



PSU DINING TRAYLESS PILOT IMPACT ANALYSIS - FALL 2024

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PREPARED FOR: PENN STATE DINING

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WELCOME

Thank you for choosing Net Impact at Penn State to help you navigate the effectiveness of the Trayless Dining Sustainability Initiative.

We've put together an analysis of the initiative over the Fall 2024 semester, as well as recommendations based on our findings.



Project Basis

This report delves into our analysis of Penn State Dining's trayless pilot and explores the gaps within the original implementation and analysis of the initiative, while aiming to provide solutions for future semesters.

We are excited to be a part of your sustainability endeavors as you strive to reach sustainability goals, innovate, and educate the student body about the importance of mindful consumption.



SITUATIONAL ANALYSIS

INTERNAL ANALYSIS

CLIENT OVERVIEW

For the past 3 months, Net Impact has been working closely with Matt Nevling and Haley Sankey to explore the impact of North Buffet's newest trayless initiative. With an attempt to combat food waste in Penn State's dining areas, it is crucial to understand the implications of green initiatives across campus procedures and operations from every aspect. Net Impact aims to assist in evaluating the effects of this new initiative while providing suggestions in regard to further implementation.

Penn State Dining plays an integral role in the University's strides toward more sustainable operating procedures. Along with renovated dishwashing systems for more efficient back-end operations and bamboo silverware from a student-facing perspective, Warnock Commons has piloted the removal of trays within their buffet area in hopes of reducing post-consumer waste. The rationale for this initiative is that students often select more dishes than they can eat. By eliminating trays, students are encouraged to make smarter decisions about the food they take, ensuring that less food is wasted.

The transition to trayless at most Penn State dining halls must be coupled with the installment of new dishwashing systems that eliminate the prior need for trays to collect used dishes. This renovation has been completed in the Warnock kitchen, and there are similar plans to transition Penn State's other four dining halls, Findley, Waring, Pollock, and Redifer Commons, within the next year. This has led to curiosity regarding the effectiveness of the trayless initiative and whether the elimination of trays should be carried out campus-wide in the following semesters.

To understand this more, Penn State Dining is looking to strengthen their understanding of the initiative. For an efficient and successful transformation, Penn State Dining needs to consider the effectiveness, timing, tactics, and marketing of this initiative.

SITUATIONAL ANALYSIS

CURRENT SITUATION: POST-CONSUMER WASTE DATA COLLECTION

Penn State currently records all of its post-consumer waste with a software system called LeanPath, which is a software company that partners with thousands of clients to provide food waste recordings and solutions. It achieves this by recording all food waste data at trash receptacles across the campus. Whenever any waste is placed into the trash bins, the LeanPath records a new entry for a time food was disposed, as well as the weight of the additional food. When compiled together, these data points are able to provide aggregates for any desired amount of time, as well as averages per person when combined with swipe totals.

EXTERNAL ANALYSIS

Though Penn State is ranked highly in sustainability in the Big Ten Conference, it falls behind in sustainability in dining. Most Big Ten schools have implemented trayless dining, along with various other initiatives such as Tapas, Unlimited Dining Plans, and more. With the implementation of trayless at some schools occurring over a decade ago, positive results have already been documented. The University of Michigan and Ohio State are two of the most well-known, and they have seen success with a 32% reduction in food waste. Some schools like Michigan State University even utilized the COVID-19 remote-learning system to seamlessly adjust to trayless when students returned.

Considering that most schools within the Big Ten Conference have implemented sustainability initiatives towards reducing food waste in dining halls, Penn State's reputation may be at risk in this criterion. Thus, it is imperative that Penn State bridges this gap and works to reduce food waste across their five dining halls.

To understand the various initiatives implemented by Penn State's colleagues in the Big Ten Conference, we utilized benchmarking interviews. These findings also contributed to the final recommendations presented in this report.

SITUATIONAL ANALYSIS

CLIENT ASSIGNMENT

Net Impact Penn State has volunteered to support Penn State Dining's analysis of the effectiveness of the Warnock Commons trayless Initiative, a pilot program meant to reduce food waste on campus. Net Impact will also recommend actions to potentially improve the impact of the initiative on food waste reduction.

The Impact Consulting Unit has collaborated with North Dining Associate Director Matthew Nevling, as well as Sustainability Specialist Haley Sankey, to obtain food waste data, cost of goods wasted information, and customer totals across the five core dining locations at Penn State University Park.

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PROCEDURE

OVERVIEW

Starting in late September, our team initiated bi-weekly meetings with Penn State faculty. These meetings were primarily with Matthew Nevling and Haley Sankey and served as a means to clarify objectives for both Net Impact and Penn State, gather any necessary information, and provide progress on the report's findings.

Our assessment included three parts: benchmarking with other universities, research of past trayless studies at other universities, and a case study of Penn State's trayless pilot in Warnock Commons.

BENCHMARKING ANALYSIS

To understand how trayless dining was implemented successfully in other schools within the Big Ten Conference, we gathered data from the University of Michigan, Ohio State University, and Michigan State University. With a carefully designed questionnaire, we were able to gauge the main themes that determined success of trayless dining. Furthermore, in interviewing these schools, we gained insight into their data tracking systems, marketing campaigns, and overall goals that led to successful implementation.

SECONDARY RESEARCH

We conducted secondary research regarding other university implementations and past studies around trayless dining. Our goal was to gauge the effectiveness of this initiative found by other credited organizations. We used websites and databases in our search.

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PROCEDURE

WARNOCK COMMONS CASE STUDY

In order to test the effectiveness of the trayless pilot in Warnock Commons, our team conducted a case study. The goal was to compare the food waste per swipe in Warnock Commons before and after the implementation of trayless.

To accomplish this, we collected LeanPath data from the Fall 2023 Semester, before the implementation of trayless, and the Fall 2024 Semester, after the implementation of trayless. The data spanned from the beginning of each semester to October 31. Penn State Dining confirmed that similar meal schedules were followed during these two periods. We also gathered swipe counts for each day during the 2023 and 2024 semesters with each swipe representing one visit to the dining hall.

Many errors were found with the raw Leanpath data [See Appendices 12-15]:

1. Changing the trash generated a food waste entry of around 15-18 pounds when the trash can was replaced on the scale.
2. The data contained both pre-consumer and post-consumer entries.
3. The Leanpath system would occasionally turn off due to internet failures.
4. A problem occurred on several days where the same entry would appear many times in the span of seconds, generating an unrealistic entry count.

We used Power BI software to effectively clean the data. We first removed any large or pre-consumer entries [See Appendix 16]. We then removed any days where the Leanpath system went down for a portion of time, or the repeating entry issue occurred [See Appendix 17]. After this removal, we were left with 40 days in Fall 2023 and 30 days in Fall 2024 still in our dataset.

To calculate our final metrics, we took the following steps [See appendix 18]:

1. We found the total food waste produced on each day in the dataset.
2. We divided each daily food waste total by the swipe count for that day
3. We took the average of the daily food waste per swipe for 2023 and 2024 respectively for our final metric of “ounces of food waste per swipe in 2023/2024”

FINDINGS

BENCHMARKING ANALYSIS

Through the conducted interviews, we concluded that the most important determinant of successful trayless dining is a well-crafted marketing campaign that educates both students and workers. Using the school mascot to do so was received exceptionally well by students. Another important consideration is assuring students that going trayless does not equate to less food. In order to relay this information, University of Michigan organized a “Just Ask” marketing campaign that encouraged students to take less food initially and ask for more as needed [see Appendix 2].

Through the benchmarking efforts, another key factor to the success of trayless dining was the simultaneous implementation of other sustainability initiatives. At the University of Michigan, the Tapas Initiative was implemented alongside trayless, sizing down plates so students took less food at a time. Soon after, they implemented unlimited dining plans, so students did not feel pressured to take large amounts of food in one swipe. University of Michigan also developed their own system for tracking data in the dining halls through their sustainability team, crafting a personalized system that worked for the school and presented accurate data.

Benchmarking also found that the best time for implementation is the Fall Semester. Michigan State University particularly emphasized the science behind fixed routines and habits which are difficult to break. Thus, interference with fixed routines and habits results in greater pushback, which may result in rejection of trayless dining.

While these valuable insights were gained from the benchmarking interviews, the interviewees were unable to provide access to their data systems. Thus, any data pertaining to the results or efficiency of their trayless initiative was not accessible to our team.

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FINDINGS

SECONDARY RESEARCH

Three trayless studies stood out as the most credible. These included a study from ARAMARK, a study from the University of Georgia, and a peer-reviewed journal by Wenhao Zhang and Junehee Kwon about a study conducted in the Midwest. Links to the full research studies can be found in the “References” section of this report. The following includes a summary of each:

ARAMARK Study: ARAMARK is an organization that provides dining services and facilities management to universities and businesses around the globe. In 2008, ARAMARK conducted a comprehensive study to test the trayless initiative that included 25 colleges and 186,000 served meals. The study reported a food waste reduction between 1.2 and 1.8 ounces per meal from going trayless, representing a 25-30% reduction. Another key finding was that the start of the school year was the best time to implement trayless and correlated with the least pushback from students. The study also provided some important recommendations for universities going trayless [See Appendix 8]. Finally, the study included a survey which showed 75% of students would accept their dining halls implementing trayless [See Appendix 9]. Overall, the quantity of data in this study far exceeds others, so it is no surprise that it is one of the most frequently cited pieces of evidence in support of trayless dining. Though this does present convincing evidence in support of trayless, it is important to note that the study does not go into depth about the implementation or means of measuring food waste at the 25 included locations.

University of Georgia Study: A 2015 study at the University of Georgia concluded that going trayless was associated with a 26.7% reduction in food waste and 16.4% reduction in water usage. Their full results break down waste by food category [See Appendix 10]. This provides further evidence for more universities to commit to trayless. However, there were several limitations in this study. The most significant is that food waste was not directly measured. Instead, returned dishes were counted with each dish representing a serving of food. Another limitation was the length of the data collection period, spanning only 10 days (5 with trays and 5 without).

FINDINGS

Zhang and Kwon Midwest Study: This is a well outlined 2022 study regarding trayless dining at an unnamed university in the Midwest United States. The study concluded that there was no significant difference in food waste before and after the implementation of trayless [See Appendix 11]. Similar to the other studies, there were several limitations. The biggest limitations were that only 329 student meals were included in the dataset, participation in the study was optional, and about 1/3 of students contributed no food waste per meal.

WARNOCK COMMONS CASE STUDY

We did not find a significant difference between food waste per swipe in 2023 and food waste per swipe in 2024, suggesting the implementation of trayless did not make a significant contribution in reducing food waste [See Appendix 19]. More specifically, we found that 2.56 ounces of food waste were produced per swipe in 2023 with a standard deviation of 0.392 ounces, and 2.51 ounces of food waste were produced per swipe in 2024 with a standard deviation of 0.397 ounces. This represents a reduction of 0.05 ounces of food waste per swipe after implementing trayless.

A two sample T-test confirms that this reduction is insignificant and likely caused by chance alone, as the resulting p-value was 0.57. To accept the reduction in food waste observed, we would require a p-value lower than 0.05.

Of course, it is important to note that external variables could have impacted the findings of this study. The most notable is Penn State's simultaneous transition to 100% reusable takeout containers. When students participate in the takeout program, they still add to the swipe total for that day, but their food waste is not recorded. This could raise the food waste per swipe for 2024 if less students decided to participate in takeout because of the initiative.

Unfortunately, we were not able to obtain usable data surrounding this subject. Still, the results of this study are convincing because it is known that students generally choose take-out in far lower proportions at Warnock Commons, meaning the effect of this initiative is likely negligible to this study. It is also unlikely that any external variable exactly canceled out the effect of the trayless initiative to produce the nearly identical 2023 and 2024 food waste figures.



RECOMMENDATIONS

SUMMARY

The following recommendations are based on 3 months of research and the development of benchmarking and software analysis to align with North Dining Hall's stated goals at the beginning of the semester. Net Impact deems these as the most feasible and effective approaches to fostering a seamless transition for future semesters.

RECOMMENDATION 1: LEANPATH REFINEMENT

As noted, there were many issues in the Leanpath data. Though we were able to effectively clean the data to produce reliable results, it was apparent that aggregate food waste numbers pulled from the Leanpath system are extremely inaccurate and have little value without excessive refinement. Furthermore, it's unlikely that individuals accessing the data for future projects will be able to spend the proper time fixing these issues.

Thus, to ensure food waste data is represented properly in the future, steps must be taken regarding the Leanpath system. We recommend the following:

Talk to operators of the system to gauge the cause of the repeating entry problem. If this does not provide an answer, talk to a Leanpath representative to further troubleshoot the issue. If this issue cannot be fixed, it is worth looking into alternative systems for waste tracking.

Explore ways to ensure changing the trashcan does not register as a food waste entry. This could mean turning off the system while changing the trash, finding a tare button, deleting the entry directly after, etc.

Upgrade the Wi-Fi in Warnock Commons to decrease the chance of Leanpath outages. Additionally, implement routine checks to ensure the system is turned back on if it does go down.

Educate staff on the Leanpath system. Make sure staff members are informed about the issues with the Leanpath system and how to correct them.



RECOMMENDATIONS

RECOMMENDATION 2: MARKETING CAMPAIGNS

Penn State Dining should invest heavily in a well-designed marketing campaign to ensure a smooth transition for students. Based on our benchmarking analysis with University of Michigan and Michigan State University, the biggest factor that ensured the successful implementation of the trayless Initiative is running an effective marketing campaign. This marketing campaign should help students and staff feel ownership in contributing to reducing food waste, affirm that trayless dining does not equate to less food, and educate them to plan their meals prior to entering the dining halls, promoting mindful consumption.

The University of Michigan emphasized the importance of students and all workers in the dining halls feeling ownership in contributing to the school's success. knowing the importance of the initiative, and how to answer students' questions about them. Every single worker and student should feel ownership in knowing that they are contributing to the school's success. Rather than telling students and workers about the initiative, they should be asked to help in making the initiative a success, emphasizing the consequences of food waste.

To facilitate the feeling of ownership, Penn State should invest in a life-size cardboard cutout of the Nittany Lion with a thumbs up, holding a board that thanks students for going tray-less, helping Penn State dining raise awareness and communicate the importance of student cooperation in this initiative, while also giving students a feeling of ownership over reducing food waste. This cutout should be placed in various locations around the dining halls, specifically the entrance, exit, and other high-traffic areas.

Michigan State University for instance, designed stickers with the school mascot thanking students for reducing food waste, placing the stickers around the rooms as well as on dishes so students subconsciously become aware of the initiative. At Penn State Altoona, their career services department used the school mascot to encourage students to borrow business formal clothing from

RECOMMENDATIONS

the career closet [See Appendix 1]. The act of using the school mascot to promote engagement and awareness has been studied extensively. In one study by the University of Delaware, it was found that school mascots can effectively protect the environment by threatening disappointment.

It is also especially important to help students understand that going tray-less does not equate to less food, University of Michigan implemented a program titled “Just Ask” [See Appendix 2], which included hanging posters at each food station encouraging students to “Just Ask” for more food if needed. This also ensured students that they needn’t stack large amounts of food on their plates, and that they have the option to ask for more or different food than what is available to suit their needs. We took inspiration from this “Just Ask” movement, as well as their school mascot incorporation. Therefore, we developed a unique Penn State movement and original creative materials [See Appendices 3-7].

Another form of marketing that we heavily relied on is the use of “Celebrity Endorsement.” Celebrity Endorsement is a marketing tactic that is known to be successful in creating “copy-cat” behavior in a target audience. Much like in consumerism, if a buyer views a celebrity they enjoy following, they are more likely to buy the same product later on because they subconsciously want their life to reflect the celebrity’s. In this case, the celebrity of Penn State is known to be the Nittany Lion Mascot. Therefore, it was featured in several of the marketing materials. This depicts the tray-less movement in an enticing light, as students will likely feel motivated to follow the movements the Nittany Lion represents.

An additional marketing technique used in the promotional materials was the “bandwagon” tactic. This method aims to convince the audience they would be part of an important group by participating in the information presented. In this case, the use of the schools slogan “We Are” and student community images help develop this appearance. Throughout the marketing materials we incorporated humor and bite-size information to properly advertise to the target audience of Penn State Students, specifically underclassmen. We



RECOMMENDATIONS

wanted to best appeal to their interests and attention spans while positively promoting the trayless initiative to better support the future implementations of it campus-wide.

It is also important to understand how going trayless may affect special needs or disabled students. Penn State must market the fact that a select number of trays are still available for special needs and disabled students, who may request them as needed. Penn State Dining will also benefit from peer-to-peer marketing strategies, as consumers are more likely to listen to those that they relate to. Students that are working in the dining halls should strive to answer their peers' questions, and encourage them to plan their meals before arriving at the dining hall.

Finally, Penn State must consider training students from when they are freshmen and their orientations and resident halls. University of Michigan touched on making students aware from the start to scan a dining hall when entering, and taking just the food that they want, rather than a little bit of everything, and throwing it away. By coaching students to plan their meals upon entering the dining hall, students learn to take less food, and ask for more as needed.

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RECOMMENDATIONS

RECOMMENDATION 3: IMPLEMENT BETWEEN ACADEMIC YEARS

Penn State Dining should implement the trayless Dining Initiative during the Fall Semester to ensure smooth transition for workers and students. Habits and routine are difficult to break in students, which is why implementation of the initiative over the Spring Semester often results in more pushback. Based on our benchmarking efforts, we understand that the Big 10 schools sought to go trayless in their dining halls during the Fall Semester. It is also imperative that the initiative is implemented in most dining halls on campus at once so students don't actively experience the trays in other dining halls, with the exception of few. If students see that most other dining halls on campus conveniently provide trays, Penn State Dining could experience pushback.

Such an event occurred during the 2023-24 year when Penn State Dining attempted to remove trays from Waring Commons. After significant Pushback from students, the trays were quickly reinstated. Such dissatisfactions can be mitigated by starting off the new academic year with trays already removed. These implementations are most important at areas with a primarily freshman customer base, such as Pollock and Findley. When updating these areas to accommodate the new dishwashers, it is also important to ensure the structure of the areas enable students to return plates and take additional food without leaving the dining area.

In the same effort to introduce incoming students to trayless dining, Penn State can also consider removing trays during their summer session and orientation operations. This will serve as a means to test the expansions in more limited environments, while still familiarizing staff and students ahead of the semester.

Finally, food waste per swipe should be tracked with every implementation of trayless. If similar results to the Warnock case study are found in every dining hall, then there should be a discussion to return trays to the dining halls.



TIMELINE

December 2024:

Commit PSU Dining to expanding trayless to the other dining locations in Fall 2025.

May - August 2025:

Complete necessary renovations such as installing new dishwashers. Create promotional materials. Remove trays from summer Session buffet lines if feasible.

September - May 2026:

Monitor food waste data collection throughout the year. Compare food waste data with the previous year to make a decision on whether trayless should become permanent.

January - May 2025:

Revise any Resident Life Policies to include food waste education, ensure structural renovations to accommodate trayless dining. Troubleshoot the LeanPath software to ensure reliable data collection.

August 2025:

The Fall Semester begins with trays eliminated from all dining commons.

CONCLUSION

From the onset of this engagement, both the PSU Residential Dining Faculty, as well as our team, were expecting to find an immediate and significant reduction in food waste at North Halls, suggesting that the elimination of trays from on campus dining buffets would yield substantial results from an environmental and financial perspective.

While the truth of the data is a far cry from initial projections and may come as a disappointment for Penn State Dining and its stakeholders, it does showcase an important truth for the university's efforts going forward. In order to see a significant reduction in waste, the primary focus should be on educational and promotional efforts to influence consumer behavior. Many other universities have found success with their trayless dining programs as part of larger initiatives, and Penn State will almost certainly be no exception. By utilizing the provided recommendations, PSU will be able to expand the trayless initiative as part of a larger effort to encourage students to reduce waste from their first moments with the university, with access to enhanced recording software to capture the long-term impact.

For further recommendations on the implementation, timeline, and further expansions, Net Impact is more than willing to provide assistance for the next steps being taken by Penn State Dining Facilities.

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APPENDIX



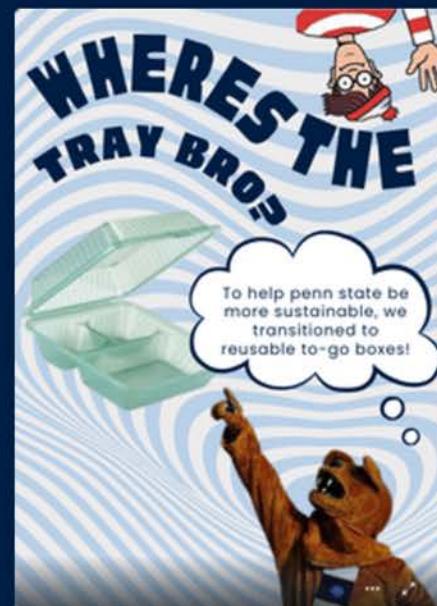
Appendix 1: Nittany Lion Cutout to Promote Career Service Resources



Appendix 3: Relatable Educational Advertisement



Appendix 2: Michigan Promotional Ad that Pairs with Trayless Initiative



Appendix 4: Nittany Lion Educational Advertisement

APPENDIX



Appendix 5: Penn State Promotional Ad to Assist in Implementation



Appendix 6: Informational Poster Promoting Sustainability at Penn State



Appendix 7: Potential Penn State Promotional Ad that Pairs with Trayless Initiative

APPENDIX

Best Practices

No. 1: Keep trays stored but readily available for people who demand one.

In any institution, there's usually some resistance to change from long-standing practices. Although trayless dining has gained widespread acceptance from campus constituencies where it has been implemented, there are always individuals who may be reluctant to convert.

No. 2: Provide trays for the disabled.

Many people, because of disability or other physical or medical challenges, require the use of a tray.

No. 3. Convert staff and employees.

Food service managers discovered that a prime source of resistance can come from their own dining and kitchen staffs, especially long-time employees. Because trays have always have

been a part of their operation, changing to trayless is an adjustment for them.

No. 4. Feedback is important.

It's important to conduct surveys before implementing a trayless program to gauge issues and concerns, and equally important to solicit and share feedback with campus stakeholders after implementation.

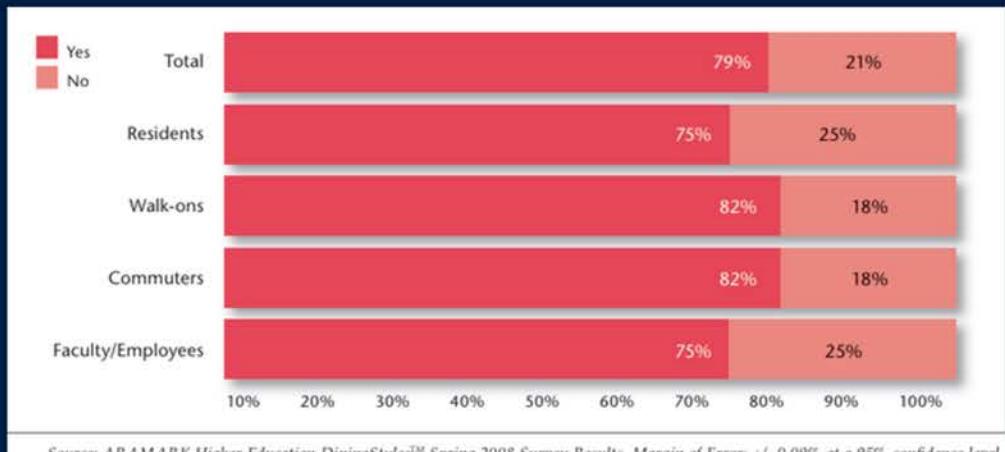
No. 5. Create a smooth transition.

To achieve a smooth transition to trayless, start slowly. Conduct a pilot program (preferably during Earth Day/Week) that is voluntary, and then migrate to mandatory.

No. 6. Audit.

Perform waste and energy audits and share the results with students and the campus community.

Appendix 8: ARAMARK's Recommendations for Trayless Implementation



Appendix 9: ARAMARK Trayless Sentiment Study

This study asked students "Would you accept the removal of trays from all dining locations in an effort to reduce waste on campus?" The survey included over 92,000 respondents nationwide.

APPENDIX

	Outcome measures	Control		Intervention		P value
		Mean	S.D	Mean	S.D	
Pre	No. of lunch servings	1.83	(1.02)	1.76	(0.97)	0.161
	No. of drink servings	1.39	(0.86)	1.32	(0.95)	0.124
	No. of salad servings	0.16	(0.43)	0.12	(0.38)	0.029
	No. of dessert servings	0.03	(0.18)	0.06	(0.27)	0.004
	No. of dish with at least a quarter leftover	0.62	(0.71)	0.56	(0.68)	0.088
	No. of entrée with at least a quarter leftover	0.55	(0.64)	0.51	(0.63)	0.312
Post	No. of lunch servings	1.92	(1.00)	1.66	(0.88)	0.000
	No. of drink servings	1.50	(0.87)	1.02	(0.80)	0.000
	No. of salad servings	0.12	(0.37)	0.14	(0.43)	0.269
	No. of dessert servings	0.03	(0.19)	0.04	(0.20)	0.528
	No. of dish with at least a quarter leftover	0.60	(0.69)	0.39	(0.55)	0.000
	No. of entrée with at least a quarter leftover	0.54	(0.64)	0.35	(0.53)	0.000

Number of servings is based on number of dishes used for each type of food items, assuming one dish is equal to one serving

Appendix 10: University of Georgia Study Final Results

The University of Georgia (UGA) conducted this case study by measuring the number of dishes produced per student. Each type of dish was associated with a food category such as “dessert”, and one empty plate represented one serving of food in that category. UGA also utilized two dining halls for this study, a “control” and an “intervention”. The “control” dining hall used trays for two weeks, while the “intervention” dining hall used trays for one week and went trayless for the other. The “pre” label in the chart represents the week in which both dining halls were trayless, and the “post” label in the chart represents the week in which the “intervention” dining hall implemented trayless.

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APPENDIX

Table 3. Average food selection, consumption, and waste information (in kilocalories and grams) before and during trayless dining implementation ($n = 183$ before and $n = 146$ during).

Variables	Before M (<i>S.D.</i>)	During M (<i>S.D.</i>)	<i>z</i>	<i>p</i>	<i>t</i>	<i>p</i>
1. Fullness level	8.6 (1.0)	8.3 (0.8)	-2.61	0.009	2.63	0.009
2. Average calories selected per person	606.2 (289.0)	544.2 (298.1)	2.14	0.032	1.92	0.046
3. Average fat selected per person	26.8 (13.7)	20.2 (14.6)	4.54	<0.001	4.23	<0.001
4. Average food selected per person	448.9 (215.3)	393.2 (195.1)	2.38	0.017	2.47	0.014
5. Average food consumed per person	419.6 (220.8)	363.6 (198.0)	2.37	0.018	2.36	0.019
6. Average food waste per person	37.2 (51.9)	34.9 (54.7)	-0.07	0.942	0.01	0.992

Appendix 11: Zhang and Kwon Study Final Results

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APPENDIX

Large Entry Issue

Time Food Waste (lbs)

Time	Food Waste (lbs)
12:47:23 PM	0.66
12:49:33 PM	0.86
12:50:00 PM	0.53
12:51:03 PM	0.69
12:52:45 PM	0.62
12:53:00 PM	17.74
12:53:51 PM	0.65
12:55:58 PM	0.61
12:56:24 PM	0.83
12:56:29 PM	0.58
12:57:57 PM	0.76
1:02:32 PM	0.52
1:02:57 PM	0.78
1:07:44 PM	0.53
1:09:11 PM	0.63

Pre-Consumer Waste Issue

Time Food Waste (lbs) Stage of Processing

Time	Food Waste (lbs)	Stage of Processing
1:11:29 PM	0.75	Post-Consumer
1:11:58 PM	0.75	Post-Consumer
1:13:02 PM	0.95	Post-Consumer
1:14:22 PM	1.16	Post-Consumer
1:14:57 PM	0.51	Post-Consumer
1:15:49 PM	0.99	Pre-Consumer
1:18:10 PM	0.64	Post-Consumer
1:18:32 PM	0.96	Post-Consumer
1:21:22 PM	0.57	Post-Consumer
1:27:00 PM	0.56	Post-Consumer
1:27:41 PM	0.30	Pre-Consumer
1:33:41 PM	0.50	Post-Consumer
1:36:25 PM	8.11	Pre-Consumer
1:38:23 PM	0.51	Post-Consumer
1:39:40 PM	1.63	Pre-Consumer

Appendix 12: Large Entry Issue

This is a string of data from October 3, 2024. Here, you can clearly see an outlier of 17.74 pounds of food waste recorded at the time 12:53:00.

Obviously, a student did not dispose of that much food waste at one time. Instead, this is the weight of the trashcan being placed back on the scale after changing the bag.

Appendix 13: Pre-Consumer Issue

This is a string of data from September 27, 2023. You can see pre-consumer waste entries scattered throughout the data.

APPENDIX

LeanPath System Down

Time Food Waste (lbs)

10:54:33 AM	0.59
10:59:17 AM	0.54
11:05:49 AM	0.85
11:08:13 AM	0.68
11:08:28 AM	0.83
11:08:58 AM	0.67
11:09:24 AM	0.51
11:12:37 AM	0.61
11:14:48 AM	0.63
11:20:19 AM	0.67
11:23:48 AM	0.74
11:24:45 AM	0.52
11:27:26 AM	0.69
11:30:13 AM	0.66
11:35:39 AM	0.82

Repeating Entries

Time Food Waste (lbs)

11:37:19 AM	1.51
11:37:20 AM	1.51
11:37:21 AM	1.51
11:37:22 AM	1.51
11:37:23 AM	1.51
11:37:24 AM	1.51
11:37:25 AM	1.51
11:37:26 AM	1.51
11:37:27 AM	1.51
11:37:28 AM	1.51
11:37:29 AM	1.51
11:37:30 AM	1.51
11:37:31 AM	1.51
11:37:32 AM	1.51
11:37:33 AM	1.51
11:37:34 AM	1.51
11:37:35 AM	1.51
11:37:36 AM	1.51
11:37:37 AM	1.51
11:37:38 AM	1.51
11:37:39 AM	1.51

Appendix 14: LeanPath System Down

This is a string of data from October 14, 2023. The first entry of the day is at 10:54:33 AM. Obviously, 10:54 AM is not the first time a student is disposing of waste for the first time. Instead, this is when the system was turned on after the Wi-Fi went out sometime overnight or the day prior.

Appendix 15: Repeating Data Entries

This is a string of data from October 9, 2024. There is clearly a problem with the data, as over 21 equal entries are generated in the span of only 20 seconds.

APPENDIX

```
1 [DATA CLEANING ALL ] =
2 IF('Waste Data'[Stage of Processing] = "Post-Consumer",
3 IF('Waste Data'[Weight] < 2,
4 "CLEAN DATA",
5 "MESSY DATA"),"MESSY DATA")
6
7 //Filtering the weight to only include post consumer entries
8 //Filtering the weight to exclude large entries
```

Appendix 16: Removing Pre-Consumer and Large Waste Entries

This is a calculated column we created in Power BI. It checks to make sure each entry is post-consumer waste and no more than 2 pounds. By including this calculated column as a filter, we were able to easily toggle between “clean data” and “messy data”.

```
1 DATA CLEANING NORTH =
2 VAR HasMorningEntry =
3 CALCULATE(
4 COUNTROWS('Waste Data'),
5 'Waste Data'[Time] >= TIME(8, 0, 0) && 'Waste Data'[Time] <= TIME(10, 0, 0),
6 'Waste Data'[Location] = "PSU Warnock (North)",
7 'Waste Data'[Stage of Processing] = "Post-Consumer",
8 ALLEXCEPT('Waste Data', 'Waste Data'[Date])
9 ) > 0
10
11 VAR HasAfternoonEntry =
12 CALCULATE(
13 COUNTROWS('Waste Data'),
14 'Waste Data'[Time] >= TIME(11, 0, 0) && 'Waste Data'[Time] <= TIME(14, 0, 0),
15 'Waste Data'[Location] = "PSU Warnock (North)",
16 'Waste Data'[Stage of Processing] = "Post-Consumer",
17 ALLEXCEPT('Waste Data', 'Waste Data'[Date])
18 ) > 0
19
20 VAR HasEveningEntry =
21 CALCULATE(
22 COUNTROWS('Waste Data'),
23 'Waste Data'[Time] >= TIME(17, 0, 0) && 'Waste Data'[Time] <= TIME(20, 0, 0),
24 'Waste Data'[Location] = "PSU Warnock (North)",
25 'Waste Data'[Stage of Processing] = "Post-Consumer",
26 ALLEXCEPT('Waste Data', 'Waste Data'[Date])
27 ) > 0
```

```
28 VAR NoRepeatingEntries =
29 CALCULATE(
30 COUNTROWS('Waste Data'),
31 'Waste Data'[Location] = "PSU Warnock (North)",
32 'Waste Data'[Stage of Processing] = "Post-Consumer",
33 ALLEXCEPT('Waste Data', 'Waste Data'[Date])
34 )) < 450
35
36
37 RETURN
38 IF('Waste Data'[Location] = "PSU Warnock (North)",
39 IF(HasMorningEntry && HasAfternoonEntry && HasEveningEntry && NoRepeatingEntries, "CLEAN DATA", "MESSY DATA"),
40 "CLEAN DATA")
41
42 //Filtering out days where North Dining Halls system goes down for a portion of the day
43 //Filtering out days when the system randomly generated a ton of repeating entries
```

Appendix 17: Removing Any Days Where LeanPath Goes Down or Repeating Entries are Present

This is a calculated column we created in Power BI. It checks to make sure each day in the dataset has entries between 8-10 AM, 11 AM-2 PM, and 5 PM to 8 PM. It also checks to ensure the total entry count for each day is below 450, as days with the repeating entry problem had far above 450 entries. By including this calculated column as a filter, we were able to easily toggle between “clean data” and “messy data”.

APPENDIX

```
1 Waste Per Customer =
2 AVERAGEX(
3     FILTER(
4         VALUES('DateTable'[Date]),
5         DIVIDE(
6             CALCULATE(SUM('Waste Data'[Weight])), -- Sum of weight for each distinct date
7             CALCULATE(
8                 SUM('Customer Counts'[Customer Count]), -- Customer count for the same date
9                 USERELATIONSHIP('Customer Counts'[Date], 'DateTable'[Date]) -- Activate relationship
10            )
11        ) > 0 -- Exclude dates where Waste Per Customer is 0 or less
12    ),
13    DIVIDE(
14        CALCULATE(SUM('Waste Data'[Weight])), -- Sum of weight for each distinct date
15        CALCULATE(
16            SUM('Customer Counts'[Customer Count]), -- Customer count for the same date
17            USERELATIONSHIP('Customer Counts'[Date], 'DateTable'[Date]) -- Activate relationship
18        )
19    )
20 )
```

Appendix 18: Calculation of Waste Per Swipe

This is a measure we created in Power BI. This measure takes the sum of food waste for each individual day. It then divides each daily total by the swipe count for that day. Finally, it takes the average of these daily values to produce a final metric representing food waste in pounds per swipe. This can easily be converted to other units of weight such as ounces. This measure was applied to 2023 and 2024 data separately after issues in the waste data were removed. Swipe totals were also not included on days that had to be removed from the dataset due to issues with Leanpath.

Additionally, we recognize that an alternative way of calculating food waste per swipe could be to find the weight of all food waste in the 2023 dataset, then divide this by the total swipe count for all days included in the dataset. We did test this alternative method, which produced very similar resulting figures. Thus, choosing this alternative calculation method would not have influenced the findings from the study.

APPENDIX

Warnock Commons Trayless Study		
Parameter	With Trays	Without Trays
Food Waste Per Swipe (Ounces)	2.56	2.51
Standard Deviation (Ounces)	0.392	0.397
# Days Tested	40	30
# Swipes	44,719	29,925
Two Samp. T-Test	p= 0.57 > 0.05	

Appendix 19: Warnock (North) Case Study Results

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REFERENCES

Situational Analysis

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Findings

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Recommendations

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