

Comparing Different Food Waste Reduction Strategies at College Dining Services

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Introduction

I want to evaluate the effectiveness of different strategies for food waste (FW) reduction in higher education campuses. I will focus on comparing bottom-up vs. top-down strategies effectiveness on reducing FW at major dining facilities on campus. Bottom-up approaches are ones that aim to influence affect an individual's behavior and include putting up information posters, and holding educational events about the environmental costs of FW. Top-down approaches are structural changes that influence how food is presented such as removing trays and reducing portion sizes. I will evaluate the effectiveness of strategies by measuring post-consumer FW. I will also use survey data to evaluate the effect on student's attitudes towards food reduction policies. The purpose of this study is to find the most effective strategies that college campuses can use to reduce FW.

Justification

Davidson College wastes pounds of food daily, and each pound of FWd is an opportunity to reduce our carbon impact. FW is a major contributor to greenhouse gas (GHG) emissions, yet there is limited research on comparative strategies regarding FW. Additionally, college students' values and behaviors surrounding environmental practices are still forming, so any intervention on food behavior has the potential to have a long-lasting effect.

Bottom-up approaches to changing environmental behavior have been widely studied. Campbell-Arvai (2015) found that individual beliefs about the environment factor into food decisions. demonstrating that changing beliefs and attitude could reduce FW could be effective. Similarly, at a University in China, Wu et al. (2019) found that attitudes towards FW can greatly influence someone's behavior and that informing people of what is good and bad for the environment has an impact on their decisions. Educational campaigns are easy and low cost while other campaign formats involve additional labor, supplies, and costs.

Top-down approaches have been widely tested as well, and have the potential to make a large impact because they don't involve any behavioral change by the consumer. Freedman and Brochado (2010) examined the effect of changing the portion size of only one food and found reductions in FW. Further trayless policy is another top-down approach that has been widely researched, and is now a common practice at collegiate, all-you-can-eat dining facilities. (Thiagarajah and Getty 2013) (Kim and Morawski, 2012). There is research on many different top-down strategies, but few that quantify and compare the aggregate result of implementing many strategies simultaneously.

Research Design

This research would reveal which has greater effect on waste reduction, a bottom-up approach that educates students on environmentally friendly practices and or top-down approach that changes the structure in which food is presented and consumed. My research will have three phases. Phase one involves a preliminary survey and interviewing to pinpoint students values, concerns, and knowledge about FW on Davidson College campus. The second phase evaluates bottom-up approaches will involve implementing a four-week educational campaign. The third phase is the implementation of top-down strategies. I will measure FW outcomes as well as attitudes.

The Site: The site of the study will be Davidson College's main dining facility, Vail Commons. Commons is an all-you-can-eat dining hall with a mix of self-serve, employee portioned, and pre-portioned food. Commons currently uses a tray system and conveyor belt return, where dishes are washed and all FW is diverted and pulped. Commons does not require trays, but tray do make dishwashing more convenient (Varghese 2019). Vails is a good site because portion sizes and waste measuring are easily changeable. In a typical week, 1000-2000

pounds of post-consumer waste are generated from this dining facility alone (Davidson College Office of Sustainability, 2018).

Phase One: The first phase of the project will involve a few focus groups to determine the needs, values, and knowledge about food practices on Davidson College. Groups will be volunteers which will lead to self-selected bias. The focus group questions will be based on previous research on the attitudes and beliefs of Davidson College students conducted by Melanie et al. (2018). In their survey, they found that 80% of Davidson students think they contribute less to FW than the average American, 75% of students have not sought out any information about ways to reduce FW, and 66% of students haven't heard about the issue at all in the past year. Their results suggest that a green eating educational campaign is needed. Results from the focus group will help identify gaps in FW knowledge, students' attitudes towards the environment, dining facilities commitment to FW reduction, the correlation between students' beliefs and behaviors. Informed by the results of the focus groups, I will create an educational campaign for phase two.

Phase Two: Bottom-up Approach. Phase Two will involve a campus-wide education campaign. Monroe et al. (2015) used a direct education intervention involving online modules that informed people about environmental food practices increased green behaviours in university students. The direct approach is more likely to produce results, but is time-consuming and doesn't have the ability to reach a large audience. On the other hand, Whitehair, et al (2013) used the Elaboration Likelihood Model to evaluate peripheral and direct approaches to simulated FW reduction at a dining campus. Whitechair et al. (2013) used simple, prompt-type messaging that encouraged students to only take what they would eat and found significant reductions. I would implement both a peripheral approach by posting signs and a direct approach by offering food-practice seminars to the entire school. Although, there is no empirical way to test whether

the educational campaign informed people about FW, behavioral outcomes will be measured in food reduction and any attitude changes will be measured in the students' valuation of a food reduction policy.

Phase Three: Top-Down Approach. The top-down approaches I will test will reduce FW without requiring behavioral changes of the consumer. I will reduce portion sizes which is known in the past to reduce FW (Ahmed, 2018) (Freedman and Brochado, 2010). Freedman et al. (2010) only examined one food. However, I would want to evaluate more than one food and find the aggregate FW in pounds to get a general indicator of total FW as a result of many top-down strategies.

In addition to reducing portion size, another common waste reduction strategy in dining facilities is removing trays. Kim and Morawski (2012) evaluated the effect of removing trays on FW, by randomizing when trays were available or not. They found FW reduced almost 32% (Kim and Morawski, 2012). However, I don't need to randomize the availability of trays because I will control for tray availability in my regression. I will implement multiple, top-down approaches and will not specify which change had the greatest effect. Thiagarajah and Getty (2013) measured the impact of a trayless policy a week after trays were removed so students had time to adjust. Due to time constraints of the study, I would start measuring only a few days after the trays are removed. Implementing a trayless approach has been attempted in the past at Davidson College by students (Basnyat and Sharp, 2018.) Results from this study showed no significant decrease in post-consumer FW. However, the study only lasted 4 days and the results are not conclusive because the trays were still optional during their study.

I will measure FW based on total pounds of post-consumer waste per day. Ahmed et al. (2018) evaluated FW by implementing a quarter-waste system to measure plate waste and individual waste. Whitechair et al. (2013) measured an individual's FW through a tray-tracking

system and was able to evaluate how food practices changed overtime. Although their method provided more detail, it is time consuming. Ellison et al. (2019) and Ahmed et al. (2018) categorized the FW, but neither research found a significant difference between food categories, therefore I will not categorize the FW. Ellison et al. (2019) and Thiagarajah et al. (2013) weighed the waste in aggregate rather than by the individual. Thiagarajah divided the weight by the number of students who used the dining facility that day and used that average to quantify their results. Instead, I will control for number of students per day in my regression analysis.

I will use traditional regression methods to evaluate the effectiveness FW strategies in the dining facility (see the model in Appendix A). I will only use data on post-consumer FW from the college's main dining facility as an indicator of FW. Wu et al. (2019) broke down the FW by nitrogen, phosphorus, carbon, and ecological footprints giving a more direct perspective on how much energy these strategies save the school. However, due to measuring constraints and resource access, I will only evaluate the post-consumer waste.

The survey will determine what factors influence someone's likelihood to support or not support a food reduction program on campus. I will conduct a longitudinal study surveying students after each intervention. For the survey, the target population will be students who use Davidson College dining services and on-campus food distribution. The sampling frame is the student body.

I will use a convenience sampling method since the target population is easily reachable via email. To reduce coverage error, I will send a school-wide email that will reach everyone on campus. To reduce sampling error, I will survey a minimum of 60 students to achieve a 95% confidence interval at 10% margin of error assuming Davidson College students care about the environment at 80/20 split (Kanazawa, 2018). I believe this will be a sufficient sample size for a reliable estimate of students' values. However, I expect a certain degree of sampling error

considering this is a volunteer-based study and not everyone reads spam emails and I expect some students abroad or students without meal plans to respond. To reduce non-response error, I make the survey less than 5 minutes. At minimum I need a 3-4% response rate, so expect this strategies to yield a sufficient sample.

I created a survey I believe captures student beliefs in an unbiased way (see Appendix B). I used the principles of surveying from Kawakawa (2018) to guide my survey design. To reduce measurement error, all questions will be closed-ended and categorical, so that all questions are easy to answer. I also designed a series of follow up questions that will weed-out answers that are potentially protest opinions or do not demonstrate values of environmental food practices.

I designed the survey question to address the attitudes students have towards food reduction programs. Similar to Monroe et al. (2015) and Whitehair et al. (2013), I will use a 5-point, anchored Likert scale to measure considerations in food choice decisions. I will ask participants to rate the importance of factors surrounding food choices such as ease and convenience, eating organic foods, cost, ect. Next, I will ask the participants rate the effect they think different policies will affect outcomes such as food cost, student satisfaction with dining services, ect. on a 5-point bipolar scale ranging from “harmful” to “beneficial” effect. These questions will reveal what valuations will cause someone to support or not support a food reduction policy. Then, I will ask if a person if they think Davidson College should change their food practices and implement a FW reduction program. This is the most important variable, the participant can answer yes or no. Finally, I ask follow-up questions about the reasons someone chose their answered question. I designed follow-up questions to determine which answers are biased and do not reflect a person’s value of reducing food in post-survey adjustments. I will also discard anyone who does not use dining services or is abroad that semester.

Data from the survey is qualitative because I ask questions on a scale. I will use regression analysis to determine the effect of the education campaign and the structural changes (See the model in appendix C). I will compare the results of the two approaches to determine which strategies have a greater impact on food reduction and students' attitudes.

Informed consent will not be needed to measure the FW since no one individual is directly involved. However, I will need IRB approval for focus groups and the survey. I will need to ensure anonymity when administering the survey. Participation in the survey will be considered consent. For the focus group, I will need informed consent from each participant. I will also need to disclose any funding.

Expected Contributions

Different strategies for FW have been widely studied but rarely compared. This study would help colleges and other similar dining services choose what kind of FW reduction strategies are most effective. The results of this study will show whether top-down or bottom-up approaches are more effective. Further, the practical implications of this research would help colleges reduce FW by changing things that will help them in the most ways. To put the research in perspective, let's say I could find a strategy that reduced FW by 5%. Using data from fiscal year 2018, that reduction would divert approximately 12,000lbs of FW per year (Davidson College Office of Sustainability 2019). If the average person consumes 5 pounds per day, that waste would represent the daily food intake for 2400 people. This would decrease the GHG emissions of the school by 18.6 Metric Tons of Carbon Dioxide Equivalent, bring the college closer to its goal of becoming carbon neutral (calculations are made through SIAMP).

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Appendix A

$$\ln[\text{Waste}_i] = \beta_0 + \beta_1 \text{Edu}_i + \beta_2 \text{Treatment}_i + \beta_3 \text{Treatment}_i * \text{Edu}_i + \beta_4 - \beta_9 \text{DayofWeek}_i + \beta_{10} \text{Students}_i + \beta_{11} \text{hoursopen}_i$$

i represents an individual day. Waste_i is the aggregate pounds of FW per day and is \ln so that units don't matter and results will be measured in percent difference. Edu_i and Treatment_i are dummy variables, and 1 = educational campaign is in place or treatment are implemented, 0 = they were not implemented. Important to note in the study, the education campaign will end when the top-down approach is implemented. The Interaction effect, $\beta_3 \text{Treatment}_i * \text{Edu}_i$ will account for differences between treatment and education. $\beta_4 - \beta_9 \text{DayofWeek}_i$ is a control variable and a set of 6 dummy variables to account for the difference between the days of the weeks, the omitted variable will be Monday. Also results from $\beta_4 - \beta_9$ could help dining service better estimate how much food to produce. For example, if the results show that a certain day of the week produces more FW, the dining service could consider altering the menu for that day or producing less food. β_{10} is the number of students dining on that day, data will be collected from the Davidson College Vail Commons database which keeps track of how many people dine on a given day. β_{11} hours open per day will account for the difference from day-to-day schedules because they are not consistent. I will not differentiate between breakfast, lunch, or dinner which was found to insignificant determinate in waste production in past studies (Kim and Morawsk). I might also want to test education levels influence because Wu, Tian, Li, Yuan Liu. 2019. found lower educational levels and higher incomes both led to more FW, but since this factor does not vary significantly in my population of interest I wouldn't test for it.

Appendix B

Collaboration with dining services, and office of sustainability to provide more information on students values and preferences in determining student practice.

Survey to Determine Student's Beliefs and Attitudes Surrounding Food Practices

Because food reduction is important for school. We would appreciate your thoughts on how food practices should be managed. There are five main dining locations and food distribution sites on Davidson College Campus, Vail Commons, Davis Cafe, Wildcat Den, Lulu Bells, and Patterson Court Organizations. **For the purposes of this survey please only consider Vail Commons, Davis Cafe, Wildcat Den. All results are confidential.**

1. Please select the level of importance for each factor of your food choices and practices at Davidson College,

Considerations you make in your food choices,	Not at all important	somewhat important	important	very important
Ease /convenience				
Getting sufficient calories				
Eating organic foods				
Reducing my carbon impact				
Cost				
Eating healthy foods				
Family Cultural or Religious tradition				
Eating locally sourced food				
Taste				
Animal welfare				

2. Effect of Policy Changes to Dining Practices at Davidson College,

Davidson College is working towards an efficient and satisfactory EPA food period. The best way to reduce waste is to reduce at the source. Student perception on the impact of different policy changes on Davidson Dining experience. People have different opinions about the effect of different food practices on waste reduction. Please tell us what you think the effect of these policy changes will have on reducing FW. How do you feel about the effect of different dining practices?

We will ask about three policy changes, Eliminating Trays, Increasing food Options, and Reducing Food Portions. **These are all hypothetical, do not expect that any of these policies will certainly be put into place after this survey.**

Eliminating Trays at vail commons would have a...	Harmful Effect	Somewhat Harmful effect	No effect	Somewhat Beneficial Effect	Beneficial Effect
Food Cost					
Reducing FW					
Workload of employees at vail commons					
Student satisfaction with dining					
Water and chemical resource use					
GHG emissions of the school					
The environmentally conscious image of the school					

Increasing food options such as more vegan/vegetarian at vail commons and Davis Cafe would have a...	Harmful Effect	Somewhat Harmful effect	No effect	Somewhat Beneficial Effect	Beneficial Effect
Food Cost					
Reducing FW					
Workload of employees at vail commons					
Student satisfaction with dining					
Water and chemical resource use					

GHG emissions of the school					
The environmentally conscious image of the school					

Reducing food portions at vail commons would have a,	Harmful Effect	Somewhat Harmful effect	No effect	Somewhat Beneficial Effect	Beneficial Effect
Food Cost					
Reducing FW					
Workload of employees at vail commons					
Student satisfaction with dining					
Water and chemical resource use					
GHG emissions of the school					
The environmentally conscious image of the school					

3. Do you think Davidson College should change their food practices and implement a Food Waste reduction program?

- Yes
 No

If no, what was the main reason you said Davidson College should not change their food practices (please only select the most important reason to you)?

- a program is not worth anything to me
 I think Davidson College is already doing a great job at reducing FW*
 I don't think the school should spend money on a program
 I don't think a program would be effective^{1*}
 I don't want the dining services to change*

¹ * questions with asterisks are considered protest votes and do not capture a students value of a FW reduction program, if a respondent answer yes to these questions their values will be disgard in post-survey adjustments.

- I am opposed to institutional program changes*
- Other ²....

If yes, why would you want a FW program (please only select the most important reason to you)

- Reducing FW is important to me
- I have an environmental responsibility to reduce FW
- I support programs that will benefit the institution*
- Other ...

How often do you use Davidson college dining services (not including Patterson Court Organizations) **on a typical day** this semester

- Not at all
- 1-2
- 3
- more than 3

5. Demographic Information

Gender

- Male
- Female
- Trans female
- Trans male
- Non-binary

Graduation year

- 2020
- 2021
- 2022
- 2023
- Not sure

Meal Plan with Davidson College

[drop down menu]

² I will determine if the other reason for saying yes or no proves that the respondent values or doesn't value the food reduction policy in post-survey adjustments

Appendix C

$$\text{ValueOfPolicy}_i = \beta_0 + \beta_1 - \beta_{11} \text{FoodConsiderations}_i + \beta_{12} - \beta_{18} \text{PolicyEffect}_i + \beta_{19} \text{Edu}_i + \beta_{20} \text{Treatment}_i + \beta_{21} \text{Treatment}_i * \text{Edu}_i + \beta_{22} \text{Use}_i$$

i = individual respondent to the survey. ValueOfPolicy is a dummy variable, based on the participant's answer to the question “do you think Davidson College should implement a food reduction policy”, yes = 1 and no = 0. FoodConsiderations _{i} is a set of 10 variables that capture the effect of different factors influencing food choices effect on the Value of a policy if someone selects “not at all important” this should indicate that that factor has no effect on someone’s behavior and therefore “not at all important” = 0. Because the participants ratings are on a contentions continuous scale “very important” = 3. PolicyEffect _{i} is a set of 7 variables which will be the aggregate of a person’s valuations of the effect for all three Policies that I asked about. Where “no effect” = 0, “harmful effect” = -2 and “beneficial effect” = 2. Use _{i} measures how often the person uses Davidson College Dining services. Other Demographic data will be controlled for in model (2). I will conduct t-tests and subset-Ftests to evaluate the effect of different factors. To compare the effect of top-down and bottom-up approaches, I will conduct a hypothesis test on the coefficient of the interaction term at the 5% significance level.