-emphasis only on one-particular-objective-matter, and were restricted to specific-aspects of SWM-system. This-paper, on the-other-hand, provides a-fusion of five-important-aspects, in-the-large-scale-investigation, on SWM-practices, at the-university. To-develop and implement tailored-transformative-strategies, for the-subject-university, this-study, is focused on one of the-core biophysical-aspects of environmental-performance--waste-generation; and the-main activity- specific-aspect, such-as waste-management (including: generation, storage, collection, handling, and disposal). In-particular, the-study can-be subdivided into: (i) identification of waste-generators, at the-university; (ii) establishing background-information on SWM-system, from the-service-providers' point of view; (iii) observation and examination of current-SWM-practices; (iv) assessment of compliance of SWM-practices with SWM-laws and regulations; and (v) SWOT-analysis.

This-study will, hopefully, contribute valuable-information, to both; the-theory and practice, of SWM.


2.1. Background-information on Kenya and on the-subject-university.

The-study was conducted at the-Moi-University (MU), situated at Kesses-Constituency, the-Uasin Gishu-County, Kenya. MU is the-second-largest-public-university, after the-University of Nairobi. As of 2007, it had over 20,000 students, including 17,086 undergraduates. It operates eight-campuses and two-constituent-colleges (Starovoytova & Cherotich, 2016b). This-study is limited to-the-main-campus, of MU.

Analogous to Starovoytova (2017), interested-readers could-refer to Starovoytova et al. (2015) to-find informative-synopsis regarding Kenya, and its-educational-system. Besides, study by Starovoytova & Cherotich (2016a), provides valuable particulars, on MU, where the-study was conducted. Figure 1 shows the-geographical-position on the-subject-university.
2.2. Study-area, its-climate, land-use, and soil-type.

The-Kesses-Constituency, Uasin-Gishu-County of Kenya is not only the-focus of this-research; it-is also the-spatial-category, which defines the-boundaries of this study’s empirical-analysis. Kesses-Constituency has a-population of 135,979 people, and an-area of 299.00 Sq. Kms (GoK, 2013).

Sited on a-plateau, with an-average-elevation of 2,085m, the-county has a-cool and temperate-climate, with annual-temperatures, ranging-between 8.4°C and 27°C, while rainfall averages to 1055mm (https://en.climate-data.org/region/1667/). The-region has a-significant-amount of rainfall, even during the-driest-months of the-year. The-wettest-season, in Uasin-Gishu-County, is experienced between the-months of April and May, while the-driest-season comes between January and February. As a-result, the-climate is classified as Cfb (no dry-season, during both; cold and warm-summer-seasons), in accordance to the Köppen-Geiger climate-classification (CFS, 2017).

Kesses-Dam-complex and Sosiani-River are the-area’s sensitive-ecosystems. Ground-water, in the-area, is of Rift-Valley-Basin, averaging to 126 x 10^6 m^3/yr (CFS, 2017).

There are segregated-land-uses, in and around the-study-area. The-main-campus is located in-areas, which are predominantly-used for agricultural, residential, and commercial-land uses; there are no industries around the-campus. Top 10 dominant soil-types (% coverage) are (NAAIAP, 2014; GSP Workshop, 2013): Regosols (Weakly-developed-soils of loose-material) - 15.04; Cambisols (Young-soils) - 11.02; Luvisols (Soils with illuvial-accumulation of clay) - 8.13; Solonetz (Alkali soils) - 6.36; Ferralsols (Highly-weathered-soils) - 6.05; Fluvisols (Alluvial-soils) - 6.02; Arenosols (Sandy-soils) - 5.49; Calci-sols (Calcium-rich-soils) - 5.46; and Lixisols (Highly-weathered and poor-soils) - 5.15.

Average-wind-speed is around 8 kts, with the-wind-probability >= 4 Beaufort 23%. Figure 2 shows prevailing-wind (https://www.windfinder.com/windstatistics/eldoret).
To achieve its 5-objectives, the study employed the following approaches:

2.3. Identification of waste-generators.

To identify the main waste-generators, the study adopted case-study framework. Starovoytova et al. (2016b) cited Yi (2010) stating that a case-study is "an empirical-inquiry that investigates a contemporary phenomenon, within its real-life context, especially when the boundaries between phenomenon and context are not clearly-evident". The advantages of case-studies have been discussed, by a number of authors; some are summarized by Yi (2010), as follows: (1) They may aid the researcher in getting a holistic-view of a situation, a view, that includes the context, as well as the details; (2) They are full of details and may, therefore, lead to a more-complete understanding of some aspect of an event, or a situation. They, consequently, satisfy the three parts of a qualitative method, i.e. describing, understanding, and explaining; and (3) They may assist in getting effective information, that cannot, otherwise, be collected.

The term 'waste generator', in this study, means a source/producer, or an originator, of waste. The task of identification of the generators was done in consultation with relevant departments of MU. A map was generated, to illustrate the location/position of each of the identified waste-generators, within the MU main campus boundaries.

2.4. Questionnaire and Interviews on SWM-practices, and challenges, experienced.

Informant interviews and structured questionnaire were utilized in the study. Such tools do greatly assist in collection of essential data, in relatively short period of time, and are therefore a prerequisite to designing programs and strategies, appropriate to meet the fundamental objectives of waste management (Dery, 2014). This part of the study was superficially divided into 3 sequential parts, which shown in Figure 3.
2.5 Physical-Observation/Examination of prevailing-waste-management-system and practices.

In-general, observation increases range of relevance and reliability of data. Non-participant observation method, with a-schedule of the-observation-frequency, was used, by this-study, to-obtain information on the-current-practices, in the-SWM, at MU. Direct-observation was used, which allowed for the-comparison, between the-data, given by respondents, of the-interviews, and the-actual-scenario, on the-ground. Observations were conducted on each, of the-waste-generators, identified, at MU. Regular physical non-participant-observation, and field-visits were carried-out, for a-period of four-months, so as to-collect relevant-data. Still-photographs were also-used, to-capture the-relevant-scenes, for further-examination, besides two-maps and a-flow-chart-diagram were generated.

Moreover, the-World-Bank-indicators were used, as a-general-guide, in the-assessment of the-SWM-system. The-indicators are (see Da Zhu et al., 2008):

(1) Quality and accessibility of SWM: (i) Collection-coverage; (ii) Collection-frequency (per-week, collection-points, and distance to collection-points); and (iii) Collection-reliability;

(2) Efficiency: (i) equipment-performance (% of operational-state) and actually-operational (as a-waste-collection-vehicle could be in-order, but there is no money for fuel); (ii) absenteeism of workers, and (iii) diligence, in-performing assigned-tasks;

(3) Legitimacy and social-acceptability: (i) labor-conditions (job-status, wages, and benefits); (ii) Customer-service (channels, for customers, to-complain regarding the-service); and (iii) Customer satisfaction (perception about overall-cleanliness of the-campus);

(4) Health and Environmental-sustainability: (i) controlled-disposal (percentage of controlled vs. illegal-dumping); (ii) reuse and recycling (percentage of waste that is reused or recycled); (iii) Equipment pollution and emissions (Exhaust emission-control of waste-transporting-vehicles; control of litter; and washing of vehicles); and (iv) Hazardous-waste (percentage of total-hazardous-waste segregated in separate-bins and treated); and

(5) Financial-viability (can the-service sustain itself?): (i) accounting-systems (estimated total-cost of SWM, including cleaning, transfer, and disposal); (ii) Cost-recovery (percentage of total-cost, recovered); and (iii) Sources of investment finance (mechanisms to-invest in-the-system).

This-concise-paper presents only selected-sub-indicators (from the-ones listed-above), in the-assessment of overall-SWM-system, at MU-main-campus. Application of the-remaining-sub-indicators will be-presented, in the-subsequent-publications, of this-series.

2.6 Assessing compliance, by comparing current-SWM-practices, at MU, with the-relevant-laws and regulations.

Critical-assessment of the-current-status/the-baseline of SWM, in the-MU, against main, existing, and relevant National, County, and local-level laws, rules, policies, and strategies, were conducted. The-assessment-findings will point-out on the-deficiencies/gaps (if any), that need-to-be-bridged, to-meet the-legal-obligations, towards SWM.

2.7 SWOT-analysis.

The-key-tool, used for this-study, is SWOT-analysis-approach, which originated from the-business management-discipline and has-been widely-applied to a-wide-array of disciplines. Strengths, Weaknesses, Opportunities, and Threats are abbreviated-as SWOT (Johnson et al., 2002). This-analysis could-be undertaken for any idea, organization, person, product, program, system, or project (see Eheliyagoda, 2016; Green & Thorogood, 2014; Nardi, 2014; Enache, 2010). Recently, a-SWOT-analysis, on-environmental management, was carried-out, where the-author has claimed, that the-results could-facilitate improved environmental-performance (Yuan, 2013).

In-this-research, analogous to Srivastava et al. (2005), SWOT-analysis was applied to-develop tailored-action-plans for successful-implementation of new-initiatives for SWM.

3. Results and Analysis.

The-presentation of results will follow the-sequence, given in the-previous-section.

3.1 Waste Generators.

Figure 4 shows a-location-map, of seven solid-waste generators, identified at the-university.
3.2. Results of the Interviews and questionnaire, administered to SWM-service-providers.

In-person-interview, with: (i) the-Head of the-Public-Health-Department, MU; (ii) his-two-deputies; and (iii) three (50%) SWM-operational-staff were conducted. This was supplemented by the-information, obtained from the-questionnaire, administered to the-same-subject-sample. The-following-narrative provides a-synopsis of the-information, obtained:

The-decentralized, semi-autonomous-nature of the-university, in-conjunction-with its-remote- location (36 km from the-nearest-town--Elodret), have provided-for an-autonomous SWM system, at MU (not under the-Eldoret-municipality), with the-university providing-funding, for all the-relevant-activities. A-centralized SWM-approach is used, in-MU; Decisions have-to-await approval, from the-senior management, in-every-relevant-to SWM-department. The-Public-Health-Department, and the-Estate Department, both; under the-Central-services, of MU, are responsible for the-sanitation, and overall-upkeep of the-campus, including SWM. The-Public-Health-Department, of the-university, has been-charged with the-responsibility of collecting and disposing, of solid-wastes, within its-areas of jurisdiction, while the-Estate-Department is assigned duties of street-sweeping, general-repairs, and installations. Working-hours; for both-departments, is limited to Monday to Friday from 8am-5pm, excluding Saturdays, Sundays, and public-holidays. The-casual-workers of the-Estates-department, however, are available/on call, for any-emergency.

The-number of personnel, responsible for actual-waste-collection and disposal, are six; two-drivers, and four waste-collectors, they call them ‘sanitary-attendants’. From these-six, one-driver, and three sanitary-attendants, are casual-workers, constituting 67%. The-casuals are usually paid KES 300.00 (USD 3.00), per-day. It was claimed, that all of them have-received, some-training, e.g., the-last-training was on Hazard-Waste-management on 24th November, 2016.

The-department only has one-vehicle for collection, and transportation of waste; the-tractor pulls a carrier, of approximate-capacity of 3 tons. The-collected-waste is taken to a-dumpsite, behind Soweto-hostels. Personal-protective-gear is, claimed, to-be-provided to the-relevant-workers, including: gloves, boots, and nose-masks.

Waste-segregation, at-source, is only being-carried-out at the-Health-Center-facility, MU (including clinic and in-patient-admission-ward). Recycling-processes are not practiced; only office-paper is recycled, by an-external-party. Incineration-facilities are available at the-Health-Center.

Current-annual-budget-allocation, for SWM-activities, at MU, is KES 500,000.00 (USD 5,000.00); while Recurrent-expenditure is KES 20,000.00 (USD 200.00), weekly, mainly, to-fuel the-waste-collection vehicle.

From the-analysis of the-interviews and from the-responses to the-questionnaire, several-problems were also-reported, by the-service-provider (the-PHD, MU), while managing SW; these were-categorized, by the-respondents, as:
(a) **Very-serious:** Lack of readily-available, and sufficient-allocation of financial-resources; Lack of service-quality (*not* frequent enough, spills, etc.); *No* specialized (covered)-vehicle; Lack of number of vehicles; Old-vehicle/equipment with frequent-breakdown; and Difficulty obtaining spare-parts;

(b) **Serious:** Inadequate-service-coverage (some-areas were *not* given service); Lack of trained personnel; Lack of waste-collection-equipment/tools; Payment of wages, is also irregular (sometimes leading-to strikes of waste-collectors, lasting for a-long-time, leaving the-waste uncleaved); and

(c) **Occasional:** sometimes (i) personal-protective-gear was *not* available/provided/worn, and also their-appropriate-sizes were difficult to-get; and (ii) difficulty have being experienced, in-obtaining sufficient-quantity of inert-material/soil, to-cover the-waste, at the-dumpsite, so, currently, it *is* *not* practiced, whatsoever.

In-addition, the-department lacks an-office-space, changing-rooms, and showers, for WM-workers. Besides, severe-understaffing of SWM-workers, resulted that some of them, were assigned larger-areas to-handle, beyond their-capability. Moreover, there are *no* clear-plans to-enhance workers-efficiency, or improve working-conditions, through the-provision of modern-equipment, and appropriate-protective-gear. Also there is *no* amortization-fund, pointing at poor-planning, of SWM-activities.

Another-interview was conducted with the-Head, Grounds-section, the-Estates-Department, and 13 sanitary-attendants (50% of the work-force); this-section is responsible, mainly, for street-sweeping, grass-cutting (*via* mechanical and manual-means), cleaning of drainage-channels, and tree-nursery. The-current-number of staff is 15 full-time-workers, and 11 casuals; full-time-staff operate Mondays to Fridays (8am to 5pm), while casuals work also on-Saturdays. The-HoD have complained, that the-department is chronically-understaffed, as last-year, alone, they have lost 24 people (including those, who retired, died, shifted to other-sections, and left MU-completely). Regarding equipment, they currently have: (i) a-tractor, with attached gyro-mower, to-cut the-grass, at the-large areas, of MU, such-as: Graduation-ground, sports-grounds, and others; and (ii) 6 smaller, portable-grass-cutting-machines. Some-of-the-machines are out of order (waiting for spare-parts), one has reached its-physical-death (beyond-repair), and therefore, the-majority of work is done manually, with such-primitive-tools, as slashes and machetes, hence labor-intensive, and time-consuming. The-HoD, also pointed-out on financial constraints, as the-MU annually-allocates only KES 1.1 million (USD 11,000.00), for their-daily-operations; the-allocation is *not* sufficient, to-cater for a-campus of 300 acres. Besides, MU pays the-casual-workers, and also pays an-annual-allowance, of KES 6,000.00 (USD 60.00), for each-full-time-worker, to-purchase their-own-uniforms and protective-gear. In-addition, lack of a-reliable-mechanic was identified as a-real-problem, delaying repairs and also adding an-extra-expense, for outsourcing of services. The-HoD have also-explained, that it *is* being a-common-practice, that, for-example, they recruit a-mechanic, but after sometime, he is relocated (by his-own-initiative), to-work as-a-driver, which is more-prestigious.

In-addition, both-departments do *not* conduct, or facilitate, routine-health-check-ups for all-the-WM-workers. Besides, there is lack of inspectorate; when one complains (verbally), they-sing only one-song: ’*no* money and *no* people’. There are also *no* specific (clear-cut) prescribed-responsibilities, so two-departments, the-Estates and the-Public-Health, are shifting responsibility to each-other. Logical- solution, to this-problem, is to-eliminate overlaps, in the-responsibilities, relevant to-SWM, and formulate, in-consultation with both-departments, an-unambiguous and exclusive-list of tasks, for each-department, avoiding any-duplication.

On-the-other-hand, the-management of both-departments, stated that they have being stretched, indeed, to-perform their-duty, and they are just doing their-very-best, under-the-circumstances.

### 3.3. Observed current-WM-practices, at MU.

The-observed-practices, at-the-university, included: waste-generation; street-sweeping; waste-storage (before collection); waste-collection; transportation of the-collected-waste, to a-dumpsite; off-loading of the-wastes; and final-disposal. Waste-generation, together-with its-characterization, will-be presented in-a-separate-publication. The-following-sections will detail the-results of the-non-participant-observations, of SWM-process, at MU.

#### 3.3.1. Street-Sweeping.

At MU, each-sweeper is given (verbally) a-specific-area, of the-street-road, for sweeping. Sweeping is supposed to be-done twice a-day; in-the-morning-hours, and the-same-area repeated, after lunch; this, however, is *not* strictly practiced, most of the-times. Several-sweepers were, hence, asked why they do *not* usually sweep the-second-time. Their-answers varied, but the-most-interesting-point, to-note, is that *none* of them actually-denied that the-practice of half-service-provision does exist. Regarding the-answers, for-example: some said, it is because the-street is still clean, or relatively-clean, others said that usually there is *no* supervision in the-afternoons, so they just go home. Yet another-group said that they feel embarrassed, as some-students looking at them with disgust, or even intentionally littering, in-front of them. It was also reported, that some-sweepers have developed a-habit, not coming to-work, for one or even, few-days, every-week. This, however, is very-difficult to-prove, as the-suspected-workers keep insisting that they indeed cleaned the-relevant-streets, which afterwards become dirty again, due-to irresponsible behavior/ littering of the-students, staff, market-vendors, and bus and motorbike-drivers, among-others.
In-addition, it-is a-daily-practice, for nearby-village-shepherds, to-bring their-cattle to-graze, at the-university-campus, considering such-practice as mutually-beneficial; on one-side, there is no enough-workers, available, to-constantly-cut the-grass, so it grows, uncontrollable all-over the-vast-area of the-university, which on-the-other-side provide plenty of fresh-food, to ever-hungry-cattle. The-issue, however, is that this-practice leave visible-marks of the-cattle'-presence, in a-form of unsightly-animal waste, all-over the-MU-streets. In-the-author’ opinion, such-practices cannot be eliminated, completely, as they were traditionally-practiced, by the-villages, even before the-establishment of the-university, in 1984. Nevertheless, to-preserve decent-social-relationships with the-surrounding-communities, there should-be some-form of agreement, between the-university-administration and the-area-chiefs, of the-local community that, for the-practice to-continue, cleaning/removal of animal-waste should be-the-responsibility of the-shepherds. Open-discussion, with the-affected-villages, hence, is necessary to-emphasize the-importance of the-animal-waste-removal exercise, and also, villages should establish and facilitate some-sort of a-compensation, for the-additional-work, to-be-done by the-shepherds.

It was also-observed, that some-very-visible-areas, such-as Administration-block, Student-Centre, Library, MU-medical-Centre, are relatively-clean. Many-other-areas, however, are neglected, for-example staff-quarters (accommodating more-than 150 families), are rarely-cleaned, if at all, forcing residing-staff to-recruit private-cleaners, to-sweep, mainly inside the-compound of a-particular-house, and in-front of the-house, leaving streets largely-unattended, and therefore, with-time, filthy.

Besides, although, considered as an-essential-service, street-sweeping is not carried-out on-Saturdays, Sundays, and on public-holidays. This is particularly-visible on the-next-day of Graduation-ceremony and subsequent-celebrations (conducted twice a-year), when campus is usually drowning in all-sort of waste, left by graduates and their-invitees. It usually takes some-time, for the-small-team of sweepers, to-bring the-campus, to a-relatively-acceptable/decent-status.

Another-shocking-practice, was witnessed, by the-author, severally, that some-students, particularly the-first-years (leaving on the-upper-floors of the-hostels), throw their-waste, thorough the-windows, of their-residence/hostels, directly to-the-street, where people walk. They also-perceive-it as-a-laughable-matter/a-joke, as some of them, do laugh very-loudly, especially when their food waste is dropped, directly on somebody’ head or shoulders.

In-addition, the-street-sweepers are not given appropriate-tools, to-perform their-duties, effectively. For-example, uniforms, such-as overcoats, aprons, gloves, and shoes, are not provided, at all; workers, therefore, have to-use their-own-clothes, some of which might-be old and torn, adding negatively to their-own-image, as well-as to the-image of the-university. This, in-turn, may amplify the-already bad-attitude towards waste-handlers and street-sweepers. In-addition, it was also-observed, that they are given short-handled-brooms (the-cheapest, available in-the-market), which necessitate constant-bending (at an-angle higher than the-ergonomic-limit of 45°), with potential-risk of occupational-back-injury, or respiratory-diseases, due-to exposure to the-dust, disturbed, by sweeping. It-can also-cause fatigue, and overall-loss of productivity. Besides, cheap-sweeping-equipment/tools generally can last only for a-short-time, which manifested in a-hip of broken-tools, discarded in the-store. On-observation, the-tools, still used, were very-dirty, probably never cleaned, after use.

Meticulous daily-sweeping of streets, and public-places, at-MU, is paramount, because waste-littering is still-common, and massive. The-identified current-practice show lack of appropriate planning, supervision, and control, and hence, inadequate-use of personnel, which is a-problem, contributing to inefficient-SWM, at MU. To-improve the-situation, the-allocation of work, should be rotational, to-facilitate working on-weekends, and on public-holidays. Workers should also be-provided with appropriate-uniforms, and proper cleaning-equipment (sweeping-tools).

Ironically, people generally assume and expect, that waste, thrown on the-streets, would-be picked-up, through street-sweeping. There is also a-large-number of other-causes, that can-contribute to an-increase in public-littering rates, such-as: a-lack of social-pressure to-prevent littering; absence of realistic-penalties or consistent-enforcement; and lack of knowledge of the-environmental-effects of littering (Al-Khatib et al., 2009). Other-causes also-include the-amount of litter, already-present, at a-particular-site; presence of signs, referring to-litter; and the-number and/or placement and appearance (if any) of waste-collection-bins, at the-site. Convenience of garbage-bins has-been-cited, many-times, in-research, as a-priority, when disposing of trash, and when these are not present, or lacking in-areas, this has-been reason-enough to-litter (Henry et al., 2006).

Overall, street-sweeping is sporadic and inefficient; service is limited to-high-visibility-areas, such-as: Administration-block, Library, students-Centre, etc., while far-away/hidden-places, such-as staff houses, students-hostels, etc. are not properly attended to.

The-amount of litter, and indiscriminate-dumping, in-MU, suggest that there is a-poor-waste-handling attitude, among campus-residents, workers, and visitors. In-turn, the-effect of living, in an-unhygienic and untidy-environment may lead people to-become demoralized, and less-motivated to-improve-conditions around-them. Negative-perception on-waste, and on-waste-handlers, was found to-highly-affect the-civil-society-
commitment, as households, and business-sector, view them as poor and illegitimate-workers, and treat them harshly, as throwing-stones, and calling-names (Sibanda et al., 2017). There is, therefore, a need to improve public-awareness and increase the participation of residents, in waste-management issues. This recommendation is in accord with Sibanda et al. (2017). Besides, according to Al-Khatib et al. (2009), to get a clearer understanding of the complexity of street-litter problems, integration, between socio-economic and environmental studies, is essential. Such integrated study is, therefore, recommended, where knowledge, attitudes, and practices, on SWM, at MU, will be examined.

3.3.2. Waste-storage.
Discarded waste materials are stored, at points of generation, before collection. The storage of waste, prior to collection, or disposal, is an important aspect of waste-handling practices. Three options for primary storage and collection, at MU, are: (i) door-to-door; (ii) community waste bins (known as the ‘bring system’); and (3) stationary street waste bins.

In the ‘door-to-door’ approach, there are two principal variants, at MU; one is being practiced in the staff houses, and the other is, mainly, in student hostels. Each of the residing families of the staff houses is responsible for collecting and storing their waste, and for maintaining their collection container(s); hence, this method could be considered as potentially more sanitary. However, taking into consideration, that there are more than 200 staff houses, at the campus, the number of bins, required is correspondingly large; besides, significant human resources are required for door-to-door waste collection, and also it takes time to accomplish the entire exercise. In the student hostels, the method is a bit different, by the fact, that students drop their waste into a designated waste bin, positioned on every floor (usually in the bathroom area). Then, the hostel caretaker brings all the bins, on the ground floor, awaiting collection, which ideally supposed to be done, daily. In both cases, mobile plastic and metal waste bins are used, for waste storage; they measure up to a limited capacity of 240 liters (contents only), some do not have lids (due to being broken, stolen, or misplaced). Bins, therefore, frequently overflow, because of their inadequate capacity, and often more waste is found, outside the bin, than in it. Besides, as most of the bins do not have lids, it attracts rats and other scavengers.

In the ‘bring system’, residents collect their waste, in paper bags or in small containers, then they have to bring the collected waste, by themselves, and deposit it into large capacity waste cubicules, made of metal, and positioned outside, but in relatively close proximity to hostels; in some hostels, the collection is done by hostels’ caretakers. This system provides 24-hour availability to residents, also the waste is stored outside, the buildings, supposedly make it even more sanitary. Ideally, such bins should not be emptied, but exchanged, by a clean empty bin, with a help of a truck. In MU, however, the bins are unloaded, into a tractor, manually. After emptying, the bins (inside and outside), as well as the area around and under the bin are supposed to be cleaned; this however is rarely practiced, if at all. Also it was observed, that the cubicules, have not been emptied in time, overflow, thereby causing an unhygienic and unsightly situation. This situation is made even worse, because students tend to throw their waste, at this bins, from a distance, because they do not want to come too close, hence leaving the waste, lying on the ground. In addition, when waste bins are not emptied, on a regular basis, this brings all sort of animal, vultures and scavengers, such as birds, rats, street dogs, cats, and even small monkeys. Sometimes, one can even witness cruel and noisy animal fights for food, resulting in even more mess, and creating visual pollution.

The last waste storage mode, utilized, at MU, is a street waste bin. Street waste bins are available, to a very limited extend, as only 50 are currently installed, for 14,000 students and staff. Observations revealed, that some of the bins are overflowing, while others are empty not utilized. This could be attributed to the fact that, the street bins are not strategically placed, for easy access. Besides, emptying intervals could be irregular, as it was observed, at times, some bins were full to capacity, or even overflowing, as they were not sufficient to the students’ population, at the campus. Waste, over flown, from the street waste bins, if not regularly collected, being blown away and spread by wind, attracting scavengers, animals, and birds. Overall, street dust bins were found highly insufficient, small in size, distributed too far apart, from each other.

There are also small plastic containers, available inside the offices, and laboratories, for waste collection. The waste from these containers, is supposed to be emptied, daily, consolidated, and brought, in front of every office building, at the road side, awaiting centralized collection. There are, however, no waste containers in classrooms.

Overall, the waste storage facilities are provided, at MU, however, they are inadequate, particularly so when waste collection is irregular. Not only financial constraints, but also widespread lack of proper coordination, and communication, could be contributing to such state of affairs, at the university.

3.3.3. Waste Collection and Transportation.
At MU, collection of the waste, from each of the identified waste generators, is done manually. Figure 5 shows the common practice of waste collection (e.g., from the staff houses). From the figure, it is clear, that waste collection is done, by a sanitary attendant, manually, wearing his own clothes (not a uniform), and casual light-
open-shoes. *Only* gloves were used by a-collector; overcoat, boots, and face-mask, were *not* utilized. Although, from the-interview, it was claimed, that PPEs are provided-to each-waste-collector. Practiced manual-loading of waste, without use of appropriate-protective-gears, is potentially-dangerous to the-health of workers. Besides, the-lack of PPEs, it was observed, that first-aid-kit was also *not* available. Contreau-Levine (2000) has emphasized, that inadequate safety-gear, low-wages, advanced-age, and weak-workers, in the-SWM-activities put the-workers to-health-hazard-situations. In-addition, it is time-consuming-activity, resulting in-loss of labor-productivity.

![Figure 5: An-example of manual-waste-collection-practice.](image)

At the-MU, a-motorized-method of waste-transportation *via* a-tractor, which pulls a-carrier/trailer, of approximate-capacity of 3 tons, is used; the-carrier is open-bed-type (*not* covered). Besides, tractor trailer is *not* fitted with any-sort of compactors, necessitating the-transportation of *loose* waste and, hence, imposing a-constraint on the-capacity of the-collection-system, and contributing to-the-increased cost of waste-transportation, as more-trips will-be required. In-addition, it was observed, that the-waste, transported in an-open-trailer, with the-tendency to-fall-off, at every-bump, pothole, or turn, on the-road, loses part of its-load, during the-trips to the-disposal-site, contributing to even-more-street-litter, at the-MU. According to several-authors, such-as, for-example: Zerboc (2003); Medina (2002); Zurbrugg & Ahmed (2000); and Hoornweg *et al.* (1999), improper-transportation-means, in-conjunction-with poor-state of many-roads, is a-typical-problem, for developing-nations, around the-world. It was also-observed, that many-flies cover the-garbage-collection-trailer, on its-journey, to the-disposal-site; this-finding is in-accord-with Medina (2002).

It was also-observed, several-times, during the-observation-period, that as-soon-as the-collected waste, is deposited into the-trailer, the-sanitary-attendants, with *no* hesitation, begin openly and quickly, yet very-attentively, and carefully, sorting-out valuable-materials, from the-waste. There is a-high-probability, that these-worker have a-deal/illegal-contract, with the-scare-dealers, who, in-turn, re-sell the-materials to a-recycling-industry. This-practice shows, those waste-collectors, do indeed, understand the-value of waste; however, this-knowledge is used, primarily, for selfish-gains, with *no* profits to-the-MU. The-study, hence, recommends, that sorting, at-source, should-be-introduced at MU, which in-turn, will assist is waste 3Rs, in therefore contribute to-cost-recovery for WM-operations.

Logically, due-to *only one* designated-vehicle, available for the-WM, all-the-MU-areas *cannot* be serviced properly. Besides, it brings a-complete-freeze of WM-operations, when it breaks down. Moreover, the-vehicle is poorly-maintained, as only-emergency/breakdown-maintenance is practiced. This is due-to-the-fact, that required-spare-parts are *not* readily-available, because the MU-procurement-system is cumbersome, and slow, in-addition, to-service financial-constrains, experienced by the-MU. Therefore, the-vehicle should-be-serviced regularly to-minimize breakdowns, and the-number of vehicles, should, ideally, be increased, to-avoid unpleasant-delays.

Above-reasons, individually, or cumulatively, leading to-situations, where the-tractor stays out of service, for long-periods of time (even for weeks, awaiting funds, for replacement to-be-processed, due-to centralized-mode of SWM-system, lack of finance; and a-high-level of dependency on the-limited-budget, allocated, for SWM). At the-same-time, the-two-drivers earned their-normal-pay, which is a-financial-lost, to the-institution.

Besides, vehicle-movement is *not* monitored, in-terms of quantity of waste carried, number of trips
made, and optimum-use of personnel; moreover, there is an-inefficient transport-logistics, as many-times, empty tractor-trailer was observed, going up and down, within the-campus.

Due-to relatively-small-capacity, of the-trailer, many-trips are required to-collect all the-waste, generated at MU (see Figure 6).

Figure 6: Transportation-routs, at MU.

Overall, transportation of collected-waste is performed very-inadequately and in an-unhygienic-manner.

3.3.4. Off-loading of the-collected-waste.
Because no segregation of waste, at its-source, takes place, waste of all-types, including some-infectious waste, from the-medical-facility, and even hazardous-waste, from some of the-laboratories, are deposited at the-dumpsite. Off-loading, of the-collected-waste, is done manually, with a-metallic-shovel, by the-same sanitary-attendants, who collects the-waste.

The-waste, off-loaded from the-tractor-trailer, haphazardly, and is neither spread nor compacted, or covered with the-soil, as demanded by the-best-practices. On-the-other-hand, the-major-soil-type, in-the-area (see section 2.2), is Regosols (Weakly-developed-soils of loose-material), which presumably easy to-dig. In-addition, the-dumpsite is surrounded by a-vast-unutilized-land; therefore the-claims of the-workers, that they have difficulty to-get cover-materials, is not justified (just an-excuse).

Instead of providing soil-cover, waste-is just left, uncovered, to-degrade/decompose, under natural-conditions. Liquid, seeping through the-rotting-waste called leachate, which pollutes underground water-table, and subsequently surrounding-water-bodies. In-addition, decomposing-waste contaminates the-air with methane-emissions, and smoke, due to uncontrolled-burning, creating serious-health and environmental-problems, more-particularly, for the-students, living in the-vicinity of the dumping-ground, e.g., the-near-by-hostels (see Figure/map 7).

Taking into-account the-very-close proximity of hostels to the-dumpsite, and the-prevailing direction of the-wind, in the-area (see Figure 2), dispersion of air-pollutants, alongside with the-offensive smell, is highly-possible.

In-addition, there is no weighting-machine, and therefore, the-weight is only approximated, based on the-average-trailer-capacity of 3 tons. This-approximation, based on the-physical-capacity (by volume) of the-trailer, however, such-approximation is very-rough, as some-wastes are bulky and light, while others are dense and small.

3.3.5. Disposal of Waste.
The-waste-disposal-site, at-MU, caters for the-wastes, collected from all waste-generators, at MU, including incineration-ashes, from the-MU-medical-centre. The-SW, generated in-MU, is by and large, not treated, but is
directly taken to a waste-disposal-site; no storage-depots, or transfer-stations. The site is relatively small, in size, of around 0.6 hectares. As seen from the Figure 7, the dumpsite, is situated very close (less than 150m), to some of the-hostels, particularly Soweto-hostel. This points out that probably, the position for the waste-disposal-site was initially chosen, for convenience, and also to reduce waste-transportation-cost, rather than based on environmental-safety considerations.

On observation, it was revealed, that the MU waste-disposal-site is not fenced, and there is no gate, signpost, and no evidence of any systems for fire-controls. The site is largely unmanned, and hence, unmonitored; Inspection and monitoring of the dumpsite was not evidenced, if at all conducted. Besides, there is no site-office and sanitary-facilities. Although the site has an access via a motor-able-road, it is not easily accessible, during rainy seasons. In addition, there is no lining, gas-control, and provision for methane and leachate-collection. The build-up of landfill-gas (predominantly methane), can lead to spontaneous ignition/fires. Besides, there is no provision for storm-water-control. Moreover, neither waste-sorting nor recycling-facilities exist, at MU. Overall, the site is not a designed landfill, but it is an open and uncontrolled dumpsite.

![Figure 7: Position of the dumpsite and its size.](image)

In contrast, according to the provisions by the World Bank (2007a; 2007b), waste-disposal facilities, must: (i) be fenced, or hedged; (ii) be provided with a proper gate, to monitor incoming vehicles; (iii) be well protected, to prevent entry of unauthorized persons, and stray-animals; (iv) have an approach, and other internal roads, for free movement of vehicles, at the site; (v) have a waste-inspection facility, to monitor waste, brought to the site; (vi) have an office facility for recordkeeping, and a shelter for equipment and machinery, including pollution-monitoring equipment; (vii) have a weigh-bridge, to measure the quantity of waste; (viii) have a fire-protection equipment; (ix) have utilities, such as drinking-water and lighting arrangements, for easy-site operations, in night hours; (x) have safety provisions, such as periodic health-inspection, for site workers/sanitary attendants; and if possible, bathing/shower facilities, for workers, should be provided.

The setup and operations of the dumpsite, at MU, hence, violates each and every one of the above provisions, by the World Bank.

Moreover, during several physical examinations, open burning of waste, was evidenced, with significant smoke, seen, in various dump-locations. The burning can be man initiated, to reduce the waste volume, or it can be due to self ignition of greenhouse gases (predominantly methane), emitted from rapidly decomposing wastes (especially at elevated ambient temperatures, prevalent at the site; see section 2.2). Waste, at the site, is regularly burned; spontaneous ignition outbreaks of fire, was also observed (twice, during the observation period). Similar practices were described by other researchers, for example: Sibanda et al. (2017); and Munala & Moirongo (2011), among others. Regardless of the initiator, burning is negatively affects air quality, and consequently human health.

On-the other hand, although the World Bank (1999) had recommended waste burning, as a solution, affirming that the exercise minimizes 85-90% of waste, there are limitations, if uncontrolled. These are: (i) It may result in the release of harmful gases into the atmosphere (Zurbrugg, 2003); (ii) Rise in greenhouse gases (Arukwe et al., 2012; Prechthai et al., 2008); and (iii) Is a threat to the public health and to the environment, e.g., Bleck & Wettberg (2012); and UNEP (2009b) researches found a high blood lead concentration and gastric-
The current-SWM-practices, at the-university, were assessed vs. main-relevant-policies and laws, governing waste-management, at a-local-context (described in Starovoytova, 2018 b).

Environmental-Management and Co-ordination-Act (EMCA) No. 8 of 1999:
Section 87 of this-Act prohibits against dangerous-handling and disposal of wastes. Besides, section 87(4), states, that every-person, whose activities generate wastes, shall employ measures, essential to-minimize wastes, through practices, such-as waste treatment, reclamation, and recycling. Section 87(2), paragraphs (a) and (b) provides that no person shall transport any-waste, other-than in-accordance-with a-valid-license to-transport waste, issued by the-Authority; and to a-waste-disposal-site, established in-accordance with an-operational-license, issued by the-Authority. It also-stipulates, that the-driver, or his-agent(s), should-possess, at all-times, during-transportation, of the-waste, a-duly-filled tracking-document, as set-out in Form III of the-First-Schedule, to the-Regulations and shall produce the-same, on-demand, to-any law-enforcing-officer. Section 87(3) prevents anybody from operating a-wastes-disposal-site, or plant, without a-license, issued by the-Authority. Such-licenses, however, may only be-granted, subject to the-written-application, and payment, of the-appropriate-fee.

Section 89 states, that any-person/entity who, at the-commencement of this-Act, owns, or operates, a-waste-disposal-site, or plant, or generate hazardous-waste, shall apply to the-Authority, for a-license, within six-months, after the-commencement of the-Act. In-addition, Section 90, allows NEMA to-apply to a-competent-court, for orders, compelling any person/entity to-immediately-stop the-generation, handling, transportation, storage, or disposal of any-wastes, where such-generation, handling, transportation, storage or disposal, presents an-imminent and substantial-danger to-public health, the-environment, or natural-resources.

These-provisions are largely not complied with, as on-observations, the-SWM, at-MU, is exemplified as: dangerous-handling of mixed-waste (lack of PPEs and First-aid-kit); Absence of waste treatment, reclamation, and formal-recycling; illegal-operations of the-dumpsite (no valid-license); and illegal-transportation of waste (no valid-permit/license). It was also-revealed, that the-tractor-drivers do not carry duly-filled tracking-document, as they claimed they have never being issued with one. In-addition, the-inspection of the-waste-transporting-trucks is never carried-out, due-to severe-understaffing of inspectors, at NEMA.

Municipal/household-SW is not considered, by definition, to be a-hazardous, but, it may contain small-amounts of items and substances, which could be-hazardous to the-health; therefore PPEs are necessary. The-protective-clothing, necessary in-SWM-activities can include: dust-overcoat; nitrile-gloves; steel-toed-boots or heavy-duty rubber-boots; safety-glasses/goggles; dust-masks; and leather-driving-gloves (for the-driver), among others.
others. In-contrast, only selected-sanitary-workers were observed wearing rubber-glovers, at the-university.

On-the-other-hand, the-MU-dumpsite has been-in-existence, since 1985, way-back before both; the-EMCA (1999) and the-NEMA, Kenya (2002), were created. Still, not having an-operational-license is in-contravention-with the-Section 89, of the-Act. The-authority has also not exercised the-powers, coffered under-the-Section 90.

On biomedical-wastes, the-regulations provide the-following: Section 36 requires for an-Environmental-Impact-Assessment, for a-bio-medical-waste-generator (incinerator), while section 37 states the-approval of biomedical-waste-generating-facility by a-lead-agency and the-Authority. The-fourth-schedule, regulation 22 defines biomedical wastes as hazardous. The-eighth-schedule (39) provides the-color-codes and specifications, for biomedical-waste-storage, adopted from the-WHO color-code. Sections 119 and 120 stipulate the-legal-provisions, for the-inspection and auditing, of incinerators, through the-collection of samples, for analysis, to-check whether they are complying with the-set-standards. Section 78(1) mandates the-Stands and Enforcement-Review-Committee, to-advice the-Authority on measures, necessary to-reduce existing-sources of air-pollution, by requiring the-redesign of plants, or the-installation of new-technology, or both; to-meet the-requirements of standards, established under this-section; and recommend to-the-Authority guidelines to-minimize emissions of GHGs, and identify suitable-technologies, to-minimize air-pollution.

NEMA, however, does not really do an-Environmental-Auditing, to-the-existing-incinerators, including the-one at MU-medical-centre. An-incineration-facility (at MU-medical-centre), to-dispose of medical-waste, was found operational, but was assessed as outdated/primitive, and inefficient. Incineration air-pollution-control-equipment is not installed; since, there is little or no stack-emissions-monitoring, which is potentially dangerous to-public-health. The-study, hence, recommends to-conduct further examinations on the-MU-incinerator-efficiency.

In-addition, there is no spontaneous-collection (spot-check) of samples and analysis, by the-environmental inspectors, as no inspection was conducted, whatsoever. Also no active-communication with the-Stands and Enforcement-Review-Committee, to-advice the-Authority, was reported.

The-Local-Government-Act (Cap 265 of Laws of Kenya):

Most-functions, undertaken by-local-authorities include the-provision of public-services, such-as garbage-collection. According to this-Act, decision-making-powers rest with councilors, as-policy-makers. Section 207 of the-Act provides, that a-copy of every-by-law, which has-been-approved, by the-minister, is to-be-deposited, at the-offices of the-local-authority, which made the-by-law, and shall, at-all-reasonable hours be open to-public-inspection without payment, and the-local-authority shall, on-application of any-person, furnish to-such-person a-copy.

The-same-law is applicable, in the-MU-case, but instead of municipal-councilors, the-policy makers, at MU, is the-MU-council. In-contrast, to municipal-councilors, which are available daily, MU-councilors are available (for regular-scheduled-meetings), only once a-month. Secondly, one has to-book an-appointment, with them, way in-advance, explaining the-purpose. Thirdly, most (if not all) SWM-stakeholders, at MU, are probably not aware of the-existing laws, governing the-sector, and hence, they do not fully-understand the-role, they are expected to-play, in the-SWM-sector.

The-Occupational-Safety and Health-Act, of 2007:

Part V11, Section 55 of the-Act, presents a-legal-provision, for regulating the-operation of incinerators. Part V11, Section 58(1), provides that every-dangerous-party of any-machinery, other party prime-movers and transmission, shall-be securely-fenced, by means of a-fixed-guard, unless an-automatic-guard prevents the-operator from coming in-direct-contact-with the-part. This applies to the-fencing and safeguarding, of incineration-machines. Section 60 states, that all-fencing or other-safeguards, provided, shall-be of substantial-construction, constantly maintained, and kept in a-position, while part, required to-be-fenced or safeguarded, are in-motion, or use. Besides, Section 81 (1) states, that in-every-workplace, or workroom, there shall be: (a) firefighting-equipments provided, maintained, and conspicuously-displayed; and (b) persons, trained in the-correct-use of such-means.

On-observation, there was no safe-guiding of the-MU-incinerator, whatsoever. Besides, there is a-lack of fire-fighting-equipments.

The-Building-Code of Kenya:

Section 240(4) states, that the-owner, or contractor, shall on-completion of the-building/demolition, ensure that all-materials and debris, not forming part of any-structure, are removed, from the-site, and that the-site is left, in a-clean and tidy-condition. The-law, however, does not provide for disposal of construction and demolition-waste; Section 142(1) says that before a-certificate of completion is issued, in-respect of any-building, by the-council, the-means of refuse-disposal, shall-be completed and the-receptacles/ containers provided. Therefore, there is no exactly-written-law, which shows, precisely, were construction and demolition-waste should-be disposed.
From the visits, to several-construction-sites, at MU, it was observed, that demolition/ construction-waste is dumped on-the-ground, and left there, for a-long-time, at times; as no waste containers were provided. On-observation, of the-MU-dumpsite, demolition/construction-waste was visible, meaning that eventually, such-waste was collected by the-understaffed-sanitary-attendants.

The-Traffic-Act (Cap 403 Laws of Kenya):
Section 55(1) of the-Traffic-Act stipulates, that no vehicle shall-be-used on, a-road, unless such-vehicle and all-its-parts and equipments thereof, including lights and tires, maintained in-such a-condition, that the-driving of the-vehicle is nor likely to-be a-danger to-other-road-users, or to-persons, travelling on-the-vehicle.

However, as discussed earlier, the-tractor-trailer is not covered, and hence, as it moves, the-collected-waste spills, over on-the-road. It also-lacks basic-lights, reflectors, and the-horn, posing great-danger to-other road-users, contrary to the-provision of the-Act, section 55(1).

Besides, in-some-cases, the-trailer is noticeably-overloaded, this is against section 56(1) of the-Act, which states that no vehicle shall-be-used on, a-road with a-load, greater than the-load, specified by the-manufacturer of the-chassis of the-vehicle, or than the-load-capacity, determined by an-inspector, under the-Act. Because there is no weighing-bridge, at the-site, it is difficult to-get the-exact-weight, of the-waste, carried, in-each-suspicious-case, and hence there is no proof, of an-overloading.

The-Transport Licensing-Act (Cap 404 Laws of Kenya):
According to Section 26, of the-Act, any-police-officer, in-a-uniform, may stop any-vehicle, and demand for the-production of any-license, certificate, document, or record, of any-description, whatsoever, which may, be required to-be-carried-on such-vehicle.

The-site-visits have established, that this-provision is not being adhered-to, as most-police-officers (of a-fully-armed, and uniformed, police-unit, of MU) tend not to-stop the-trailer, carrying the-waste. This could-be due-to the-fact, that the-trailer is uncovered, and hence produces awful-smell, secondly Kenyan-police-force is generally-corrupt, and they do know very-well, that they cannot get any-corruption, from the-poor-trailer-drivers.

In-Kenya, the-NEMA, is mandated to-issue annual-licenses, to-waste-transporters, in-accordance with the-provisions, of the-Waste-Management-Regulations, of 2006 (see Starovoytova, 2018 b). At MU, however, the-waste-transporter operates illegally, as it does not meet NEMA (2015)-requirements.

Minimum requirements for Solid Waste Management, stipulated by NEMA, Kenya.
According-to Nema, Kenya (2015), relevant-authorities, responsible for SWM, are expected to-implement the minimum requirements, across the-WM-cycle, and in-particular:

In-waste-collection, to-ensure: (i) that the-waste-collection-areas are zoned; (ii) timely and regular-collection of all solid-wastes, either, through door-to-door-collection, or from centralized-collection-points; and (iii) waste-collection-facilities such-as: skips, bulk-containers, and waste-cubicles, are regularly-emptied and do not become eye-sores.

In-waste-transportation, to-ensure that all the-collected-waste is transported, using NEMA-licensed vehicles to-designated-disposal-sites.

On-waste disposal site: (i) Ensure there is a-designated and licensed-site(s), for waste-disposal; (ii) Ensure that the-disposal-site is secured-with a-fence and a-gate, manned by a-county-government-official, to-control dumping and spread of waste; (iii) Ensure all incoming-waste is weighed, or estimated and the-quantities, recorded in tons; (iv) Develop and maintain motor-able-roads inside the-site, to-ensure ease of access, during disposal; (v) Ensure the-waste is spread, covered, and compacted, at regular-intervals; (vi) Put in-place appropriate-control-measures, for the-management of dumpsite-fires; and (vii) Enhance security and control of the-disposal-sites, so that illegal-activities are contained.

The-assessment of current-SWM-practice shows gross-nonconformity with NEMA-requirements. The-study, therefore, strongly advise that, first, MU should-obtain a-NEMA-license, to-operate the-waste disposal-site; and then to-ensure waste-transportation-vehicle has NEMA-license, as-well.

With regard to law-limitations, although there are more-than 30 laws and regulations, governing waste, and its-management, in-Kenya (see Starovoytova, 2018b), there is no national-policy, for reduction of generated-waste, at-source.

On-overall, the-above-comparison, points-out on a-gross noncompliance with the-relevant, to SWM laws, and regulations. According-to Coad (2011); and UN-HABITAT (2010), however, legislation and, more-importantly, the-enforcement of legislation, are critical, in-shaping an-effective waste management-system, particularly in-developing-countries. The-gap, between waste-management policy and legislation, and actual WM-practices, is expanding, owing to continuing-capacity limitation, and/or non-existence of WM-facilities, for the-different waste-streams. Resolving this-capacity gap will require major-investments and access-to technical-know-how. According-to UNIDO (2009), however, the-means, for accessing these, in-developing-countries of Africa, including Kenya, are far-fetched.
3.5. **SWOT-Analysis.**

A detailed SWOT-analysis was performed, based on the study-findings. The-findings were abstracted, through analyzing information, obtained from identification of SW-generators, examining their-practices on SWM, as-well-as via non-participant-field-observations, interview of relevant-officers, and the-comparison of the-current-SWM-practices with the-legal-requirements. Table 1 shows the-analysis.

<table>
<thead>
<tr>
<th>STRENGTHS:</th>
<th>WEAKNESSES:</th>
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<tbody>
<tr>
<td>University-Administration is aware of the-existing environmental-laws, and the-role of the-NEMA.</td>
<td>Inadequate political-good-will at National, County, and the-University-levels.</td>
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<tr>
<td>There are by-laws, governing waste-management, in the-counties.</td>
<td>Low-priority to waste-management leading to low-budgetary-allocations.</td>
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<tr>
<td>The-university is aware of its-obligations on waste-management.</td>
<td>Poor waste-collection-services (irregular and inadequate-coverage).</td>
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<tr>
<td>It has established units, recruited staff, and provided a-tractor-trailer, to-deal with SWM, at the-campus.</td>
<td>No segregation at source, and no recycling, practiced.</td>
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<tr>
<td>It allocates and provides a-budget for SWM-activities.</td>
<td>Inappropriate-location, design and management of the-waste-disposal-site.</td>
</tr>
<tr>
<td>It has a-designated-waste disposal-site, and provided community dust-bins, in some-points, at the-campus.</td>
<td>Inappropriate waste-collection-vehicle, operated illegally.</td>
</tr>
<tr>
<td>It’s-clinic operates small-incinerator, to-treat biomedical-waste.</td>
<td>Inadequate/ poor-maintenance of machinery and equipments.</td>
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<tr>
<td>General-public, including students and staff, are becoming more-aware of their-right to clean-environment.</td>
<td>Inadequate-number of WM-staff, most of them are casuals, and lack of trained-personnel.</td>
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<td>Low-wages, and irregular-payments, for WM-workers.</td>
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<td></td>
<td>Poor public-perceptions/ attitude on individual responsibility towards waste management.</td>
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<td></td>
<td>Tolerance to living in a-dirty-environment, and littering-habits.</td>
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<td></td>
<td>Insufficient waste-infrastructures (waste-bins, transfer-vehicles, waste-handling-tools, protective-gear).</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>OPPORTUNITIES:</th>
<th>THREATS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity to-implement the-existing environmental-regulations.</td>
<td>Uncontrolled-GHG-emissions, contributing to Global-warming (due-to lack of gas-control, at the-dumpsite).</td>
</tr>
<tr>
<td>Employment opportunities in WM (waste as a resource by recovery).</td>
<td>Environmental-risks of water, air, and soil-pollution (due-to uncontrolled-waste-disposal).</td>
</tr>
<tr>
<td>Investment opportunities in recycling, energy recovery, composting, and incineration.</td>
<td>Exposure of WM-workers to-health-hazards, leading to injuries, and occupational-diseases (due-to lack of PPEs).</td>
</tr>
<tr>
<td>Adoption of emerging-technologies in waste-management.</td>
<td>Poor-image of the-institution, due-to largely dirty-campus.</td>
</tr>
<tr>
<td>Increased public-awareness on waste-management and related-opportunities</td>
<td></td>
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<tr>
<td>Increase involvement of the private sector</td>
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<tr>
<td>Design and build a-sanitary-landfill.</td>
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</tbody>
</table>

The SWOT-analysis helps further-understanding about both; external and internal-conditions of SWM, at MU. The-findings also-present some major-opportunities that MU can exploit, as-well-as some-threats, that need to-be mitigated, in the-future. In-particular, it-is necessary to-maximize both; strengths and opportunities, minimize the-external-threats, transform the-identified weaknesses into strengths, and to-take advantage of opportunities, along with minimizing both; internal-weaknesses and external-threats.

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On the other hand, from the analysis, it is clear that the weaknesses and threats, to successful WM, identified, are sizeable (in comparison with the Strength, and Opportunities), which possibly points out on inadequate attention to research on environmental conservation and occupational safety; such studies, are therefore, recommended.

4. Discussion.

The focal issues, revealed from the research findings (such as: Waste-scavengers/pickers; Potential dangers of uncontrolled-waste-dumpsite; Socio-cultural barriers; and, Financial-assistance for SWM projects), are imperative in understanding an overall picture of SWM challenges, at MU; hence, these are detailed in the subsequent sections.


The presence of large number of informal-waste-pickers, and the massive presence of vultures, at MU, is an indicator, of the absence of an effective waste-collection and management-system, at the university.

The terms ‘waste-pickers’, ‘waste-scavengers’, ‘rag-pickers’, ‘waste-handlers’, ‘waste-collectors’, and ‘waste-recyclers’ refer to people, who make a living, by selling recyclables, found in trash. They are found in the city-streets, in the dumps, and on the municipal-trucks, that collect and transport waste, to disposal locations (Gutberlet et al., 2017; Wilson et al., 2012; Scheinberg et al., 2011). Most waste scavengers are poor, socially marginalized, openly discriminated, and politically disenfranchised (Marello & Helwege, 2014). Although some waste-pickers work alone, the field is dominated by families, and microenterprises, comprised of women, children, and elderly relatives/neighbors (WIEGO, 2012; Wilson et al., 2006).

The workers are at risk, as they do not have the appropriate protective gear, to be handling waste. Besides, according to Tumusiime et al. (2013), and Marshall & Farahbakhsh (2013), the waste handlers usually manage waste, without adequate skills and knowledge on the type, importance, and hazard, associated with the SW, they handle. In addition, these individuals are also prone to cuts and infections, as a result of dealing with glass, tins, sharp pieces of metal, and syringes, while scavenging for valuable materials (Gutberlet et al., 2017).

Waste-pickers are highly susceptible to diseases (UNEP, 1996). In particular, cuts, can easily expose, the affected picker, to a potential risk of HIV (due to handling of biomedical waste); Tetanus (due to handling of jagged-metals); Respiratory problems (due to exposure to fire smoke); Neural damage (due to exposure to lead); Stress (due to competitive, and nerve-racking nature of the job); stress-related drinking and substance abuse; and skin and gastric problems, among others (UN-HABITAT, 2010; Gunn, 2009). Items, which may be worthless, to one individual, may not necessarily be valueless to another. For instance, waste scavengers, children, in particular, may also be tempted to pick some leftover food, from the waste heaps; this is likely to increase the risk of gastroenteritis, dysentery, and other illnesses.

Scavengers are very often socially discriminated, for the nature of activity, they indulge in, for survival. Additionally, the involvement of children, in scavenging, suggests that they being removed/deprived from education opportunity, which is against the GSGs, as well as the Constitution of Kenya (2010), and therefore should be highly discouraged.

Waste-scavengers recycling activities, in developing countries, plays a major role, in recovering secondary materials. It is estimated (Inclusive Innovations, 2017), that in many cities, across developing countries, the waste sector provides livelihood to more informal waste workers, than formal ones. The World Bank estimates, that about 2% of the population, in developing countries, are waste scavengers. Waste picking is often driven by poverty, high unemployment rates, low education level, and demand for secondary materials (Eawag, 2008).

Although waste picking is an entrepreneurial activity, it is not a prosperous one. In the poorest countries, like Nicaragua, waste pickers are said to earn between USD1.50 and USD2, per day (just below the World Bank’s poverty line). Even if many waste pickers are not poor, by income-based official benchmarks, they experience hardships, in multiple dimensions. The job itself, is exhausting and risky, exposing workers to pathogens, fallen debris, and rabid animals. Scheinberg (2011) describes the working conditions of many waste pickers, as:

They face injuries from dogs, rats, and other vectors, combined with chemical and biological health risks due to contact with toxic substances, health care wastes, fecal matter, body parts, used syringes and other materials in the waste stream. In the best of situations, pickers report ergonomic problems due to the physically taxing nature of the work, and psychological and social disadvantages stemming from their low social status.

Besides, as informal workers who do not pay tax, and not unionized, waste pickers are largely denied access to social benefits, such as health insurance, sick leave, annual leave, and pensions. Waste pickers rarely achieve
economic-mobility, through this-profession. Although equipment could significantly-raise productivity, waste-picker-methods are labor-intensive, due-to a-lack of access to-credits (CWG; GIZ 2011). Besides, an-absence of economies of scale, in-turn contributes to-weak-bargaining power, in the-recycling supply-chain. Waste-pickers complain, that middlemen pay them far-less, than they pay formal-businesses, for the-same-type of goods, possibly as-little-as 10% (Fergutz, 2011). In-some places, collusion, between intermediaries, leaves waste-pickers with few-outlets for their-goods.

On-the-other-hand, like-most-people, at the-bottom of the-economic-pyramid, waste-pickers seek, and deserve dignity, and recognition of their-rights. As Peter Coy noted, “You don’t rummage through piles of garbage looking for recyclable items if you have other options in life” (Coy, 2014); largely, they just victims of circumstances. According to Zurbrügg (2003); and UNEP, UNICEF, WHO (2002), the-need to-improve-the-working-conditions of waste-workers, is a-critical-aspect, in the-social-value-chain development. In-this-regard, in-many-countries, particularly in-Latin-America, there is a-rise of waste-picker cooperative/’Inclusion’-movement, which is also-used as an-anti-poverty-program, particularly in poor-countries, where budgets are strained. Waste-management-programs, that incorporate waste-pickers, are viewed as potential-contributors to-the ‘triple bottom line’--creating jobs, reducing-the-environmental-damage, caused by growing-use of disposable-goods, and cutting fiscal-costs, by reducing landfill-expenses. For-more-details see Marello & Helwege (2014).

Given the-low-collection-rates, across developing-countries, it-is apparent, that waste-collection enterprises have a-significant-opportunity-to-plug in the-gaps, in-servicing low-income-populations (Inclusive-Innovations, 2017). For-example, waste collection-models, such-as Kenyan, TakaTaka-Solutions, is a-fee-based door-to-door waste-collection service-provider, with specific-focus on low-income-customers. The-enterprise cross-subsidizes its-services by charging higher-prices to-affluent-households and commercial-clients. It collects waste, sorts it, sells recyclable-fractions, to recycling-companies, and converts wet-waste to-organic-compost. It charges low-income-customers a-fee of USD 1, per-month, per-household. As of 2017, it provides services to 12000 households (of which 9600 households are low income) as customers, and employs 105 waste-workers.

The-study recommends to-establish waste-management-programs, which incorporate waste pickers.

4.2. Closer-look at potential-dangers of open and uncontrolled-waste-dumpsite.

It-is becoming a-common-knowledge, that the-open-dumping of waste is a-major-source of land-contamination, water, and air-pollution, environmental-degradation, and health-hazards (Omoleke, 2004). Many-people, however, do not realize the-full-spectrum and the-magnitude, of the-negative-effects, of an-open and uncontrolled-waste-dumpsite, such-as the-one, at the-MU. To-benefit potential-readers, the-following-sections provide some-details on: Public-health-effects, as-well-as Effects on the-Environment, due to-uncontrolled-waste-dumping.


(i) Disease-vectors and pathways: Wastes, dumped indiscriminately, provide plenty of food, for booming-populations of vermin, which can-cause various-diseases. Decomposing-organic-waste attracts animals, vermin, and flies. The-pathways of pathogen-transmission, from wastes to humans, are mostly, indirect, through: insects (e.g., flies, mosquitoes, and roaches); and animals (rats, rodents, and pigs).

(ii) Flies: Most-common in this-category, is the-housefly, which transmits typhoid, salmonellosis, gastro-enteritis, and dysentery. Flies have a-flight-range of about 10 km, and therefore, they are able to-spread their-influence over a-relatively-wide-area. Flies may also-play a-major-role, in the-transmission of fecal-oral-diseases, particularly where domestic-waste contains feces (often those of children). The-four-stages, in their-life-cycle are: egg, larva, pupa, and adult. Eggs are deposited in-the-warm, moist-environment, of decomposing-food-wastes. When they hatch, the-larvae feed on the-organic-material, until certain-maturity is reached, at-which-time they migrate, from the-waste to-the-soil, before being-transformed into pupae. The-pupae are inactive, until the-adult-fly emerges. The-migration of larvae, within 4 to 10 days, provides the-clue to an-effective control-measure, necessitating the-removal of waste, before migration of larvae.

Consequently, in-warm-weather of MU, waste should-be collected twice-weekly, for effective- control. In-addition, the-quality of waste-storage-containers is very-significant; ideally they should be covered with a-lid, to-restrict access to flies. At a-dumpsite, solid-wastes should-be covered-with a-layer of earth, at the-end of every-day, to-arrest the-problem of fly-breeding.

(iii) Mosquitoes transmit diseases, such-as: malaria, filarial and dengue-fever. In-particular, mosquitoes of the Aedes-genus variety lay eggs in-water, stored in-discarded-items, such-as: tins, and drums; these are responsible for the-spread of dengue and yellow-fevers. Such-conditions may also-attract mosquitoes of the Anopheles-genus, which transmit malaria. Mosquitoes of the Culex-genus do breed in-stagnant-water, with high-
organic-content and transmit micro-filariae. Since they breed in-stagnant-water, control-measures should centre on the-elimination of breeding-places, such-as tins, cans, tyres, etc. Proper-sanitary-practices and general-cleanness, in the-community, help eliminate the-mosquito-problems, caused by the-mismanagement of solid-waste.

(iv) **Roaches:** These cause infection, by physical-contact, and can-transmit typhoid, cholera, and amoebiasis. The-problems of roaches are associated with the-poor-storage of solid-waste.

(v) **Rodents:** Rodents (including rats) are usually proliferate in-uncontrolled-deposits of solid wastes. They are responsible for the-spread of diseases such-as: plague, murine-typhus, leptospirosis, histoplasmosis, rat-bite-fever, dalmonelosis, trichinosis, etc. The-fleas, which rats carry, also cause many-diseases. This-problem is associated **not** only with open-dumping, but also poor-sanitation.

(vi) **Animals:** Apart from rodents, some-animals (e.g., dogs, cats, pigs, etc.) also-act as-carriers of disease. For-example, pigs are involved in-the-spread of diseases, like trichinosis, cysticercosis, and toxoplasmosis, which are transmitted-through infected-undercooked-pork.

(vii) **Occupational-hazards:** Workers, handling wastes, are at-risk of accidents, related to the-nature of the-material, they handle, and lack of safety-precautions. The-sharp-edges of glass and metal, and poorly-constructed storage-containers may-inflict injuries to-workers. It-is, therefore, necessary for waste-handlers to-wear gloves, masks, and be-vaccinated. The-infections, associated-with waste-handling, include: skin and blood-infections, resulting from direct-contact with waste, and from infected-wounds; eye and respiratory-infections, due-to exposure-to infected-dust, especially during landfill/dumpsite operations; diseases, from the-bites of animals, feeding on the-waste; intestinal-infections, that are transmitted by flies, feeding on the-waste; and chronic-respiratory-diseases, including cancers, resulting from exposure to-dust and hazardous-compounds. In-addition, the-accidents, associated-with waste-handling, include: bone and muscle-disorders, resulting from the-handling of heavy-containers, and the-loading heights of vehicles; infecting-wounds, resulting from contact with sharp-objects; reduced visibility, due to-dust, along the-access-routes, creates greater-risk of accidents; poisoning and chemical-burns, resulting from contact-with small-amounts of hazardous-chemical-wastes, mixed with general-wastes, such-as pesticides, cleaning-solutions, and solvents; burns and other-injuries, resulting from occupational-accidents, at waste-disposal-sites, or from methane-gas-explosion, at landfill-sites; serious health-hazards, particularly for children, due-to careless-dumping of lead-acid, nickel-cadmium and mercuric-oxide-batteries.

### 4.2.2. Effects on the-environment (Vesilind et al., 2002; El-Fadel et al. 1996; Neissen, 1977):

#### (i) **Air-pollution:** Burning of solid-wastes, in-open-dumps, or in-improperly-designed-incinerators, emit pollutants (gaseous and particulate-matters) to the-atmosphere. The-open-burning of waste results in-the-release of toxic-pollutants and emissions, such-as: sulphur-dioxide (SO$_2$), nitrogen-oxides (NOx), dioxins, and furans. These-gases can cause respiratory-diseases, when inhaled, while others, like dioxins and furans, are carcinogenic, and known to-aggravate bronchial and asthmatic-disorders (Omoleke, 2004). These-GHG namely methane and carbon-dioxide are also released, during the-breakdown of biodegradable-materials. These-gases, in particular, are of concern, because of their-high global-warming-potential (Sibanda et al., 2017).

In-addition, studies show, that the-environmental-consequences of open-burning are greater, than incinerators, especially with respect-to aldehydes and particulates. Emissions from an-uncontrolled incinerator-system include particulate-matter, sulphur-oxides, nitrogen-oxides, hydrogen-chloride, carbon-monoxide, lead, and mercury. Discharge of arsenic, cadmium, and selenium, is to-be-controlled, since they are toxic, even at a-relatively-low exposure-levels. Polychlorinated dibenzo-furans (PCDFs), commonly-called dioxins and furans, are of concern because of their-toxicity, carcinogenicity and possible-mutagenicity.

(v) **Odour-pollution:** Obnoxious-odors, due-to the-presence of decaying-organic-matter, are characteristic of open-dumps. They arise from anaerobic-decomposition-processes and their-major constituents are particularly-offensive. Proper-waste-covering, however, eliminates this-nuisance.

(ii) **Water and land-pollution** results from dumping, in-open-areas and storm-water-drains, and improper design, construction, and/or operation, of a-waste-disposal-site. Control of infiltration, from rainfall and surface-runoff, is essential in-order-to-minimize the-production of leachate. Pollution of groundwater can-occur, as-a-result of: the-flow of groundwater, through deposits of solid-waste at landfill-sites; percolation of rainfall, or irrigation-waters, from solid-wastes, to the-water-table; and diffusion and collection of gases, generated by the-decomposition of solid-wastes.

(iii) **Visual-pollution:** The-aesthetic-sensibility is offended by the-unsightliness of piles of wastes, on the-road-sides. The-situation is made-worse by the-presence of animal and bird-scarengers, rummaging in the-waste. Waste carelessly and irresponsibly-discarded in-public-roads, along and around communal- bins, gives easy-access to-animals, scavenging-for-food. The-solution, to-this social-problem, is definitely lies in the-implementation of public-education, at all-levels, and in-raising the-status of public-health workers and managers, in-SWM.
(iv) Noise-pollution: Undesirable-noise is a nuisance, associated with operations at disposal-sites and incinerators. This is due to the movement of vehicles, arguments of waste-pickers, and frequent-fights among animal-scavengers, for food. The impacts of noise-pollution may be reduced by careful-sitting of SWM-operations, and by the use of noise-barriers. 

(vi) Explosion-hazards: Landfill-gas, which is released, during anaerobic-decomposition-processes, contains a high-proportion of methane (35-73%). It can migrate, through-the-soil, over a considerable distance, leaving the-buildings, in the vicinity of the dumpsite, at-risk, even after the closure of landfills.

Overall, the open and uncontrolled waste-dumpsite, for MSW, in MU, is making, all; environmental-pollution, health-impacts, and safety-violation, highly-probable. People, residing near-by the dumpsite, as well as Kesses-Dam-complex and Sosiani-River (the area’s sensitive ecosystems), soil, and ground-water of Rift Valley-Basin, are facing impending-threat, from the open and uncontrolled dumpsite.

On-the-other-hand, the Clean-Development-Mechanism (CDM), established by the Kyoto Protocol, in 1997, recognized waste and its disposal as one of the sectors, identified for GHGs-reduction. In addition, according to waste-hierarchy (see WASTECOSMART, 2015), open and uncontrolled dumping is the least-preferable, and hence, the least-environmentally-friendly-option, for SW-disposal. The study, hence, recommends (on a long-term-scale), MU-management to identify a new location, and design an engineered-sanitary landfill, and in addition, waste-resources should be targeted for 3Rs (reduction, reuse, or recycle). Besides, assessment-studies should be conducted on the groundwater-quality (as one of the indicators of pollution).

4.3. Socio-cultural-barriers.

Negative-attitudes towards waste, and waste-handlers, as well as careless-habits, such as indiscriminate-littering, observed at the campus, can be seen as social-cultural-barriers to effective-waste-management. These barriers, referred to as ‘lack of participation, poor-co-operation, and negative-attitudes of residents, towards waste’ (Hoornweg & Bhada-Tata, 2012).

According to Yukalang et al. (2017); and Siriratpiriya (2014), most-people think, that throwing-waste away, from their house (so-called ‘NIMBY’-attitude) is a quick and easy-solution, to get rid of waste, and forget about it, as they also presume that such waste has absolutely no value (to them), and also that it will be collected, during street-sweeping. Getting people to consider the value of waste, and think, before throwing things away, can significantly reduce waste-volume and littering. UNHSP (2010) have even introduced a new term ‘valorization’ of materials, meaning that even if the owner of an item throws a material/item away, it still has some retained-value.

MU-administration, needs to understand the culture and perceptions, about waste, among their students (comprising 47 local-tribes, and foreign-students), as well as surrounding community, and determine suitable solutions to current problems in SWM. Addressing these attitudes and inappropriate practices, in SWM, requires inputs, such as, to organize awareness-campaigns (can be in the form of street-theatre, cartoons, or posters), training, and/or education programs, to encourage people to look at waste as a resource. For the neighboring community, to better understand the message, this can be done in their local language.

This study, therefore, recommends further research on knowledge, attitudes, and perception (KAP) on waste and its management, among students, and local community.

Besides, public-participation and awareness are linked directly, to WM-problems. The literature suggests that encouraging people to participate will increase awareness, input, and change negative-reception. Regular activities (including students, and staff), such as clean-up of the department/laboratory/school/campus, can be effective in changing the ‘NIMBY’ attitudes. Sponsors can be drawn from: UNEP (United-Nation-Environmental-Program, which has its headquarters in Nairobi), Ministry of Environment Conservation, Ministry of Health, and private organizations.

With regard to the negative-attitude towards solid waste-handling/collection, as a job, training, motivation, incentives for outstanding-service, and disincentives, for those, who fail to perform, are essential, for human-resource-development, at MU, and hence, recommended for consideration.

4.4. Assessment of the main research findings.

Generally, waste collection is the most-essential-component of SWM-service; however, in many developing countries, including Kenya, it is grossly neglected. In particular, waste collection-system, in MU is rather primitive and largely inefficient. The assessment of the SWM-system, at the university, done via World Bank indicators, is characterized (in a nutshell) as: (1) of Inferior Quality and accessibility of SWM; (2) Inefficient; (3) of Poor Legitimacy and social acceptability, (4) Potentially damaging to Health and Environmental sustainability; and (5) Financially incapable.
The-SWM-situation, at MU, is not much-different, from the-one, described by Joseph et al. (2002): Open dumping is a traditional and common disposal method at which solid wastes are disposed in a manner that do not regard environmental and health impacts, is susceptible to open burning, and is exposed to the elements, disease vectors and scavengers. These unplanned heaps of uncovered wastes, often burning and surrounded by pools of stagnated polluted water, rat and fly infestations with domestic animals roaming freely and families of scavengers picking through the wastes is not only an eyesore but a great environmental hazard.

The-findings of this-study are similar, to-some-extent, with other-related-studies. For-instance: (1) Within developing-countries, rising-MSW is often-managed with little-technical-capacity and inadequate-resources (UN-ESCAP, 2014; UN-DESA, 2014; Kawai & Osako, 2013; UN-Habitat, 2010); (2) Open-dumping and burning of MSW, is commonly practiced across the-region, leading to a-range of problems (Ball & Rodic-Wiersma, 2010); Rapid-urbanization, and increasing-global-consumerism, is driving unprecedented levels of waste-generation, increasing environmental, social, and economic-burden, for the-society (Lerpiniere et al., 2014); (3) In-many-parts of the-world, waste-collection is still limited-to more-affluent-areas and communities, disposal via open-dumping is still-widespread, and many of the-world’s-poorest-people depend on informal-‘recycling’ activities to-survive (Lerpiniere et al., 2014); (4) The-findings, on bad-smell, released from a-dumpsite, are in-accord-with Okot-Okumu (2012); Firdaus & Ahmad (2010); Omooleke (2004); and Obera & Oyier (2002), among-others. (5) Another-study, conducted in-Kenya found, that much of the-municipal-budget, for waste-management, is directed to-pay, for an-over-staffed and under-qualified workforce (Henry et al., 2006), and not allocated, to-make improvements, within their-own-infrastructure; (6) The-data from yet-another-study suggests that the-inadequacies of vehicles, supervisors, and solid-waste collection-crews, were the-major-obstacles to the-management of solid-waste, in the-country. Inadequate service-coverage and operational-inefficiencies of services, including an-unskilled-workforce, is another-major-set of challenges, faced by municipalities, in-providing sufficient-waste-services to-citizens (Mwanthi & Nyabola, 1997); (7) Another-study, done in-India, found that poor-conditions of containers, and inadequate maintenance and replacement, of worn-out collection-vehicles, contributed to-behaviors, such-as littering and illegal-dumping, by citizens, who felt they could not properly-dispose of trash, because trash-bins and waste-services were not properly-maintained (Hazra & Goel, 2009); and (8) Besides, Nagawiecki (2009), established that the-waste, found in-dumpsters, at the-University of Idaho, excluding waste from dining facilities, was composed of more-recyclable and compostable-materials, than waste that should-be-sent to the-landfill, pointing-on lack of waste-segregation. The-significance of waste-segregation, as a-method of WM, has been underscored by several-studies (see Maklawe et al., 2015; Espinosa, 2008; and Iman et al., 2008). Waste-segregation at-source, increases the-reuse and recycling-rate of waste, and therefore is recommended for consideration, at the-campus.

On-the-other-hand, the-findings of this-study, do differ, to-some-extent, with other-related-studies. For-example: (1) Bailey et al. (2015) established that recycling of waste, is a-common-practice among staff, students, and visitors to University of West-Indies, Cave-Hill-Campus, Barbados; and (2) Smyth et al. (2010), likewise, established that waste-segregation, was a-common practice at the-Prince-George-campus of the-University of Northern-British-Columbia.

The-research-observations paint largely a-grim-picture of current-SWM-system and practices, at the-MU; it-would-be unfair, however, not to-mention some-positive-initiatives, on-SWM, at the-campus, such-as, a-campus-cleaning-day, initiated by the-acting-Vice-Chancellor, MU. Addressing students and staff, on Saturday October 22, 2016, the-acting Vice-Chancellor termed the-exercise as-symbolic to-clean the-hearts and minds, of staff and students, so as to-have pride and ownership of the-University, and make it clean. The day’s events were themed: “A Clean and Friendly University: Our Pride”. This-event, is one-step the-MU, has tried to-do the-rebuilding trust in the-service-delivery, and in the-wake of advocating for waste-responsibility. However, there was no agreement, made, with stakeholders, on-voluntary basis-involvement. In-contrast, students and lecturers were actually forced (by a-memo), and not invited to-attend a-cleaning-exercise, without proper-understanding of good-intention, behind. Although resulted in some-visible-cleanness, the-exercise has never been repeated. In-this-regard, it is recommended to-revive the-good-initiative, putting emphasis on awareness-campaign, first.

All-the-suggestions/recommendations, provided, by this-study, are commonsensical; the-main operational-constrain, however, is financial (as stated by both-interviewed-SWM-managers, of the-MU); therefore, elaborations on opportunities for extra-funding, for efficient-SWM-operations, is beneficial.

4.5. Financial assistance on SWM-projects.

Apart from making capital-investments in-equipment, money is also required for the-daily-WM-operations, such-as: procurement of fuel, and spare-parts; payment of salaries; and purchase/provision of working-gears (PPE). Appropriate disposal-bins, transportation-vehicles, and other-relevant-equipment should be prioritized
and timely acquired, by the university-management. To improve current-practices, and even to transform the whole-SWM-system, financial-assistance is required.

The international-development co-operation activities play a key role in improving governance, and building the local capacity and infrastructure, necessary for effective-SWM, for the world’s poorest communities (Lerpiniere et al., 2014). Effective-waste-management is expensive, often comprising 20 - 50% of operational-budgets. Providing this essential-service requires integrated-systems that are efficient, sustainable, and socially-supported. Several International organizations provide some focused-SWM assistance; one of such organizations is the World-Bank.

The World-Bank finances and advises on SWM-projects, using a diverse-suite of products and services, including: traditional-loans, results-based financing, development policy-financing, and technical-advisory. World-Bank financed WM-projects address the entire lifecycle of waste, from generation to collection and transportation, and finally treatment and disposal. Objectives, which guide the Bank’s SWM-projects and investments, include (World Bank, 2018):

Infrastructure: The World Bank provides capital-investments, to build, or upgrade, waste-sorting and treatment-facilities, close dumps, construct or refurbish landfills, and provide bins, dumpsters, trucks, and transfer-stations.

Legal-structures and institutions: Projects advise on sound-policy-measures and coordinated-institutions, for the municipal-WM-sector.

Financial-sustainability: Through the design of taxes and fee-structures, and long-term-planning, projects help governments improve waste cost-containment and recovery.

Citizen engagement: Behavior-change and public-participation is a key to a functional waste system. The World-Bank supports designing incentives and awareness-systems, to motivate waste reduction, source-separation, and reuse.

Social inclusion: Resource-recovery, in most-developing-countries, relies heavily on informal-workers, who collect, sort, and recycle 15 - 20% of generated waste. Projects address waste-picker livelihoods, through strategies, such as: integration into the formal system, as well as the provision of safe-working-conditions, social-safety-nets, child-labor restrictions, and education.


Knowledge-creation: The World Bank helps governments plan and explore locally-appropriate solutions, through technical-expertise, and data and analytics.

Since 2000, the World Bank has committed over USD 4.7 billion to more than 340 SWM-programs in: Indonesia, China, Azerbaijan, Argentina, Jamaica, Morocco, Nepal, Pakistan, Liberia, and Burkina-Faso. The commitment of the World Bank to SWM-projects, is ever-increasing, both in the number of projects, and in expenditure. For example: the World Bank has committed to 10 SWM-focused projects, in 2003, whereas in 2012 it committed to 24. In addition, the Bank’s financial-commitments to SWM, was over USD 200 million-higher in 2012, than in 2003 (World Bank, 2014a; World Bank, 2014b; Vergara & Banna, 2013).

World Bank engagement in SWM is supported, through valuable-partnerships, including funding from: the Climate and Clean Air Coalition, Korean Green Growth Trust Fund, and the Global Partnership on Output Based Aid (GPOBA), as well as collaboration on capacity-building and knowledge-sharing, through a memorandum of understanding with the International Solid Waste Association (ISWA).

ISWA, in particular, is a global, independent, and non-profit-making association, working in the public interest, to promote and develop sustainable WM. ISWA has members in more than 60 countries, and is the only worldwide association promoting sustainable, comprehensive, and professional WM. An estimated USD 4 billion was committed to development co-operation in SWM, between 2003 and 2012. The proportion (3-year average) of development finance for SWM, has more than doubled from 0.12% to 0.32% over the 10 years. The majority (70%) of this support has been in the form of lending from development-banks, amounting to USD 2.8 billion, over the 10-years, from 2003 to 2012. This has provided access to capital in low and middle-income countries and helped develop much-needed SWM-infrastructure, particularly collection-systems and engineered landfill capacity. Grant-funded support is the other key element of development co-operation, amounting to an estimated USD 1.2 billion, between 2003 and 2012, comprising over 3,000 grants. Around 75% of total grant funding has been used to increase local skills and capacity, and to provide other technical assistance on issues such as the informal-recycling-sector, private sector participation, cost-recovery, awareness raising, and climate change. The remaining grant funding has been used to fund the purchase of refuse-collection vehicles and containers; and to provide SWM, in the aftermath of natural disasters, or as part of conflict-related relief-efforts.
The study recommends, MU-management to approach the organizations, indicated, or any other entities, for funding, for example for the designing and building of an engineered landfill, at MU.

5. Conclusion and Recommendations.

Solid-waste is an unavoidable by-product of everyday-living; each human-being/ an-organization/ an-industry/ a-society does generate waste. At the MU, 8 main-waste-generators were identified. Numerous-barriers, to-effective SWM, were also reported; lack of readily-available, and sufficient allocation of financial-resources, was identified as the most-serious-barrier. On the other-hand, the responsible-authority for SWM, at MU, stated that they have being-stretched, indeed, to perform their-duty, and they are just trying-to-do their very-best, under the circumstances.

The study also revealed that: the current-SWM-system, at the university, is unacceptable, as it is largely-characterized as: (i) of Inferior-Quality and accessibility of SWM; (ii) Inefficient; (iii) Illegitimate and of low-social-acceptability; (iv) Potentially-damaging to Health and Environmental- sustainability; and (v) Financially-incapable.

In particular, this study has justified, that the current-WM-system and practices, of the MU, is exceedingly-deficient and primitive. The use of the open and uncontrolled-waste-dumpsite, for MSW in-MU, makes environmental-pollution highly-probable. In-addition, there is a gross non-compliance with legal-SWM-provisions (both; international and national); and in particular: the-World-Bank; the-NEMA, Kenya; the-EMCA; The-Local-Government-Act; The-Occupational-Safety and Health-Act; The-Building Code; The-Traffic-Act; and The-Transport-Licensing-Act of Kenya.

The-challenge of SWM, at the-campus, should be addressed, in such a-way, as to reduce the public-health-risks, being faced by WM-workers, as well as students, residing near the-dumpsite, and vulnerable-communities (waste-pickers); also to reduce the global-environmental-burden of GHGs; and concurrently provide opportunities for livelihood-development and job-creation, through both; improved service-delivery, and through establishing reuse and recycling-businesses. In particular, this study has made recommendations (on 3 different-levels), as follows:

On the-actual-operations.

(a) On a-long-term-scale:

(i) MU-management should identify a new-location, and design an engineered-sanitary-landfill. They can approach the-World-Bank, the-ISWA, or any other-organization, for financial and technical-assistance;

(ii) Waste should be considered as resource, targeting 3Rs (reduction, reuse, or recycle);

(iii) Sorting, at-source, should be introduced at MU, which in turn, will assist waste 3Rs; and

(iv) MU management should establish waste-management programs, that incorporate waste pickers.

(b) Meanwhile/On a short-term-scale:

(i) MU must obtain a NEMA-license, to operate the waste-disposal-site; and then to ensure waste-transportation-vehicle has NEMA-permit/license, as well;

(ii) To arrest the problem of fly-breeding, waste should be collected, at least twice, weekly. In addition, the quality of waste-storage-containers is very significant; ideally they should be covered with a lid, to restrict access to flies. At a dumpsite, solid-wastes should be covered with a layer of earth, at the end of every day;

(iii) Potentially-dangerous open-waste-burning should be highly discouraged;

(iv) To improve the general-cleanliness, at the-campus, the allocation of work, for street-sweepers and for sanitary-attendants, should be rotational, to facilitate working on weekends, and on public-holidays. Workers should also be provided with appropriate uniforms, and proper cleaning equipment (sweping-tools);

(v) The waste-collection-vehicle should be serviced regularly, to minimize breakdowns, and the number of vehicles, should ideally, be increased, to avoid unpleasant delays; and

(vi) Both departments, responsible for SWM, should conduct, or facilitate, routine health check-ups for all the WM workers.

On Social-involvement:

(i) With regard to the negative attitude towards solid-waste-handling/collection, as a job, training, motivation, incentives for outstanding-service, and disincentives, for those, who fail to perform, are essential, for human-resource-development, at MU;
(ii) There is a need to improve public awareness and increase the participation of campus residents in waste-management issues.

(iii) To preserve decent social relationships with the surrounding communities, there should be some form of agreement, between the university administration and the area chiefs, of the local communities that, for the practice of cattle grazing at the university grounds to continue, cleaning/removal of animal waste should be the responsibility of respective community; and

(iv) To change the ‘NIMBY’ attitudes, the clean-up initiative should be revived at MU; Sponsors can be drawn, for facilitation of regular activities (including students and staff), to clean-up a department/laboratory/school/campus.

On Further studies, about/on:

(i) Knowledge, attitudes, and perception (KAP), on waste and its management, among the students, and the local community, of MU (via integration, between socio-economic and environmental studies);

(ii) Assessment on the groundwater quality (as one of the indicators of pollution);

(iii) Environmental conservation and occupational safety at SWM, at the university; and

(iv) The MU incinerator efficiency.

The findings of this study will be used as a baseline, in further development of tailored SWM system (an integrated SWM plan/model), for the university. The study is, hopefully, also contributes (in its small way) to the body of knowledge on the subject matter.

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