Undergraduate Thesis Prospectus

Unfantastic Plastic: How Has Single-Use Plastic Reduction Affected Waste Management at the University of Virginia?

(technical research project in Engineering Systems and Environment)

How the Plastic Pollution Coalition Fights Plastic Pollution

(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

How can global waste production be reduced?

Waste creates many of today's environmental, health, and economic problems. Globally, more than 0.74 kilograms of waste per capita is produced daily. In 2016, 2.22 billion tons of waste were made, almost 1000 times more than in 1950, with expected growth to 3.75 billion tons in 2050 with a business as usual approach. Waste from low-income countries is expected to triple by 2050, and is growing fastest in Sub-Saharan Africa, South Asia, and the Middle East. Globally, about 19 percent of waste is recycled or composted, 11 percent is incinerated, and 70 percent is openly dumped or landfilled (Kaza et al., 2018). This waste kills wildlife, emits greenhouse gas emissions into the atmosphere, and endangers human health (Joyner & Frew, 1999). Thus, there is a need to address the waste problem before it gets even worse.

Unfantastic Plastic: How Has Single-Use Plastic Reduction Affected Waste Management at the University of Virginia?

How has the implementation of Executive Order 77, banning single use plastic in State Agencies, impacted UVA's waste stream?

Pollution from plastic waste is a major problem affecting earth's ecosystems and human health. Plastic's persistence in the environment and ability to collect toxic contaminants makes it a huge threat to humans and wildlife. In recent years, the United States has developed a heavy reliance on single-use plastics. To combat this, Governor Ralph Northam of Virginia has ordered that all state agencies stop purchase and distribution of single-use plastics (SUPs) and completely phase out their use by 2025 (Office of the Governor, 2021). As a public institution of higher

education, the University of Virginia (UVA) must adapt its waste management strategy to comply with this executive order.

UVA is at a crossroads with composting. The recent ban on SUPs across the Commonwealth pushes the University to adapt its status quo waste management system to allow for more compostable materials in the waste stream. The UVA Sustainability 2020-2030 Plan is another driving factor in reducing waste to 30% of the University's 2010 tonnage by 2030, while also making university operations carbon neutral by 2030 and fossil fuel-free by 2050.

This technical project assesses UVA's waste management and its impacts on UVA's sustainability goals prior to EO77, and projects the results for future waste management options. This project is within the Engineering Systems and Environment department, the advisors are Lindsay Ivey-Burden and Lisa Colosi Peterson, and the collaborators are Shannon Hepp, Taylor Donches, Madeline Alwine, Geneva Lanzetta, and Madison Crouch. The team's goal is to analyze the solid waste management (SWM) system currently used by UVA against its priorities, assess possible structural changes to the system, and find and compare the performance of the current SWM to those alternatives.

UVA's current SWM system allows for back of house composting from dining halls and select other locations on Grounds, hand sorting of recyclables, and landfilling. Given current SWM options available, this waste can be reduced and the remaining could be used for energy production. Stanford University, another school working towards a low waste future, currently diverts 64% of its waste from landfill using source reduction, reuse, recycling and composting (Stanford University, 2021). Given proper information and funding, UVA could have similar or better diversion rates. Without our project, UVA does not know the effects of its current SWM system and how different options would affect sustainability metrics.

The team will create a model evaluating different SWM systems, which reflects the following parameters: landfilled mass in tonnage, composted mass in tonnage, global warming potential (GWP) in kg CO2-eq, energy in MJ, and cost in U.S. dollars (USD). One constraint is the lack of consistent SWM data, so the team will use ranges of historical and projected data to evaluate the target parameters. The team may also conduct a solid waste audit to aid in data projections. The target parameters will be evaluated annually for 2018 to represent the status quo and for the 2021 academic year to represent post-ban. The model will be created using Microsoft Excel and Google Sheets. The model will be optimized in Spring 2022 for presentation of viable, alternative waste stream options to UVA Facilities Management. Using this model, UVA will have a clear understanding of its options and important metrics.

How the Plastic Pollution Coalition Fights Plastic Pollution

How does the Plastic Pollution Coalition advance its agenda?

Plastic pollution harms humans, animals, and the environment. It kills marine life, leeches harmful chemicals into waterways and soil, and emits greenhouse gasses (Joyner & Frew, 1999). At least 8 million tons of plastic end up in our oceans every year, and plastic makes up 80 percent of all marine debris (Thevenon et al. 2014). In waterways, only some of the plastic waste can be captured (Schmaltz et al., 2020). Plastic waste includes microplastics (fragments less than 5 mm long, typically from cosmetics, clothing, and industrial processes), and macroplastics (larger objects, such as shopping bags or plastic bottles). According to the Pew Charitable Trusts (2020), in 2016, microplastics accounted for 1.3 million metric tons of plastic pollution entering oceans. Microplastics can be a vector for water borne pollutants, including polychlorinated biphenyls (PCBs), which can cause cancer, mutations, or birth defects (Thevenon et al. 2014). Over 200 marine species get entangled in or ingest toxic plastic debris,

which can kill them (Li et al., 2018). If humans eat these animals, they will also consume the toxic plastic. Macroplastics also make up the bulk of plastic pollution in rivers, adversely affect the river habitat, and can increase flood risk (Al-Zawaidah, 2021). Plastic pollution can also cause serious economic impacts. Plastic debris can impair fishing and tourism; cleanup can be time consuming and expensive (Thevenon et al. 2014). According to the UN, $13 billion is lost per year from plastic pollution (Raynaud et al. 2014).

Researchers have investigated how advocacies promote their environmental agendas. For instance, Hall and Taplin (2019) found that climate campaigners in California took advantage of states' competition for economic growth, environmental awareness in some communities, the state's history of progressive legislation, and public trust of nonprofits (Hall and Taplin, 2019). According to Koebele (2020), coalitions that unite diverse people are effective. Kuppuswamy (2020) found that used in combination with conventional media, social media can boost environmental awareness.

The Plastic Pollution Coalition is a global alliance of 1,200 organizations, businesses, and advocates in 75 countries working to diminish plastic pollution (PPC, 2021). PPC and other participants sponsor research (Vered & Sheknar, 2021). The Plastics Industry Association represents plastics manufacturers, defending the business interests of its member companies (PIA, 2017). Waste management companies, such as Waste Management or Republic Services, are in the business of waste disposal, including the disposal of plastic products (Waste Management, 2021). According to Principles for Responsible Investment, a UN-affiliated network representing investors committed to more sustainable economies, waste management companies influence waste disposal policies (PRI, 2021).

References

Al-Zawaidah, H., Ravazzolo, D., & Friedrich, H. (2021). Macroplastics in rivers: Present knowledge, issues and challenges. *Environmental Science: Processes & Impacts*, 23(4), 535–552. https://doi.org/10.1039/d0em00517g

Hall, N., & Taplin, R. (2019). Environmental Nonprofit Campaigns and State Competition: Influences on Climate Policy in California. *Voluntas*, 21(1), 62-81. Web of Science.

Joyner, CC. (1999). Plastic Pollution in the Marine Environment. *Ocean Development and International Law,* 53(3). Web of Science.

Kaza, S., Yao, L., Bhada-Tata, P., Woerden, V. F., & Ionkova, K. (2018). *What a waste 2.0: A global snapshot of Solid Waste Management to 2050*. World Bank Group.

Koebele. (2020). Cross-Coalition Coordination in Collaborative Environmental Governance Processes. *Policy Studies Journal*, 48(3), 727-753. Web of Science.

Kuppuswamy. (2020). A Study on the Environmental Campaigns in Traditional and Social Media. *International Journal of E-Politics*, 9(1). Web of Science.

Lau, W., & Murphy, M. (2021, March 30). Microplastics Are a Big – and Growing – Part of Global Pollution. Pew Charitable Trusts.

Li, J., Liu, H., & Chen, J. P. (2018). Microplastics in freshwater systems: A review on occurrence, environmental effects, and methods for microplastics detection. *Water Research*, 137, 362–374. https://doi.org/10.1016/j.watres.2017.12.056

Office of the Governor (2021, March 23). Commonwealth of Virginia. Executive Order 77. Virginia Leading by Example to Reduce Plastic Pollution and Solid Waste.

PIA (2017, Oct. 26). Plastics Industry Association. Power of Plastics.

PPC (2021). Plastic Pollution Coalition. The facts.

PRI (2021, July 29). Principles for Responsible Investment. Engaging on plastic packaging: Waste management.

Raynaud, J., Richens, J., & Russell, A. (2014). *Valuing plastic: The business case for measuring, managing and disclosing plastic use in the consumer goods industry*. UNEP.

Schmaltz, E., Melvin, E. C., Diana, Z., Gunady, E. F., Rittschof, D., Somarelli, J. A., Virdin, J., & Dunphy-Daly, M. M. (2020). Plastic pollution solutions: Emerging technologies to prevent and collect marine plastic pollution. *Environment International*, 144. https://doi.org/10.1016/j.envint.2020.106067

Stanford University. (2021). *Peninsula Sanitary Service/Stanford Recycling*. Peninsula Sanitary Service/Stanford Recycling | Land, Buildings & Real Estate. https://lbre.stanford.edu/pssistanford-recycling

The Pew Charitable Trusts & SYSTEMIQ. (2020). *Breaking the Plastic Wave: Top Findings for Preventing Plastic Pollution*. The Pew Charitable Trusts & SYSTEMIQ.

Thevenon, F., Carroll, C., & Sousa, J. (2014). *Plastic debris in the ocean: The characterization of marine plastics and their environmental impacts, Situation analysis report*. IUCN.

Vered, G. Shenkar, N. (2021). Monitoring plastic pollution in the oceans. *Current Opinion in Toxicology*, 27, 60-68. https://doi.org/10.1016/j.cotox.2021.08.005.

Waste Management (2021). *Our position on plastics - plastic exports: Waste management*. Waste Disposal & Recycling. https://www.wm.com/us/en/recycle-right/plastic-exports