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Effective strategies for enhancing waste management at university campuses

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Abstract

Purpose – The purpose of this study is to identify and assess the waste management strategies that should be priorities for higher education institutions. The role of policy instruments (i.e. purchasing policies and recycling initiatives) in implementing sustainable zero-waste management programs at higher education institutions was investigated through comparison of American top-level and Western Kentucky University (WKU) benchmark universities.

Design/methodology/approach – Waste minimization-oriented policy instruments implemented at American top-level and WKU benchmark universities were analyzed through policy evaluation techniques. Digital surveys were distributed to sustainability coordinators at WKU benchmark and top-level universities. Semi-structured interviews were conducted with survey participants.

Findings – It is important to identify well-defined temporal periods with goals and allocated tasks for direct and indirect stakeholders. Time periods should include planning for readiness programs and infrastructural needs, along with performing comprehensive waste characterization studies. As the waste program matures, the creation of integrated waste management policies with specific responsibilities for all stakeholders and departments will be required.

Research limitations/implications – The sampling of universities evaluated in this research is not representative of all universities in the USA or internationally, as they can vary widely. Yet, general waste management trends applicable to most universities can be gleaned from this research.

Practical implications – Widely varying zero-waste strategies are readily implemented at universities. A holistic review of successful waste management plans highlights key management approaches that should be included in all plans to ensure their success.

Originality/value – This study is one of the first of its kind to holistically evaluate policy factors influencing effective zero-waste management at higher education institutions.

Keywords Recycling, Integrated waste management, Waste management framework, Waste policy, Zero-waste

Paper type Research paper

1. Introduction

In today's consumption-driven societies, large amounts of paper waste, food waste, e-waste, plastics, ferrous and non-ferrous metals, and excessive packaging are causing socio-economic and environmentally adverse impacts (Kumar *et al.*, 2005). Additionally, in a world with finite resources, the generation of enormous amounts of waste places pressure on city authorities to manage waste in an efficient, environmentally responsible manner (Zaman and Lehmann, 2011). In nature, all organisms fulfill a unique role in cycling nutrients to minimize the accumulation of excess waste (Waste Management Inc., 2013a). Similarly, individuals, households, municipalities and other organizations (e.g. businesses and universities) should be considered organisms of urban environments that must collectively

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function as an isolated unit, as well as work within the larger ecological system (Zero Waste Alliance, 2017).

More than three decades ago, higher education institutions in developed countries began to implement integrated waste management programs (Armijo de Vega *et al.*, 2008; Waste Management Inc., 2013a). Some strategies for waste reduction and recycling accomplished satisfactory results. Many American universities have institutionalized recycling programs as one of the most prominent and assimilated approaches to waste reduction in the USA (Armijo de Vega *et al.*, 2008). For instance, in 2010, Georgetown University successfully diverted 85 per cent of its waste from landfill disposal and reported a 45 per cent annual recycling rate as a direct result of its waste management practices (Sustainability at Georgetown University, undated). Rutgers University, which recently achieved a 67 per cent recycling and materials diversion rate, delivers food waste to local farmers as part of its waste management program (Armijo de Vega *et al.*, 2008; Waste Management Inc., 2013b).

Similar to universities, most communities in the USA provide waste collection services for all households within their boundaries. Predominantly, tax revenues fund these services, regardless of the volume of waste that each household may generate (Palmer and Walls, 1997). In contrast, user fee policies require households to pay an incremental fee for each container of waste produced. All communities in Minnesota and Washington, for example, are required to implement user fees by state legislation, but commitment to the implementation of this waste management strategy is not nationally consistent (Kinnaman, 1996), nor equally effective, in every state. Reschovsky and Stone (1994) investigated how household recycling behavior is impacted by quantity-based pricing of waste disposal and how household recycling behavior may change when the quantity-based pricing is adopted in conjunction with curbside recycling programs or mandatory recycling laws. From a random survey of households in the Finger Lakes region of upstate New York, the researchers found that recycling behavior is influenced most by the curbside pickup of recyclables. By providing a combination of mandatory recycling and curbside pickup, the probability of recycling newspaper and glass were increased by 22 and 37 per cent, respectively, compared to the use of drop-off centers (Reschovsky and Stone, 1994). This finding demonstrates how enforced policies in waste management can minimize waste production and lead to behavioral change in the long-term. Although the aforementioned instances relate to municipalities, it is possible the same underlying findings are applicable to universities. Higher education institutions can utilize policy instruments to establish an aspirational philosophy of zero-waste throughout the enterprise. In more developed countries, universities, as influential organizations in their communities, are increasingly developing zero-waste programs to take action against adverse environmental impacts and costs of waste disposal. The study of waste management structures, along with a regular assessment of environmental awareness and recycling behavior of campus individuals, can aid universities in reducing landfill waste and operational costs and promotes their reputation and role within surrounding communities.

This research focused on identifying required instruments with the goal of creating a framework for sustainable waste management systems at higher education institutions. Owing to the significance of universities' role in global sustainable development and their ethical obligation to act responsibly toward the environment (Armijo de Vega *et al.*, 2008), all types of educational institutions, particularly universities, are anticipated to play an important leadership role in the environmental protection movement. Proper operation of integrated and sustainable waste management programs within educational institutions is expected. In addition, aside from moral and ethical obligations to adopt waste management schemes, the establishment of zero-waste philosophy within educational organizations can

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help the institutions minimize the amount of fiscal resources needed for waste management (Armijo de Vega *et al.*, 2008). Even so, in many instances, educational institutions are unaware of how to participate in the environmental movement effectively and efficiently, especially with regard to waste management and generation reduction.

Though not particularly relevant for this study, published research related to recycling behavior and mechanisms at universities, as well as financial burdens of waste management, is abundant. A comprehensive discussion of waste management policies, exclusively, is, however, lacking in the published literature. The objectives of this study were to identify and assess which strategies should be priorities for higher education institutions that may lack stringent sustainable waste management infrastructure and evaluate existing waste management practices at American higher education institutions in an attempt to answer the research question:

RQ1. What should be the main components of a universal/widely applicable waste management framework for university campuses that aspire to implement an efficient and sustainable system?

To conduct this research, a small selection of mid-sized institutions was sampled from the hundreds located in the USA. Western Kentucky University (WKU) served as an identifiable marker from which other universities could be selected and compared (e.g. benchmark universities). WKU has a notable influence on its surrounding community and is anticipated to act toward substantial sustainability goals by 2018 (Western Kentucky University, 2012a). Yet, the University, like many others, has struggled with establishing a successful comprehensive waste management plan, despite serving as a model for other sustainability-related initiatives.

2. Methods

For this study, waste management policies at two WKU benchmark universities and two top-level, large-sized universities were investigated to assess whether and how existing waste management policies at selected universities achieve waste management goals. This was completed through two processes:

(1) the distribution of a qualitative survey (and follow-up interviews as needed) to waste and sustainability coordinators at selected universities; and

(2) an in-depth policy analysis of all waste management policies and practices at four (two each category, mid-sized and top-level) randomly selected universities.

Although, the term "policy" includes a wide range of meanings, in the context of this research, written guidelines, practices, and implemented and published rules were considered "policy". The aim of the survey was to compare top-level universities to benchmark universities in terms of zero-waste strategies, waste management plans and waste reduction policies by asking a sample from both populations questions about each of these management strategies.

2.1 Site selection

Benchmark universities are identified in accordance with specific operating practices and organizational measures and outcomes. Accordingly, goals and organizational objectives of a higher education institution are normally created on the basis of a comparison with benchmark universities (Wade, 2011). The use of WKU benchmark universities in this research allowed the researchers to identify and objectively narrow the list of possible study

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sites from the hundreds of mid-sized American higher education institutions (see Table I). For the purpose of this work, among WKU benchmark universities, Pacific Lutheran University was substituted for the University of South Alabama, as Pacific Lutheran had only 3,142 undergraduate and 320 graduate students in fall 2013, which was an enrollment not comparable to the other institutions being assessed (Pacific Lutheran University, 2017). Morehead State University in eastern Kentucky, which had 10,076 undergraduate and 1,282 graduate students in the fall 2013 semester (Morehead State University Office of Institutional Research and Analysis, 2013), was included in this study for 18 benchmark universities. From the list of 18 WKU benchmark universities, Appalachian State University and James Madison University were selected as the benchmark universities for more in-depth evaluation because of their high overall sustainable waste management efficiencies at these two institutions.

In this study, top-level universities were defined by being large (student body enrollment greater than 30,000) and/or receiving significant amounts of grants as endowments (greater than $250 million). For a better comparison among these top-level institutions, information about annual endowment and number of enrolled students is provided in Table II. The College Sustainability Report Card is an initiative of the Sustainable Endowments Institute. The Institute collected more than 1,100 full school survey responses from over 300 American and Canadian institutions and scored multiple sustainability indices at these colleges and universities. The sustainability categories evaluated through surveys are as follows: administration, climate change and energy, food and recycling, green building, student involvement, transportation, endowment transparency, involvement priorities and shareholder engagement (Sustainable Endowments Institute, 2011). The College Sustainability Report Card was used as the basis for selection of universities with excellent and very good scores in sustainability indices. Of these, two indices, food and recycling and student involvement, were the primary factors used in the identification of which top-level universities to include in the

Institutions	Fall 2013 enrollment		No. of full-time faculty
	Undergraduate	Graduate	
Appalachian State University, NC	16,025	1,813	901
Ball State University, IN	16,300	4,203	961
Bowling Green State University, OH	14,477	2,481	750
Central Michigan University, MI	20,534	6,368	747
East Carolina University, NC	21,508	5,379	1,250
East Tennessee State University, TN	11,820	2,260	870
Florida Atlantic University, FL	25,523	5,280	724
Illinois State University, IL	17,749	2,523	886
Indiana State University, IN	10,268	2,180	470
James Madison University, VA	18,431	1,750	940
Middle Tennessee State University, TN	21,162	2,719	931
Morehead State University, KY	10,076	1,282	1,170
Northern Illinois University, IL	15,814	5,324	891
Ohio University, OH	23,505	5,281	889
Towson University, MD	18,779	3,720	870
University of North Carolina at Charlotte, NC	21,503	5,068	1,066
University of North Carolina at Greensboro, NC	14,348	3,359	764
University of Southern Mississippi, MS	12,475	2,774	694
Western Kentucky University	17,517	2,939	791

Source: Western Kentucky University Fact Book (2014)

Table I.
WKU benchmark universities surveyed in the study

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Institutions	Undergraduate	Graduate	Student No. Semester	Endowment
Arizona State University (2017a)	67,507	15,794	Fall 2014	$441 million as of June 2010
Clark University (2015)	2,205	1,063	Fall 2014	$268 million as of March 31, 2010
Duke University (2017)	6,471	8,379	Fall 2014	$4,400 million as of June 30, 2009
Harvard University (2012)	7,245	21,049	Fall 2011	$26,035 million as of June 2009
Michigan State University (2017)	38,038	7,780	Fall 2014	$1,047 million as of June 30, 2009
Northeastern University (2014)	17,107	7,638	Fall 2013	$531 million as of March 31, 2010
Purdue University (2012)	29,440	8,407	Fall 2013	$2.182 billion as of June 30, 2013*
The Ohio State University (2014)	44,741	10,389	Fall 2014	$3.548 billion as of June 30, 2014**
University of California at Berkeley (2015)	27,126	10,455	Fall 2014	$137 million as of June 30, 2009
University of Colorado Boulder (2017)	26,240	5,760	Fall 2013	$948 million as of March 31, 2010
University of Florida (2017)	32,776	17,137	Fall 2012	$1,129 million as of March 31, 2010
University of Illinois-Urbana Champaign (2015)	32,281	12,239	Fall 2013	$1,112 million as of June 30, 2009
University of Kentucky (2012)	19,884	5,774	Fall 2013	$806 million as of March 31, 2010
University of Louisville (2017)	15,893	6,400	Fall 2012	$682 million as of March 31, 2010
University of Michigan (2017)	28,283	15,427	Fall 2013	$6,115 million as of June 30, 2009
University of Oregon (2017)	20,569	3,612	Fall 2014	$427 million as of March 31, 2010
Yale University (2014)	5,379	6,501	Fall 2012	$16,327 million as of June 30, 2009

Table II. Top-level universities contacted for participation in research survey

survey distribution list. Sixteen universities were randomly selected from the published list of the 2011 Green Report Card with the aforementioned criteria met and one more university (the University of Kentucky) was added to the selected list, for 17 universities. The selected universities received an acceptable overall grade of "good" for the food, recycling and student involvement categories (see Table III). For instance, OH State University is home to one of the most successful stadium recycling and composting programs in the USA, with a 90 per cent+ recycling diversion rate (Natural Resources Defense Council, 2013). Purdue University has long-term zero-waste goals related to cost reduction/sales growth, carbon footprint reduction and health risk reduction (Purdue University, 2013). The only university that did not acquire an "A" or "B" grade on the Green Report Card list was the University of Kentucky; however, considering the University of Kentucky is a top-level university in WKU's region and its influential role in Kentucky, the University was included in this study. Among top-level universities, AZ State University and Michigan State University were randomly selected for in-depth policy review from the list of American large universities that received "A" scores for their recycling and food activities on the College Sustainability Report Card.

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Institutions	Overall grade	Food and recycling	Student involvement
Arizona State University – Tempe	A−	A	A
Clark University	B+	A	C
Duke University	B+	A	A
Harvard University	A−	A	A
Michigan State University	B+	A	B
Northeastern University	A−	A	B
Purdue University	N/A	N/A	N/A
The Ohio State University	N/A	N/A	N/A
University of California – Berkeley	B+	A	A
University of California – Davis	A−	A	A
University of Colorado at Boulder	B+	A	A
University of Denver	A−	A	B
University of Florida	B+	A	A
University of Illinois – Urbana Champaign	B	A	B
University of Kentucky	C+	C	B
University of Louisville	B	A	A
University of Michigan	B	A	C
University of Oregon	B+	A	B
Yale University	A	A	A

Source: The Sustainable Endowments Institute (2011)

Table III.
Sustainability scores for top-level universities

2.2 Survey

In this research, a digital Qualtrics survey containing a combined total of 17 multiple-choice, five-point Likert scale and short answer questions was designed, validated and distributed to recycling and sustainability coordinators and zero-waste managers at identified WKU benchmark and selected American top-level universities (see Tables I and II). Example survey questions included, "Your university waste stream has the highest percentage of which of the following recyclable materials?", "Please rate the education/outreach efforts from the recycling, waste management, housing and residence, and/or sustainability departments at your university with the following department/sector (Academic, Operations, Dining and Food Services, Purchasing, Surplus, Marketing)" and "Please rate the influence of the following factors on adopting waste minimization strategies at your university (economic incentives, rules and regulations, student demand, local community demand, other)". Through email, the potential participants were encouraged multiple times to participate in the survey. From the top-level universities, 12 of 17 contacted participants responded to the survey, while 13 of 19 contacted university representatives from the benchmark population completed the survey.

2.4 Semi-structured interview

To supplement the collected survey data, semi-structured in-person or phone interviews with participants from the aforementioned universities were conducted. Example questions included "Do you feel you have enough human resources to complete all waste-related tasks?", "How much waste do you think should be diverted from the landfill by your Institution? What is your current situation and what are your future targets?" and "Has your university ever changed its purchasing policies toward Zero-Waste strategies? If so, what steps have been taken?". Semi-structured interviews were also conducted with the Recycling

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Coordinator, Campus Operations Manager, Student Technology Coordinator, Purchasing and Accounts Payable Director at WKU and staff with the WKU Restaurant Group.

3. Results and discussion

3.1 Policy analysis

3.1.1 Appalachian State University. ASU handles over 3,200 tons of waste through reuse, recycling, composting or landfilling, annually. In 2012, they committed to achieving a zero-waste campus, with a goal of 90 per cent diversion from landfill by 2022. For this goal, several initiatives focused on engaging the campus community in sustainable practices were proposed in the ASU Waste Reduction Strategic Plan. The initiatives include implementing awareness-raising programs, integrating sustainability into all dimensions of university activities and creating a new paradigm for food systems and waste production (Appalachian State University Office of Sustainability, 2012). Three distinct temporal periods and goals are outlined in the Plan:

(1) 2012-2014: Awareness, operation and organizational readiness;

(2) 2015-2018: Infrastructure upgrades, cultural and behavioral shift; and

(3) 2019-2022: Paradigm shift and transformation.

For implementing this effort, 23 stakeholders, who are anticipated to play significant roles in reaching established goals, were identified (Appalachian State University Office of Sustainability, 2012).

In 2006, ASU aggressively expanded its recycling program by allocating funds for two graduate assistants, identifying new locations for placing bins, integrating logos and stickers on all campus recycling containers and developing an education and outreach plan. In 2008, a tailgate recycling program, which consisted of installing recycling receptacles in and around the stadium and distributing green recycling bags to all tailgaters, was initiated at the University. By implementing this program, an estimated 36+ tons of waste were diverted from landfills between 2006 and 2012. As part of another effort, over 100 tons of food is collected and composted annually at ASU (Appalachian State University Office of Sustainability, 2012).

The Waste Reduction Strategic Plan required a comprehensive waste audit to be conducted in an effort to determine the amount and composition of waste ASU produces, as well as measure the effectiveness of pre-existing campus waste management operations. In 2013, single stream scheme was replaced with dual stream to provide convenience, raise participation and reduce sorting costs (Participant A, personal communication, 2015). In the same year, a mini-bin system was deployed in academic and administrative offices, which increased recycling by 30 per cent (Appalachian State University Office of University Sustainability, 2015). Under the second temporal period of the strategic plan, ASU is required to conduct the Environmentally Preferable Purchasing Program (EPP), which is likely a critical step in any waste diversion plan. According to this program, ASU is committed to purchasing products that have a reduced negative effect on human health and the environment when compared with competing products (Appalachian State University Office of Sustainability, 2012).

3.1.2 James Madison University. By legislation passed in 1990, the Commonwealth of Virginia mandated that all state agencies establish programs for the collection of all recyclable materials (Virginia Department of Environmental Quality, 2017; James Madison University, 2014a). In 2007, the JMU President signed the American College and University Presidents' Climate Commitment. In the same year, the President's Commission on

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Environmental Stewardship and Sustainability prepared a report recommending possible environmental actions for which JMU must undertake. The report supplied the University with a basis for making and implementing multiple environmentally stewardship-centered policies (James Madison University, 2017a). According to the JMU Sustainable Procurement Policy, the Associate Vice President for Business Services is responsible for upholding the policy, but the responsibility for managing this policy is assigned to the Director of Procurement. At JMU, Fixed Assets and Surplus Property, under the Accounting and Reporting Department, is responsible for managing JMU's fixed assets such as buildings, land and equipment (James Madison University, 2017b).

At JMU, the Office of Recycling is required to create waste and recycling reports and provide those to state officials (Participant B, personal communication, 2015). The recycling policy outlines that cooperation between the recycling department and building coordinators is fundamental to educate departmental employees and procure recyclable supplies. By policy, the University is required to procure recycled products whenever economically feasible and the community is not permitted to bring any non-recyclable waste to the campus (James Madison University, 2014a). In this policy, recycled products are considered any product that is manufactured with waste material recovered, diverted from solid waste, or derived from post-consumer waste, industrial scrap or other waste that would otherwise be discarded (James Madison University, 2014b).

The sustainable procurement policy is intended to align its procurement plans with the environmental stewardship goals reflected in the Environmental Stewardship Action Plan (James Madison University, 2014b). In 2009, JMU added environmental stewardship as a defining feature of the JMU community, meaning JMU policymakers have decided to focus on making the University community environmentally literate and to act as model stewards of the natural world (James Madison University, 2017a). In the action plan, eight areas (energy, commuting, water, food, materials, land use, education and scholarship, and citizenship) are identified as institutional objectives; waste management is related to many of these areas. For example, the materials section of the plan requires a development strategy for landfill waste reduction and green procurement guidelines and a plan to increase the sustainability of food services (Participant B, personal communication, 2015; James Madison University, 2017a).

Between 2008 and 2011, solid waste recycling at JMU increased by 2 per cent, composting increased from 0 to 8 per cent and Material Recovery Facility (waste-to-energy) improved to 22 per cent (James Madison University Office of Environmental Stewardship and Sustainability, 2015). Increased recycling is attributed to multiple efforts such as increasing the number of recycling bins on campus, relabeling all existing bins, providing composting bins at dining halls, replacing dining take-away packaging with compostable packaging, and improving and widely distributing recycling guidelines across the campus (Participant B, personal communication, 2015). In the environmental strategic plan of the University, environmental education, with an emphasis on interdisciplinary learning, developing courses about conservation of natural resources, assessment of students' environmental literacy and providing support for pursuing environmentally centered research, is required. Best practices for environmentally responsible behavior change and innovation grants to foster environmental awareness-raising campaigns are also included (James Madison University, 2017a).

3.1.3 Arizona State University. In the early 1990's, Arizona State University's (AzSU) recycling program was initiated under the Surplus Property Program of the Business Service Division (Arizona State University, 2014). The program operated as a dual stream collection for paper and aluminum. In 2008, the program became a single-stream collection system and the responsibility of the program was transferred to Grounds Services. The Surplus Property Program is now only responsible for handling auctions for AzSU property,

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electronics and appliances (Arizona State University, 2014). Over the past decade, a comprehensive policy toward sustainable waste management, "*Roadmap to Zero Waste*" was developed. The AzSU *Roadmap to Zero Waste* document suggests 12 steps to achieve zero-waste: setting a date to achieve zero-waste; developing and enforcing purchasing policies; establishing a teamwork model that includes all stakeholders; ongoing training for anybody involved with waste management and recycling operations; developing simple and effective signs; maintaining customer service; post-event sorting; keeping a baseline of program performance data; monitoring the economics of zero-waste projects; celebrating success and rewarding best project performers; encouraging regional synergies to make projects look similar on campus and off; and fostering local capacity development by supporting local companies that make recycling or compost goods (Arizona State University, 2014). The document recommends that effective purchasing policies should encourage green purchasing (products with minimum packaging and high durability) and promote purchasing products with recyclable content. The document also encourages using food items that are certified by Biodegradable Products Institute.

In January 2012, after forming a strategic partnership between Waste Management, Inc. and AzSU (Arizona State University, 2013, 2014), Waste Management, Inc., became a project manager for the implementation of the zero-waste strategy and practices reflected within the *Roadmap*. February 2012, Waste Management, Inc., conducted a waste audit study to detail the composition of materials in the AzSU waste stream. Potential projects that could reduce waste generation at AzSU were assessed and/or proposed based on outcomes from the waste stream assessment. The Sustainability Projects Assessment Tool was developed to analyze various dimensions of the proposed projects. Detailed descriptions, number of required employees, tasks for various project roles and required logistics for each project were identified and/or developed. In total, to date, the AzSU/Waste Management, Inc., zero-waste team has developed 50+ projects and programs (Participant C, personal communication, 2014).

AzSU and Waste Management, Inc., have achieved an estimated diversion rate of 31 per cent by implementing a comingle Blue Bin Recycling Program. The AzSU Blue Bin Recycling Program is funded by the institution and staffed by a campus Zero-Waste Manager, a Recycling Program Manager, a team of recycling technicians and student interns (Arizona State University, 2014; Participant C, personal communication, 2014). Approximately $594,000 was funded for the procurement of bins for full implementation of the program at all four AzSU campuses (Arizona State University, 2014).

As outlined in the AzSU *Roadmap to Zero Waste*, Purchasing and Business Services and Central Receiving are required to implement a policy of "sustainable procurement" university wide. Paper and package reduction and improvement of packaging material quality are the primary focus areas of this policy. The sustainable procurement policy requires any packaging material that is provided by AzSU vendors to meet at least one, preferably all, of the following criteria: made from 100 per cent post-consumer recyclable material; biodegradable; recyclable; reusable; and non-toxic) (Arizona State University, 2014). Central Receiving staff evaluate sustainable purchasing policy compliance and student teams perform audits to support their efforts. As a result of implementing this sustainable procurement policy, packaging has been reduced by 50 per cent below previous levels, which is equivalent to 40-50 tons of packaging, annually (Arizona State University, 2014, 2017b).

Waste-related programs that are exclusively designed for AzSU food and dining services include *Compostable Food Service Items*, *Food Donation*, *Food Management Process*, *Trayless Dining*, *Reusable To-Go Containers*, *Reusable Bag and Mug Discount* and *Bottled Water Reduction* (Arizona State University, 2014; Participant C, personal communication, 2014). AzSU diverts hundreds of tons of food-related material from landfills across all

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campuses. For example, through a study of 186,000 meals served at over 25 higher education institutions, ARAMARK estimated that the *Trayless Dining Program*, alone, could reduce 76 tons of food waste and over 652,000 gallons of water in an academic year (Arizona State University, 2014).

3.1.4 Michigan State University. The recycling program at MSU is rooted in student demand (Michigan State University Recycling Center, 2017; Participant D, personal communication, 2014). In 2013, the MSU Surplus Store and Recycling Center joined with the Office of Campus Sustainability to form a comprehensive waste reduction and sustainability team (Michigan State University Recycling Center, 2017), with approximately 120 active employees (Participant D, personal communication, 2014). Currently, MSU Surplus Store and Recycling Facility receives about $1 million in funding from MSU's General Fund (Participant D, personal communication, 2014; Michigan State University Recycling Center, 2017), but they are striving to become a self-funded unit (Participant D, personal communication, 2014).

By utilizing the Recycling Center's fleet of 41 vehicles, the Surplus and Recycling Center is its own service provider and nothing is paid to a third party contractor for collecting recyclables. The MSU Recycling Center maintains a record of the number of dumpsters, compactors, and recycling and waste bins distributed across MSU (Participant D, personal communication, 2014). Under certain circumstances, recycling commodities may be either separated or comingled. For instance, for events and athletic venues, single-stream and comingled recycling is available, while most other recycling stations at MSU have separate recycling containers for different commodities. Containers at residence hall loading docks are used for comingling cardboard, plastic and metal. In fiscal year 2013, MSU Recycling collected 7,655,613 lbs of recyclable materials (this number does not include composted organic waste), which equates to an average of 147,224 pounds each week (Participant D, personal communication, 2014). Additionally, MSU increased plastics recycling by investing time into hand-sorting plastics (Michigan State University Recycling Center, 2014).

Four compost/organics collection options are provided on the MSU campus: MSU Digester (anaerobic digestion), Landscape Services/Nursery (compost), MSU Student Organic Farm (vermicomposting and hot composting) and University Farms (compost). About 122,350 lbs are diverted from the landfill through the organics waste collection options, monthly (Participant D, personal communication, 2014). Expanding organic waste collection and seeking more opportunities for organic waste diversion will remain the focus of MSU; in fact, the University plans to reach a 70 per cent waste diversion rate by 2017 (Participant D, personal communication, 2014).

Surplus, recycling and sustainability programs on campus, along with participation in national programs such as *RecycleMania* and *Game Day Challenge*, are various ways that MSU promotes waste reduction and increases awareness. The *Green Steward/Spartan EcoReps Program* is also being developed to involve faculty and staff in the sustainability initiatives on campus (Participant D, personal communication, 2014). As a Spartan EcoRep (formerly MSU Environmental Steward), individuals can assist in reviewing buildings' Environmental Stewardship Report and brainstorming ways to improve performance in waste reduction (Michigan State University, undated b). In 2013, MSU reduced waste by 10 per cent, while revenue increased by 10 per cent. In 2014, 57 per cent of waste was diverted from the landfill (Michigan State University Sustainability Report, 2014). For ease of comparison, Table IV summarizes the key elements of the waste management programs implemented at JMU, MSU and AzSU.

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University	Waste management program characteristics
Appalachian State University	- Implemented awareness-raising program - Sustainability integrated into all dimensions of university activities - Food systems and waste production emphasized - Established time periods with identified goals - Stakeholders identified and engaged - Allocated funding for 2 graduate assistants - Identified new locations for placing bins - Integrated logos and stickers on all campus recycling containers - Developed education and outreach plan - Developed tailgate recycling program - Conducted comprehensive waste audit - Minibin system implemented in faculty offices - Environmentally preferable purchasing program
James Madison University	- Sustainable Procurement Policy Implemented - Fixed Assets & Surplus Departments Combined - Create waste and recycling reports - Cooperation between recycling department and building coordinators achieved through education programs - Recycled products must be procured when 'economically feasible' - Community not permitted to bring non-recyclable waste to campus - Green procurement guidelines for food services developed - Increased number and relabeled recycling bins on campus - Provide composting bins at dining halls - Replaced dining take-away packaging with compostable packaging - Improving and distributing recycling guidelines across the campus - Developed environmental courses
Arizona State University	- Use single-stream waste collection - Recycling program managed under Grounds Services - Published comprehensive waste policy - Developed purchasing policies - Established a teamwork model that includes all stakeholders - Training offered for anyone involved with waste management - Implementing post-event sorting - Establishing baseline of program performance data - Celebrate success and reward best project performers - Encouraging regional synergy to make projects look similar on campus and off - Fostering local partnership by supporting local companies that make recycling or compost goods - Sustainable Procurement policies implemented - Waste audit conducted - Partnered with professional waste management company - Each waste project developed with detailed description, number of required employees to achieve, tasks for project roles and required logistics identified/developed - Waste-related programs for food and dining services created - Surplus Store and Recycling Center joined with the Office of Campus Sustainability to form a comprehensive waste reduction and sustainability team
Michigan State University	- Invest large amount of funding from general fund, 120 employees - Service as their own waste management provider - Under certain circumstances, recycling commodities may be either separated or comingled - Hand sorting plastics conducted - 4 compost/organics collection options available for campus waste - Participate in national programs such as RecycleMania and Game Day Challenge - Green Steward/Spartan EcoReps Program being developed to specifically engage faculty and staff in the sustainability initiatives

Table IV.
Summary of waste policies at investigated universities

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3.1.5 Western Kentucky University. Two decades ago, the recycling program at WKU was limited to recycling only paper, cardboard and metal (Western Kentucky University, 2012b). At this time, the Department of Facilities Management and the Department of Environment, Health and Safety were also required to recycle hazardous commodities such as florescent light bulbs, paints, batteries and used motor oil (Western Kentucky University Recycling and Surplus Department, 2015a). In 2008, a full-time Sustainability Coordinator was hired at the University and the WKU Sustainability Committee was created (Western Kentucky University, 2012b). In the same year, the Department of Facilities Management allocated $30,000 for the procurement of recycling bins to continue supplying infrastructural facilities for waste management. The Department of Facilities Management worked collaboratively with the Sustainability Coordinator, who provided educational and outreach programming support. In 2011, single-stream scheme was announced to facilitate program expansion, surplus operations joined with recycling operations to create the Recycling and Surplus Department, and oversight of the Recycling and Surplus Department remained under the Department of Facilities Management (Western Kentucky University Recycling and Surplus Department, 2015a). Today, the recycling and surplus program at WKU is staffed with students (Western Kentucky University Office of Sustainability, 2017), one full-time recycling and surplus coordinator, one full-time surplus operations staff and one full-time staff for recycling pickup (Western Kentucky University Recycling and Surplus Department, 2015a).

For several years, recycling and surplus have been the main drivers of the WKU waste management system, which primarily utilizes a single-stream approach (Western Kentucky University Recycling and Surplus Department, 2015a). Although this approach requires fewer human resources, lower costs for collection and leads to higher diversion rates, opponents of this approach indicate disadvantages in the processing and marketing of these materials. Opponents argue that, although the single-stream scheme helps increase speed of collection compared to the split-stream scheme (Hopewell *et al.*, 2009), it still requires post-collection separation, which requires a human or mechanized workforce. For instance, the MSU Recycling Center and Surplus Store has 41 vehicles and 120 employees (Participant D, personal communication, 2014) to execute its different recycling programs and hand-sort plastics after accumulation in a single recycling container; this type of resource is simply not available at most universities.

WKU produces approximately 3 million pounds of solid waste, annually (Western Kentucky University Office of Sustainability, 2017). According to the 2007 dumpster audit conducted by Ryan-Downing (2007), nearly 34 per cent of the contents of each dumpster comprised recyclable commodities. Similarly, inventories of campus dumpsters undertaken by an archeology class in 2008 and 2009 revealed that 36 and 43 per cent of the refuse, respectively, were recyclable. Based on visual waste audits and Scott Waste Inc., the single-stream is made of 40 per cent plastic containers #1-7, 35 per cent mixed paper, 20 per cent small cardboard and 1 per cent metal cans (Participant E, personal communication, 2014; Participant F, personal communication, 2014). These audits revealed potential opportunities for increased revenue and efficiency through modest investment in waste management facilities (cardboard collection, compartmentalized dumpster, etc.; Ryan-Downing, 2007).

The Department of Recycling and Surplus currently has two main goals:

(1) updating campus bins and signage; and

(2) training and education (Western Kentucky University Recycling and Surplus Department, 2015a).

Yet, several gaps in waste management are currently not closely considered on a holistic, campus-wide scale while working toward the two aforementioned goals. The environmental

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awareness and recycling behavior of campus individuals, existence of adequate waste minimization policies at the campus-wide and departmental levels, efficiency of operational instruments to implement those policies, waste generation stream analysis, and the need for supplying more facilities and tools to handle waste are lacking. For example, waste reduction through the development of thoughtful purchasing strategies, increasing reuse opportunities and conducting comprehensive outreach and education services has been defined in the mission statement of the Recycling and Surplus Department (Western Kentucky University Recycling and Surplus Department, 2015b). Yet, although there are many ongoing efforts to promote waste reduction awareness by the Department, such as holding an annual campaign on campus during the University's Earth Day celebration (Western Kentucky University, 2012b), a formal university-wide recycling or waste reduction policy has not been implemented at WKU. Recently, drafting a comprehensive plan was initiated. Several stakeholders will be required to come together under a common directive to create this plan and enforce the policy (Participant E, personal communication, 2014).

3.2 Top-level vs benchmark university waste management survey

Each contacted participant from the top-level universities (n = 11) responded that they have established zero-waste strategies, while 8 (of 13) participants from the benchmark sample population indicated the same response. A waste management plan is implemented at seven of the top-level universities included in this portion of the study, while eight respondents from the benchmark universities indicated that their institutions have an implemented waste management plan; few explanations from the participants at top-level universities were provided, but respondents did indicate that their waste management policy is voluntarily, or, if the policy is mandatory, there is no penalty for not abiding by the policy. Six benchmark and six top-level universities answered "Yes" when asked, "Do you have a recycling or waste reduction policy".

Participants from both populations believed *Increasing Reputation by Taking Environmental Actions* and *Economic Incentives* (i.e. cost savings and higher landfill costs) have the greatest influence on universities adopting waste minimization strategies. Among respondents' answers from both populations, *AASHE STARS Rating*, *presidential initiative*, *compliance with the President's Climate Commitment obligations* and *becoming a notable college focusing on sustainability* were implicated as the main influencer on whether waste minimization strategies are adopted. Figure 1 summarizes these survey responses. Please note, however, these responses represent only a portion of the data considered when

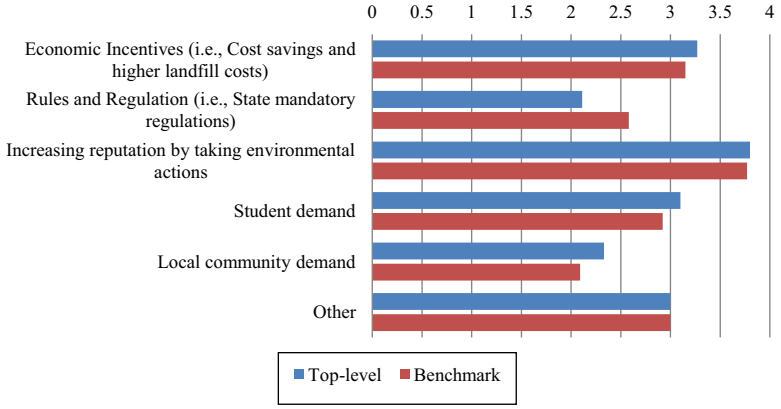

Figure 1.
Influential factors in adopting zero-waste strategies at universities

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reaching our research conclusions and waste management policy recommendations. Data included in Figures 1-4 were sourced from the developed and distributed survey and interviews with waste management leaders at participating survey sites.

Both populations were asked about communication and education/outreach efforts from the recycling, waste management, housing and/or sustainability departments at their representative university. Using a five-point Likert scale, participants were asked to choose "5" for the sector with the greatest amount of efforts and "0" for sectors with the least

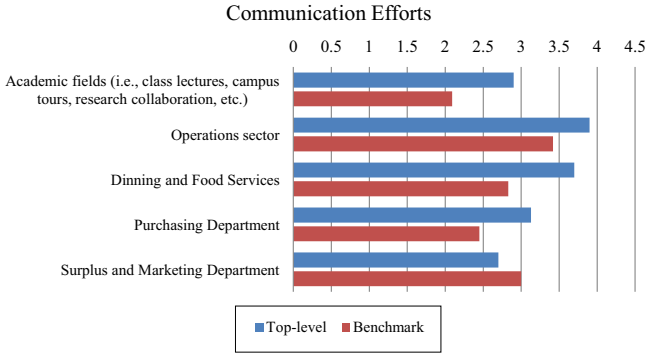

Figure 2.
Communication efforts between waste management departments and other departments, top-level vs benchmark

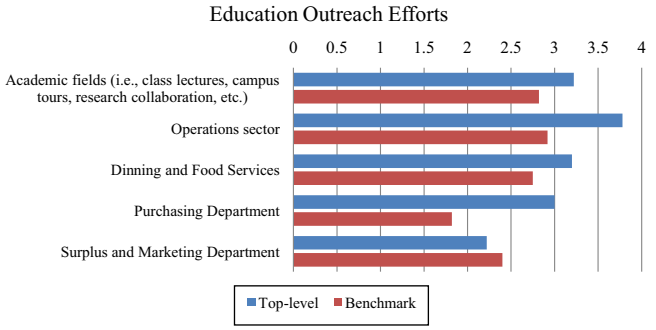

Figure 3.
Education/outreach efforts by department, top-level vs benchmark

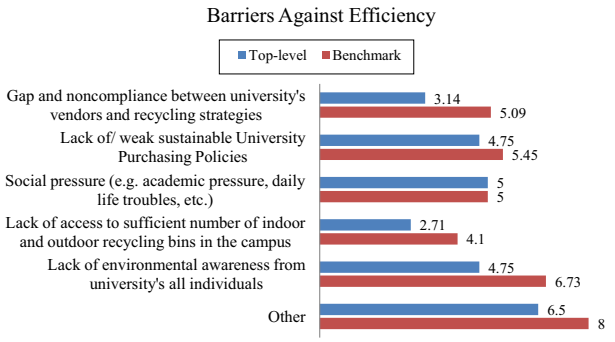

Figure 4.
Barriers against efficiency in adopting sustainable waste management operations at higher education institutions

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amount of communication and education/outreach efforts being pursued. According to collected data, education and communication efforts are pursued more at top-level universities than benchmark universities (see Figures 2 and 3). For both top-level and benchmark universities, waste management efforts are centered on the operations sector. Collected data also revealed that surplus and marketing departments follow the operations sector at benchmark universities and highlight that communication between academic and sustainability/recycling sectors of campuses are not desirable; this finding is contrary to the pursuit of education/outreach at WKU (Participant G, personal communication, 2015). Eco-friendly education efforts are needed in purchasing departments at benchmark universities.

Respondents from both top-level and benchmark universities were asked to identify the most influential barrier against increasing efficiency in the recycling program at their institution. A wide range of issues from contractors/agencies/vendors who are unfamiliar with the universities recycling programs and do not want to take part in them because of a lack of a full-time recycling coordinator and more staff dedicated to sustainable waste management were reported (Figure 4). For example, a participant from a top-level university indicated that the largest barrier to increasing efficiency in their Institution's recycling program is convincing students, staff and athletic fans that recycling is essential and worth the extra time, while another participant from a benchmark university highlighted a similar issue by suggesting that after six years of pursing a recycling program, occupants of their campus have "no idea what should be in each bin and do not want to learn". Survey respondents also described a lack of faculty/staff engagement in the recycling process.

A preliminary survey investigating recycling behavior of faculty, students and staff at WKU, through anonymous digital survey, provided complementary data to the aforementioned survey responses provided by sustainability and waste management coordinators (Ebrahimi, 2015). For instance, among several questions, respondents were asked about their primary source of recycling information. Over half of the respondents (n = 728) believed their primary information source for waste management strategies were media. The WKU Office of Sustainability and WKU Recycling and Surplus Department as indicated as recycling information sources by 41 per cent of respondents, while 112 participants (15 per cent) proclaimed that they had no information about recycling. Participants were also requested to rate factors (design of the bins, layout of the bins, size of the bins, availability of the bins, awareness-raising programs and ease of understanding signage) that may influence their on-campus recycling behavior. Participants responded that availability of the bins is the most influential factor that can encourage them to recycle more. Ease of understanding signage was selected as the next most influential factor, and signage was reported as perfect in its current form through another survey question. Overall, these insights suggested that, although specifically directed to recycling at WKU, similar questions could and should be asked of students at other universities to ensure maximize outcomes from utilized resources, including, but not limited to, bin signage and bin availability.

4. Conclusion

WKU is representative of many American mid-size universities in that financial and human resources available for waste management are limited, but a commitment to serve as a leader of responsible environmental stewardship is evident. By reviewing best practices at four higher education institutions with implemented plans for reaching zero-waste goals and from surveying waste managers at 17 WKU benchmark and top-level American universities, the researchers recommend that any university without an institutionalized sustainable waste management should take the following steps. A direct correlation is noted between amount of monetary and personnel investment in waste management programs and achievement in waste

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diversion. Although many universities are not equipped for such large investments of financial and employee resources into waste management programs, this research revealed several low-cost initiatives that can positively contribute to the reduction of a university's waste production with minimal investment. Based on collected data, waste bins and signage are the primary unavoidable investment in any effective university waste management program.

At each of the assessed universities with successful waste management programs, a published waste management plan is developed. Within this document, a project timeline for becoming a zero-waste campus should be clearly defined. This timeline should include clear time periods for awareness-raising and behavioral change programs, as well as providing infrastructural needs (e.g. sufficient availability of the bins across the campus). Deadlines for when a university must reach identified waste management goals should be outlined in accessible waste management plans. JMU's experience revealed one of the crucial steps in the first time period will be signing a commitment to take environmental stewardship actions. The commitment will act as the driver for implementing multiple environmental stewardship-centered policies, particularly sustainable procurement policies. The commitment, whether nationally recognized or community-based, ensures accountability for waste management practices across the campus. All programs must be regularly evaluated and changes made to implemented programs whenever necessary.

For the purpose of behavioral change, the entire campus community must be the target of all implemented activities, with all waste management decisions driven by survey data collected from all active community occupants (faculty, students and staff). Additionally, at each investigated university, measures are taken to ensure all direct and indirect waste management stakeholders are identified and invited to participate in the sustainability movement from both education and management perspectives. Comprehensive waste audits must be regularly conducted to ascertain a full understanding of the Institutions' waste stream and to ensure waste reduction resources are allocated appropriately. While some institutions may have the resources available to have full or part-time employees conduct waste audits, as proven effective on the WKU campus, students in select courses could be encouraged to participate in waste audit activities to reduce the need for investing monetary resources in hiring full- or part-time waste management employees to perform audits.

Data collected suggest a university should implement an EPP to commit a university to purchase products that have a reduced impact on human health and the environment when compared to competing products. Each of the investigated universities have sustainable procurement policies implemented, with particular emphasize on sustainable procurement in the food services sector. An implemented purchasing program can be part of a broader, more comprehensive sustainability policy, which includes sustainable procurement, food management, waste minimization and recycling programs in a single document. Any sustainable-purchasing policy should require any packaging material that is provided by university vendors to meet durability, recyclability, biodegradability, compostability and non-toxicity criteria.

The authors put forth that a zero-waste management plan should strive to clearly separate the management structure of surplus and recycling programs, yet allow flexibility in complimentary operations. In three of four reviewed universities, specifically ASU, JMU and AzSU, the surplus sector operates separately from the recycling sector. These two sectors can work together under a centralized management, but with clear tasks and ample well-trained employees and financial resources for each sector. Most higher education institutions frequently have limited resources (both manpower and financial) so grouping surplus and recycling operations under a single management structure is rather unsuccessful. By separating the two sectors, equal resources can be distributed to both and management decisions can be made by qualified individuals in each.

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