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Research Proposal

Measuring Food Waste in Prince George Restaurant: Volume, Model, and Effects

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Over 5 years in food service business

- Server: seeing a lot of still edible food going back and thrown away
 - Kitchen: trying to find new menu ideas from food that is usually dumped
 - Management: managing inventory and training staff on how to eliminate food loss
- ⇒ step out the restaurant and do some research on food loss and waste.

Today's Menu

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Food Loss and Waste (FLW) happens everywhere.

- One-third of food is lost or wasted around the world[4].
- Around 1.3 billion tons of FLW is generated annually, and the rate is projected to grow by 44% per year by 2025[2].
- Canada creates about 35 million tons and the largest waste generator per capita in western countries in 2016[9].
- Canada's avoidable FLW is \$49.5 million CAD[3].
- In BC, 40% of the waste to landfills is organic waste, the majority is produced from domestic waste[10].

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Few studies of FLW done on the supply side

- Recent huge discoveries in the food waste research focus on waste generated by households:[1, 7, 11].
- Limited number of studies done on the food supply side.
- Even little estimations of FLW in food service industry.
- E.g. from 1.0% to 15.5% (up to 52% under some conditions) [8].

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Research Questions

- What is the average volume of food that is wasted during processing and consumption in a restaurant?
- What is the extent of food wastage in Japanese restaurants in Prince George?
- What are the main factors contributing to food loss and waste?
- To what extent is a social or environmental impact from food loss and waste generated by a single restaurant?
- What approaches are Japanese restaurant operators taking to reduce food waste generation?

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What is Food Loss and Waste (FLW)?

Definition of FLW (Source [6])

Organization	Definition
Food Loss (FAO)	reduction in weight or quality of food for human consumption
Food Waste (FAO)	edible food discarded following spoilage or after the expiration date
Food Waste (EU)	any food removed from the food supply chain
Food Loss (US/CA) Food Waste (US/CA)	unused product from the food supply chain still edible food scraps at disposal

⇒ No universally accepted definitions of FLW

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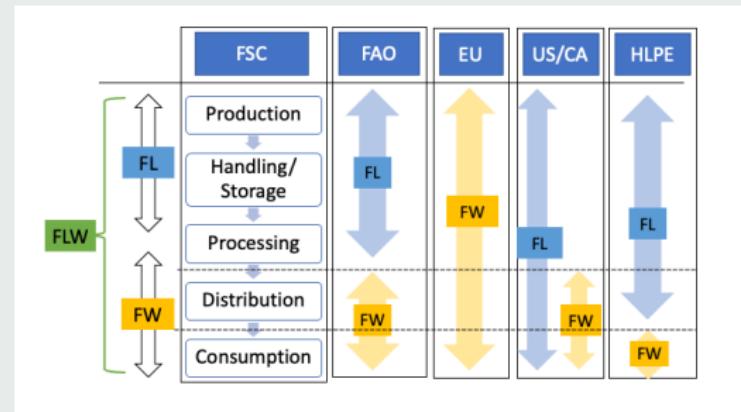
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Dim definition

- Definition of FLW varies among organizations.



General Idea:

- Food Loss \iff Upstream process.
- Food Waste \iff Downstream process.

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Few studies on liquid food waste

Not only Solid but Liquid food

- All these-above defined FLW are solid waste
- e.g. food scraps, peels, or leftovers
- Not only solid but also liquid waste
- Environmental pollutions: soil, water, and air contamination
- Drainage blockages: clog drains and sewage blockages
- Resource Losses: water, energy, land used to produce food

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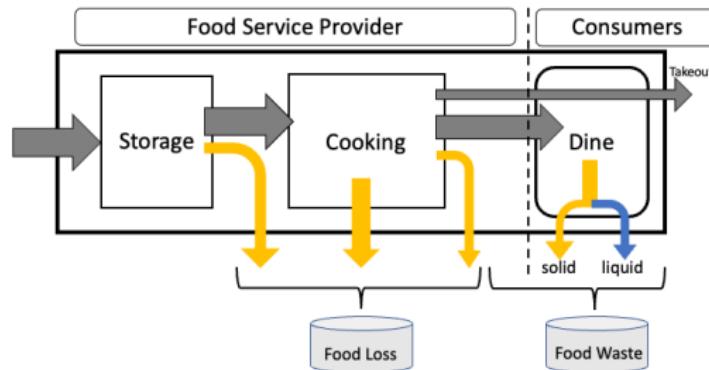
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In this research on a restaurant's FLW:

Definition of FLW in Restaurant

- Food Loss: generated by **provider**
- Food Waste: generated by **consumers**
 - Solid Food Waste: solid portion of food waste
 - Liquid Food Waste: liquid portion of food waste



Literature Review

How to measure FLW?

FLW Measurements used in the past research

Method	Note
1. Self-report	individuals report FLW low-cost but high dropouts
2. Survey	collect FLW by interview or questionnaire cost-effective but not accurate
3. Composition	sample and analysis at lab need special knowledge and equipment
4. Mass balance	material flow analysis limitation in waste factor assumptions
5. Direct weight	directly measure FLW most accurate but high cost

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What is the main factors of FLW?

8 Classifications ([5])

- 1 Society:** culture, awareness and legislation.
- 2 Business model:** a la carte or buffet style.
- 3 Product procurement:** raw or frozen; where to buy.
- 4 Management:** menu development, inventories.
- 5 Professional skills:** untrained mistakes throwing food.
- 6 Diners:** preference, taste or presentation mismatch.
- 7 Competitors:** existence of other restaurants.
- 8 Communication:** with customers and with staff.

⇒ No substantial change during the study period.

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Any other potential factors of FLW?

Other factors

- **Calendar effect:** sales vary between months, day of week, holidays.
- **Weather conditions:** ice cream sells well in summer and not in winter.

⇒ Calendar effect (week of the day) and weather conditions (temperature, humidity, precipitation) may cause FLW?

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How to test associations between FLW and potential factors?

Regression Model and Strategy

$$Y = X\beta + \epsilon$$

- set-up regression model
- test whether true slopes β is zero or not

where,

Y is {daily food waste, liquid waste, solid waste},

X is {temperature, humidity, precipitation, day of week,

#customers, sales, liquors}.

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What is the consequence of FLW?

Effects of FLW

- **Economic Loss:**

- loss of resources: labour, material, time, and energy

- **Environmental Effects:**

- water pollution, deforestation, soil erosion, and GHG

- **Social Impacts:** food insecurity and social inequality

Reducing FLW can mitigate these economic and environmental impacts. Through better supply chain management, reducing consumer food waste, and increasing food recovery.

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Research Goals

- Estimate average FLW
- Any patterns between FLW and business operations
- Any association between FLW and weather conditions
- Estimate economic and environmental impacts

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Which restaurant is to be studied?

Study Area

- **Location:** Japanese restaurant (suburban area of PG)
- **Hours:** lunch and dinner for three hours each
- **Day:** six days of a week (Tue to Sun; Mon closed)
- **Offer:** dine-in & takeouts
- **Items:** sushi & ramen (soup and noodle)
- **Duration:** 6-month (Sept. to Mar.)
- **Permission:** Cooperation; Name disclosure.

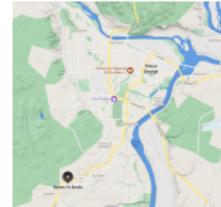


Figure: Research Location Site



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How to capture the FLW?

Collection Apparatus

Bucket for FL



Bucket & Colander for FW



Weight scale (0.05 - 150 kg)



Pen & notebook



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Research Variables

Variables	Note
1.Food Loss	Daily disposed food by kitchen
2.Liquid Food Waste	Daily disposed liquid food by customers
3.Solid Food Waste	Daily disposed solid food by customers
4.# of Customers	Daily number of dine-in customers
5.Sales	Daily sales
6.Liquor	Daily number of liquors sold
7.Orders	Daily number of orders sold
8.Takeouts	Daily number of takeout sold
9.Business	Changes in operations / environment
10.Temperature	Hourly mean temperature each day
11.Humidity	Hourly mean humidity
12.Precipitation	Precipitation
13.Calendar	Week of day

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Multiple Linear Regression (additive) Model

$$Y = X\beta + \epsilon, \quad \epsilon \sim N(0, \sigma_y^2).$$

$$\begin{aligned} food_waste &= \beta_0^1 + \beta_1^1 * temperature + \beta_2^1 * humidity \\ &\quad + \beta_3^1 * precipitation + \beta_4^1 * customer + \beta_5^1 * sales \\ &\quad + \beta_6^1 * liquors + \beta_7^1 * takeouts + \beta_{8,\dots,12}^1 * day + \epsilon^1. \end{aligned}$$

$$\begin{aligned} solid_waste &= \beta_0^2 + \beta_1^2 * temperature + \beta_2^2 * humidity \\ &\quad + \beta_3^2 * precipitation + \beta_4^2 * customer + \beta_5^2 * sales \\ &\quad + \beta_6^2 * liquors + \beta_7^2 * takeouts + \beta_{8,\dots,12}^2 * day + \epsilon^2. \end{aligned}$$

⇒ Check each confidence interval of the coefficients.

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Expected Results

- Estimations of FLW in a restaurant.
- Any patterns / factor of FLW.
- Implications of FLW reduction.

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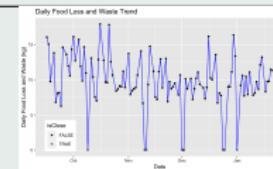
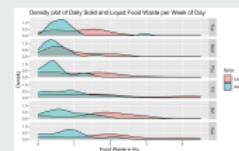
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Current Progress

- From Sept. 16, five months.
- Collected over 140 samples.
- Basic analysis (Histogram, Time series plots)
- Finishing statistical model.

Food Waste per Week of Day Food Loss and Waste Trend



Future Plan

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September 2022 - March 2023: Data collection

1. Mid of March: 150 samples
2. Take photos for presentation

March 2023 - June 2023: Write up of research paper.

1. Research up on potential factors: weather conditions and calendar effects.
2. Finish up descriptive graphs and stat model, and analyze it.
3. Explore consequence of FLW and estimate its effects

June - July 2023: Prepare for thesis defence.

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Thank you for listening to my presentation!
Any questions?

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