University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Campus Food Delivery: GHG Assessment

Accelerate Climate Action - Climate Friendly Food Systems (CFFS) and Enable the Great Food Transformation - Decarbonizing Transportation

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Campus Food Delivery: GHG Assessment

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Executive Summary

This project aims to quantify the environmental impacts of the food delivery industry on UBC campus in line with the UBC Food Services and UBC SEEDS Sustainability Program Food System Project objectives. Part 2 of this project is conducted by UBC ESW to determine the global warming potential (GWP) of food delivery orders to on-campus residences and explore recommendations for less GHG-intensive alternatives. Data was collected in Part 1 of this project by the CHBE 220 students encompassing the data and time, residences, restaurants and vehicle types for food delivery orders. Most orders were delivered between 5:30 and 7:30PM with the majority of orders on Friday, followed by Wednesday, with Marine Drive encompassing the bulk of orders. The majority of orders are from on-campus restaurants with the majority of orders from McDonalds (16%, 25 orders total) and the average distance per order being 3.8km and the most used vehicle type being gas vehicles (64%). Much of the packaging used for food delivery orders are plastic or paper plastic containers with an Australian study showing the GWP per container to be roughly equivalent to 1 km of travel by car. It is also more common for online food orders to be discarded due to portion size, taste, or to meet a minimum order amount, which results in more food waste. The average GWP per order is estimated as 0.65 kg $CO_{2\,eq}$ using emissions factors for gas vehicles, hybrid vehicles and motorcycles and for an average total of 470 orders per day where the restaurant is known. For all total orders, the average GWP is 0.79 kg $CO_{2\,eq}$ per order. Future recommendations for this study include surveying non-residence buildings as well as increasing the time periods of the study and more rigorous inclusion of vehicle type, make and model to better determine associated GHG emissions. Some recommendations to reduce GHG emissions include designated pick-up locations for food delivery orders to reduce convenience, lower vehicle distance traveled, and facilitate multi-order deliveries. It is also recommended to explore a UBC-run delivery service for on-campus restaurants and order-ahead services to facilitate lower emission delivery options such as cycling.

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Introduction

UBC Food Services and the UBC SEEDS Sustainability Program have proposed this project as a step to advance the UBC Food System project objectives. The COVID-19 pandemic has increased take-out and ready-made food delivery orders [1]. This project aims to estimate the environmental impact of these food deliveries to campus through a greenhouse gas (GHG) assessment.

Data was collected by students from the CHBE 220 class by counting deliveries arriving to campus residences and reporting the restaurant food was ordered from, the vehicle type making the delivery, and if possible, the food delivery service. This data was analyzed and used to estimate the GHG emissions associated with food delivery to campus. The environmental impact has been calculated and reported in terms of global warming potential (GWP). GWP measures the amount of energy the emission of a gas will absorb relative to an equivalent amount of carbon dioxide (CO_2) over a period of time [2]. The GWP is commonly measured based on a time period of 100 years, the 100 year GWP is what has been used for this assessment.

Background

This project was done in two parts. The first part was conducted by students from the CHBE 220 class and involved collecting data on food deliveries to campus residences. Teams each collected data for 2 hours at an upper-year or first-year residence. Data collection took place at two upper-year residences and two lower-year residences; Marine Drive and Walter Gage, Totem Park and Orchard Commons. The data collected included the number of food deliveries, delivery mode, and restaurant to help quantify the distance traveled. The food delivery service was only recorded for a small portion of the deliveries.

Data Analysis

Data was collected from November 22nd to November 26th at three different time periods. The time periods were as follows: 3:30-5:30 pm, 5:30-7:30 pm, and 7:30-9:30 pm. The restaurant names, distances between restaurants and residences, and the vehicle types were also recorded.

Most deliveries (38%) were made from 5:30-7:30 pm. However, there was not a large difference between the number of deliveries made in each time period with 37.5% made from 3:30-5:30 pm and 24.5% of deliveries made from 7:30-9:30 pm. Figure 1 shows the distribution of orders per time period.

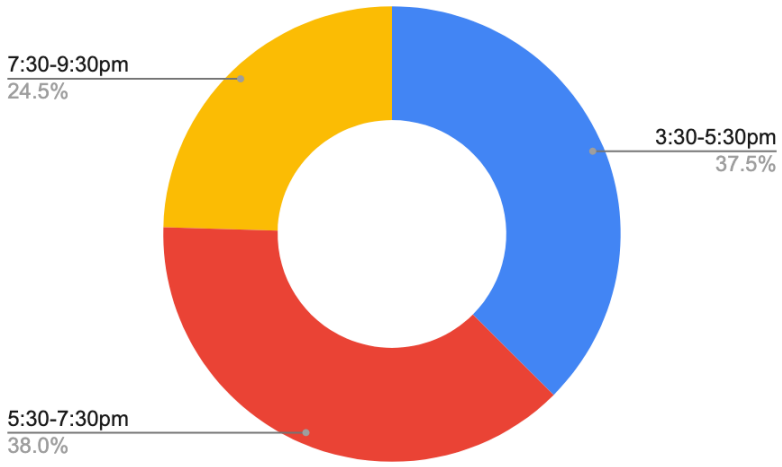

Figure 1: Percentage of deliveries made in each time period, calculated based on the total deliveries recorded

Deliveries per resident per hour was calculated and compared for each residence from which data was collected. The number of deliveries from each residence and each time period was divided by the number of residents and by 2 hours. These values were then averaged for each residence, the results are shown in Figure 2.

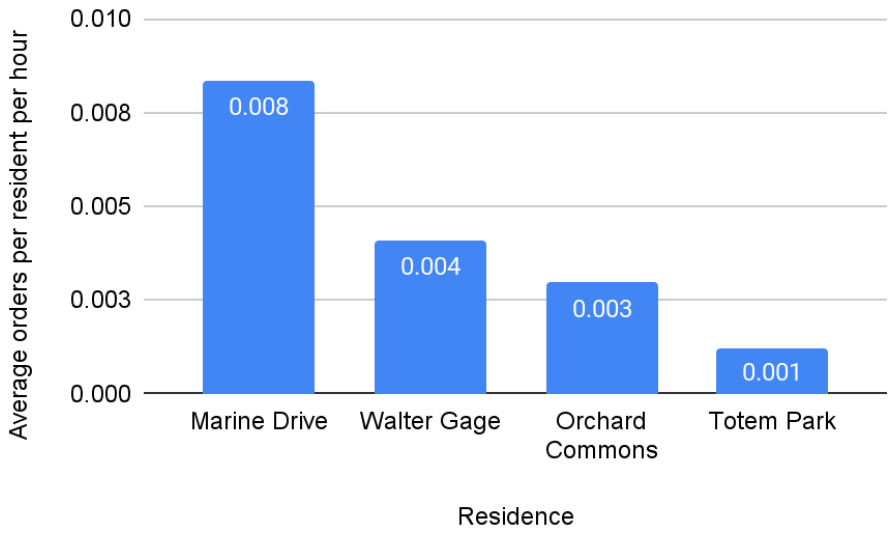

Figure 2: Average values of orders (deliveries) per resident per hour calculated for each residence from which data was collected

As shown in Figure 2, Marine Drive residence has the highest number of orders per resident per hour, followed by Walter Gage. The two first-year residences, Orchard Commons and Totem Park, had reduced numbers of deliveries. The first-year meal plan and dining hall availability may contribute to the reduced number of food deliveries.

Most popular restaurants were classified as those having 2 or more orders. Figure 3 shows a map with the locations and names of these restaurants.

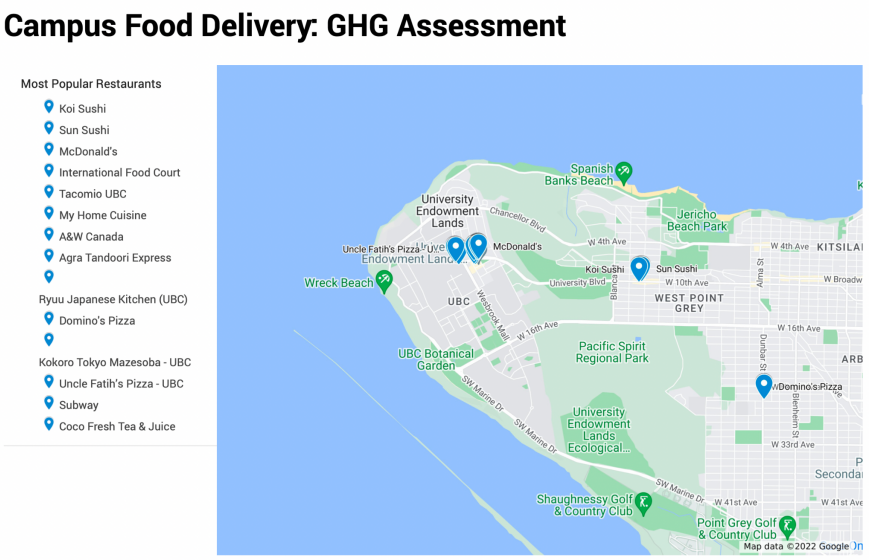

Figure 3: Map displaying the most popular restaurants from which deliveries were made. Popular restaurants have been classified as those with 2 or more deliveries were made.

The greatest number of deliveries came from McDonald's, with 25 deliveries total making up 16% of total deliveries made. Though the most popular restaurants were majorly located on campus, several restaurants were located at greater distances, thus the average delivery distance was found to be 3.5 km.

The vehicle types used for deliveries were also recorded. 64% of all deliveries were completed with gas vehicles, while the vehicle type was unknown for 20% of all deliveries. The remainder of deliveries included the use of the following vehicles: hybrid, electric, bike, motorcycle, and on foot. Figure 4 shows the variation in the number of orders delivered with the various vehicle types.

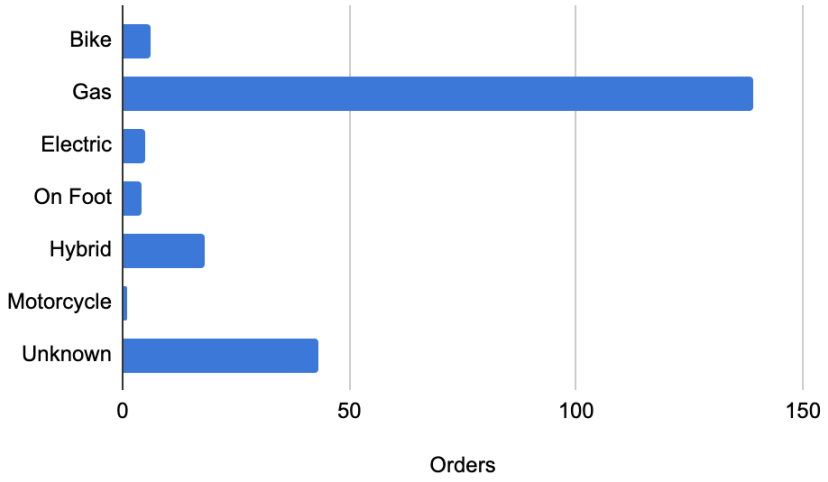

Figure 4: Number of deliveries made with each vehicle type.

Analysis

Data analysis was initially conducted for deliveries in which the restaurant names were recorded. The one-way distances between restaurants and residences for each delivery were determined from Google Maps. The shortest possible distance was used. For data where the restaurant names were not recorded an average distance was used as the delivery distance. This average delivery distance was determined to be 3.5 km.

Zero emissions were assumed for bike, on foot, and electric vehicle transportation methods. The GWPs associated with all other modes of transportation used for deliveries are shown in Table 1.

Table 1: Global warming potential impact factors associated with gas and hybrid vehicles as well as motorcycles.

Vehicle	kg CO2eq/km
Gas	0.22
Hybrid	0.16
Motorcycle	0.002

For many deliveries, the vehicle type was not determined, so a weighted average was used to calculate a GWP for the unknown vehicle types. The number of deliveries made with each vehicle type was divided by the total number of deliveries to give each vehicle type a weight. These weights were then multiplied by the number of deliveries made using each vehicle type to find the average. The weighted average GWP utilized for unknown vehicles was found to be 0.193 kg CO_2/km.

The distance traveled by each vehicle type was added for each residence on each day of data collection. These distances were then multiplied by the GWPs for each vehicle type and divided by the number of residents and the number of hours for which data was collected. Averaging the resulting values allowed for the calculation of a GWP per resident per hour. It was assumed that food orders would most likely be made between 9 am and 9 pm, this is also more representative of the data collected as the times considered were only from 3:30-9:30 pm. Thus, GWP calculations are based upon deliveries made for 12 hours daily. By multiplying the average GWP per resident per hour by the total number of residents in UBC student housing and 12 hours, the average daily GWP was determined to be 501.35 kg $CO_{2\,eq}$/day.

Values of orders per resident per hour were averaged for upper and lower-year residences considered. By multiplying these values by the total upper and lower-year residents the daily orders for upper and lower-year residences were determined to be 148 and 402 orders per day respectively. This results in a total of 550 orders per day on average.

Assuming orders are made 365 days a year, the annual GWP is 182,993 kg $CO_{2\,eq}$. If the summer months (May-August) are not considered due to lack of data and differences in residence occupancy the annual GWP is 121,828 kg $CO_{2\,eq}$.

Environmental Impact

In addition to global warming effects from GHG emissions associated with transportation, there are several other environmental impacts that must be considered. These include plastic waste and food waste.

Packaging used for take-out orders is often plastic or paper-plastic laminate containers. Containers that are marketed as biodegradable, bioplastics, and paper-plastic laminate containers currently cannot be recycled or composted in the Metro Vancouver area [3]. Recycling processes for plastic laminate containers are difficult and costly, and the process requirements for the recycling or composting of biodegradable plastics and bioplastics require specific conditions [3]. There are also emissions associated with the production of delivery containers. A study conducted in Australia estimated that the GWP associated with food delivery service containers to be 0.15-0.29 kg CO_2 per container [4].

Food waste can also increase as a result of food delivery services. Many of these services include additional service fees if an orders subtotal is less than a specified amount [5]. Increasing the order subtotal to reach the specified subtitle amount and avoid the service fee will often result in a total cost that is less than paying the service fee. This can lead to more food being ordered than was originally required [5]. Studies have also found that it is more common for online food orders to be wasted [5]. Factors influencing food orders being discarded include taste and portion size [5].

Recommendations

To improve the GHG estimate of campus food delivery future research should include data collection over a larger time frame in order to facilitate rigorous data analysis. It is also suggested to collect data from different periods of the day, such as breakfast and lunch, in order to determine which periods see the most deliveries throughout the week. Furthermore, data collection should include deliveries made to non-residence buildings on campus, including orders made by commuter students, staff, and faculty. Many orders recorded did not include vehicle type, which is important in the determination of GWP. Future research should ensure that vehicle type is collected along with make and model.

This project did not include research into the behavioral aspects of food deliveries. For future work, surveys are recommended as a means to collect student opinions and identify major factors in food decisions. Surveys allow the collection of information that is subjective or otherwise difficult to determine, such as packaging and disposal trends, how much food is ordered, and the cost of orders.

Short-term recommendations for reducing emissions from food deliveries include creating policies to limit food delivery pick-up locations, similar to ride-hailing. This will reduce the convenience of food delivery services by enforcing students to go to a designated location to pick up their food, as well as reducing environmental impact by limiting the locations drivers must go to. With this method, it is also easier to facilitate multi-order deliveries to a single location that would service multiple residences.

Long-term recommendations include exploring a UBC-run delivery or order-ahead service to increase the convenience of accessing on-campus restaurants as the majority of food delivery orders are for on-campus restaurants. By limiting the radius of these orders, it is possible for orders to be delivered through walking, bicycle or EV vehicles which further reduces environmental impact and distance traveled from restaurant to consumer. Order-ahead for UBC Food Service outlets would also facilitate students picking up food at a convenient time rather than ordering delivery from the same location.

Conclusion

Overall, this study confirms that the food delivery industry on UBC campus has serious environmental impacts, not only from the GHG emissions occurring from vehicle transport but also the increased consumption of single-use plastics and otherwise unrecyclable containers. The majority of orders were placed to upper year residences with an estimated amount of total orders per day being 550 orders to UBC Student Residences. For each order delivered, the GWP associated only with the transportation of the order is 0.65 to 0.79 kg $CO_{2\,eq}$ with the estimated GWP associated with each food delivery container being 0.15 to 0.29 kg $CO_{2\,eq}$. It is

recommended to increase the amount of data collected to make more rigorous conclusions regarding the total environmental impact of the industry, however, base conclusions may be made confirming that the GWP of food delivery orders on UBC campus is significant.

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