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Solid Waste Management at a University Campus (Part 3/10): Waste Generators, Current Practices, and Compliance with relevant-law-provisions.

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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-being-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.

1. Introduction.

1.1. SWM.

Waste-generation is an-inherent and unavoidable-part of human-existence. Waste-materials are typically characterized by their-nature, components, and quality. Variations in quality, quantity, and composition of solid-waste can-be linked to-various-factors, such-as: cultural, economic, social, and financial-status of inhabitants, of the-particular-space, being studied. These-distinct-factors will also determine the-best WM-practice, to-adopt (Al-Khatib *et al.,* 2010).

SWM is an-essential public-health-service, *but* both; developed and developing-countries, still experiencing different-challenges in providing-universal and satisfactory-service to their-citizens (see Starovoytova, 2018 a; Starovoytova, 2018 b; UNEP & ISWA, 2015; ISWA, 2015; Riyad & Farid, 2014; Che *et al.,* 2013; Hara & Yabar, 2012; Phillips & Thorne, 2011; Greater-London-Authority, 2011; Atienza, 2011; Govindaraju *et al.,* 2011; Modak, 2010; Timlett, 2010; Troschinetz & Mihelcic, 2009; Kollikkathara *et al.,* 2009; Shekdar , 2009; Jenkins *et al.,* 2008; Herbert, 2007; UNDP/ GEF/SPREP, 2006; UNEP, 2005; Ferrara & Missios, 2005; Dijkgraaf & Gradus, 2004; Idris *et al.,* 2004; Poll & Kahlon, 2004; Louis, 2004; Addo-yobo & Mansoor , 2003; OECD, 2002; and Murray, 2000, among-others).

Rapid-economic-development, Population-growth, Inadequate-infrastructure, and expertise, have

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-Panel on Climate-Change (IPCC). In-particular (Eawag, 2008), 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_2O), 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 of 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-affects environmental-sustainability.

To-meet sustainability-challenge requires a-detailed-understanding of the-particularities 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-SWM-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. Materials and Methods.

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.

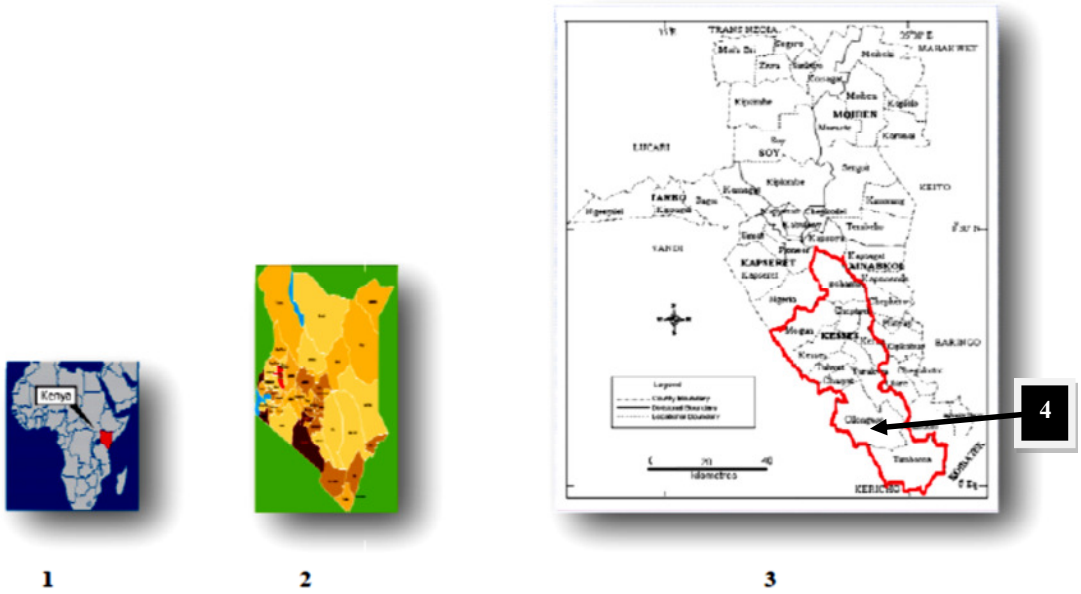

Figure 1: Consolidated-map (Modified from Starovoytova *et al,* 2016a).
Key: 1- Position of Kenya in African continent (in red); 2- Position of Uasin Gishu County in Kenya (in red);
3- Position of Kesses Constituency in Uasin Gishu County (in red); and
4- Position of Moi University in Kesses-Constituency.

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; Calcisols (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).

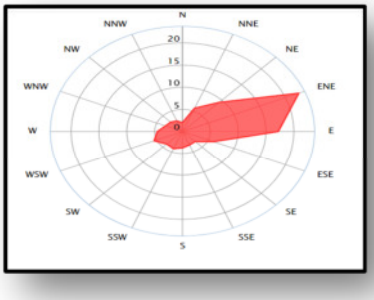

Figure 2: Prevailing-wind, at the-area.

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/a-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.

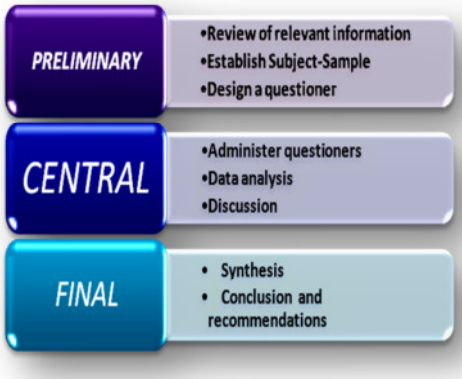

Figure 3: Sequential-parts of the study (Starovoytova & Namango, 2016a).

The-major-aim, of the-questioner and interviews, was to-determine the-current-practices, and challenges, experienced by the-SWM-service-providers (e.g., waste-management-administrators and operating-staff). *Non* probability-sampling was used for participant-selection approaches and techniques, according to Nardi (2014). Interviewing was done with the-help of formulation of an-interview-guide. Interviews took between 20 and 40 min, per-person. Subject-sample-participants, were interviewed individually, to-avoid any-bias.

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 cleanness of 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-cleanness 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-broad-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.

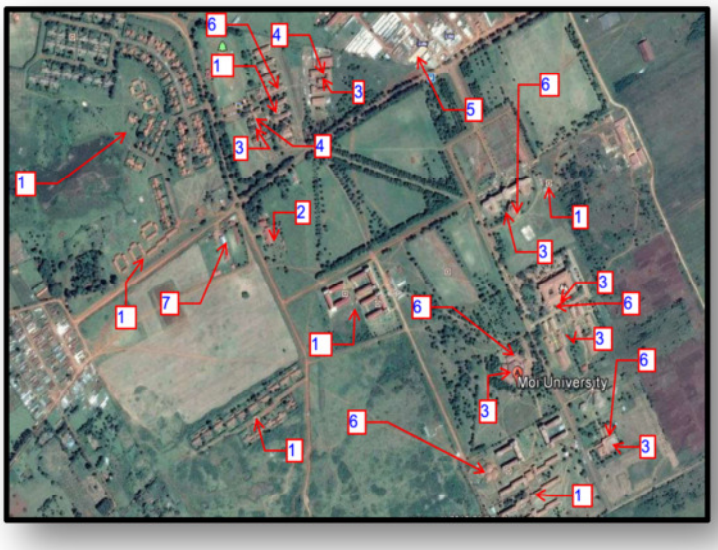

Figure 4: Waste-generators, identified, at the-MU, main-campus.
Key: 1--Student-hostels; 2-- MU-clinic; 3--Administrative-Offices; 4--Laboratories; 5--Stage-market; 6--Canteens/restaurants/eateries; and 7--MU mill.

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 uncollected); 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 some-time, 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^{o}), 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, manly, in-student-hostels. Each of the-residing-families, of the-staff-houses, is responsible for collecting and storing their-waste, and for maintaining of 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-cubicles, 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 empting, 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-cubicles, 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 the-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 reveled, 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.

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-dumping-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-scrap-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-chronic-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).

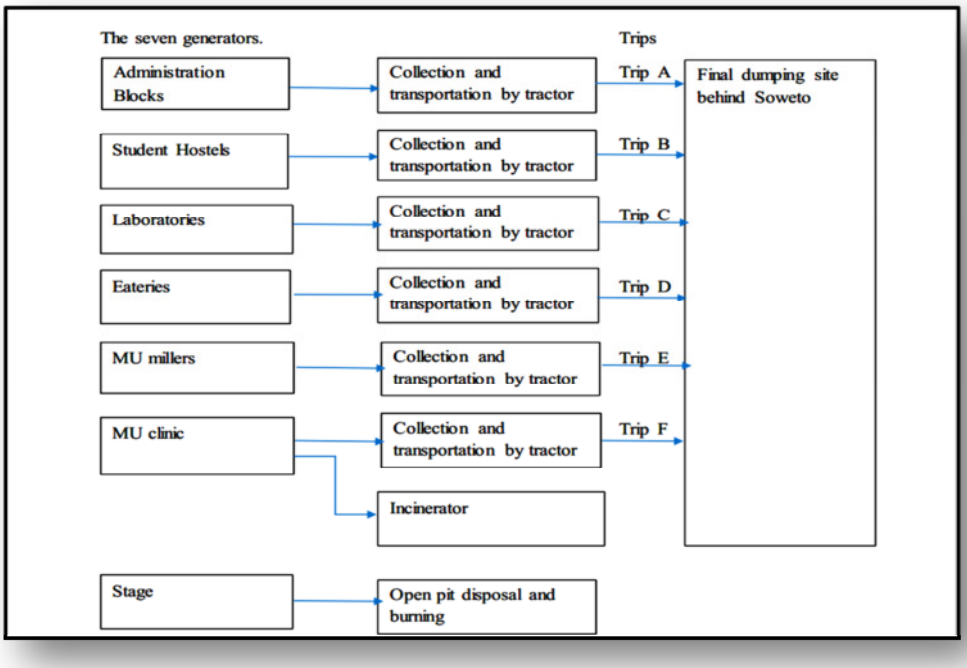

Figure 6: Transportation-routs, at MU.

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 *no* 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.

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-effects 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-

diseases, mostly-affecting the-waste collectors/handlers, and the-surrounding communities, caused by the-smoke from dumpsite. Also, traces of mercury, heavy-metals, polychlorinated biphenyls (PCBs), and copper-contents-particles, were in-high-concentration, on streams of water, originating from the-leachates, flowing from the-dumping-site, to-nearby lakes and rivers. Therefore, potentially-dangerous waste-burning should-be highly-discouraged.

Besides, other-problem, observed, is very-pronounced sickening-smell, emitted from decomposing organic-waste; smell starts to-be-noticeable even 200 meters from the-dumpsite. In-addition, '*leachate*' pollutes underground-water and poses a-serious-threat to health and environment. For-example, during the-rain, run-off, contaminated-with leachate, easily finds its-way to the-water-sources around.

Furthermore, the *open* dumpsite, at MU, is exposed and accessible, to-scavenging-birds, animals (such-as: rats, street-dogs, cats, and unattended-cattle and pigs, among-others), variety and high-population of insects, and informal-waste-pickers. During regular-site-visits, several-groups of waste-scavengers, sorting out the-waste, at the-dumpsite, were revealed. These are traditionally poor, unemployed-people, including most-vulnerable-segment of the-population, such-as: recent-migrants, internally-displaced persons, widows, disabled, elderly, and even children.

From-above-observations, and based on the-World-Bank-indicators (see section 2.5), the-SWM system, at-the-university, is characterized as: (1) of *Inferior Quality and accessibility of SWM*, manifesting in: inadequate-collection-coverage; insufficient-collection-frequency; and low-collection-reliability; (2) *Inefficient,* with low-equipment-performance; reported-absenteeism of workers; and lack of diligence, in-performing assigned-tasks; (3) of *Poor-Legitimacy and social-acceptability,* shown in deprived-labor conditions; and lack of customer-service; (4) *Potentially-damaging to Health and Environmental sustainability,* due to 100% illegal-dumping; absence of reuse and recycling; equipment-pollution and emissions (exhaust-emission-control of waste-transporting-vehicle; control of litter; and washing of vehicles); and presence of hazardous-waste; and (5) *Financial-incapability,* shown in lack accounting systems; absence of cost-recovery; no identified-mechanisms to-invest in-the-system.

Overall; open and uncontrolled-dumping-site, and the-current-SWM-practices, were assessed as *unacceptable*.

3.4. Compliance with SWM-laws and regulations.

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-sane, 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. 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-Standards and Enforcement-Review-Committee, to-advise 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-Standards 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) fire-fighting-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 *not* 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 1: SWOT-analysis of current SWM system and practices.

STRENGTHS:	**WEAKNESSES:**
University-Administration is aware of the-existing environmental-laws, and the-role of the-NEMA.	Inadequate political-good-will at National, County, and the-University-levels.
There are by-laws, governing waste-management, in the- counties.	Low-priority to waste-management leading to low-budgetary-allocations.
The-university is aware of its-obligations on waste-management.	Poor waste-collection-services (irregular and inadequate-coverage).
It has established units, recruited staff, and provided a-tractor-trailer, to-deal with SWM, at the-campus.	*No* segregation at source, and *no* recycling, practiced.
It allocates and provides a-budget for SWM-activities.	Inappropriate-location, design and management of the-waste-disposal-site.
It has a-designated-waste disposal-site, and provided community dust-bins, in some-points, at the-campus.	Inappropriate waste-collection-vehicle, operated illegally.
It's-clinic operates small-incinerator, to-treat biomedical-waste.	Inadequate/ poor-maintenance of machinery and equipments.
General-public, including students and staff, are becoming more-aware of their-right to clean-environment.	Inadequate-number of WM-staff, most of them are casuals, and lack of *trained*-personnel.
	Low-wages, and irregular-payments, for WM-workers.
	Poor public-perceptions/ attitude on individual responsibility towards waste management.
	Tolerance to living in a-dirty-environment, and littering-habits.
	Insufficient waste-infrastructures (waste-bins, transfer-vehicles, waste-handling-tools, protective-gear).
OPPORTUNITIES:	**THREATS:**
Opportunity to-implement the-existing environmental-regulations.	Uncontrolled-GHG-emissions, contributing to Global-warming (due-to lack of gas-control, at the-dumpsite).
Employment opportunities in WM (waste as a resource by recovery).	Environmental-risks of water, air, and soil-pollution (due-to uncontrolled-waste-disposal).
Investment opportunities in recycling, energy recovery, composting, and incineration.	Exposure of WM-workers to-health-hazards, leading to injuries, and occupational-diseases (due-to lack of PPEs).
Adoption of emerging-technologies in waste-management.	Poor-image of the-institution, due-to largely dirty-campus.
Increased public-awareness on waste-management and related-opportunities	
Increase involvement of the private sector	
Design and build a-sanitary-landfill.	

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.

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.

4.1. Waste-scavengers/pickers.

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 family, and microenterprises, comprised of women, children, and elderly-relatives/neighbors (WIEGO, 2012; Wilson *et al.,* 2006).

The-workers are at-risks, 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-risks 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 gastro-enteritis, dysentery, and other-illnesses

Scavengers are very-often socially-discriminated, for the-nature of activity, they indulged-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 USD 2, 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.

4.2.1. Public-health-effects (Tchobanoglous & Kreith, 2002; Ali *et al.,* 1999; and Médecins Sans Frontières, 1994):

(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-filariases. 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-cleanliness, 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.

(vii) *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, cysticerosis, and toxoplasmosis, which are transmitted-through infected-undercooked-pork.

(vi) *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 dibenzofurans (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-roadsides. The-situation is made-worse by the-presence-of animal and bird-scavengers, 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-lest-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 a-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/collecting, 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); Omoleke (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-out 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.

Climate-change and the-Environment: Projects promote environmentally-sound waste-disposal. They support greenhouse-gas-mitigation, through food-loss and waste-reduction, organic-waste diversion, and the adoption of disposal-technologies, which capture biogas and landfill-gas. Waste-projects also support resilience, by reducing waste-disposal, in-waterways, and safeguarding infrastructure against-flooding.

Health and safety: The-World Bank's work in MSWM improves public-health and livelihoods, by reducing open-burning, mitigating pest- and disease-vector-spread, and preventing crime and violence.

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, 2014 b; 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

(Lerpiniere *et al.,* 2014).

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 to-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 is 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 (sweeping-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/collecting, 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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