The Price of Plastic: An Analysis of the Environmental and Economic Impacts and Social Perceptions of Single-Use Plastic Containers at Dalhousie University

Dalhousie University
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Table of Contents

Executive Summary

While recyclable, landfills house 22 to 43% of plastics (Gourmelon, 2015, p. 2). Plastic packaging comprises the majority of plastic waste (Brooks et al., 2018, p. 1). With rises in plastic production (Gourmelon, 2015, p. 1), it is important to examine plastic waste reduction, particularly from packaging. Plastics comprise 21% of Nova Scotia landfill waste (Maccallum, 2018, slide 22), indicating a need to focus on plastic waste reduction in Nova Scotia.

Dalhousie University aims to promote sustainability on campus ("Policies and Guidelines," n.d., para. 1), however, produces a large quantity of plastic waste ("Dalhousie University Waste Auditing History," 2011, p. 12, 13). The Student Union Building (SUB) at Dalhousie is a student "hub," with multiple food vendors ("Student Union Building," n.d., para. 1; "Food & Drink," n.d.). Mezza Lebanese Kitchen in the SUB is a food vendor that provides much of its food in hard plastic containers, making it the focus of the present study. This study aimed to answer the question "what are the economic and environmental impacts of the use of plastic containers at Mezza Lebanese Kitchen in the Student Union Building on Dalhousie University's Studley Campus?"

To answer this question, a mixed methods approach was taken. Counts of different packaging types used to serve food at Mezza Lebanese Kitchen were conducted at one peak and one non-peak time over 30-minute intervals from March 5th to March 11th, and once on March 21st. Results were used, alongside relevant literature, to quantify economic and environmental impacts of plastic waste from Mezza. A survey was also conducted to examine SUB user perspectives of plastic waste on-campus, and to determine the feasibility of implementing a reusable container program at Dalhousie.

While time of day did not impact amount of containers sold, hard plastic containers comprised the majority of containers used to serve food from Mezza. As well, it was found that 359 pounds of plastic container waste is generated by Mezza each month, costing Mezza $525. These results exemplify that reducing or eliminating these containers would greatly reduce both plastic waste entering the environment and food vendor costs. Significant student support for a reusable container program on-campus was also found, provided that barriers of cost, sanitation and convenience were addressed.

Many other universities have implemented reusable container programs for campus food vendors, and it is our recommendation that Dalhousie do the same. Based on the results of this study, a reusable container program could save vendors money and benefit the environment, and is also supported by those who use these services on campus. Future research should further examine the feasibility of a reusable container program at Dalhousie, including potential storage and cleaning facilities.

Introduction

Millions of tons of plastics are produced globally each year, with the deposition of 22% to 43% of global plastics in landfills, despite plastics being recyclable (Gourmelon, 2015, p. 1, 2). As such, plastics contribute to waste build-up in the environment. Packaging also adds to greenhouse gas emissions entering the atmosphere (Accorsi et al., 2014, p. 87). The majority of plastic waste (40%) comes from packaging materials (Brooks et al., 2018, p. 1). Plastic has been used as a packaging material since the 1900s (Risch, 2009, p. 8089), and packaging innovations, including plastic packaging, have allowed safer, longer, and more convenient food transport and storage (Claudio, 2012, p. A233). Since 1950s (just after the innovation of plastic packaging), plastic production has increased annually by 8.7 percent (measured until 2012; Gourmelon, 2015, p. 1). These findings affirm that plastic, and in particular plastic packaging, is currently contributing greatly to global waste.

In 2009, it was found that globally, Canada has the highest per capita municipal waste generation. While Nova Scotia has one of the lowest waste disposal rates per capita in Canada, in part because of its recent implementation of a successful recycling model, Nova Scotia has seen consistent increases in waste disposal since 2013 (Maccallum, 2018, slides 3, 8, 9, 24) that correlate with increases in human consumption (Maccallum, personal communication, 2018). Further, China has, in the past, received around 50% of global recycling products (Maccallum, 2018, slide 23), but has recently implemented stricter regulations on imported recycled materials (including plastics; Brookes et al., 2018, p. 1). Plastics make up the second largest percentage of landfill waste in Nova Scotia (21%; Maccallum, 2018, slide 22). The prevalence of plastics in the Nova Scotian waste stream, alongside recent increases in waste disposal and China's reduction in acceptable waste contamination, highlight the importance of reducing plastic waste in Nova Scotia imminently through reducing plastic product use. In particular, a focus on reducing plastic packaging (which contributes most to global plastic waste; Brooks et al., 2018, p. 1) is necessary.

A major barrier to "institutional sustainability" (such as on university campuses) has been identified as "solid waste management" (Smyth et al., 2010, p. 1007). Dalhousie University aims to promote on-campus sustainability ("Policies and Guidelines," n.d., para. 1). However, according to a 2011 audit, Dalhousie University generates 71.6 kg of recycling waste each day from the three campuses. Plastic containers and bottles comprise the majority (31%) of this recycling waste ("Dalhousie University Waste Auditing History," 2011, p. 12, 13), exemplifying the magnitude of Dalhousie University's plastic waste contribution and affirming the need for Dalhousie University to reduce on-campus plastic waste.

In particular, Dalhousie's Student Union Building (SUB) on Dalhousie's Studley Campus has been defined as "the hub of student extracurricular and social life on campus" ("Student Union Building," n.d., para. 1), indicating that many students, faculty and guests pass through this building each day. The

SUB houses multiple food vendors ("Food & Drink," n.d.), many of which include plastic packaging in the deliverance of their services. Through its prevalence of food vendors and heavy foot traffic, the SUB was identified as a key contributor to plastic waste on campus. Further, Mezza Lebanese Kitchen, a 2017 addition to the SUB ("Mezza Lebanese Kitchen," 2017, para. 1), uses hard plastic take-out containers as packaging for much of their food, and as such contributes greatly to single use plastic waste on campus. For the present study, plastic containers refer to the hard plastic, circular containers that Mezza defines as "reusable takeout containers" ("Our commitment," n.d., para. 9). Mezza's disposable containers are made of polypropylene plastics (Pactiv, 2019), which can be reused multiple times before disposal (Canadian Plastics Industry Association, 2019). However, many containers purchased from Mezza Lebanese Kitchen in the Student Union Building are disposed of after one use. To highlight the magnitude and impacts of plastic waste from food packaging on Dalhousie University's Studley campus, the present study investigates the question "what are the economic and environmental impacts of the use of plastic containers at Mezza Lebanese Kitchen in the Student Union Building on Dalhousie University's Studley Campus?"

The goal of the present study was to understand the magnitude of Dalhousie University's contribution to plastic waste in Halifax and Nova Scotia, as well as quantify the environmental and economic impacts from unnecessary plastic waste generated at Dalhousie University, specifically looking at plastic waste generated by Mezza Lebanese Kitchen in the SUB. Further, the study aimed to understand SUB user perceptions of plastic waste on campus, alongside barriers to increasing reusable container use on campus in the place of single use plastics. Finally, the feasibility of implementing a reusable container program for Dalhousie University food vendors was evaluated based on SUB user interest levels in such a program. The purpose of this research was to determine how Dalhousie University can mitigate its plastic packaging waste and the impact this could have, both environmentally and economically for campus food vendors.

In 2010, researchers from the University of Northern British Columbia conducted a waste audit for the University's Prince George campus, sampling all waste at 15 sites for five days. This process was repeated, yielding two sets of data. Recyclables were found to comprise the majority of on-campus waste, with much (8.1% when averaged for the two sample periods) recycling waste being plastics (Smyth et al. 2010, p. 1008, 1010, 1012). Additionally, a residence hall waste audit conducted in 2009 at the University of Missouri-Kansas City found that plastic waste contributed over 20% to solid waste disposal for each of the three sample sites (Hasan & Johnston, 2010, p. 957, 960). These studies highlight the large contribution of plastics to University campus waste, and as such, the importance of quantifying and reducing plastic waste on university campuses such as Dalhousie University's Studley campus.

Previous studies have also been conducted regarding the environmental and economic impacts of plastic food packaging waste. A life cycle assessment of the use of reusable plastic containers (RPCs) versus single use plastics by a food caterer conducted by Accorsi et al. in 2014 found that RPCs had lesser impacts on the environment when considering packaging use and disposal. While the RPCs used were made of Polypropylene Polymer, which is the same material as Mezza's plastic containers, as mentioned, often the Mezza containers get thrown out after a single use, equating them to single-use plastics. RPCs were more expensive than the single use packaging, but provided lower "packaging purchasing" costs (Accorsi et al., 2014, p.91, 97, 98). However, a study by Vink et al. found reduced disposal costs associated with sustainable polylactide packaging, highlighting possible economic benefits of switching to sustainable packaging (Vink et al., 2004 p. 553). These findings validate that a focus on reduction of plastic packaging, rather than investigation of alternate sustainable packaging options, will be more economically feasible on campus, and affirm our focus on on-campus packaging reduction.

Methods

Study Design

To determine the environmental and economic impacts of plastic consumption on campus, a mixed methods approach was employed that consisted of a quantitative analysis of packaging consumption at Mezza Lebanese Kitchen, as well as a qualitative analysis of consumer behavior and perceptions of single-use plastics. Research was focused on the Student Union Building on Dalhousie University's Studley campus, as it is a popular location for students, faculty, and visitors to purchase food on campus. For our quantitative analysis, we chose to focus on Mezza Lebanese Kitchen. Mezza is a popular food vendor on campus, and is unique in that polypropylene plastic containers make up the majority of its packaging, in addition to other forms of packaging. We conducted a literature review, in combination with our quantitative data from Mezza Lebanese Kitchen, to determine the economic and environmental impacts of the use of plastic containers on Dalhousie's Studley campus. For the qualitative analysis, a survey of SUB users was conducted over a two-week span, with a QR code or survey web link being used to deliver the survey.

Packaging Consumption (Quantitative)

The quantitative component of our research focused on packaging consumption at Mezza Lebanese Kitchen in the Student Union Building. We collected this count data through observations of food purchases during 30-minute sampling periods, counting the number of food purchases that were served in reusable containers, polypropylene hard plastic containers, paper/aluminum foil wraps, cups, or on paper plates during each sampling period. Sampling was conducted between March 5th and March 11th,

with an additional sampling period on March 21st. Counts were collected twice daily during this period, with one count collected during peak times (defined as between 12:00 and 14:00) and non-peak times (defined as outside of 12:00-14:00), to account for differences in food purchases from Mezza depending on time of day.

Once the quantitative data had been collected, a literature review was conducted to determine the environmental and economic impacts of the polypropylene plastic containers used at Mezza. We extrapolated our count data to represent the monthly amount of plastic containers purchased by Mezza consumers. This would avoid sources of error due to decreased consumption during the summer months, as we could present our findings in the context of an average month during the school year. The value obtained for amount of plastic containers purchased per month from Mezza in the SUB was multiplied by the average cost of the same container sold by an online wholesaler to determine economic impacts.

Counts were collected rather than an audit because count data was able to be feasibly taken by researchers over a week-long period and at multiple time points each day, which provides a better estimate of overall plastic container use from Mezza by accounting for day to day variations in food purchases from Mezza. This approach is limited in that data was collected only twice each day over a 30-minute sampling period, and the assumption was made that these two sampling periods are representative of containers purchased throughout the entire day, reducing the accuracy of container purchase estimates.

Survey Methods (Qualitative)

The qualitative component of our research consisted of a survey distributed to students, faculty, and visitors to the Student Union Building on Dalhousie's Studley campus. The survey focused on personal habits of food consumption on campus, and the respondents' perceptions of single-use plastics on campus, with questions asking respondents to comment on the frequency of food purchases on campus, the frequency of food obtained in non-reusable packaging, and possible barriers or incentives involved with reusable container use. We created our 10-question survey using Google Forms, an online survey service. An online survey was selected because of the masses of data able to be collected with this method of sampling in a short time span. Online surveys also increase the efficiency of data analysis (Palys & Atchison, 2014, p. 147-148).

We took a non-probabilistic approach with our sampling method, choosing participants from our defined population of students, faculty, and visitors of the Student Union Building at random. Our sample size was calculated using the total Dalhousie University population as of 2014 (19,831 people; "Dalhousie university," n.d., para. 3) and a margin of error of 5% using an online sample size calculator ("Sample size," n.d.), yielding a sample size of 377 people. The survey was distributed in person throughout the Student Union Building, where we used a quota sampling approach. Participants had the

choice of scanning a QR code with their personal electronic devices or using an electronic device provided to them to complete the survey. The survey was designed to ensure the highest degree of anonymity possible, despite the survey being distributed in person, with no personal identifying questions being asked. A limitation to the quota sampling approach is that it can limit representativeness of the population (Palys & Atchison, 2014, p. 116-117), as the first respondents up to the quota may not share the views of the entire SUB user population.

General Limitations

The major limitation of our research was the scope of our research question. In order to determine a more accurate understanding of the economic and environmental impacts of single-use packaging used in the Student Union Building, we would need to have conducted count data at multiple food vendors. Due to the purposes of our study and the duration of ENVS 3502 Campus as a Living Lab, we did not have the time and resources available to conduct a full analysis, which is why we limited our study to focus on Mezza Lebanese Kitchen.

A limitation of the qualitative survey was the lack of participants, leading to an inability to collect responses from a representative sample size. While aiming for a sample size of 377 students, faculty, and visitors of the Student Union Building, only 50 students completed the survey. Due to this limited sample size, there is a large margin of error for the results of our study. As well, we were not able to represent the important perspectives of faculty and visitors in our analysis due to only receiving student responses.

The consumption of plastic containers and other packaging at Mezza Lebanese Kitchen likely changes throughout the year. Count data was collected in March, during Dalhousie's winter semester. Therefore, the results of our study operate under the assumption that consumption of Mezza's plastic containers will remain fairly consistent throughout the year. However, other periods of the year, for example summer months, are likely to see a drop in consumption as there will be less student traffic on Studley campus. We minimized this inaccuracy by extrapolating our data to container consumption per month, rather than per year.

Finally, our review of the economic impacts of Mezza's polypropylene containers was limited, as we were unable to access the true costs of containers that Mezza Lebanese Kitchen pays due to proprietary confidential pricing information. The information used for our analysis was obtained from a wholesaler website selling containers made from the same material and with the same dimensions as those used by Mezza. This may lead to some discrepancy in the economic impacts of plastic containers and packaging used by Mezza. Additionally, the present study is limited in that only environmental impacts associated with the amount of plastic contributed to the waste stream are considered, and greenhouse gas emissions associated with plastic packaging production and transport are not included.

Results

Qualitative

When the survey question "on average, how often do you purchase food on campus?" was posed to Dalhousie University SUB users, of 50 total respondents the majority of individuals (48%) responded that they purchased food on campus a few times a week. 11 individuals (22%) stated that they purchase food on campus less than once a week. 9 individuals (18%) stated that they purchase food on campus once a week, followed by 4 individuals with the response "every day" and the fewest number of individuals (2) responding that they "never" purchase food on-campus (Figure 1).

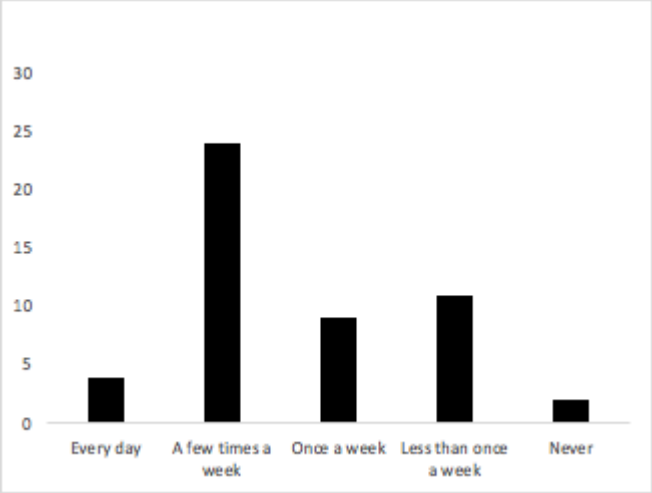

Figure 1. The frequency (total + SE) that survey respondents purchase food on Dalhousie University's Studley campus, with data obtained from a survey yielding 50 responses and conducted in March of 2019 in the Student Union Building.

When the survey question "on average, how often do you bring reusable containers for food purchases on campus?" was posed to Dalhousie University SUB users, of 50 total respondents, most individuals (25) reported that they never bring a reusable container to campus, followed by <50% of the time I purchase food (12 individuals). The fewest number of participants (2) always brought a reusable container when they purchased food (Figure 2).

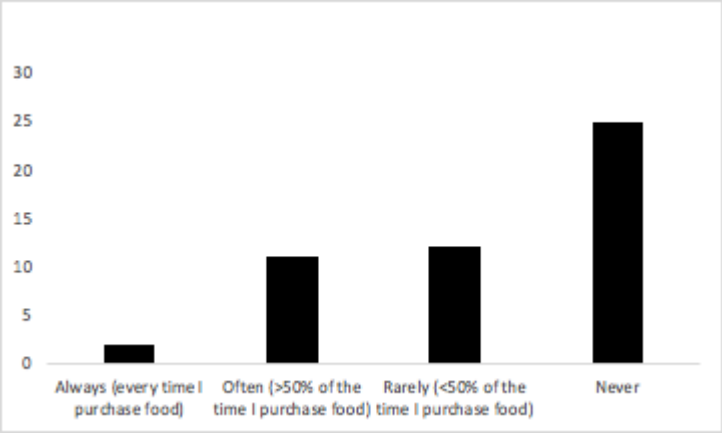

Figure 2. Distribution of how often survey respondents (total + SE) bring reusable containers for food purchases on Dalhousie University's Studley campus, with data obtained from a survey yielding 50 responses and conducted in March of 2019 in the Student Union Building.

When the survey question "would you use a reusable container when buying food on campus if it was provided?" was posed to Dalhousie University SUB users, of 50 total respondents, 90% of respondents (45 individuals) responded "yes" (Figure 3).

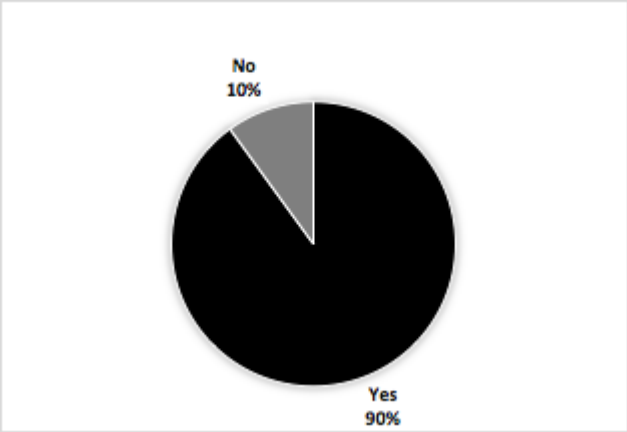

Figure 3. Percent of survey respondents who would and would not use a reusable container on campus if it was provided, with data obtained from a survey yielding 50 responses and conducted in March of 2019 in the Student Union Building.

When respondents were asked whether they "agree" or "disagree" with the statement "it is important that food establishments in the Student Union Building minimize the use of single use plastics," 49 of the 50 respondents (98%) agreed with the statement (Figure 4).

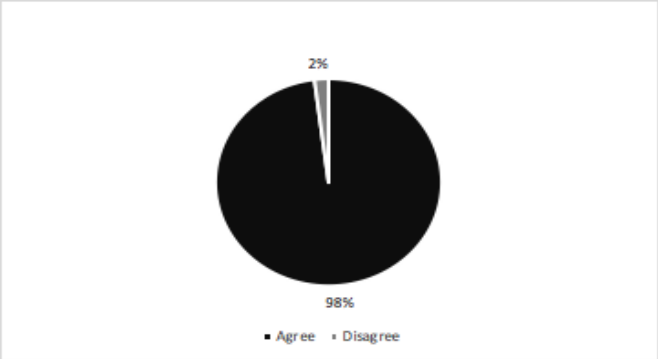

Figure 3. Percent of survey respondents agree or disagree with the statement that it is important that food establishments in the Student Union Building minimize the use of single-use containers, with data obtained from a survey yielding 50 responses and conducted in March of 2019 in the Student Union Building.

When asked "what would be the biggest factor (or factors) that would encourage you to use a reusable container when buying food on campus," respondents identified convenience as the largest factor that would encourage reusable container use, followed by cost and then environmental benefits (Figure 5).

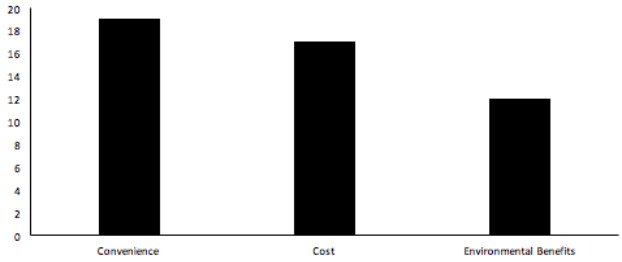

Figure 4. Factors, as identified by survey participants, that would encourage reusable container use when purchasing food on Dalhousie University's Studley Campus, displayed as number of responses that correlated to each category (convenience, cost, environmental benefits), with data obtained from a survey yielding 50 responses and conducted in March of 2019 in the Student Union Building.

When asked "what would be the biggest factor (or factors) that would discourage you to use a reusable container when buying food on campus," respondents identified a lack of convenience as the largest factor that would discourage reusable container use, followed by sanitation, and then higher costs (Figure 6).

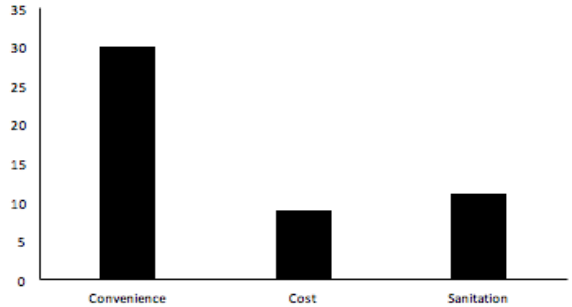

Figure 5. Factors, as identified by survey participants, that would discourage reusable container use when purchasing food on Dalhousie University's Studley Campus, displayed as number of responses that correlated to each category (convenience, cost, sanitation), with data obtained from a survey yielding 50 responses and conducted in March of 2019 in the Student Union Building

Quantitative

Using a two-tailed t-test, no difference was found between the amount of any of the food packaging types for purchases at peak and non-peak times, except for paper/aluminum foil wraps (p=0.36, 0.90, 0.27, 0.36 for personal reusable containers, hard plastic containers, cups, and paper plates respectively, and p=0.05 for paper/aluminum foil wraps, at alpha=0.05; Figure 5). Using a two-tailed t-test, a significant difference was found between the hard plastic containers and all other types (p=0.001, 0.002, 0.002 at alpha=0.05 when compared to personal reusable containers, cups, and paper plates respectively) with the exception of paper/aluminum foil wraps (p=0.115 at alpha=0.05; Figure 7).

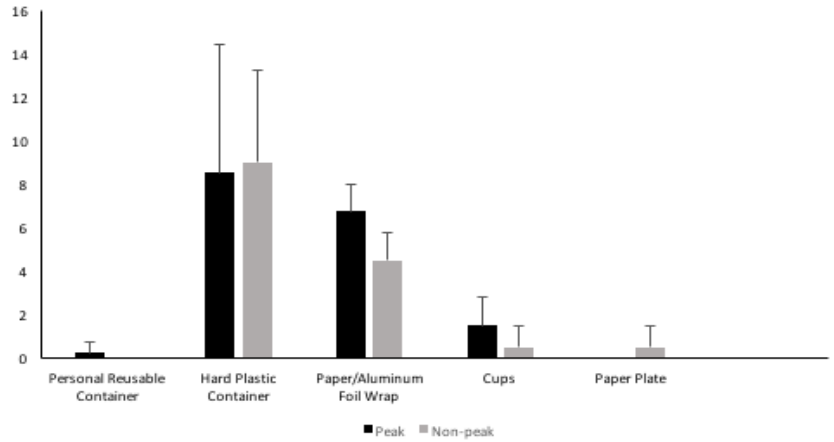

Figure 6. Type of packaging used (mean + SE) for Mezza food purchases, with data collected each day from March 5th- March 11th and on March 21st over 30-minute sampling intervals at peak (12:00 to 14:00) and non-peak times (not 12:00 to 14:00) in the Student Union on Dalhousie University's Studley campus.

Discussion

The present study aimed to determine the environmental and economic impacts of plastic container use at Mezza Lebanese Kitchen in the Student Union Building on Dalhousie University's Studley Campus. Count data observations were used to determine environmental impacts based on the magnitude of plastic waste generated, in addition to being used in conjunction with a literature review of similar plastic containers to better understand economic impacts. Mezza was used as a case study to exemplify the impact of plastic packaging waste on Dalhousie's Studley campus as a whole. This study also aimed to examine the perceptions of single-use plastics on campus among Dalhousie community members by looking at current behaviors of the Dalhousie community in terms of food purchases on campus and single-use plastic consumption, and whether or not the community would be receptive to reducing their plastic waste consumption through the use of reusable containers.

Count data revealed no significant difference between peak and non-peak times for the amount of any type of packaging given with food purchases at Mezza (Figure 7). These results reveal that in terms of consumer tendencies, time of day does not play a large role in amount of food (and as such, containers)

purchased from Mezza, with container waste being generated consistently throughout each day. Count data also revealed that the polypropylene plastic containers were the most common packaging used by Mezza, and significantly more polypropylene plastic containers were purchased than any other packaging type (with the exception of paper/aluminum foil wraps; Figure 7). These results validate the results of Dalhousie's 2011 waste audit, which found 31% of recycling waste to be made up of plastic containers and bottles (Dalhousie University Waste Auditing History, 2011). Our results indicate that plastic packaging waste is the largest contribution to the waste stream from Mezza, and exemplify the large contribution plastic waste from food vendors makes to Dalhousie University's waste stream.

When counts were averaged to calculate monthly plastic container waste from Mezza, we found that 3,320 containers are purchased every month by Mezza consumers, equating to an addition of 359 pounds of plastic waste to the waste stream from Mezza alone. When considering how many food vendors in the Student Union Building and across Dalhousie's Studley campus use plastic packaging in their operations, the immense negative environmental impacts of single-use plastic consumption on campus are clear. Despite being recyclable, landfills house 22 to 43 percent of plastics (Gourmelon 2015), and as such, a large portion of the 359 pounds of plastic waste contributed from Mezza to Dalhousie's waste stream will likely end up in landfills, largely impacting the environment.

After contacting Mezza to find the type of container used, a literature review was conducted to find the cost of containers from an online wholesaler selling polypropylene containers with the similar size and dimensions of Mezza's packaging (Webstaurant Store, 2019). It was found that Mezza spends approximately $525 on these plastic containers every month. As such, by eliminating or reducing the use of these plastic containers at Mezza, for example through the implementation of a reusable container program, $525 could be saved by Mezza alone each month. If this was extended to all food vendors across Dalhousie University's Studley Campus, even larger amounts of money could be saved, meaning reducing plastic container use would be economically favorable for food vendors on-campus.

Qualitative results revealed that 98% of SUB users agreed that food establishments in the Student Union Building should minimize the use of single use plastics (Figure 3), showing that SUB users feel that plastic waste reduction on campus is important. Results also revealed that the majority of SUB users purchased food on campus a few times each week (Figure 1). Despite purchasing food multiple times each week on campus, and identifying single-use plastic waste as an issue on campus, the majority of respondents revealed that they never bring a reusable container for on-campus food purchases (Figure 2). These results show that there is a lack of reusable container use on campus, but a great deal of on-campus food purchases occurring, indicating that a great deal of unnecessary food packaging waste is being generated, despite the knowledge among SUB users that single-use plastics are an issue.

90% of respondents indicated that they would use a reusable container when purchasing food if it were provided (Figure 3). These results indicate that there is interest and support among SUB users to reduce the use of single-use containers on campus through the use of reusable containers. When asked about what would encourage or discourage the use of reusable containers, SUB users identified convenience as the biggest barrier (lesser convenience) or incentive (greater convenience) to reusable container use on campus (Figures 5 & 6), followed by sanitation (Figures 5 & 6). Higher cost was also identified as a barrier to reusable container use on-campus (Figure 6). As such, qualitative results show support among SUB users for a reusable container program on Dalhousie University's Studley campus, but success of such a program will depend on ensuring convenience for users, good sanitation, and low or no increase in costs.

Other universities in North America have implemented programs to reduce single-use plastic waste on campus. In particular, the University of Florida aimed to produce no waste as of 2015, and to reach this goal, foam packaging and plastic bags were removed from meal halls and food vendors on campus. This action reduced annual foam container waste by 1.2 million containers, replacing these containers with alternate sustainable packaging materials, and saved 500,000 plastic bags annually (Chapman, 2013, para. 2, 3, 4). Reusable container programs have been introduced on university campuses across North America, including University of Guelph, McGill University, and Harvard University (University of Guelph Sustainability Office, 2017; McGill University Food and Dining Services, 2019; Harvard University Sustainability, 2018). Many of these universities have implemented programs that operate on a card or token system in which participants pay a small fee of $4-5, and can turn in their token for a reusable container at food vendors across campus (University of Guelph Sustainability Office, 2017; University of Waterloo, n.d.). Once finished with their meal, participants return their containers to be washed, sanitized, and redistributed, and their tokens are returned to them. Other universities, such as McGill University, have implemented the Ozzi system, operating much like the token systems, however containers are collected from a vending machine (McGill University Food and Dining Services, 2019). These projects demonstrate how changing the types of packaging at on campus food vendors can largely reduce packaging waste on campus.

Our study shows that small changes to Dalhousie University's food vendor packaging can similarly allow large-scale packaging waste reduction on campus. Through our study, we found that the majority of our sample population would be supportive of reducing single-use plastics on campus through the introduction of reusable container programs or initiatives. The success of these programs at other universities exemplifies that such a project is feasible on University campuses, and could be applied at Dalhousie.

Conclusion

The results of our study illustrate the immense negative environmental and economic impacts of the polypropylene containers used at Mezza Lebanese Kitchen in the Student Union Building. These impacts are even more evident when considering how many food vendors across Dalhousie's Studley campus use plastic packaging. From our qualitative analysis, we found that the majority of students that purchase food from the Student Union Building believe that these food vendors should be limiting their use of single-use plastics, and would use reusable containers if they were provided, as long as the barriers of convenience, cost and sanitation were addressed in the implementation of a reusable container program.

Based on these findings, we recommend that Dalhousie University introduces a reusable container program for food vendors on Studley campus. Many universities across Canada and the United States have been very successful in reducing plastic waste on their campuses by implementing reusable container programs. While there are a range of reusable container programs and flexibility in how they are implemented, reusable container programs have proven to be an effective tool in reducing plastic waste while encouraging participation through convenience and cost reductions or incentives. These programs also benefit food vendors, as they can save money and resources by reducing availability of plastic packaging for this reusable system, and have been found to save Mezza alone $525 each month. Whether it be a card or token system, or a vending machine operation similar to McGill University's Ozzi system (McGill University Food and Dining Services, 2019), we believe that the Dalhousie community would greatly benefit from a reusable container program of its own, and has the support among students to participate in such a program.

However, if Dalhousie decides to reduce its plastic waste, it is important to consider the barriers that we discovered through our survey. It is essential that any projects or solutions to plastic waste consumption on campus ensure low cost, convenience, and proper sanitation. Further research should explore these barriers to understand specifically what aspects of cost, sanitation or convenience are discouraging reusable container use to better address these concerns (for example, exactly what costs would be too high for a reusable container program to maintain support among students). Additionally, future studies should be conducted to examine the feasibility of convincing food vendors to phase out plastic containers at food vendors, alongside the feasibility of implementing such a program with Dalhousie's current infrastructure to understand aspects such as reusable container storage and cleaning.

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Appendices

					Count Data					
Date (d/m/y)	Collector Initials	Location	Time Start	Time Finish	Personal Reusable Container	Hard Plastic Container	Paper/Aluminum Foil Wrap	Cups	Paper Plate	Total
05/03/19	HM	Mezza @ SUB	3:00 PM	3:30 PM	0	6	6	0	0	12
06/03/19	JF	Mezza @ SUB	12:00 PM	12:30 PM	0	13	7	1	0	21
06/03/19	JF	Mezza @ SUB	2:27 PM	2:57 PM	0	9	5	0	0	14
07/03/19	JZX	Mezza @ SUB	1:30 PM	2:00 PM	1	14	7	3	0	25
07/03/19	HM	Mezza @ SUB	5:30 PM	6:00 PM	0	6	3	0	0	9
08/03/19	JH	Mezza @ SUB	2:30 PM	3:00 PM	0	15	4	2	2	23
11/03/19	HM	Mezza @ SUB	1:00 PM	1:30 PM	0	5	8	0	0	13
21/03/19	JZX	Mezza @ SUB	1:30 PM	2:00 PM	0	2	5	2	0	9
				Total	1	70	45	8	2	

Appendix A. Raw count data of packaging consumption by type at Mezza Lebanese Kitchen at the Student Union Building on Dalhousie's Studley campus.Appendix B: Informed consent paragraph that was presented to survey participants before they began out survey.

Food Packaging on Dalhousie's Studley

This survey is being conducted as part of a research project for ENVS-SUST3502 Environmental Problem Solving II (Campus as a Living Lab). Responses will remain confidential, and survey questions will not ask for any personally identifying information. All survey data will be aggregated, and any quotes that may be used in our final report will have no personal identifying information attached. Responses will be collected and used towards completing a research project for the purposes of this course. This report may be used in the creation of a recommendation for the Sustainability Office of Dalhousie University. The final report and results will be posted on the Dalhousie Environmental Science page under past research projects. If you have any additional questions, please contact our research team, Julia Fast (julia.fast@dal.ca), Jordan Haughn (jr567193@dal.ca), Hannah Miller (hn443815@dal.ca), or ZongXu Jiang (zn632293@dal.ca), or Dr. Amy Mui (amy.mui@dal.ca).

Appendix A. Informed consent paragraph that was presented to survey participants before they began our survey.

What is your affiliation with Dalhousie University?	On average, how often do you purchase food on campus?	How often does your purchased food include packaging that is non-reusable (i.e. must be thrown away or recycled)?	On average, how often do you bring reusable containers for food purchases on campus?	Would you use a reusable container when buying food on campus if it was provided?	CODED: Why or why not? (Environmental Benefits, Convenience, No Need)
Student	A few times per week	Always (every time I purchase food)	Never	Yes	Environmental Benefits
Student	Once a week	Often (>50% of the time I purchase food)	Never	Yes	Environmental Benefits
Student	A few times per week	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	-
Student	A few times per week	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	-
Student	A few times per week	Often (>50% of the time I purchase food)	Never	Yes	Environmental Benefits
Student	A few times per week	Always (every time I purchase food)	Often (>50% of the time I purchase food)	Yes	-
Student	A few times per week	Never	Never	-	-
Student	A few times per week	Often (>50% of the time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	Environmental Benefits
Student	Less than once a week	Often (>50% of the time I purchase food)	Always (every time I purchase food)	Yes	Environmental Benefits
Student	Every day	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	-
Student	A few times per week	Always (every time I purchase food)	Never	Yes	Environmental Benefits
Student	A few times per week	Often (>50% of the time I purchase food)	Never	Yes	Environmental Benefits
Student	Once a week	Always (every time I purchase food)	Never	Yes	Environmental Benefits
Student	A few times per week	Often (>50% of the time I purchase food)	Never	Yes	-
Student	A few times per week	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	-
Student	A few times per week	Rarely (<50% of the time I purchase food)	Never	Yes	?
Student	A few times per week	Often (>50% of the time I purchase food)	Often (>50% of the time I purchase food)	Yes	Environmental Benefits
Student	Less than once a week	Always (every time I purchase food)	Never	Yes	-
Student	Once a week	Always (every time I purchase food)	Often (>50% of the time I purchase food)	Yes	Environmental Benefits
Student	Less than once a week	Often (>50% of the time I purchase food)	Never	Yes	Environmental Benefits
Student	Less than once a week	Always (every time I purchase food)	Often (>50% of the time I purchase food)	Yes	-
Student	A few times per week	Always (every time I purchase food)	Often (>50% of the time I purchase food)	Yes	Environmental Benefits
Student	Every day	Always (every time I purchase food)	Never	Yes	Environmental Benefits
Student	Always (every time I purchase food)	Never	Yes	-	
Student	A few times per week	Always (every time I purchase food)	Never	Yes	-
Student	A few times per week	Often (>50% of the time I purchase food)	Never	Yes	Environmental Benefits
Student	Less than once a week	Often (>50% of the time I purchase food)	Often (>50% of the time I purchase food)	Yes	Environmental Benefits
Student	Every day	Always (every time I purchase food)	Never	No	Convenience (+)
Student	Once a week	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	Environmental Benefits
Student	A few times per week	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	Environmental Benefits
Student	A few times per week	Rarely (<50% of the time I purchase food)	Often (>50% of the time I purchase food)	Yes	-
Student	Less than once a week	Often (>50% of the time I purchase food)	Often (>50% of the time I purchase food)	Yes	?
Student	Less than once a week	Often (>50% of the time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	No Need
Student	A few times per week	Rarely (<50% of the time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	Environmental Benefits
Student	Less than once a week	Rarely (<50% of the time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	Convenience
Student	Every day	Always (every time I purchase food)	Never	No	Convenience (+)
Student	Never	Often (>50% of the time I purchase food)	Often (>50% of the time I purchase food)	Yes	Convenience (+)
Student	Less than once a week	Rarely (<50% of the time I purchase food)	Always (every time I purchase food)	Yes	-
Student	Once a week	Always (every time I purchase food)	Never	Yes	?
Student	Once a week	Often (>50% of the time I purchase food)	Often (>50% of the time I purchase food)	Yes	Environmental Benefits
Student	Once a week	Always (every time I purchase food)	Never	No	-
Student	A few times per week	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	Environmental Benefits
Student	A few times per week	Always (every time I purchase food)	Never	Yes	-
Student	Less than once a week	Always (every time I purchase food)	Never	No	Convenience (-)
Student	Once a week	Always (every time I purchase food)	Never	Yes	-
Student	A few times per week	Always (every time I purchase food)	Never	No	No Need
Student	Never	Often (>50% of the time I purchase food)	Never	Yes	Environmental Benefits
Student	Less than once a week	Always (every time I purchase food)	Often (>50% of the time I purchase food)	Yes	-
Student	A few times per week	Always (every time I purchase food)	Rarely (<50% of the time I purchase food)	Yes	Environmental Benefits
Student	Once a week	Always (every time I purchase food)	Never	Yes	Environmental Benefits

CODED: What would be the biggest factor (or factors) that would ENCOURAGE you to use a reusable container when buying food on campus?	CODED: What would be the biggest factor (or factors) that would DISCOURAGE you from using a reusable container when buying food on campus?	CLEANED (binary): Rate your agreement with the following statement: It is important that food establishments in the Student Union Building minimize the use of single-use containers.	CODED: Additional Comments
Environmental Benefits	Convenience	Agree	No
Environmental Benefits	Convenience	Agree	-
Cost	Sanitation	Agree	-
Convenience	Convenience	Agree	-
Environmental Benefits	Convenience and Sanitation	Agree	-
Convenience	Cost	Agree	-
Environmental Benefits	-	Agree	-
Environmental Benefits	Convenience	Agree	-
-	-	Agree	-
-	Sanitation	Agree	-
Environmental Benefits	Sanitation	Agree	-
Cost	Convenience	Agree	-
Cost, Convenience	Convenience and Cost	Agree	-
Cost, Convenience	Convenience and Cost	Agree	-
Cost	Convenience	Agree	-
-	Convenience	Agree	-
Cost	Convenience	Agree	-
Environmental Benefits	Cost	Agree	Pro reusable containers
Cost	Convenience and Cost	Agree	-
Cost	Sanitation	Agree	-
Convenience	Convenience	Agree	-
Environmental Benefits	Convenience	Agree	-
Cost	Convenience	Agree	No
Convenience	Convenience	Agree	-
Environmental Benefits	Cost	Agree	-
Environmental Benefits	Convenience	Agree	-
Convenience	Convenience	Agree	-
Cost	Convenience	Agree	-
Convenience	Convenience	Agree	-
Convenience	Convenience	Agree	-
Convenience	Sanitation	Agree	-
Convenience	Convenience	Agree	No
Convenience	Convenience	Agree	-
Cost	Sanitation	Agree	No
Convenience	Sanitation	Agree	-
Cost	-	Agree	-
Convenience	Cost	Agree	-
Cost	Cost	Agree	-
Cost	Convenience	Agree	-
Environmental Benefits	Sanitation	Agree	-
-	Convenience	Agree	-
Convenience	Sanitation	Agree	-
Cost	Convenience	Agree	-
Convenience	Convenience	Disagree	Recyclable materials
Convenience	Convenience	Agree	-
Environmental Benefits	Sanitation	Agree	-
Convenience	Convenience	Agree	-
Cost	Cost	Agree	-
Cost	Convenience	Agree	-
Convenience	Convenience	Agree	-

Appendix C. Coded survey responses (to ensure the confidentiality of survey participants we have excluded raw written responses).

	Personal Reusable Container	Hard Plastic Container	Paper/Aluminum Foil Wrap	Cups	Paper Plate
Average per count	0.125	8.75	5.625	1	0.25
SD	0.353553391	4.773438413	1.685018016	1.19522861	0.70710678

Appendix D. Summary statistics of count data of packaging consumption by type at Mezza Lebanese Kitchen at the Student Union Building on Dalhousie's Studley campus.