Finding an Appetite for Reducing Food Waste:

Determinants of Commercial Food Waste Management and Diversion in Alberta

by

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Abstract

Considerable quantities of food waste have been observed globally and minimizing it has the potential to generate significant reductions in the environmental burden of the agri-food sector. The commercial food sector contributes substantially to food waste generation, so understanding the motivations for reducing food waste in this sector is of importance. Pro-environmental behaviours in businesses, have been shown to be influenced by managers' environmental concern, altruism, incentives, and corporate support. However, other factors that may motivate the adoption of strategies to prevent and divert food waste, such as demographic factors, economic beliefs, and collaborative beliefs, have not been addressed in the literature. The aim of this thesis is to investigate factors that influence commercial food businesses in Alberta to engage with behaviours that can reduce waste, firstly by examining the commercial food waste landscape and determining significant demographic and psychological variables that influence behaviour adoption, and secondly by identifying collaborations and policy options that could support food waste reduction. A questionnaire was used to survey representatives from food establishments in Alberta. Binary, fractional, and ordinal probit models were used to analyze the relative contributions of independent variables. Subjective norms, perceived behavioural control, intention, environmental beliefs, collaborative beliefs, business size, and years of experience increased the probability of adopting certain measures to address food waste. Business location influenced the reported amount of food waste produced and the percent of food waste sent to landfill, with businesses in Calgary tending to report the lowest rates. Stronger economic beliefs positively influenced the percent of food waste sent to landfill. Respondents seemed sensitive to financial considerations, showing a low willingness to pay for waste diversion services and perceiving monetary incentives as the most effective instrument to reduce food waste compared to recognition, collaboration, and information provision. There is an opportunity for improvement when it comes to preventing and diverting waste in Alberta. A high level of awareness of waste and a large percentage of respondents being interested in diversion methods indicates that businesses would likely be interested in these solutions if they become available, as long as they are considered cost-effective. This work hopes to contribute to pro-environmental literature and knowledge for policy and industry.

Preface

This thesis is an original work by Farrah Wei Yen So. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "Food Businesses Preferences for Operational Improvements," ID. Pro00110760, 6/14/2021.

Dr. John Wolodko is a supervisory author and was involved with concept formation and manuscript composition. Dr. Sven Anders is a supervisory author and was involved with concept formation, survey design, advising on data analysis, and manuscript composition.

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List of Abbreviations

FAO = Food and Agriculture Organization

FW = Food Waste

ECCC = Environment Climate Change Canada

FUSIONS = Food Use for Social Innovation by Optimising Waste Prevention Strategies

FWRA = Food Waste Reduction Alliance

ICI = Industrial, Commercial, and Institutional

MOA = Motivation, Opportunity, Ability framework

MSI = Multi-Stakeholder Initiative

TPB = Theory of Planned Behaviour

UNEP = United Nations Environmental Programme

VCMI = Value Chain Management International

Chapter 1 – Background

Reducing food waste is a pressing challenge in the global effort toward sustainable development. The importance of food availability and access for global health and security cannot be overstated; at the same time, land, energy, and water resources are used to grow, harvest, transport, and process food that is never eaten. In addition to representing an unnecessary consumption of resources, food waste is often disposed of in landfills, where it generates methane, a greenhouse gas (Thyberg & Tonjes, 2016) (Adhikari et al., 2006). Estimations of the amount of food waste generated and its impacts have propelled the issue into public consciousness. The Food and Agriculture Organization (FAO) has reported that roughly one-third of all the food produced for human consumption is not consumed yearly and that food waste is estimated to contribute to 8 to 10 percent of global greenhouse gas emissions (Gustavsson et al., 2011) (UNEP, 2021). It was even said that if greenhouse gas emissions of food loss and waste were compared to that of countries, it would be the third-largest emitter after China and the United States (FAO, 2017). The environmental impact of food waste also includes the consumption of resources to produce food, which is significant given the scale of the agri-food sector. Agricultural land makes up 38 percent of the global land surface, and agricultural irrigation accounts for 70 percent of worldwide freshwater withdrawals (FAO, 2017) (FAO, 2020). Reducing food waste is an opportunity to improve the environmental sustainability and resource efficiency of the agri-food sector.

This section will provide context on the issue of commercial food waste in Alberta by discussing definitions for food waste, its occurrence in the region, the food business and waste policy landscape in Alberta, solutions to mitigate food waste, and context for the scope of this study. Finally, the study's objectives, research questions, and contribution will be presented.

1.1 Defining Food Waste

Definitions for food waste are inconsistent between the groups working to mitigate it. Appendix Table A1 presents definitions from a few notable organizations. These variations make it challenging to quantify food waste, approach discussions on the issue, and address solutions. Three influential organizations that work towards food waste reduction are the United Nations Environmental Programme (UNEP), the Food and Agriculture Organization (FAO), and FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies). These organizations characterize food waste differently based on edibility, value chain stages, and end-use.

According to the UNEP, "food waste" is defined as "food (including drink) and associated inedible parts removed from the human supply chain…" occurring at the manufacturing, retail, food service, or household stages (UNEP, 2021). Instead of being consumed or recycled, food waste is destined for landfill, combustion, sewer, anaerobic/aerobic digestion, co-digestion, compost, or land application (UNEP, 2021). UNEP also has a definition for "food loss," which applies to levels of the value chain before retail. The FAO (2019) definition does not include inedible parts of food, such as bones, cooking oil, and peels, while the UNEP and FUSIONS definitions do. FUSIONS is a group based out of the EU focused on food waste reduction. It does not have a definition for "food loss"; instead, its definition of food waste extends across the supply chain and includes food and inedible parts of food, such as crops that are not harvested (FUSIONS, n.d.). Gustavsson et al. (2011) describe food waste as food that cannot fulfill its original objective of being sold to or consumed by humans. Food waste in this study is thought of similarly as food going from the human supply chain to being disposed of or used as a feedstock for another supply chain. This conceptualization is appropriate for this study as it covers edible and inedible food and includes all commercial food businesses (i.e. food manufacturers, retailers and food service establishments).

1.2 Estimations of Food Waste in Canada and Alberta

Since this study will be focused on a region in Canada, the extent of food waste produced in the country and its impacts should be addressed. In Canada, it is estimated that more than 11 million tonnes of edible food are thrown away every year, which makes up 20% of the food produced in Canada, and is valued at almost $50 billion (VCMI, 2019). Value Chain Management International (VCMI) reported that in Canada, around 68% of avoidable (edible) food loss and waste (by volume) occurred in the processing, retail, hotel, restaurant, and institution sectors, while 21.3% occurred in households (VCMI, 2019). In the region of interest, Alberta, food was the largest contributor to municipal solid waste compared to all other categories, composing 26.4% of waste (Environment Climate Change Canada, 2020). Of the 1.11 million tonnes of food waste disposed of in the province in 2016, two-thirds were produced by the Industrial, Institution, and Commercial (ICI) sector (ECCC, 2020). Thus, addressing waste produced by the industrial, commercial, and institutional sector is necessary to reduce food waste significantly. These types of insights are important results of quantifying food waste; however, quantifying food waste is a challenging endeavour. Although this topic is not of focus for this thesis, additional information about food waste quantification is presented in Appendix A. The types of food waste (for example, plate waste, imperfect produce, or consumer packaged goods) produced and how they are managed can vary based on the types of businesses present and regional waste management services and policies. Thus, understanding the business and policy landscape where food waste is produced is critical to address why food waste occurs and how it could be managed better.

1.3 Food Business and Waste Policy Landscape in Alberta, Canada

This section provides background on the state of food businesses and organic waste management in Alberta. Statistics on the number, type, and size of businesses that produce and sell food in the province are presented in Table 1, based on industry statistics from Statistics Canada (2021). There are over 10,000 establishments in the province involved in food retail, manufacturing, and food service. The small business size category (between 5-99 employees) makes up the majority of establishments (71.8%),

followed by the micro-size category (1-4 employees) (24.7%). The most common establishment type is full-service restaurants (71.44%), followed by grocery stores (15.1%).

The two largest cities in Alberta, Edmonton and Calgary, have different bylaws and services for managing organic waste, presenting an interesting case study. Calgary also has a bylaw for food and yard waste, which began in 2017, requiring businesses and organizations to separate organic waste from garbage. The City of Edmonton has an organic waste separation program for households but not for businesses. Municipal waste management run by the City of Edmonton stopped offering commercial collection services in 2019, while Calgary still does. No peer-reviewed journal articles on food waste in Alberta (household or commercial) were found; however, two reports that would be considered grey literature were found. "Food Waste Study" was written by Ian Murray & Company Ltd. (IMC) in 2017 for Alberta Agriculture and Forestry. IMC (2017). It notes several challenges for diverting waste from landfills: A lack of infrastructure and existing options, lack of regulation and investment in research, inadequate data which impacts the certainty of policy development, low priority, and competition with other issues such as food safety. Another report was "An Organic Waste Inventory for Alberta's Agrifood Sector', written by Jeff Bell and several other contributors in 2015 in partnership with Alberta Innovates and the Alberta Livestock and Meat Agency. By extrapolating data collected from food processors, it was estimated that this group produced over 500 thousand tonnes of organic waste yearly (Bell, 2015). Waste management costs ranged depending on the quantities of waste. Those who produced small amounts of waste paid a few dollars a month, and those with very large amounts (typically homogeneous in type) paid hundreds of thousands of dollars for disposal (Bell, 2015). Most grocers utilized third-party haulers to dispose of waste, most of which was sent to landfills. Finally, larger organizations typically had dedicated staff for waste reduction issues (Bell, 2015).

Table 1. Food Businesses by Type and Size Category in Alberta, Canada

Establishment Type (NAICS Code)	Employers		Employment Size Category (Number of Employees)			
	Total Employers	% of Total	Micro (1-4)	Small (5-99)	Medium (100-499)	Large (500+)
Full-service restaurants and limited-service eating places (code 7225)	7,526	71.4%	1,598	58.38	88	2
Grocery stores (code 4451)	1,589	15.1%	472	923	193	1
Specialty food stores (code 4452)	588	5.6%	227	360	1	0
Food manufacturing (not including animal feed) (code 311, excluding code 3111)	502	4.8%	133	328	37	4
Caterers, mobile food services and food service contractors (code 7223)	329	3.1%	168	153	7	1
Total	**10,534**		**2,598**	**7,602**	**326**	**8**
% of Total			**24.7%**	**72.2%**	**3.1%**	**0.1%**

Adapted from Statistics Canada (2021)

1.4 Framing Food Waste Reduction Solutions with the Food Recovery Hierarchy

Measures to curtail rates of FW are of immediate importance due to the environmental, social, and economic costs of FW. They can be categorized as prevention or diversion measures. Ideally, preventable waste can all be reduced or avoided, while non-preventable waste can be diverted (Morone et al., 2019). In this study, diversion is seen as utilizing food waste as a feedstock for another product, thereby directing it away from landfill disposal. One framework for understanding which food waste prevention and diversion options should be prioritized is the Food Recovery Hierarchy.

The Food Recovery Hierarchy outlines options to manage food waste based on how the option benefits the environment, society and the economy (Environmental Protection Agency). It is a tool that policymakers have used to prioritize waste reduction and management programs. From "most preferred"

to "least preferred," the order of the options is as follows: Source reduction, feed hungry people, feed animals, industrial uses, composting, landfill/incineration. Several authors have expanded on this framework to categorize types of food waste and its optimal food recovery strategy. Garcia-Garcia et al. (2017) mapped the pathways for ideal food waste management and assigned a set of hierarchy options based on nine characteristics of food: edibility, state, origin, complexity, animal product presence, treatment, packaging, packaging biodegradability, and stage of the supply chain. Teigiserova et al. (2020) looked at how the waste hierarchy could be used based on three categories of food: consumed food which is accessed through primary markets, surplus edible food that re-enters the supply chain for human consumption, and food waste, including naturally inedible materials, food scraps, residues from processing, and surplus food that has become inedible due to poor management. Notably, materials that are naturally inedible or become inedible cannot be redistributed for human consumption but could be processed and recycled into other materials. Figure 1 presents the hierarchy and each prevention and diversion method.

Reduce the amount of surplus food generated — **Prevention**

Rescue, resell, redistribute, or repurpose surplus food — **Reuse - Human Consumption**

Reprocess and add to animal feed — **Reuse - Animal Feed**

Recover and use some of the value inherent to the material — **Material Recycling**

Degradation of material value from anaerobic digestion, compost, land application — **Nutrient Recovery**

Degradation of material value to produce biofuels or incineration with energy recovery — **Energy Recovery**

Incinerate or landfill without energy recovery — **Disposal**

Figure 1. Expanded Food Recovery Hierarchy Framework

Adapted from Teigiserova et al. (2020)

Redlingshöfer et al. (2020) conducted a systematic literature review that found 22 studies, including 11 Life Cycle Assessments, confirming that the food recovery hierarchy is typically consistent with greenhouse gas emission (GHG) intensity. Aside from GHG emissions, other environmental impacts may be present. Anaerobic digestion may impact human health if there is metal contamination, and incineration treatment requires water (San Martin et al., 2016). Some authors have suggested that policy has not been aligned with the hierarchy and has promoted "less preferred" options as opposed to preventative measures, which are the priority (Giordano et al., 2020) (Mourad, 2014). Additionally, recycling is said to compete with prevention in some cases (Redlingshöfer et al., 2020). Thus, policymakers are cautioned against making options lower in the hierarchy more financially attractive (Redlingshöfer et al., 2020). Although the hierarchy appears correct based on environmental impacts, less

evidence is available for the social and economic implications of the options, and these three values (environmental, social, and economic) may compete (Mourad, 2014). Each option in the hierarchy will be described to understand what it entails as a potential solution to reduce food waste.

1.4.1 Prevention

Reducing the amount of surplus food and food waste at the source is the most preferred option. Prevention takes the pressure off channels that divert and dispose of waste and reduces the costs associated with operating and accessing these services (Goodman-Smith et al., 2020). Mourad (2016) and Diaz-Ruiz et al. (2019) have distinguished prevention measures as "strong" or "weak" prevention and advocate for the adoption of "strong prevention." "Strong prevention" attempts to address the root causes of food waste and achieve a long-term, systemic transformation of food systems (Mourad, 2016). In contrast, "weak prevention" focuses on minor improvements and optimizations (Mourad, 2016). Strong prevention measures might include the integration of imperfect products as typical product offerings, changing best-before-date labels, changing consumer habits and awareness to develop a new appreciation for food, and reviewing food safety regulations that discourage the consumption and donation of edible food (Morone et al., 2019) (Diaz-Ruiz et al., 2019). In some respects, "weak prevention" solutions may seem more appealing than "strong" ones, considering that they do not require major shifts in economic and governance dynamics and, therefore, may be easier to reach a consensus on (Mourad, 2016) (Diaz-Ruiz et al., 2019). Measures such as increasing food shelf life with new packaging technologies or improving stock management could be considered "weak" forms of prevention (Morone et al., 2019).

Three categories of prevention measures for food businesses are awareness, technology, and business models. Examples of measures in each of these categories are presented in Table 2. Improving awareness through information provision can improve a business's skills and knowledge towards FW reduction and can come in many forms. Working with consultants may support businesses in identifying areas for operational improvements that prevent food surplus and waste. Campbell Company of Canada partnered with Provision Coalition (now acquired by Anthesis to become Anthesis Coalition) to identify

four high-potential areas that would reduce product losses in the Toronto facility: push product at the end of production runs, manually sort vegetables, reduce the speed of the optical sorter for vegetables, and redesigning the mechanisms that prefill cans. These four areas had the potential to increase yields by 938 tonnes per year, and the resulting gain in the product was valued at $706,000. Technological solutions are emerging to help reduce major causes of food waste in the commercial sector (and will be discussed further in section 1.5.3). Examples include technologies that extend the shelf-life of products that easily spoil, software and hardware to measure waste, dynamic price tags, and software that optimizes inventory management and forecasting with AI. Business model changes have created markets for imperfect produce, leftovers, and products getting close to best-before-dates.

Food resale and repurposing is another preventative strategy that allows surplus food to be sold on a secondary market or processed into another product (Garrone et al., 2016). Suboptimal products can be sold at a discount that accounts for aesthetic, quality, or shelf-life differences compared to their conventional counterparts (Garrone et al., 2016). One example of this is the sale of discounted imperfect fruits and vegetables, like the "naturally imperfect" range from the No Name brand of Loblaw Companies, which operates several supermarket chains in Canada. Another example is Flashfood, a service that partners with Loblaw Companies to discount items approaching their sell-by date and promote them through an app. Unsold food can be used for marketing purposes like product tastings or internally, such as when an organization provides a "free to take" area (Garrone et al., 2016). Food repurposing utilizes surplus food to create another product, sometimes with a higher price. For example, croutons can be made from stale bread, and fruit past its prime in the produce section can be trimmed, cut, portioned and packaged to be sold as a convenient product (Van Bemmel & Parizeau, 2020). For manufacturers, rework is a practice that involves incorporating trimmings of a product that has a specific shape into the production of subsequent batches, thus reducing waste and the number of inputs needed (Tavill, 2020). If a production error occurs, remanufacturing and repackaging could be conducted, although it may require an additional cost (Garrone et al., 2016). If prevention cannot be achieved, then

there are also ways to manage food surplus and waste that minimize its economic and environmental impacts and raise its social impacts, which will be examined in the rest of section 1.4.

Table 2. Examples of Measures to Prevent Food Waste

Category	Examples of Measures to Prevent Food Waste
Awareness	● Work with a consultancy (e.g. Provision Coalition) ● Information provision ● Invest in employee training ● Measure waste (e.g. Winnow Solutions)
Technology	● Extend shelf-life (e.g. Apeel) ● Dynamic pricing (e.g. Wasteless) ● Inventory management and forecasting (e.g. Spoiler Alert, Afresh, Fresh4Cast)
Business Models	● New product Lines (e.g. "Naturally Imperfect") ● Specialty Retailers (e.g. Misfit Market) ● Discounts (e.g. Flashfood) ● Sell extra food (e.g. Too Good To Go)

1.4.2 Re-use for Human Consumption - Food Rescue, Redistribution and Social Implications

Rescuing, redistributing, or donating food are ways that food surpluses can be managed so that they do not become food waste. Surplus food can be "rescued" by giving it at no cost to non-profit food aid organizations such as food banks and service agencies that support people in need (Garrone et al., 2016). Manufacturers, retailers, and restaurants often donate items such as day-old baked goods that will not be sold or served, "imperfect" fruits and vegetables, products that marginally fail quality control, and products past or coming close to a sell-by or best-before date. To reduce the risk to donators that would

impede donation, policies have been enacted to protect parties from the potential liability of donation. Nevertheless, many establishments may still act with caution or view donation as risky (Goodman-Smith et al., 2020). Training staff on donation procedures has been recommended to increase the utilization of food rescue options (Dhir et al., 2020). Alternative models for donation that reduce the burden on charitable organizations have also been suggested, such as one that requires businesses who regularly donate to pay a membership fee.

Reducing food waste has been suggested to act on food security by increasing the quantity of food available and achieving price reductions (Thyberg et al., 2016) (de Gorter et al., 2020). Donations and food aid can directly support food insecure individuals; however, organizations that aim to reduce food insecurity face challenges (Lee et al., 2017). Donated food may not be in edible condition or quality and may not support the nutritional needs of the vulnerable populations who access the services of these organizations (Millar et al., 2020). Organizations that prepare cooked foods may not be able to rely on consistent amounts of food, and large influxes of rescued food may burden organizations with limited transportation, storage infrastructure, and volunteer resources (Millar et al., 2020). Even more importantly, redistributing surplus food as food aid is not a long-term solution for individuals who are food insecure, as food insecurity is an issue of income and not food availability (Tarasuk et al., 2005). As a result, redirecting surplus food to service agencies may be seen as improving food access to some degree, but its contributions to food dignity and food insecurity are limited.

1.4.3 Re-use for Animal Feed

For suitable products (i.e. non-meat), food surpluses and waste can often be given or sold to companies that produce animal feed (Garrone et al., 2016). In South Korea, feed manufacturers convert municipal food waste into dry feed (Salemdeeb et al., 2017). It is processed through multiple stages: shredding, filtering, sterilizing, and drying (Salemdeeb et al., 2017). In the European Union, the LIFE-F4F (Food for Feed) project is piloting a process that pasteurizes and dries hotel food waste using solar energy (European Commission, 2021). Co-products from food processing, such as soybean meal, are

already common feed ingredients (Salemdeeb et al., 2017). Many bioactive compounds found in food loss and food waste are beneficial for animal diets and may even be incorporated into feed to produce value-added animal products (Georganas et al., 2020). There are many considerations regarding how food waste is processed for feed application and if it is appropriate. Regional or even source-specific nutritional composition studies that look at amino acid profiles, minerals, fatty acids, and vitamins are necessary to determine if feed application is appropriate (Georganas et al., 2020). Bans and limitations exist for converting waste into animal feed (e.g. in the UK and EU) based on food safety concerns, such as preventing outbreaks that have been traced back to feeding untreated food waste to animals (Georganas et al., 2020). Heat treatment is, therefore, a critical processing step of food waste fed to animals to reduce the risk of disease transmission, and several countries that permit this practice have requirements for the temperature and duration of heat treatment (e.g. US and Japan) (Georganas et al., 2020). Fresh fruits and vegetables that are commonly wasted foods have high water content and require drying to reduce water activity and remain stable for feed application (San Martin et al., 2016). There may also be undesirable substances present in food waste that have maximum legal limits (such as in the EU), including nitrites (present at high levels in coffee and wine by-products), mycotoxins, pesticides, pathogenic bacteria, and mold (San Martin et al., 2016).

1.4.4 Material Recycling

Food that would typically be wasted can be transformed into valuable products. In the context of food, this is referred to as valorization. Existing or novel processing technologies repurpose by-products and suboptimal quality products into new, higher-value materials and foods. Well-known examples of valorizing by-products include taking whey from the cheese-making process and turning it into whey protein powder. Another is the sale of wheat and rice bran from cereal milling. If processors cannot convert their by-products, partnerships could be made with companies that purchase the by-product material. Examples of applications are presented in Table 3.

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Table 3. Applications of Processing By-products

	Produce	Meat	Dairy	Cereals
Processing Step	Peeling, Separation	Bleeding, deboning, deskinning, fat removal, evisceration,	Cream separation, Butter and cheese manufacturing	Milling
By-products	Pomace, trimmings, peels	Blood, skin, fat, bone, viscera, hide, hair	Skim milk, buttermilk, whey	Bran, straw, husk, hull
Applications	Thickening agents, citric acid, aroma compounds, fibre, antioxidants	Gelatin, collagen, oils as natural preservatives (e.g. conjugated linoleic acid), Vitamin B12	Buttermilk, dried milk powders, whey and casein protein, cottage and whey cheeses	Bran oil, dietary fibre, beta-glucan

Adapted from Chandrasekaran (2012)

This section has addressed the most preferred methods available to mitigate the impacts of food waste: prevention, re-use for human consumption, re-use for animal feed, and material recycling. Even if these options exist, many businesses may need to be informed or incentivized to take them on. Policy, collaboration, and technology are a few of the routes available to increase the availability and uptake of these options and diminish the effects of the determinants of FW.

1.5 Policy, Collaboration, and Technology and the Motivation, Ability, Opportunity Framework

The Motivation, Opportunity, Ability framework (MOA) is a model used to understand the decision process for pro-environmental action. It has been used to study food waste from consumers and supply chain actors through interviews and focus groups and tends to be evaluated qualitatively (Soma et al., 2021) (Hooge et al., 2018). It has also been used to develop interventions for consumer food waste (Soma et al., 2021). The three determinants of this model are motivation, which is values, beliefs and attitudes; opportunity, which pertains to situational conditions like structures and systems; and abilities, which are habits, skills, and task knowledge (Ölander and Thøgersen, 1995) (Soma et al., 2021). These factors describe how policy, collaborations, and technology may overcome a gap between intention and action.

1.5.1 Public Policy to Reduce Food Waste

Acknowledging the impacts of food waste on climate change and environmental degradation, international organizations and policymakers have taken steps to understand and address the issue. Target 12.3 of the United Nations' Sustainable Development goals aims to "halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest processes" (FAO, 2015). Several countries and levels of government have similarly adopted food waste reduction goals and introduced policies to support them. A couple of examples include corporate tax reductions in France, Hungary, and Turkey, based on amounts of donated food, and the launch of a $20 million challenge by the Canadian federal government to fund innovations in technology and business models to reduce food waste (EU FUSIONS, 2016) (Government of Canada, 2020). Existing policies around food often indirectly influence amounts of food waste without that outcome in mind. Interventions that impact one level of the food value chain can also have implications for the rest of the chain (de Gorter et al., 2021). Policies that impact food production, food prices, and waste management can have an indirect (and possibly unintentional) effect on food waste generation (de Gorter et al., 2021).

Public policy instruments can affect motivation, opportunities, and ability through changing values, skills, and logistics (Thyberg and Tonjes, 2016). Awareness campaigns influence values which motivate waste prevention and propagate information about skills that can enable desired behaviours. This type of campaign has some evidence of impacting consumer food waste in the short term (Reynolds et al., 2019) (Chinie et al., 2021). Campaigns could be targeted toward the commercial sector to publicize the moral and environmental issues and potential economic advantages and make businesses aware of their options regarding donations and other services (Thyberg and Tonjes, 2016) (Bhattacharya and Fayezi, 2021). Skills-based campaigns are delivered similarly but focus on how food can be better managed, for example, by training/re-training staff on donation procedures (Thyberg and Tonjes, 2016) (Diaz-Ruiz et al., 2019). Abilities and motivations may not lead to action without situational conditions allowing them to be expressed. Policies may create these opportunities. Fiscal instruments such as taxes, fees, grants, and

subsidies, can also influence options and costs for waste treatment, encourage donation, encourage conversion of food waste to animal feed, and support research and development (Thyberg and Tonjes, 2016). Regulatory measures can mandate source separation, reporting of food waste audits, changes to date labelling, and compulsory food donation (Bhattacharya and Fayezi, 2021) (Diaz-Ruiz et al., 2019). Finally, policies that address logistics can promote, incentivize, and facilitate connections that enable more preferred options in the food recovery hierarchy, such as donation or conversion to animal feed (Thyberg and Tonjes, 2016). These kinds of opportunities can be promoted by policy but are typically accessed through partnerships.

Public policy is one route to encourage the uptake and development of prevention and diversion measures (as addressed in section 1.4.1). However, policymakers may be hesitant to make recommendations until there is clear evidence as to the expected outcomes of a policy instrument. Legislation that induces corporate action toward reducing food waste is scarce (de los Mozos et al., 2020). The development of policies might be encouraged if the expected effects and uptake of certain instruments were studied further.

1.5.2 Collaboration to Reduce Food Waste

Collaboration is a key success factor in several initiatives that can reduce food waste by providing opportunities, competencies and incentives (Aschemann-Witzel et al., 2017). Several actions to mitigate food waste require collaborations, such as formal or informal partnerships to rescue, resell, and repurpose surplus food and food waste. These partnerships create opportunities for options higher in the food recovery hierarchy to become accessible, especially for smaller businesses that do not have the capacity to establish waste management systems internally. Collaborative action may occur internally within the business or externally with other organizations. Collaboration may entail an exchange of services or involve discourse and alignment to progress towards a collective goal.

Partnerships can be found across the food recovery hierarchy. At the prevention level, businesses can seek advice from experts and consultants (e.g. Anthesis Coalition in Canada) to identify key areas of

food waste production and devise reduction strategies. To redistribute food, food rescue organizations (e.g. Leftovers Foundation and Second Harvest) can support the logistics necessary to get surplus food to service agencies, or businesses can work directly with a local food bank or service agency. The necessary processing of most food waste to be included in animal feed means that businesses typically work with other organizations to do so (e.g. Loop Resources) unless they are vertically integrated enough to operate these services. Material recycling can also be achieved through in-house production or vertical integration, but for businesses without that capacity, other businesses specializing in processing by-products can be partnered with (e.g. Renewal Mill, Outcast Foods).

Knowledge sharing among actors is one way to reduce the miscommunication and incoordination often seen as a driver of food loss and food waste production (Halloran et al., 2014). Food value chains often have complex stakeholder relationships that can be a barrier to reducing food waste (and will be discussed in section 2.1.4). Thus, a concerted approach to reducing food waste may be necessary to produce harmonized solutions across supply chain stages (Bhattacharya and Fayezi, 2021). One type of collaboration seeking to achieve this are Multi-Stakeholder Initiatives (MSI). They represent one type of formal knowledge sharing and partnership and can tackle complex problems that may require systemic change or create conflict between stakeholders (Matzembacher et al., 2021). MSIs can address various issues in this space: preparing policy or regulations, increasing materials efficiency, developing new markets, management practices, capacity building, food redistribution, and research (Matzembacher et al., 2021). In the area of food waste reduction, a notable example is the Food Waste Reduction Alliance (FWRA), an initiative led by the industry groups: Consumer Brands Association, The Food Industry Association, the National Restaurant Association, and businesses from these industry groups. FWRA seeks to reduce food waste, donate surplus food, and recycle food waste. So far, they have sought to measure food waste, identify and share best practices, and advocate for policies (FWRA, n.d.).

1.5.3 Technological Solutions to Reduce Food Waste

Technological advancements increase the ability of food businesses to reduce waste by optimizing food resource use and even remedying systemic causes of food waste. In the commercial sector, many technologies could potentially reduce waste, including those that prolong shelf-life, improve information on the state of food, improve forecasting, enable food redistribution, measure waste, and reduce human error. Some technologies developed to improve food safety have the dual purpose of reducing waste. Active packaging systems modify a food's environment and can prolong shelf life, while intelligent packaging displays food quality changes and provides insights into how food should be managed (Yucel, 2016). Commercial refrigeration appliances have been developed to be controlled by "smart devices" and have alarms to notify users of power supply faults or food expiration; others can track freshness and inventory, and some even come equipped with cameras to recognize food through image search or barcodes (Bonaccorsi et al., 2017).

Some evidence suggests that undergoing food waste measurement can reduce waste for hospitality establishments, especially if a large amount of waste is produced (Eriksson et al., 2019). Companies like eSmiley, Matomatic, Visma, and Winnow automate data collection and reporting by using a touchscreen connected to a heavy-duty scale to record categories of food waste (Eriksson et al., 2019). Semi-automatic tools such as websites or mobile applications facilitate data entry but require weight to be manually entered (Eriksson et al., 2019). Existing processing techniques that prolong the shelf life of products, such as freezing and canning, can reduce the likelihood of products being wasted (Martindale & Schiebel, 2017). Packaging innovations serve the same purpose (Raak et al., 2017). Data can help determine how to optimally price products as they become closer to their best-before dates. This concept has been implemented through an Internet of Things-enabled price tag that displays dynamic pricing (Kayikci et al., 2022). Although many technologies have been in development, there may be challenges to implementation, such as a perceived lack of market opportunity or cost barriers (Simms et al., 2020).

1.6 Motivating Pro-Environmental Behaviour

Is it expected that business owners and managers value and make business decisions based on economic outcomes. However, values and other psychological factors may motivate decisions that are seen as pro-environmental or pro-social, especially if the behaviour is perceived to come at an economical cost to the business. Encouraging a greater number of people and businesses to undertake behaviours that are good for the environment is imperative to mitigating the negative environmental impacts of human activity. Thus, there has been a breadth of research on understanding motivations for pro-environmental behaviour. One body of work has focused on the application and effects of external motivators such as monetary and regulatory public policy. Another, from behavioural science and psychological research, looks to understand intrinsic motivators of pro-environmental behaviour. Van der Linden (2015) argues that understanding intrinsic motivators for pro-environmental behaviours is critical, as they have the potential to sustain motivations for behaviour in a way that extrinsic incentives do not. Some authors suggest that extrinsic incentives may even undermine the effect of intrinsic motivation, known as a "crowding out" effect (Cecere et al., 2014) (Graafland and Bovenberg, 2019) (Van der Linden, 2015). This phenomenon suggests that if financial incentives are created, then cancelled, pro-environmental practices may also cease (Bopp et al., 2019). It also suggests that reinforcing intrinsic motivators is preferable to providing incentives and information focused on monetary gains. Although external motivators may be ineffective or potentially detrimental for those who already have strong intrinsic motivations, those who do not may depend on external motivations to undertake a new behaviour (Bopp et al., 2019).

1.7 Theory of Planned Behaviour

Graham-Rowe et al. (2015) state that investigations into the determinants of behaviour should be based on a theoretical framework from which to identify causal processes and subsequently guide intervention development. The Theory of Planned Behaviour is a popular and well-established framework used in pro-environmental behaviour literature to predict behaviour using internal motivators, namely,

psychological factors (Mak et al., 2020). It was published in 1985 by social psychologist Icek Ajzen and it has been used in several studies looking at both household and commercial food waste (Coşkun et al., 2020) (Mak et al., 2020). It uses two dimensions of behavioural prediction, motivation and ability, to propose that behaviour is predicted by intention and that intention is a function of attitude, subjective norm, and perceived behavioural control (Ajzen, 1991). "Attitude" refers to the "degree to which a person has a favourable or unfavourable evaluation" of the behaviour, "subjective norm" refers to the "perceived social pressure to perform or not to perform the behaviour," and "perceived behavioural control" refers to the "perceived ease or difficulty of performing the behaviour" (Ajzen, 1991). Although TPB is a well-established framework, it does have its limitations.

Depending on the behaviour, the relative contributions of each of the TPB constructs can vary (Ajzen, 1991). It has been noted that perceived behavioural control and actual control are different, and depend on whether a person can freely decide to perform a behaviour, rather than that behaviour being dependent on external factors such as opportunities and resources (Ajzen, 1991). The difference observed between intention and behaviour has become known as the "intention-behaviour gap." For many pro-environmental behaviours, knowing the negative consequences of a behaviour does not shift intention or actual behaviour (Van Geffen et al. 2020). Instead, they may be hindered in their efforts, not by insufficient motivation but by external circumstances (Van Geffen et al. 2020). To account for other variables that influence behaviours, such as non-psychological factors, an "extended" theory of planned behaviour can be constructed. Additional variables used in extended models of food waste have included the additional factors of environmental beliefs, incentives, and price consciousness (Mak et al., 2020) (Coşkun et al., 2020).

1.8 Objective, Research Questions, and Contribution

The aim of this thesis is to investigate factors that influence commercial food businesses in Alberta to engage with behaviours that can reduce waste. It will be accomplished by firstly determining the commercial food waste landscape in Alberta, including perspectives on food waste, causes, diversion methods used, and how much is sent to landfill. Intentions and behaviours to reduce food waste will be tested against factors that potentially influence them. Secondly, collaborations and policy options to support food waste reduction will be identified. The research questions for this study are framed around four priorities in the space of reducing food waste: increasing intention to reduce food waste, increasing the use of options that better utilize food waste, decreasing the amount of food waste sent to landfill, and creating effective public policies, programs, and services to support food waste reduction. The desired outcome is to generate findings that will be insightful for policymakers and industry. Based on this scope, the following research questions and sub-questions were devised:

1. What demographic and psychological factors influence the intention to reduce food waste?

    a. Which factors influence if food waste is measured?

    b. Which factors influence if managers encourage employees to reduce waste?

    c. Are managers of food businesses aware of food waste causes?

        i. What causes of food waste are of most concern?

2. Which options for diverting food waste have been adopted or are of interest?

    a. Which factors influence the adoption of diversion methods?

    b. What barriers exist towards engaging in donation?

        i. Do they affect the decision to adopt donation?

3. Which factors influence the amount of food waste being sent to landfill?

4. How are new systems and programs to reduce waste perceived?

    a. If new services become available, such as technology to manage waste internally or services that divert waste, what are the cost savings expected or willingness to pay?

b. As evaluated by food business managers, how effective are features of potential programs to reduce food waste?

This study expands on existing work on commercial food waste in four ways. Firstly, it addresses the state of several food waste management behaviours, collaborations and diversions in the context of food businesses in Alberta, Canada. Since no studies published in academic journals on commercial food waste in Canada were found, this study hopes to fill that gap. Second, it studies the influence of economic, collaborative, and environmental beliefs on food waste management behaviours by extending the theory of planned behaviour. Food redistribution and waste diversion are pro-social and pro-environmental behaviours; however, the values that potentially motivate these behaviours have not been captured in current models (Vlaholias et al.,2015). Unique factors, such as economic, social, and environmental beliefs that managers have or constitute how food businesses "self-represent," can be assessed to understand whether these beliefs drive food waste reduction behaviours (Vlaholias et al., 2015). Third, this study investigates many behaviours that have not yet been tested against the Theory of Planned Behaviour, including the encouragement by managers to reduce waste, measurement of food waste, and collaborations to redirect waste. Finally, many potential actions to mitigate food waste have been proposed in the literature. Gathering the initial impressions of food businesses on potential programs will hopefully provide insight into which options should be explored further and how future investigations could be conducted.

Chapter 2 – Literature Review

Literature on food waste spans the numerous disciplines that examine food systems and waste management. Food waste generation and prevention are hot topics in the study of agri-food supply chain research (Barbosa, 2021), and interest from the academic community in tackling the food waste issue is apparent from the growth in annual publications in recent years, from 7 in 1991 to 505 in 2015 (Zhang et al., 2018). However, few publications have emerged from Canada, despite high rates of food waste (Yetkin Özbük and Coşkun, 2020). This review begins by examining the causes of food waste at the levels of the food value chain of interest: processors/manufacturers, hospitality/food service, and retail. A limited number of published peer-reviewed studies have evaluated food waste diversion in commercial food businesses. Consequently, a broader scope of literature will be reviewed to provide greater context for this study. Three other scopes will be reviewed: the application of TPB for consumer food waste, corporate pro-environmental behaviour, and intrinsic motivations of farmers.

2.1 Causes of Food Waste in Food Processing, Hospitality, and Retail

The occurrence of food waste can be traced to numerous factors, endogenous and exogenous, of the food industry and consumers. Thyberg and Tonjes (2016) summarize the historical perspectives of food waste in the U.S. and how modernization and dietary transitions affected food systems. Since the preindustrial period, food waste has constituted a significant proportion of household waste and has been fed to animals (Thyberg and Tonjes, 2016). Post World War II saw a reduction in food prices, a culture of abundance, and policies prohibiting using raw garbage as animal feed. Industrialization, economic growth, and urbanization lead to greater abundance and variety of food, diet diversification, and the distance between people and the production of food (Thyberg and Tonjes, 2016). These transitions and the infrastructure developed to support them contributed to factors that affect household waste, including personal norms and concerns about waste, food planning, shopping and management routines, when food is thrown out, where grocery shopping occurs, the likelihood of over-purchasing and convenience

lifestyles (Aschemann-Witzel J et al., 2016) (Schanes et al. 2018) (Parizeau et al., 2015). Yetkin Özbük and Coşkun (2020) compiled factors that influence food waste from 92 articles and categorized them into macro-environmental, micro-environmental, and internal factors (see Table A2 in the Appendix for a complete list). These include organizational, operational, marketing, product, handling, customer, natural, political, economic, and sociocultural factors. Many factors are specific to the food and operations of various establishments. A greater understanding of why food is wasted in specific establishments provides insight for industry and policymakers to recognize these causes and address them.

2.1.1 Food Processing and Manufacturing Level

In the processing sector, requirements and specifications for raw materials and finished products, such as quality, shape, and size, contribute to food waste generation (Raak et al., 2017). Unintentional losses can result from technical factors like machine inefficiencies, equipment defects, and power blackouts that break cold chains (Raak et al., 2017) (Dora et al., 2020). Intentional losses inherent to how food is processed also occur, such as by-products, food trimmings, residues, and samples for quality assurance and quality control (Raak et al., 2017). Logistical, package and storage factors can affect food quality and result in unexpected losses. Poor transportation, interruptions in production, product changes, defects, and changes to buyer contracts can affect food quality and result in unexpected losses (Dora et al., 2020). Packaging and storage factors, like labelling errors, damaged packaging, and suboptimal inventory management, can also affect food (Dora et al., 2020). Human error may increase the occurrence of the factors mentioned above. They are reported to be one of the most frequent causes of loss (Raak et al., 2017) (Dora et al., 2020). The magnitude of losses from this collection of factors is also influenced by the type of product being processed. Products that are frozen or are more shelf stable can withstand transportation delays and errors in inventory management (Martindale & Schiebel, 2017) (Raak et al., 2017).

2.1.2 Hospitality and Food Service Level

Food waste in a hospitality and food service establishment can be traced to one of three areas: front-of-house, kitchen, and storage. In the front-of-house, customers can produce plate waste (food served but uneaten) that can come from over-ordering, over-portioning and buffet-style service (Martin-Rios, 2018) (Okumus, 2020). Some of this waste could be reduced through portion sizing and offering varieties of plate sizes (Bhattacharya and Fayezi, 2021). Non-edible waste such as trimmings, peels, bones, and shells can come from the front-of-house and kitchen. In the kitchen, mistakes such as poor cold chain management, incorrect food preparation, and food spoilage occur (Martin-Rios, 2018). Food can also arrive in poor quality and have manufacturing or packaging defects, and food may be thrown away prematurely due to concerns about food quality and safety (Martin-Rios, 2018) (Okumus, 2020). In storage, inventory can be overstocked or stored incorrectly, resulting in unexpected spoilage (Martin-Rios, 2018) (Okumus, 2020).

A study conducted by Sakaguchi et al. (2018) illustrates the potential for information provision as a policy tool to support the proper separation of organic waste and donation of surplus food in restaurants. They survey restauranteurs in Berkeley, California, to investigate attitudes and behaviours. Although there is a financial incentive to compost (lower hauling costs compared to landfill bins), it was discovered that some restauranteurs who thought they were disposing of food waste in compost bins were using landfill bins. Sakaguchi et al. (2018) found that 24% of restaurants in California did not measure amounts of food waste. A common method of preventing food waste was giving edible leftovers to restaurant employees, which occurred in 72% of the businesses surveyed Sakaguchi et al. (2018). 79% of the respondents did not work with charities to donate surplus food, and 75% of respondents indicated liability was a barrier to food donation. However, over half approached the issue more positively after the Good Samaritan Act was discussed with them. Although a tax credit is available for businesses who donate surplus food, most were not aware of them, or thought that they were ineligible (Sakaguchi et al., 2018).

2.1.3 Retail Level

Consumers' desire for cosmetically perfect foods drives decisions at the retail level and upstream stages of the supply chain (Aschemann-Witzel et al., 2015) (Goodman-Smith et al., 2020). Retailers anticipate consumers' criteria and apply aesthetic standards that may result in the rejection of food from suppliers based on deviations in weight, shape, size, or packaging (Aschemann-Witzel et al., 2018). Fruits and vegetables may be the products most subject to this criteria, removed because of colour changes, denting, overripening, withering, or becoming moist (Lebersorger and Schneider, 2014). To prevent food-borne illness, cold chain procedures, best before dates, and recall protocols are created, but using these tools with an abundance of caution may produce unnecessarily food waste (Van Bemmel & Parizeau, 2020). In Canada, tests that determine microbial growth of products and thus substantial best before dates are not required or regulated (Van Bemmel & Parizeau, 2020). Although best before dates are not standardized, customers, retail staff, and donation organizations may use those dates as a marker of safety and when food has become waste (Van Bemmel & Parizeau, 2020). To improve customer satisfaction, retail stores may overstock shelves to create abundant displays and remove poorer-quality products (Goodman-Smith et al., 2020). Retailers may deal with products damaged in transit, such as packaging damage or product breakage (Lebersorger and Schneider, 2014). Staff errors are common, which makes training and education one of the most common barriers to food reduction cited by retail managers (Goodman-Smith et al., 2020). Broken cold chains at the retail level can produce substantial amounts of food lost and deter donation (Van Bemmel & Parizeau, 2020).

2.1.4 Inter-level Influences

Food supply chains in nature involve numerous stakeholders. Their complex relationships may contribute to disharmonization that exacerbates the causes of food waste (Bhattacharya and Fayezi, 2021). Decisions made at one level of the supply chain may contribute to greater amounts of food waste being produced at other levels. For example, the size and unit of products created by manufacturers, and made available by retailers, can influence the likelihood that customers over-purchase (Aschemann-Witzel J et

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al., 2016). Packaging design decisions at the manufacturing level and storage at the retail level may influence the shelf-life of food and consumer decisions on the edibility of food (Aschemann-Witzel J et al., 2016). There is also evidence that consumers often misinterpret best-before labels printed by manufacturers, leading to unnecessarily wasted food in retail and households (Turvey et al., 2021). Uneven dynamics in stakeholder relationships can drive over-production and waste (Ghosh and Eriksson, 2019). One party may intentionally or unintentionally push the burden of food loss and waste to partners in other areas of the supply chain or even to charitable organizations (Bhattacharya and Fayezi, 2021) (Devin and Richards, 2018) (Millar et al., 2020). In Europe, uneven bargaining power has been observed in relationships between small and medium-sized suppliers and large retailers (Ghosh and Eriksson, 2019). Retailers may reject items and send unwanted products back to suppliers, who then have the challenge of recovering residual value from these products, which often needs to be done expeditiously to avoid spoilage and often poses additional costs (Ghosh and Eriksson, 2019). To prevent reductions in food waste at one level of the supply chain from being met with increases elsewhere, initiatives that achieve collective responsibility and align goals among actors may be more successful at achieving overall reductions in food waste. MSIs (previously discussed in section 1.5.2) are one route to foster this form of collaboration.

2.2 Commercial Food Waste - Factors Driving Food Waste Reduction

Mak et al. (2018) was the only study published in an academic journal that used TPB to study commercial food waste reduction. Mak et al. (2018) interviewed 155 hotel, food and beverage, and property management representatives to evaluate the relationships between the TPB constructs and additional factors: economic incentives, logistics and management incentives, administrative incentives and corporate support. They applied Partial Least Squares Structural Equation Modelling (PLS-SEM) and determined that administrative incentives and corporate support, along with perceived behavioural control, had the greatest effect on recycling intention. Other studies that did not apply TPB can be reviewed to capture other motivations for commercial food waste reduction.

Goodman-Smith et al. (2020) conducted waste audits at retail establishments in New Zealand along with semi-structured interviews with retail managers, which were put through thematic analysis. They found that managers saw reducing food waste as profitable because of reductions in the cost of sending food to landfill and not wasting product that could be sold, even if sold at a discount. In addition to increasing profitability, managers were motivated to reduce food waste based on concern for the environment, care for the community, and to do the "right thing" (Goodman-Smith et al., 2020). Liao et al. (2019) looked at the influence of beliefs and risk on the intention to donate surplus food by food manufacturers and retailers in Sichuan, China. The studied constructs were intention, reputation risk, business risk, legislation risk, altruism, environmental concern, economic concern, and past behaviour. Each construct scale was measured using a 5-point Likert scale. Structural equation modelling (SEM) was used to test the reliability of their construct scales and quantify relationships. Economic concern was the only variable that did not produce a significant influence on donation intention.

2.3 Consumer Food Waste - Drivers of Food Waste Production

In comparison to literature on commercial food waste, many studies have used TPB to study consumer food waste. Four examples of studies that used extended TPB frameworks to study consumer food waste will be discussed. The additional variables used in each study varied. Ones found to be of significant influence were demographic factors, self identify, anticipated regret, shopping routines, re-use of leftovers, good provider identify, food taste, and price consciousness. Graham-Rowe et al. (2015) constructed an extended TPB model and used a hierarchical multiple regression analysis to determine that it could account for 64% of variance in intention. The additional variables of self-identity and anticipated regret proved to be significant in predicting behaviour. The authors suggest that future interventions should consider modifying one of the five strongest determinants revealed: attitude, subjective norm, perceived behavioural control, self-identity and anticipated regret. Stancu et al. (2016) used an extended Theory of Planned Behaviour framework with the additional variables of moral norms and routines and which also accounted for demographic variables. Among the demographic factors, lower amounts of food

waste were associated with older consumers, households with fewer members and a lower income. They found that perceived behavioural control and routines related to shopping and the reuse of leftovers are the main drivers of food waste. Visschers et al. (2016) used the additional variables of personal norms, knowledge, household planning habits and good provider identity, and analyzed their influence on self-reported food waste amounts. Linear hierarchical regressions were performed on the intention variable. Tobit analyses were performed on the self-reported amounts of food waste. It was determined that good provider identify and TPB constructs were the strongest predictors for food waste generation. Consumer food waste has also been studied in environments outside of the household. An extended TPB was applied by Coşkun et al. (2020) to study consumer food waste in restaurants. Additional factors of price consciousness and food taste increased the explanatory power of the model and had a significant positive influence on the intention to reduce food waste. Surprisingly, subjective norms were not found to significantly influence intention.

2.4 Drivers of Pro-environmental Behaviour

Pro-environmental literature has identified that managers' beliefs and values influence their organizations' environmental practices. Using an extended Theory of Planned Behaviour model, Papagiannakis and Lioukas (2012) studied how managers' values can impact corporate environmental responsiveness, which is how organizations respond to environmental issues. They surveyed manufacturing companies that work with natural resources (including food and beverage companies) through a questionnaire that used 7-point Likert scales. They conducted structural equation modelling (SEM), which revealed that the environmental attitudes of managers had a positive effect on corporate environmental responsiveness (Papagiannakis and Lioukas, 2012). Their findings are echoed by Jang et al. (2017), who used the New Environmental Paradigm (NEP) scale to measure the environmental beliefs of restaurant managers and found that they positively influence environmental practices such as environmental strategy, energy and water efficiency, waste management, re-use and recycling, and community support. Raineri and Paillé (2015) also found that when environmental protection is valued

and encouraged by the company and managers, other members of the organization were more likely to respond positively to behaviours that align with corporate environmental goals.

2.5 Understanding Intrinsic Motivations of Farmers

Pro-environmental studies on farmer behaviour have used intrinsic motivations to predict the adoption of sustainable practices. Bopp et al. (2019) studied the role of attitudes, economic incentives, and perceived behavioural control on the adoption of sustainable agricultural practices in Chile. They found that attitude was the strongest driver of sustainable behaviour (Bopp et al., 2019). Another area of study is the classification of farmers' values to improve policy messaging and subsequently increase the adoption of conservation behaviours. The idea of improving the efficacy of messaging by targeting characteristics of the audiences originated from health psychology and marketing disciplines (Maybery et al., 2005). Maybery et al. (2005) argue that the study of pro-environmental behaviours in agriculture has typically focused on responses to price signals; however, farmer values may play an important role in behaviour adoption, including enterprises with varying contexts and capacities for change. Maybery et al. (2005) identified that economic, conservation and lifestyle values were prominent among farmers. They tested correlations between groups and found that each was distinct, meaning that farmers' values could be classified into three distinct groups. Greiner and Gregg (2011) expanded on the work of Maybery et al. (2005). They observed that conservation programs in Australia have been seen as inefficient and hypothesized that policy approaches and instruments could target the intrinsic motivations of farmers through the messaging of those programs. They found that farmers' "motivational profiles" correlated to the kinds of conservation programs they preferred, the benefits they recognized, and the constraints they perceived. Although the motivations for running a food business may not be as distinct, the effect of varying values on perceptions of policies can be studied to support the same outcome of advancing policy messaging and identifying which policies may be the most attractive to the population.

Chapter 3 – Methodology

3.1 Conceptual Framework

The conceptual framework presented in Figure 2 maps relationships between four categories of variables: demographic factors, extended TPB constructs, food waste management, and the percent of food waste sent to landfill. Within the TPB framework, attitude, subjective norm, perceived behavioural control, and beliefs influence intention and intention influences FW management. Economic, environmental, and collaborative beliefs and demographic factors influence relationships within TPB and FW management. Three outcomes can be tested with this model, and they comprise three of the results sections (4.1, 4.2, 4.3):

1. The extended theory of planned behaviour constructs, in addition to demographic variables, are tested internally and then against food waste management practices.

2. Adoption and interest in external food waste management through collaborations and diversions are tested against the TPB constructs and demographic factors.

3. The percent of food waste sent to landfills can be tested against all preceding variables.

Aside from observing changes in these outcomes from the inclusion of factors, trends and responses to hypothetical programs can be identified through descriptive statistics. The design of this framework also considers that the reasonable length of an online questionnaire poses limitations on the number of questions that can be asked. Consequently, not all variables that influence these relationships can be captured. Notably, external factors such as the cost of waste management services are minimally investigated as the objective of this study has prioritized internal motivators. This model focuses on the influence of internal predictors of behaviour, namely attitudes and beliefs. In the remainder of this section, the variables used will be discussed further.
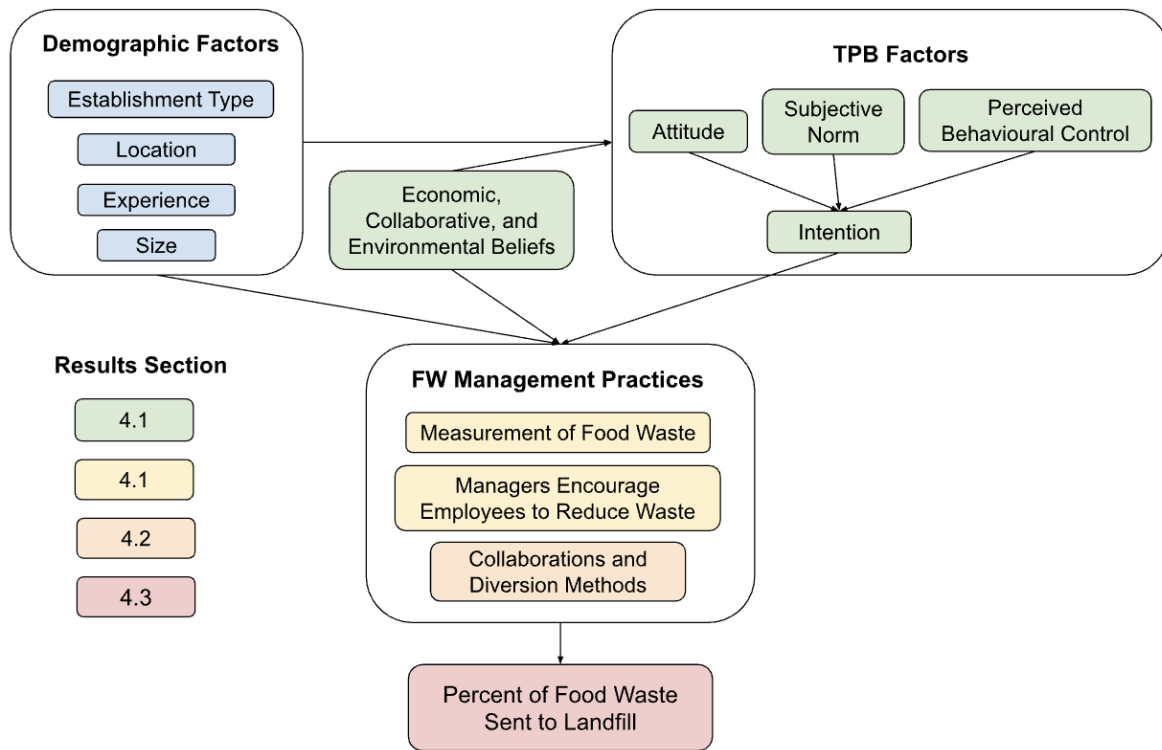
Figure 2. Conceptual Framework for Food Waste Management

3.2 Survey Design and Instrument

Survey instruments such as questionnaires and interviews have been used widely by social researchers, including those studying commercial food waste and pro-environmental behaviour (Liao et al., 2019) (Mak et al., 2018) (Sakaguchi et al., 2018). The survey instrument for this study was an online self-administered questionnaire hosted on Qualtrics that participants could complete independently and remotely, which was especially important during the ongoing COVID-19 pandemic. There were five main sections in the survey, as shown in Figure 3: 1) Background questions, 2) Program Preferences, 3) Management and Diversion of FW, 4) Belief Scales, and 5) Additional background. The complete questionnaire can be found in Appendix C, and the summary statistics in Table B1 in the Appendix.

Information Letter and Consent

Section 1. Background Questions
- Establishment Type
- Location
- Role of participant
- Business size (number of employees)
- Years of experience

Section 2. Program Preferences
- Vignette Experiment
- Identifying groups who should take again to reduce FW
- Effectiveness of potential programs
- Percent of food waste that goes to landfill
- Acceptable Cost for a new internal food waste mitigation and diversion process
- Willingness to Pay for diversion service

Section 3. Management and Diversion of FW
- Causes of food waste
- Food waste management (TPB, negligible waste, measurement, employee encouragement, knowledge of causes)
- Adoption and Interest in Diversion Options
- Barriers of donation

Section 4. Belief Scales
- Economic
- Collaborative
- Environmental

Section 5. Additional Background Questions
- Years of employment
- Food category (for processors and manufacturers)
- Food state (for processors and manufacturers)
- Where products are sold (for processors and manufacturers)
- Number of locations (for retailers and restaurants)
- Location of locations (for retailers and restaurants)
- Annual revenue
- Change your thinking after taking survey

Figure 3. Survey Structure

3.2.1 Survey Section 1 - Background Section

The main establishment categories were food manufacturers, retailers/grocers, and food service/hospitality providers. These establishments often create or sell products for an end-consumer and are subject to similar commercial waste legislation and services. Three location categories were considered based on the largest cities within the province of Alberta. The municipalities of Edmonton and Calgary are considered separately, while other municipalities in Alberta are grouped. Business size and years of experience of the respondent were also selected as other factors that could likely influence food waste management behaviours and attitudes. Background questions that were of interest but not of priority were placed in a second background section at the end of the survey.

3.2.2 Survey Section 2 - Program Preferences

This section contained scenario-based questions to evaluate potential programs:

1. Cost savings expected from a new process that reduces FW. "Imagine that your business had the opportunity to internally adopt a new food mitigation and diversion process. Compared to your current food waste disposal costs, what is the minimum cost savings that this process would have to offer for your business to implement this new system?" Participants could indicate a response between 0-100%.

2. Willingness to pay for a diversion service. "Imagine that an organization that diverts food waste approaches your business and offers to take all of your food waste and divert it from landfill. How much more would you be willing to pay for this service compared to your current food waste disposal costs?". Participants could indicate a response between 0-100%.

3. Participants were asked to rate a list of features of potential interventions to encourage FW reduction based on effectiveness, using a four-point Likert scale. A preliminary vignette experiment was also conducted.

3.2.2.1 Vignette Experiment

This study employed a limited vignette experiment to conduct a preliminary test of policy interventions that could reduce food waste. A vignette is a detailed description of a scenario that contains a set of attributes (Atzmüller and Steiner, 2010). It is applied in an experimental approach where respondents are randomly assigned multiple vignettes, and their evaluations are analyzed to identify the contribution of each of the components of the vignette to the strength of preference (Atzmüller and Steiner, 2010). Vignettes can represent realistic respondent judgements more accurately by capturing multiple factors and latent variables simultaneously (Atzmüller and Steiner, 2010). For a scenario where participants may have varying interpretations of a concept, like in the case of food waste, a vignette can attempt to hold factors that contribute to a decision constant (Ellison and Lusk, 2018).

The questionnaire presented participants with one out of nine possible scenarios. The nine scenarios contain a mix of three programs (workshops, roundtable discussions, and partnership with a local charitable organization) and three incentives (a tax credit, an award system, and access to expert marketing advice). Respondents were asked to indicate willingness to participate (from 0-10) in a set of scenarios. A vignette approach was attempted in this study, but unfortunately, the randomization of questions by the survey software resulted in a very uneven distribution of responses for each of the scenarios. Additionally, participants were only shown a single scenario, which restricted the comparability of the scenarios. Hence, the use of vignettes in this study cannot be seen as a full vignette experiment but instead as a preliminary exploration of the technique.

3.2.2.2 Percent of Food Waste Sent to Landfill

Section 2 of the survey also asked respondents to approximate the percent of food waste sent to landfill by asking, "At your business, approximately, what percentage of the food waste you produce goes to landfill?". Respondents could answer this question by selecting a value from 0% to 100% in increments of 10% (i.e. 0%, 10%, 20%, etc.). There are many end destinations for food waste, but landfill is arguably the least desirable. The percent of food waste sent to landfill is also an indication of the proportion of food

waste being diverted from landfill. Asking this question in a survey has shortcomings, such as recall bias and social desirability bias (discussed in the study limitations, section 5.1), but it is still important to understand if the practices, beliefs, and characteristics being studied impact food waste diverted from landfills. As one goal of optimizing food waste management and recovery is to divert food waste away from landfill and towards preferable options, the proportion of FW sent to landfill is an important quantifiable outcome.

3.2.3 Survey Section 3 - Management and Diversion of Food Waste

Four kinds of questions were presented in this section. Participants were first asked to indicate the concern they felt for five causes of food waste: customers waste food, overproduction, overordering and inaccurate forecasting, human error, technical malfunctions, and products/ingredients arriving are of lower quality than expected. Concern was rated on a four-point Likert scale. The second question in this section contained questions on food waste reduction TPB and management behaviours. A single question was used to determine each TPB construct (attitude, perceived behavioural control, subjective norm, and intention). A few other behaviours and perspectives of interest were also asked in this section: perception of negligible waste, manager encouragement of food waste reduction, measurement of food waste, and awareness of causes. The third question was on the adoption and interest in collaborations and diversions to reduce waste, which will be discussed in the next sub-section. The final question in the section asked respondents to indicate any of the eight barriers to donation presented that they experienced: 1) A lack of information about how to donate, 2) Employees are not informed about donation procedures, 3) A lack of organizations in the area that donate, 4) Safety concerns and legal liability, 5) Costs associated with donation, 6) The type of food waste produced is not suitable for human consumption, 7) Too many restrictions or requirements for donating, 8) Organizations that accept food donations do not have the capacity to collaborate. There was also an option of providing a written response.

3.2.3.1 Collaborations and Diversions to Prevent and Divert Food Waste

Seven types of diversion and collaboration measures were selected based on their prominence in the literature. Participants were asked to identify if they have adopted or would be interested in adopting them:

1. Donate - Working with organizations that donate surplus food to community organizations

2. Animal Feed - Working with businesses that convert food waste to animal feed

3. Biobased - Working with organizations that convert food waste to biobased products

4. Give for sale - Working with businesses that convert food waste into products that they sell

5. Take home - Giving extra food to employees

6. Recycle - Recycling surplus food into products that your business sells

7. Consult - Working with consultants to improve food waste management

These options make up most of the levels of the food recovery hierarchy, with options 5, 6, and 7, being preventative strategies for food waste. Options one through four can be seen as external collaborations to redirect and diversion food waste.

3.2.4 Survey Section 4 - Economic, Collaborative and Environmental Beliefs

The three beliefs selected to be studied are economic, collaborative, and environmental. They may influence all of the TPB factors and food waste management behaviours. Beliefs, whether held by managers or a part of how a business represents itself, may influence decision-making and the organization's direction. It is assumed that most business representatives will be greatly aligned with economic beliefs. If there is a perceived trade-off for strategies to reduce food waste, it could be speculated that those with greater economic beliefs are less likely to adopt that behaviour. Collaborative beliefs can be tested against the adoption of methods that necessitate collaboration, namely donation, re-use for animal feed, and re-use for biobased materials. As the food waste issue is foremost presented to the public as an environmental issue, environmental beliefs can be studied as a factor that may improve the likelihood that measures to reduce food waste are adopted or of interest. For smaller businesses, the

relationship between the managers' beliefs and pro-environmental behaviour may be even stronger, as they may be able to make decisions more directly and be involved in the business's day-to-day operations. Definitive and concise scales of environmental, collaborative, or economic beliefs were not found in the literature. As a result, novel scales were constructed using the five constructs of the theory of planned behaviour. The items for these scales are presented in Table 4.

Table 4. Belief Scale Statements

Belief	TPB Element	TPB Statements on Survey
Economic	Attitude	Dollars and cents is what running a food business is all about.
	Subjective Norm	Most people who are important to my business think that generating profit is essential to running the business.
	Perceived Behavioural Control	My business has control over the profits it receives and the costs it incurs.
	Intention	When planning future activities, maximizing returns is the most important aim.
	Behaviour	In the past three years, my business has improved profitability and/or reduced costs.
Environmental	Attitude	Being environmentally conscious is important to run a food business.
	Subjective Norm	Most people who are important to my business think that being environmentally responsible is essential to running the business.
	Perceived Behavioural Control	My business has control over its impact on the environment.
	Intention	When planning future activities, being environmentally responsible is the most important aim.
	Behaviour	In the past three years, my business has become more environmentally sustainable.
Collaborative	Attitude	Collaboration is important to run a food business.
	Subjective Norm	Most people who are important to my business think that being collaborative is essential to running my business.
	Perceived Behavioural Control	My business has control over what types of collaborations and partnerships it has.
	Intention	When planning future activities, taking a collaborative approach is very important.
	Behaviour	In the past three years, my business has maintained or actively pursued collaborations or partnerships with other businesses or organizations.

3.3 Participant Recruitment

The plan for this study was approved by a Research Ethics Board at the University of Alberta (UofA Ethics ID: Pro00110760). Inclusion criteria were businesses in Alberta that manufacture or sell food meant for human consumption, including, but not limited to, food processors and manufacturers, grocers and retailers, hospitality businesses (i.e. restaurants, cafes, food trucks), and agricultural businesses. However, agricultural businesses were removed during data preparation to maintain the three originally intended groups of interest. Businesses that identified as multiple categories were also included, for example, a grocery store with an in-house bakery or an individual who processes food and sells it at a local farmers market. Food businesses in Alberta were identified through online directories of manufacturers, retailers, restaurants, and vendors at farmers' markets. Over 1000 representatives were contacted through email and phone and sent at least one reminder through email. Recruitment was also supported by individuals from Calgary Waste Management, Edmonton Waste management, the Government of Alberta's Agriculture and Forestry Department, the Alberta Food Processors Association, and Leftovers Foundation, who contacted their relevant networks with the survey information. The survey was open from June 17th, 2021, until November 5th, 2021, to allow time for additional participants to be recruited. The median average time to complete the survey was 13.8 minutes.

This type of participant recruitment is considered convenience sampling. This sampling method is subject to non-response (or participation) bias, wherein members of the population who are not interested in the study may not start or complete the survey and be unknowingly excluded from participation, therefore affecting how representative the sample is of the overall population. This phenomenon may affect this study as it addresses an issue in which respondents may not want to involve their business. To try to reduce participation bias, the name and description of this study did not include a mention of waste. Instead, it was titled "Alberta Food Businesses Preferences for Operational Improvements". Anonymity was also emphasized in the study's information letter. However, many respondents did not complete the survey, which may have generated attrition bias.

3.4 Survey Completion and Exclusion

Table 5 presents the number of respondents who progressed through the survey and dropped out at various points. 171 respondents began the survey, 145 completed background information and the vignette question (≥ 44% completion), and 109 participants completed all questions (100% completion). Table 6 presents survey completion by percent of respondents in each location and establishment type. Manufacturers and businesses in Calgary had the highest completion rates, while retailers and businesses in other municipalities had the lowest rates. Participants who did not complete 44% or more of the survey were excluded as participants, along with 15 respondents from establishment types that are not included in the scope of this study: agricultural (12), nonprofit (2), and distribution (1).

Table 5. Survey Completion

Percent Completed	Number	Percent of Total
100%	109	63.7%
92%	3	1.8%
75%	3	1.8%
64%	12	7.0%
61%	3	1.8%
44%	15	8.8%
19%	7	4.1%
6%	19	11.1%

Table 6. Survey Completion by Location and Establishment Type

Completion of >92% of survey	Retail (n=24)	Hospitality (n=42)	Manufacturing (n=71)	Edmonton (n=84)	Calgary (n=33)	Other Municipality (n=39)
Number of participants from each category	15	28	59	60	27	26
Percent of participants within each category	62.5%	66.7%	83.1%	71.4%	81.8%	66.7%

3.5 Participant Characteristics

        Table 7 presents the key characteristics of the 131 respondents who were eligible for the survey and completed at least 44% of it. 70 were from food manufacturers; 38 were from hospitality establishments, such as restaurants, cafes, and food trucks; 23 were from grocery stores or food retailers. Business sizes can be grouped into two categories: 1) micro and small (1-99 employees), and 2) medium and large-sized businesses (100 and greater employees), as defined by Industry Canada. 115 participants represented micro and small businesses (89.3% of total) and 17 represented medium and large-sized businesses (12.2% of total). As addressed in section 1.3, Statistics Canada (2021) reports that 96.4% of food businesses in Alberta are micro and small, meaning that this study has a greater proportion of representation from medium and large-sized businesses compared to the general population. The overall count of participants is limited (n=131), which ultimately impacts the ability to analyze a greater number of variables. All categories of years of experience were represented (1-5 years, 6-10 years, 11-15 years, 16-30 years, 30 years or more). 74 participants were from businesses in Edmonton, 27 were in Calgary, 26 were in other municipalities in Alberta, and four were present in multiple municipalities. The role of participants in their respective businesses included owners (n=90), managers(n=31), and other (n=10) which included production staff, quality assurance, research and development, and a bookkeeper.

        Table 8 outlines the number of and percent of total respondents based on the two major categories of location and establishment type. The two sub-categories with the greatest respondents were manufacturers and hospitality establishments in Edmonton. Hospitality establishments in Calgary and other municipalities in Alberta were the smallest sub-categories, along with retailers in Calgary.

Table 7. Respondent Characteristics

Category	n = 131	% of total
Type of Business		
Food manufacturer or processor	70	53.4%
Hospitality	38	29.0%
Food retailer or grocer	23	17.6%
Location		
Edmonton	74	56.5%
Calgary	27	20.6%
Other Municipality	26	19.9%
Multiple Municipalities	4	3.1%
Position		
Owner	90	68.7%
Manager	31	23.7%
Other	10	7.6%
Size (Number of Employees)		
Micro/Small Sized (Under 100)	115	89.3%
Medium/Large Sized (100 or More)	16	12.2%
Years of Experience		
1-5	34	26.0%
6-10	24	18.3%
11-15	22	16.8%
16-30	34	26.0%
30 or more	17	13.0%

Table 8. Number of Respondents in Each Establishment Type and Location Category

Establishment Type	Location	n = 141	% of Total
Manufacturer	Edmonton	38	27.0%
	Calgary	17	12.1%
	Other	16	11.4%
Retailer	Edmonton	13	9.2%
	Calgary	7	5.0%
	Other	9	6.4%
Hospitality	Edmonton	31	22.0%
	Calgary	6	4.3%
	Other	4	2.8%

3.6 Data Preparation and Analysis Methods

The data was cleaned and coded on Microsoft Excel. Descriptive analysis was also generated using Microsoft Excel. Written responses were separated from the cleaned data before the dataset was imported into Stata 17.0 to perform regression analysis.

3.6.1 Probit Analyses and Marginal Effects

Binary probit analysis, fractional probit analysis, and ordered probit analysis are used to explore the factors contributing to the probability of engaging with the various food waste management practices. For non-continuous variables, a nonlinear probability model like probit regression is an appropriate approach (Aldrich and Nelson, 1984). Although some similar literature has used more advanced techniques such as Structural Equation Modelling, the purpose of the study is not to measure effects but rather to identify factors relevant to policy creation, which can be achieved through probit models and descriptive statistics. A probit model allows one to explore the factors that contribute to the probability of adopting the food waste management practices being studied. The three probit models used differ by the type of dependent variable. A binary dependent variable can use binary probit analysis, a dependent variable between 0 and 1 can use fractional probit analysis, and an ordinal dependent variable can use an ordered probit analysis (StataCorp, 2021). One challenge with using a nonlinear probability model such as probit is that coefficients are difficult to interpret and compare, and this is especially evident when evaluating ordered models (Breen et al., 2018). Marginal effects express the expected change of probability of the dependent variable for a unit change in the independent variable (Breen et al., 2018).

3.6.2 Factor Analysis

Factor analysis is used to create distinct constructs from a set of scale items (McCoach et al., 2013). It can validate a set of survey items and produce a value for a related construct. The survey contained three 5-question scales that measured Economic, Environmental, and Collaborative Beliefs using Likert responses. Each question is related to a construct of the Theory of Planned Behaviour:

attitude, subjective norm, perceived behavioural control, intention, and behaviour. The construction of the scale based on the TPB constructs was not to test TPB itself but to support the construction of statements that may be predictive of the belief. The frequency of scores for each scale can be found in tables 4, 5, and 6. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity was calculated to determine if the data was adequate for factor analysis. KMO assesses the appropriateness of the correlation matrix, and Bartlett's Test of Sphericity indicates if there is an adequate correlation between the variables (McCoach et al., 2013) (Shrestha, 2021). KMO values between 0.8 and 1 are adequate, between 0.7 and 0.9 are middling, and between 0.6 and 0.69 are mediocre but adequate (Shrestha, 2021). The KMO values were 0.706 (economic), 0.820 (environmental), and 0.747 (collaborative), which are appropriate values to proceed with factor analysis. The significance level from Bartlett's Test of Sphericity was found to be 0.00, which meets the appropriate condition of < 0.05 (Shrestha, 2021).

Variables of the environmental and collaborative constructs loaded onto a single factor, while those of the economic construct loaded onto two factors. Cronbach's alpha, a test of scale reliability, was determined to be at an acceptable level (above 0.7) for the environmental construct (0.85) and collaborative construct (0.77), but not the economic construct (0.63) (Shrestha, 2021). This low reliability of the economic construct suggests that items in the scale should be dropped or modified. The behaviour item, "In the past three years, my business has improved profitability and/or reduced costs." did not load onto a factor to the same degree as the other four items. This difference suggests that this item is unrelated to the others, possibly due to situational factors that made it an unfair measurement of beliefs or intentions compared to the other scale items. Considering the economic climate in the past 2+ years and the effect of the COVID-19 pandemic on small-medium food businesses, removing this item from the scale could be considered reasonable. When this behaviour variable was removed, the variables loaded onto a single factor, and a Cronbach's alpha of 0.7088 is reached, which is an adequate value. The factor analysis produced three values to represent each respondent's economic beliefs, collaborative beliefs, and environmental beliefs and can be used in regressions.
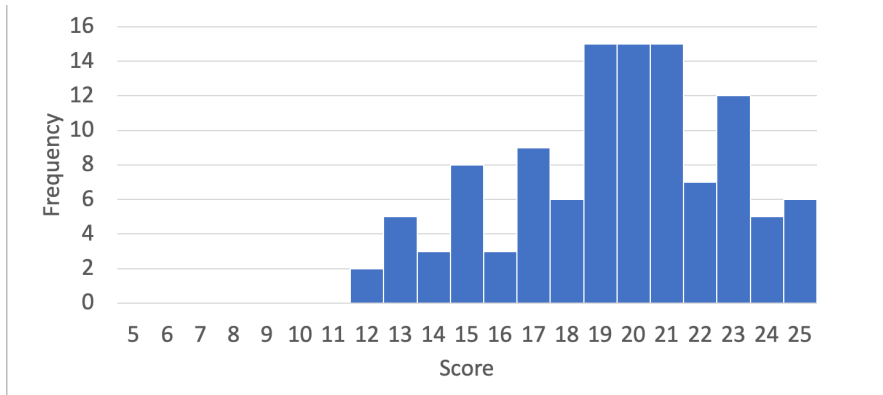
Figure 4. Frequency of Economic Scores
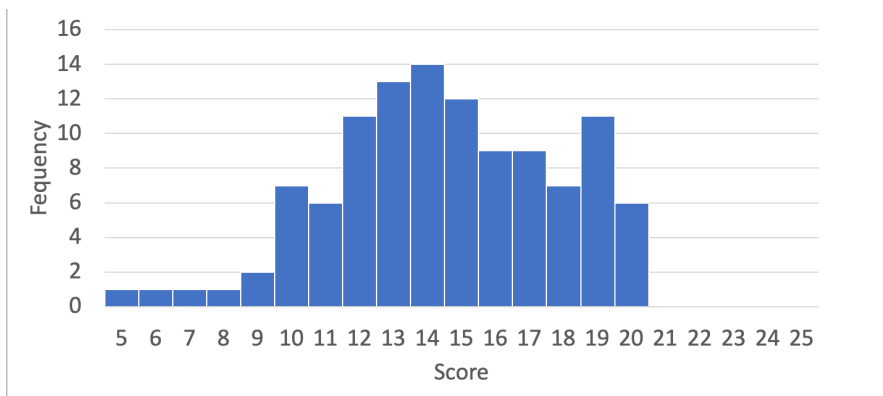
Figure 5. Frequency of Environmental Scores
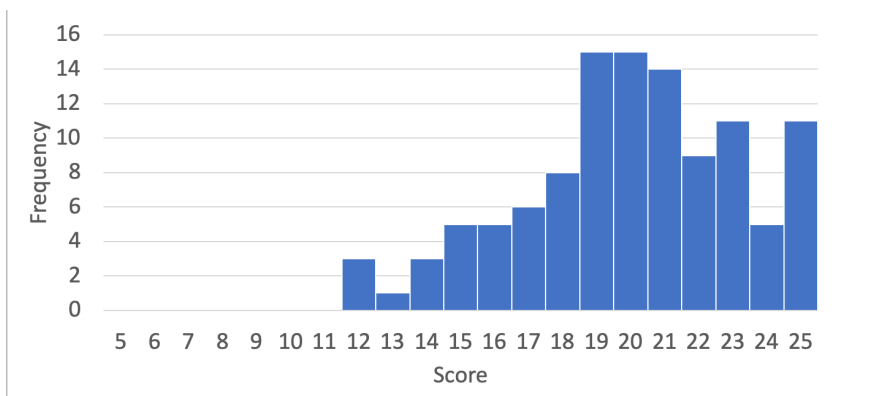
Figure 6. Frequency of Collaborative Scores

Chapter 4 – Results and Discussion

This section presents results based on the four main research questions addressed in section 1.8. Section 4.1 addresses food waste reduction attitudes, intentions, and behaviours, as well as the demographic factors and values that may influence them. Section 4.2 investigates how the dependent variables from section 4.1 may, in turn, affect the adoption of diversions. Section 4.2 also addresses barriers to engaging in food surplus donation. Section 4.3 evaluates and discusses internal and external factors that may influence the percent of FW being sent to landfill, including the factors addressed in the previous sections. Section 4.4 looks at hypothetical situations where a business has the choice to adopt a diversion technology or service or a new program is introduced to understand the propensity to adopt these solutions. Table B1 Appendix contains the complete summary statistics, including the variable name, description, and metric. With the presentation of the results of regression models and descriptive analysis, this section will discuss the implications of these findings for current and future solutions for food waste reduction, particularly for collaborations and policy.

4.1 Food Waste Management Attitudes, Intentions, and Behaviours

114 participants responded to the eight questions in this section, which capture TPB responses and select food waste management behaviours. Descriptive analysis and ordered probit regressions are presented to describe trends and relationships.

4.1.1 Descriptive Analysis of Food Waste Management Attitudes, Intentions, and Behaviours

Figure 4 shows the distribution of responses. Centered on "Neither agree nor disagree" responses, agree responses are stacked to the right side, and disagree responses are on the left. Somewhat agree and strongly agree responses were more common than somewhat disagree and strongly disagree responses across all the questions. The statement with the most "agree" responses was, "We know the causes of food waste within our operations" (86.0%), suggesting that, in general, respondents have an awareness of

food waste occurrence and where it comes from in their business. Further, it signals that the survey respondents have the appropriate knowledge to participate. It was common for businesses to engage in practices that could prevent food waste. 79.0% of respondents agreed that their "businesses [is] actively looking to reduce food waste. 71.9% agreed that "managers encourage employees to reduce food waste." For 77.2% of respondents, "most people who are important to the business believe that reducing food waste is important", which is a measurement of subjective norm. This trend points to a consensus from stakeholders that reducing food waste is important, whether from consumers, partners, clients, or other individuals in the organization. 79.0% of respondents agreed with the statement indicating perceived behavioural control, that they "have control over how much food waste [they] produce". This result reveals that participants believe that food waste occurring in their business are due to factors within their control. Many businesses reported producing negligible amounts of food waste (61.4%). Since the majority of businesses which participated (88.8%) are small, having under 100 employees, and many with ten or fewer employees (55.9%), participants may be working with a small amount of product, and consequently, the quantity of waste produced may be little.

Two statements had fewer "agree" responses compared to neutral and "disagree" responses; the first was "Our business would benefit from reducing its food waste" (49.1% agreed). Two conditions would need to be met to perceive a benefit for the business from reducing food waste. First, reducing food waste has to be seen as beneficial to the function of the business by reducing costs or increasing revenue. Secondly, there has to be a significant enough amount of food waste to reduce in the first place. Given that many businesses reported that they have a negligible amount of food waste (61.4%), this may impact the ability to agree with the statement since there is little food waste to reduce and from which to potentially benefit. This explanation may also address why the largest response category for this question was "Neither agree nor disagree." As a result, the statement may not have adequately represented the construct it hopes to measure, which is a positive attitude towards reducing food waste. The statement with the greatest "disagree" responses was "We measure the amount of food waste we produce" (56.1%

disagreed). This result is expected since the measurement is an additional, voluntary task that many businesses may not have the capacity to undertake. Interestingly, this question is more binary in practice than the others in this section. Businesses can either measure their waste or not. However, the prevalence of the "somewhat agree and somewhat disagree" categories, having 24 and 23 respondents, may point to some partial measurement taking place, or response bias. Regardless, the 27 "Strongly Agree" responses show that many food businesses are already actively measuring their waste. Sakaguchi et al. (2018) found that the percentage of restaurants in Berkley, California measuring food waste was much greater than for the businesses in this study (76% vs 44%).
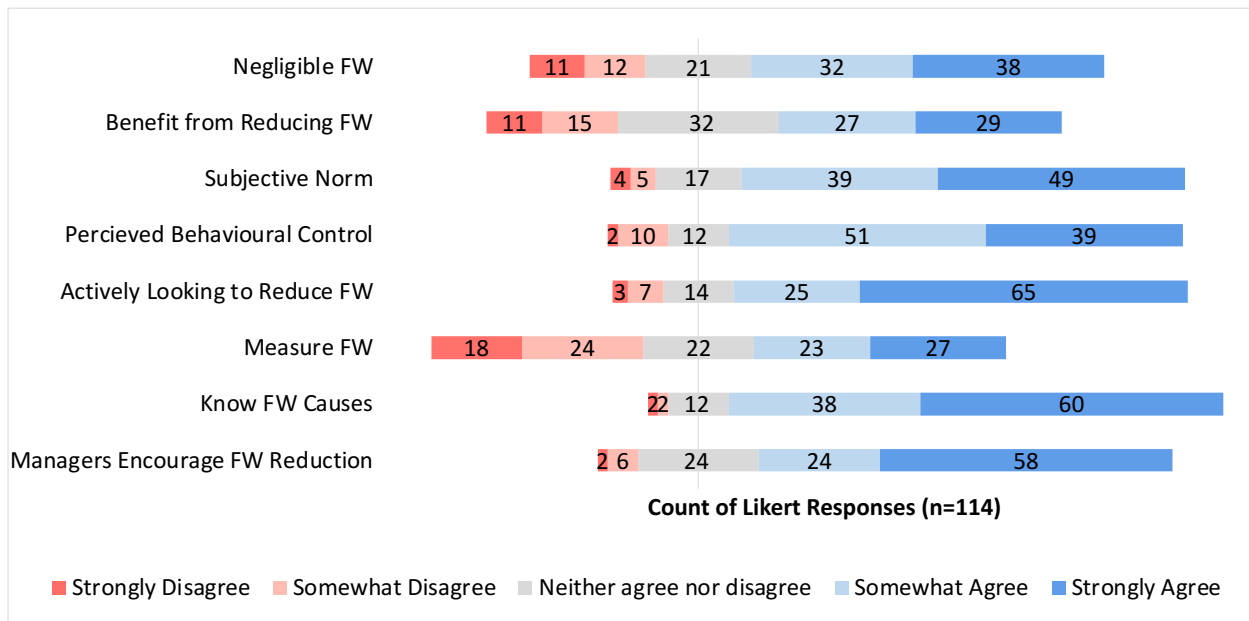
Figure 7. Food Waste Management Attitudes and Practices

4.1.2 Regression Analysis of Attitudes, Intentions and Behaviours

Ordered probit regressions were used to investigate factors influencing attitudes, intentions, and behaviours. The attitude variable "Benefit from Reducing FW" was regressed on the variables of Size, Other Location in Alberta, Retailer, Experience, Percent of FW sent to Landfill, Negligible FW, Economic Belief, Collaborative Belief, and Environmental Belief. Table 9 presents the results of this regression. Negligible FW was the only variable found to have a significant influence. The marginal effect of Negligible FW was -0.080 ($p < .01$, SE 0.029) at the "Strongly Agree" level for the benefit from reducing FW. Since the Likert scales for each variable were coded from 1-5, increasing the "Negligible FW" variable by one unit (i.e. from somewhat agree to strongly agree) significantly lowered the probability that reducing FW was seen as beneficial for the business by 8%. This finding clarifies the earlier interpretation of the "Attitude" question; Having negligible amounts of food waste does appear to affect a respondent's ability to agree with this question.

The Intention variable, "Actively looking to reduce FW," at outcome 4 (somewhat agree) was regressed on the Attitude, Subjective Norm, and Perceived Behavioural Control variables to test the strength of the theory of planned behaviour relationships. The ordered probit regression is presented in Table 10. Additional regressors used were Retailer, Size, Experience, Economic belief, Collaborative Belief, and Environmental Belief. Subjective norm had a marginal effect of 0.104 ($p < .05$, SE 0.053) and perceived behavioural control had a marginal effect of 0.107 ($p < .05$, SE 0.050). Experience had a marginal effect of 0.092 ($p < .01$, SE 0.035). In this model, increasing the Subjective Norm, Perceived Behavioural Control, and experience variables by one unit increased the probability of a stronger intention to reduce FW by 10.4%, 10.7%, and 9.2%. Considering that the attitude question may not be a reliable indicator of the construct of "attitude," these results generally confirm the TPB model, since stronger subject norms and perceived behaviour control were predictive of stronger intentions.

Table 9. Benefit from Reducing FW Regressed on Selected Independent Variables

	(n=98)	
Independent Variables	Marginal Effect	*SE*
Size	0.029	0.026
Other Location in Alberta	-0.134	0.072
Retailer	-0.132	0.076
Experience	0.046	0.025
Percent of FW Sent to Landfill	0.192	0.126
Negligible FW	-0.080**	0.029
Economic Belief	0.052	0.036
Collaborative Belief	0.007	0.045
Environmental Belief	0.058	0.045
Log likelihood	-136.076	

* p < .05, ** p < .01, *** p < .001

Table 10. Intention to Reduce Food Waste Regressed on Selected Independent Variables

	Actively looking for ways to reduce FW *(n=99)*	
Independent Variables	Marginal Effect	*SE*
(Attitude) Benefit from reducing FW	0.003	0.042
Subjective Norm	0.104*	0.053
Perceived Behavioural Control	0.107*	0.050
Retailer	0.169	0.138
Size	0.006	0.036
Experience	0.092**	0.035
Economic Belief	-0.017	0.052
Collaborative Belief	0.046	0.063
Environmental Belief	0.109	0.068
Log likelihood	-103.013	

* p < .05, ** p < .01, *** p < .001

The two behaviour variables, "We measure the amount of food waste we produce" (Measurement of FW) and "Managers Encourage Employees to Reduce FW" (Managers Encourage), were regressed on Attitude, Subjective Norm, Perceived Behavioural Control, Intention, Size, Experience, Economic Belief, Collaborative Belief, and Environmental Belief. These regressions are presented in Table 11. Size and Environmental beliefs were seen to be significant factors in the model for Measurement of FW. A larger size category increased the probability of measurement occurring by 6.4% ($p < .01$, SE 0.024), while stronger environmental beliefs increased this probability by 11.1% ($p < .05$, SE 0.047). Since measurement is a voluntary action that requires some resources, it is reasonable that larger businesses would be more inclined to do so as it is more likely that they have the resources to allocate towards it. This finding aligns with and expands on the report from Bell (2015), who found that larger food businesses in Alberta typically had dedicated staff for waste reduction issues. This result suggests that food waste measurement is one initiative that those dedicated staff of larger businesses are being tasked with. The second result, that stronger environmental beliefs have a positive effect on food waste measurement, aligns with findings from pro-environmental literature, which have associated environmental beliefs with corporate environmental responsiveness (Papagiannakis & Lioukas, 2012). In the model for Managers Encouraging FW Reduction, Subjective Norm, Intention, and Experience were significant factors. Stronger subjective norms increased the probability of agreement that managers encourage employees by 24.9% ($p < 0.01$, SE 0.066), while actively looking to reduce waste (intention) increased the probability by 16.7%, and greater experience increased the probability by 10.5%. Managers and owners with greater experience may better understand how FW can be avoided and diverted and be more likely to communicate this to employees.

Ordered probit regressions were used to analyze the "Negligible FW" variable at outcome 5 (Strongly Agree). The regressions for two models are presented in Table 12. The first model included TPB constructs, Size and Located in Calgary. Five of the seven factors were significant. The largest effect came from being located in Calgary, which reduced the probability of strongly agreeing that negligible

food waste is produced by 20.2%. The second largest relationship was with the attitude variable. Respondents who strongly believed that reducing FW would be good for the business were 12.5% less likely to report that they produce negligible amounts of FW. This finding is reasonable, considering that participants who produce negligible amounts of FW may not perceive a benefit to reducing it. Size, Experience, and Perceived Behavioural Control variables were also significant, with increased PBC and Experience leading to a higher likelihood of negligible amounts of food waste, while larger-sized businesses were less likely to produce negligible FW. The second model added the three additional beliefs (economic, collaborative, and environmental), which were not significant and did not have a large effect on the model's fit. Based on these models, the likelihood of producing and perceiving minimal waste can be attributed more to demographic factors such as size and location than economic, environmental, or collaborative beliefs.

Table 11. Measurement of Food Waste and Encouragement of Food Waste Reduction Regressed on

Selected Independent Variables

	Measurement of Food Waste (n=99)		Managers Encourage (n=99)	
Independent Variables	Marginal Effect	SE	Marginal Effect	SE
(Attitude) Benefit from reducing FW	0.011	0.028	-0.006	0.049
Subjective Norm	-0.044	0.038	0.249***	0.066
Perceived Behavioural Control	0.052	0.035	0.092	0.058
Actively looking to reduce waste	0.051	0.036	0.167**	0.055
Size	0.064**	0.024	-0.038	0.040
Experience	0.005	0.024	0.105*	0.043
Economic Belief	0.024	0.035	0.054	0.060
Collaborative Belief	-0.058	0.042	0.086	0.074
Environmental Belief	0.111*	0.047	0.005	0.079
Log likelihood	-148.028		-87.226	

* p < .05, ** p < .01, *** p < .001

Table 12. Negligible Food Waste Regressed on Selected Independent Variables

	Model 1 (n=99)		Model 2 (n=99)	
Independent Variables	Marginal Effect	SE	Marginal Effect	SE
Size	-0.065**	0.025	-0.066*	0.027
Located in Calgary	-0.202**	0.067	-0.196**	0.070
Experience	0.077**	0.027	0.082**	0.029
Attitude (Benefit from reducing FW)	-0.125***	0.035	-0.130***	0.036
Actively seeking FW reduction	0.043	0.039	0.034	0.041
Subjective Norm	0.064	0.040	0.061	0.043
Perceived Behavioural Control	0.087*	0.040	0.089*	0.040
Economic Belief	–	–	0.000	0.042
Collaborative Belief	–	–	0.036	0.050
Environmental Belief	–	–	-0.014	0.052
Log likelihood	-133.771		-128.315	

* p < .05, ** p < .01, *** p < .001

Based on the results from this section, the factors that influence attitudes and intentions around FW management are numerous. Producing negligible waste seems to be related to a weaker perception of the benefit of reducing waste. Subjective norms, perceived behavioural control, and years of experience positively influenced the intention to reduce waste. Measuring FW was influenced by size and environmental beliefs, and the encouragement by managers to reduce FW was influenced by subjective norms, intention, and experience. These trends agree with previous literature in two ways: the theory of planned behaviour constructs tends to be positively associated with one another, and the presence of environmental beliefs appears to influence pro-environmental behaviour. This analysis also found that years of experience was a significant factor that had not been identified in similar literature.

4.1.3 Causes of Waste

Section 4.1.1 addressed that most participants indicated that they were familiar with the causes of waste in their operations. Figure 5 illustrates the level of concern over five causes of waste. "Not sure" responses were not included. For all causes, the majority of respondents reported at least a little concern compared to no concern at all. The area with the lowest "not at all" responses was human error, with 86.3% of respondents indicating at least a little concern. The frequency of human error as a cause echoes findings from Raak et al. (2017) and Dora et al. (2020). The second lowest cause was overproduction, overordering, and inaccurate forecasting, with 69.7% of respondents indicating some concern.
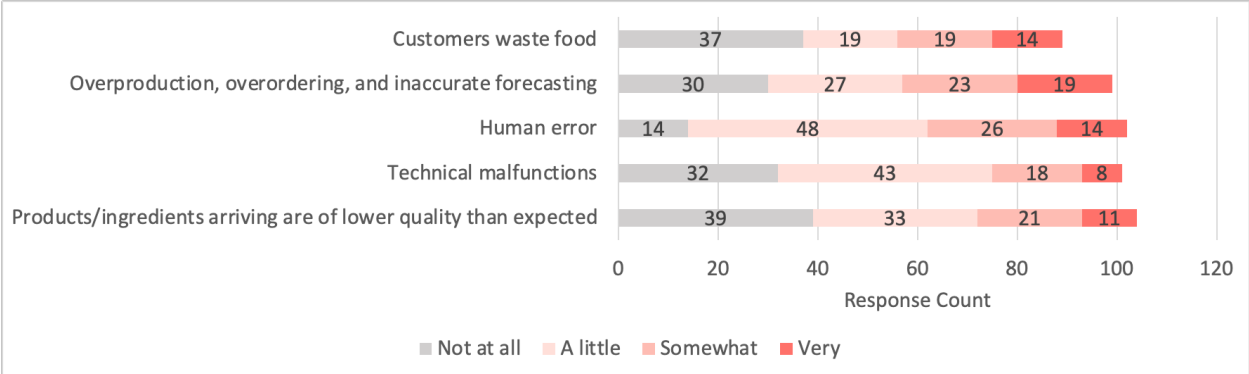
Figure 8. Concern for Causes of Waste

4.2 Diversion and Collaboration Methods, and Barriers to Donation

4.2.1 Descriptive Analysis of FW Diversion and Collaboration Methods

Figure 6 illustrates the proportions of respondents who have adopted or would be interested in adopting the prevention and diversion methods listed. Many businesses already give surplus food to employees (64.4%). This result is shared by that of Sakaguchi et al. (2018), who found that giving leftovers to employees was found to be the most common way of dealing with food waste in restaurants. Fewer businesses recycle surplus food into products the business sells (30.7%), and donate food (34.2%), and even fewer work with organizations that convert surplus food into animal feed (16.7%) and biobased products (5.3%). However, most participants were interested in these conversion options (51.8% and 58.8%). It was found to be uncommon for businesses to work with other businesses that converts food into new products (6.2%) and work with consultants (7.0%).
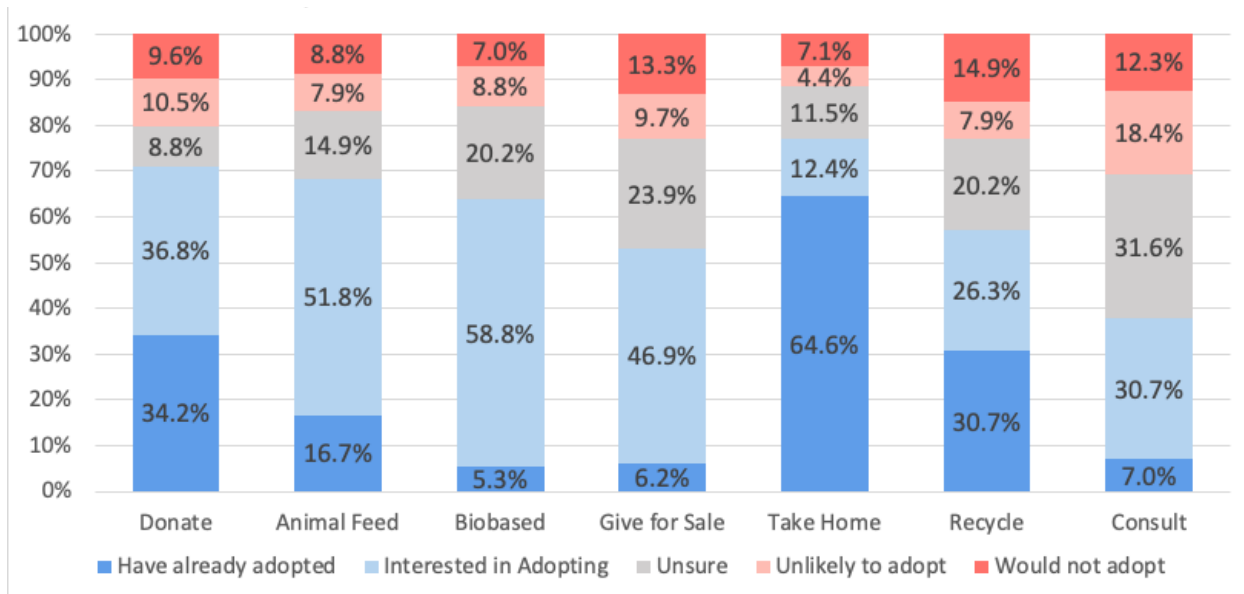
Figure 9. Adoption and Interest Responses for Prevention and Diversion Methods

Figures 10 and 11 present rates of adoption by establishment type and location. The greatest difference between establishment types is seen in donation. 62.5% of retailers reported working with organizations to donate surplus food, while this was only the case for 33.3% of manufacturers and 13.8% of hospitality establishments. Sakaguchi et al. (2018) found a slightly greater adoption of donation in restaurants in Berkley, California (21%). The nature of products at retail establishments compared to restaurants and manufacturers may be easier to donate since much of their inventory may be in ready-to-sell condition, making preparation and transportation for donation more straightforward. Rates of recycling among retailers (18.8%) was lower than for hospitality and manufacturing establishments (58.6% and 66.7%), suggesting that other diversion methods (such as donation) are more suitable for retailers or that they have a lower capacity or incentive to recycle. Retailers were also more likely to work with organizations to convert FW into animal feed (25.0% vs 10.3% and 13.3%). There was a trend for businesses in Edmonton and Calgary to be less likely to convert food waste into animal feed and give employees surplus food compared to other municipalities in the province, 38.5% of whom worked with organizations to convert FW to animal feed and 76.9% gave employees surplus food.

	Donate	Animal Feed	Biobased Products	Give for sale	Take home	Recycling	Consultant	Average
Hospitality (n = 29)	13.8%	10.3%	6.9%	3.5%	58.6%	31.0%	6.9%	18.7%
Manufacturing (n = 60)	33.3%	13.3%	5.0%	5.0%	66.7%	31.7%	5.0%	22.9%
Retail (n = 16)	62.5%	25.0%	6.3%	6.3%	50.0%	18.8%	6.3%	25.0%
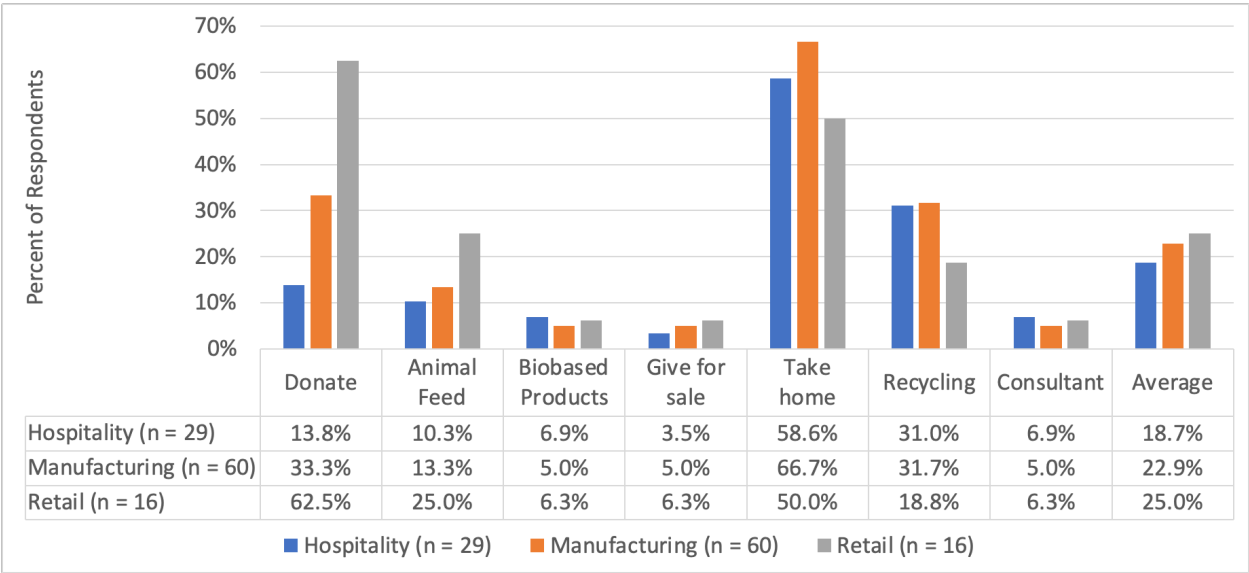
Figure 10. Adoption of Diversion and Collaboration Methods by Establishment Type

	Donate	Animal Feed	Biobased	Give for Sale	Take Home	Recycle	Consult	Average
Edmonton (n=61)	36.1%	8.2%	9.8%	4.9%	62.3%	31.1%	3.3%	22.2%
Calgary (n=27)	22.2%	11.1%	0.0%	7.4%	51.9%	25.9%	7.4%	18.0%
Other Municipality (n=26)	38.5%	38.5%	0.0%	7.7%	76.9%	30.8%	15.4%	29.7%

Figure 11. Adoption of Diversion and Collaboration Methods by Location

4.2.2 Regression Analysis of FW Diversion and Collaboration Methods

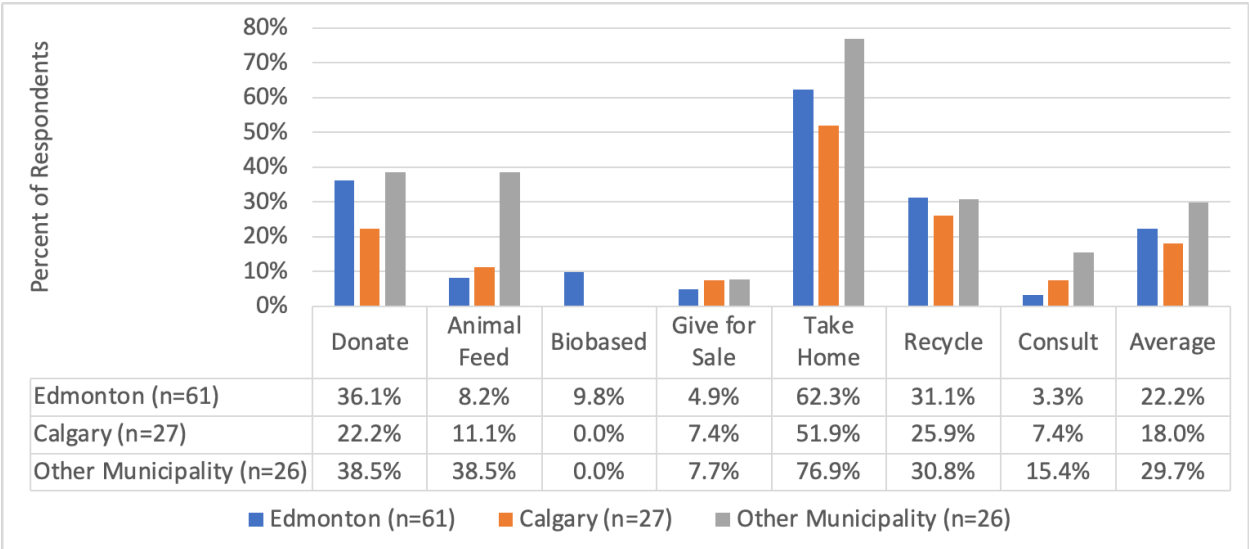A binary probit model was used to analyze diversion method adoption since adoption was coded as 0/1. Table 13 presents the regression analysis. Independent variables of Size, Intention, and Beliefs (economic, collaborative, environmental) were used to regress all seven diversion and collaboration methods, but only donation and recycling produced significant factors. Few variables were significant, and the model explained donation more than recycling. Being a larger business increased the probability of donating by 8.6%. ($p < .001$, SE 0.026) and having stronger environmental beliefs increased the probability by 13.4% ($p < .05$, SE 0.058). The association between donation and size may be for several reasons, some shared with the finding (presented in section 41.2) that measurement of food waste is also associated with size. Firstly, smaller companies are less likely to have a substantial amount of product available to donate that would make a collaboration worthwhile. Second, businesses with more employees may be able to engage in formal donation processes, which require time and resources to coordinate. This may be another outcome of larger companies having dedicated staff for food waste issues, as indicated in Bell (2015).

The significant association between environmental beliefs and donation adoption is consistent with that of Liao et al. (2019), who found that environmental concern positively and significantly affected corporate donation intention. The association between donation and environmental beliefs could be explained as a direct or indirect relationship. Donation may be seen as an environmentally friendly method of handling surplus food. Alternatively, it may suggest an indirect effect in which a mediating variable exists, such as moral attitudes and altruism. Economic beliefs were not a significant variable, which is another result shared by Liao et al. (2019). They speculate that there are labour costs and risks associated with food donation that are not outweighed by the small fiscal benefits, and consequently, managers would rather sell surplus food or dispose of it (Liao et al., 2019). Surprisingly, stronger collaborative beliefs were not a significant factor in the model for donation; however, they were for recycling FW into new products the business sells, increasing the probability of adopting by 13.6%. This

suggests there may be collaborative beliefs at play when businesses decide or implement FW recycling, which are less of an influence when deciding to donate food.

Table 14 presents interest in diversion methods analyzed with a binary probit model utilizing the same variables as the adoption model. Three of the seven diversion and collaboration methods had significant variables in this model, and only a few factors were found to be significant, indicating that the model was not a great fit. Actively looking to reduce food waste increased the probability that a respondent was interested in biobased conversion by 11.8%. The likelihood of being interested in giving FW to another business was decreased by 6.6% for larger business sizes. It increased by 11.7% if the business actively sought to reduce FW and increased by 11.2% if the respondent reported stronger economic beliefs. Finally, the probability of being interested in giving extra food to employees was increased by 22.8% if collaborative beliefs were stronger.

Table 13. Adoption of Donation and Recycling Regressed on Selected Independent Variables

Independent Variables	Donation (n=99)		Recycle into New Products (n=99)	
	r	SE	r	SE
Size	0.086***	0.026	-0.050	0.035
Actively looking for ways to reduce FW	0.063	0.050	0.037	0.044
Economic Belief	-0.008	0.045	0.019	0.044
Collaborative Belief	-0.043	0.056	-0.136*	0.055
Environmental Belief	0.134*	0.058	0.104	0.060
Log pseudolikelihood	-53.725		-54.841	

* p < .05, ** p < .01, *** p < .001

Table 14. Interest in Diversion Options Regressed on Selected Independent Variables

Independent Variables	Biobased (n=93)		Give for Sale (n=94)		Take Home (n=36)	
	Marginal Effect	SE	Marginal Effect	SE	Marginal Effect	SE
Size	0.029	0.034	-0.066*	0.031	-0.069	0.054
Actively looking for ways to reduce FW	0.118**	0.044	0.117**	0.044	0.011	0.073
Economic Belief	-0.010	0.050	0.112*	0.046	-0.010	0.073
Collaborative Belief	0.026	0.059	0.036	0.061	0.228**	0.086
Environmental Belief	-0.048	0.062	-0.046	0.066	-0.117	0.083
Log pseudolikelihood	-55.659		-58.232		-20.132	

* p < .05, ** p < .01, *** p < .001

4.2.3 Barriers to Donation

Figure 12 shows how frequently these barriers were reported based on the type of establishment. All businesses reported at least one barrier that limited the ability to collaborate to reduce food waste. Safety and legal concerns were the most reported barrier to donating surpluses, although they affected hospitality and retail establishments more than manufacturers. These finding echoes that of previous literature, in that safety and legal concerns are prominently perceived (Sakaguchi et al., 2018) (Goodman-Smith et al., 2020). The second most frequent barrier was that the type of food could not be donated because it is unsuitable for human consumption. More than a third of hospitality businesses reported that a lack of information on how to donate was a barrier. Employees not being informed about donation procedures primarily impacted retailers. Retailers found that restrictions and requirements for donating were much lower of a barrier compared to other industries. Manufacturers reported the lowest rates of perceiving a lack of organizations diverting food waste in their area. Over half (50.9%) of respondents said that the type of food they work with is unsuitable for human consumption and, therefore, could not be donated. This finding, alongside the high interest in diversion methods such as conversion to animal feed and biobased materials, indicates an opportunity for more organizations to provide these services or for existing organizations to expand their reach.

	Lack info on donation	Employee info	No organizations	Safety/legal	Costly	Type of food	Restrictions	Org capacity
■ Hospitality	34.5%	6.9%	31.0%	72.4%	20.7%	55.2%	27.6%	13.8%
■ Manufacturing	20.3%	6.8%	13.6%	49.2%	27.1%	49.2%	28.8%	20.3%
▦ Retail	28.6%	28.6%	21.4%	71.4%	21.4%	57.1%	7.1%	21.4%
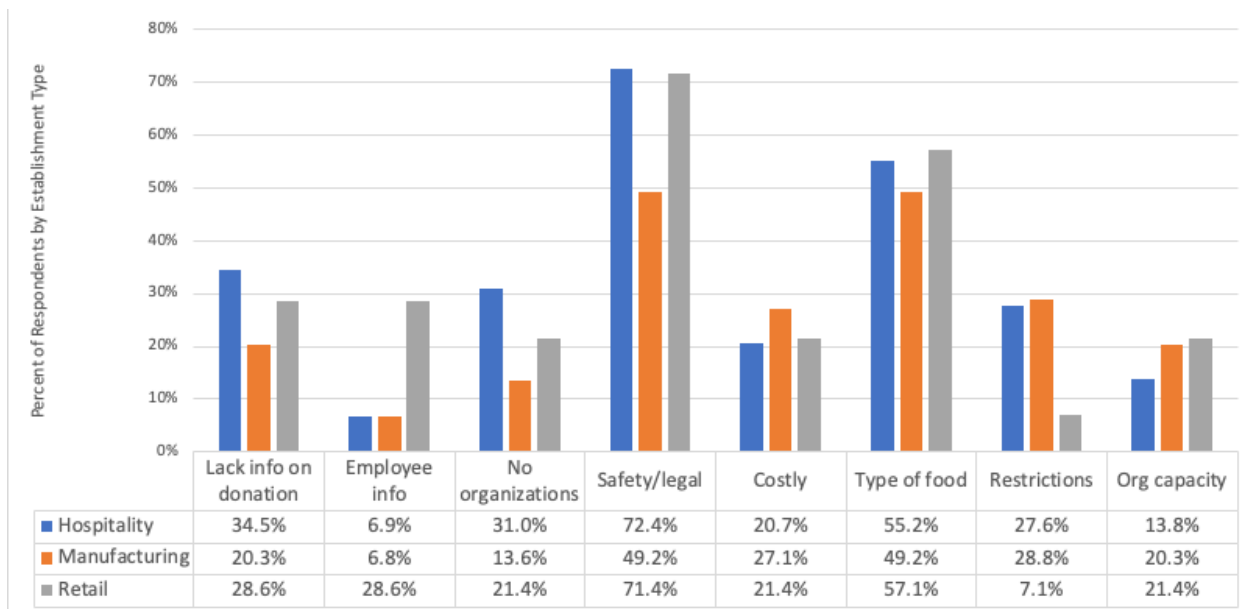
Figure 12. Barriers to Donating Food Surplus by Establishment Type

Respondents were also given the chance to describe additional barriers to donation. Two relevant cases portray the challenges that managers and owners have in donating. One respondent, a manager at a retail chain, reported that the head office in Ontario made decisions. They write, "I can only assume why head office makes certain decisions but I know the most common one would be liability since most of our stores in the chain are located in Ontario where you can't donate wasted food." This statement suggests that establishments could work towards policies that are flexible to the regulations of varying locations and give managers more autonomy over how surplus food is handled. An owner of a manufacturing establishment wrote, "most of our closing staff use public transportation and are unable to transport leftover goods. They also leave within 20-30 minutes of closing so it's hard to arrange with organizations in a timely manner whether or not we'll have any baked goods leftovers". This bakery seems to be limited by the logistical constraints of food donation and only has surplus food occasionally, making donation an ad-hoc activity. This description points to the donation organization in their area not having the capacity to arrange for pick-ups on short notice and formal partnerships between the organizations are not present.

Barriers to donation were also examined based on whether respondents had already adopted donation, were interested in adoption, were not interested or were unsure. This characterization was done to see if a greater rate of barriers was present in the interested group, which could be overcome to support the adoption of donation as a preferred option for managing food surplus. Figure 13. reveals gaps between interest and adoption based on the frequency of each barrier reported. Across all barriers, the interested group had a higher frequency of barriers than the adopted group. The highest reported constraints by interested respondents were restrictions or requirements for donating (32.2% greater than the adopted group), a lack of organizations in their area that donated food surpluses (31.9% greater), and a lack of information (30.2% greater).

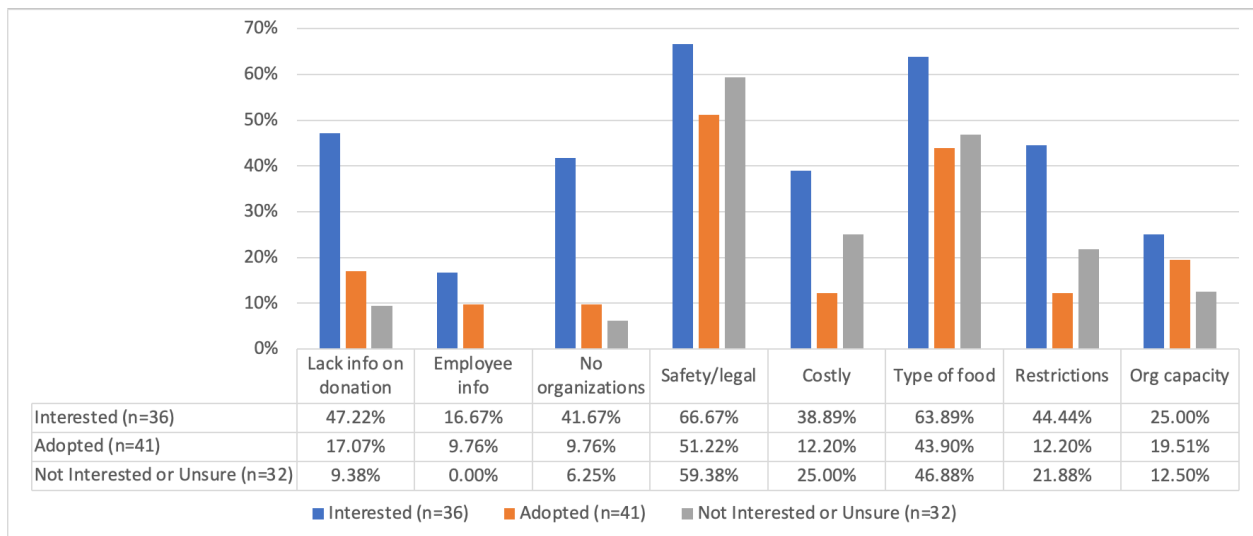|	Lack info on donation	Employee info	No organizations	Safety/legal	Costly	Type of food	Restrictions	Org capacity
Interested (n=36)	47.22%	16.67%	41.67%	66.67%	38.89%	63.89%	44.44%	25.00%
Adopted (n=41)	17.07%	9.76%	9.76%	51.22%	12.20%	43.90%	12.20%	19.51%
Not Interested or Unsure (n=32)	9.38%	0.00%	6.25%	59.38%	25.00%	46.88%	21.88%	12.50%

Figure 13. Barriers to Donation by Adoption and Interest

4.2.3.1 Regression Analysis of Barriers to Donation

Although adoption of donation has been explored in section 4.2.2, this analysis hoped to include the additional variable of the number of barriers reported to compare between donation adoption and interest. The binary probit regression model of donation adoption and interest included a variable indicating the number of barriers reported and the significant variables in the previous models for diversion adoption and interest. Table 15 contains the marginal effects of these regressions. The number of barriers reported was not a significant factor in the adoption model; however, it was in the interested model. A greater number of barriers reported increased the likelihood of being interested (but not adopting donation) by 9.5%. This finding can be compared to that of Jang et al. (2015) who found that perceived risk (including perceived legislation, business, and reputation risks) negatively affected donation intention. The group who donates seems to be affected less by potential barriers because they were not experiencing them or perceived them less. There is one curious finding in the interest to donate model. The likelihood of being interested in donation partnerships was the most influenced by being located in a municipality outside of Edmonton or Calgary, which reduced the probability by 32.5%. This model or previous descriptive statistics cannot explain this finding. It could be speculated that this population has more preferred methods for managing surplus food and food waste.

Table 15. Adoption and Interest in Donation Regressed on Selected Independent Variables

Independent Variables	Adoption of Donation (n=97)		Interest in Donation (n=67)	
	Marginal Effect	SE	Marginal Effect	SE
Number of Barriers	-0.051	0.030	0.095*	0.038
Retailer	0.314*	0.129	0.080	0.216
Located in Another Municipality	-0.174	0.114	-0.325*	0.142
Size	0.082**	0.030	-0.029	0.051
Environmental Belief	0.136***	0.043	0.024	0.062
Log pseudolikelihood	-48.367		-39.085	

* p < .05, ** p < .01, *** p < .001

The results on diversion adoption and interest point to a few possible trends. The high rates of businesses letting employees take surplus food home may indicate that diversion options that are accessible and easy seem to be more likely to be adopted. There is a great interest to adopt many of the collaborative methods discussed, which signals an opportunity if these services are further developed. In the case of donation, being a larger business and having stronger environmental beliefs seem to positively affect adoption rates. Some of the barriers towards adopting food donation behaviours may be able to be overcome (e.g. access to organizations and lack of information), while some may not (e.g. type of food and restrictions). For businesses whose products may make them unsuitable donors, options like converting to animal feed and biobased materials may be even more appealing. The prominence of safety and legal issues as barriers to donating surplus food and lacking information on donation could be reduced with information provision. A strategy employed by Sakaguchi et al. (2018) was to discuss Good Samaritan Laws with respondents, which resulted in more than half of them approaching the issue more positively. Representatives from City of Calgary's Waste Management shared through verbal correspondence that an annual telephone survey of the Industrial, Commercial, and Institutional sector

indicated that 74% of respondents said they would be very or somewhat interested in receiving tools or resources to help reduce the amount of food waste in garbage.

4.3 Percent of Food Waste Sent to Landfill

Figure 14 illustrates regional differences between amounts of food waste sent to landfills. Of the three locations, businesses in Edmonton have the highest average percentage of food waste sent to landfills (29.6%), followed by other municipalities (13.6%), then Calgary (13.4%). Differences in municipal waste management practices, such as whether services are privately or publicly run, and the availability of organic waste separation and collection, may be attributed to some of these differences. There was a trend that hospitality establishments have higher proportions of FW sent to landfills (30.3%), followed by retailers (23.5%), then manufacturers (18.7%). Table 16 presents the results of the fractional probit analysis conducted to identify factors that may increase the probability of FW being sent to landfill. The independent variables of Size, location in Calgary, Intention, number of collaborations and diversions adopted, and beliefs (economic, collaborative, environmental) were used. The variables "measuring FW" and "managers encouraging employees to reduce FW" were also tested in addition to the other variables, but they were not found to be significant and were therefore not included in this model. Being located in Calgary had the greatest marginal effect, increasing the probability of a lower percent sent to landfill by 10%. Intention to reduce waste and collaborative beliefs significantly reduced the probability of higher rates of FW sent to landfill. In contrast, economic beliefs increased this probability. There appears to be a mix of internal and external factors influencing the diversion of FW from landfill. Location is an essential factor, likely due to existing diversion services and the organic waste separation bylaw present in Calgary. Intrinsic factors of economic and collaborative beliefs and intentions also appear to have some influence.
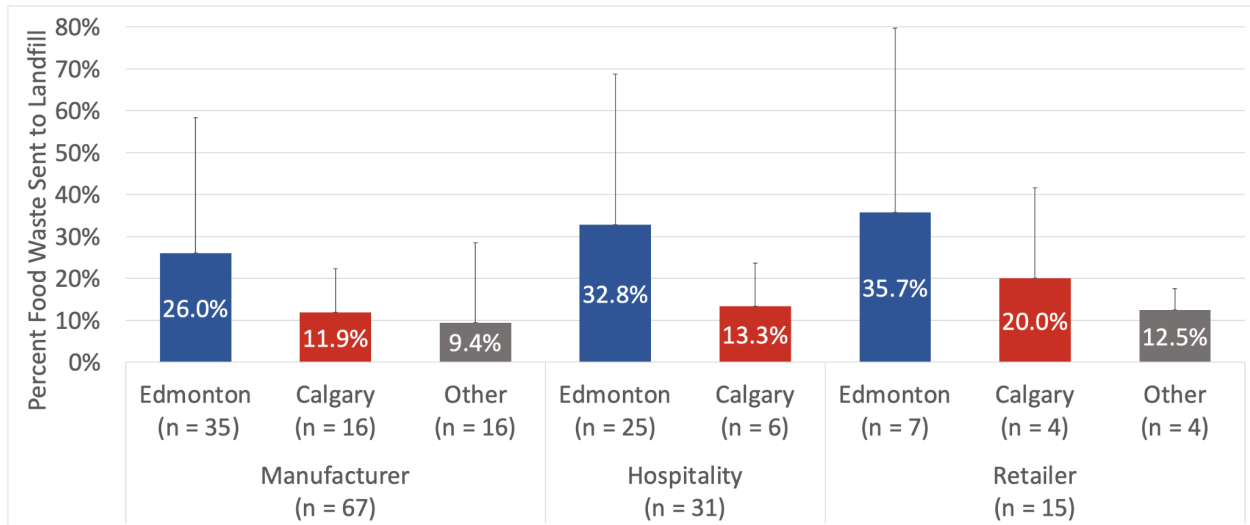
Figure 14. Average Percent of Food Waste Sent to Landfill by Location and Industry

Table 16. Percent of Food Waste Sent to Landfill Regressed on Selected Independent Variables

	% FW sent to Landfill (n=98)	
Independent Variables	Marginal Effect	SE
Size	0.014	0.017
Located in Calgary	-0.100*	0.050
Actively looking to reduce FW	-0.055*	0.026
Number of Diversions Adopted	-0.022	0.021
Economic Belief	0.060*	0.027
Collaborative Belief	-0.064*	0.028
Environmental Belief	0.019	0.032
Log pseudolikelihood	-48.644	

* p < .05, ** p < .01, *** p < .001

4.4 Adoption of Hypothetical Solutions

Most respondents (78.9%) said that they would switch to a new process or technology to reduce waste, and 27.3% were willing to switch if costs increased. Figure 15 shows the cost savings expected to motivate a switch to new technology or systems that reduce waste. Of the respondents who would not switch if the costs were greater, the majority (65%) only needed a cost savings of 30% or less. Figure 16 shows the willingness to pay for a waste diversion service compared to current food waste disposal costs. Willingness to pay was in the lowest ranges, with 56% willing to pay 10% or less. Few (15.6%) were willing to pay 30% or more.

The most attractive and effective features of interventions were evaluated through a vignette experiment and Likert question. Although there were several limitations to how this vignette was applied (addressed in section 3.2.2.1) that preclude it from being a proper vignette experiment, the scenario that received the highest rating on average was receiving a tax credit for donating food to a charitable organization (scenario number 7). Ratings of willingness to participate are plotted in Figure 17. Figure 18 shows ratings of potential intervention effectiveness. Monetary incentives received the greatest number of "Very Effective" responses (57), which was more than double that of the second highest intervention, Training for Staff and Employees (27). Monetary incentives were seen as a more effective mechanism to encourage waste reduction compared to information provision and collaboration. Overall, most respondents viewed all the options to be at least somewhat effective, but recognition and Awards had the most "Not at all" effective responses (24). These results on expected cost savings, willingness to pay and perceived effectiveness of interventions confirm previous assumptions of motivations of food businesses. Decisions appear sensitive to monetary considerations, such as incentives and costs.
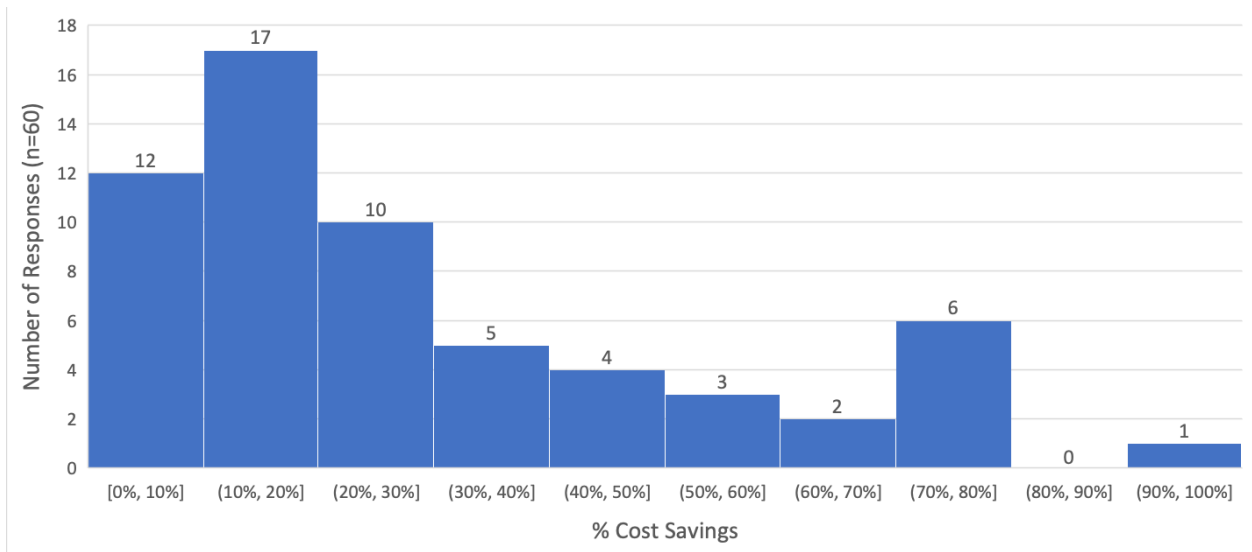
Figure 15. Frequency of Responses for Percent Cost Savings Necessary to Switch
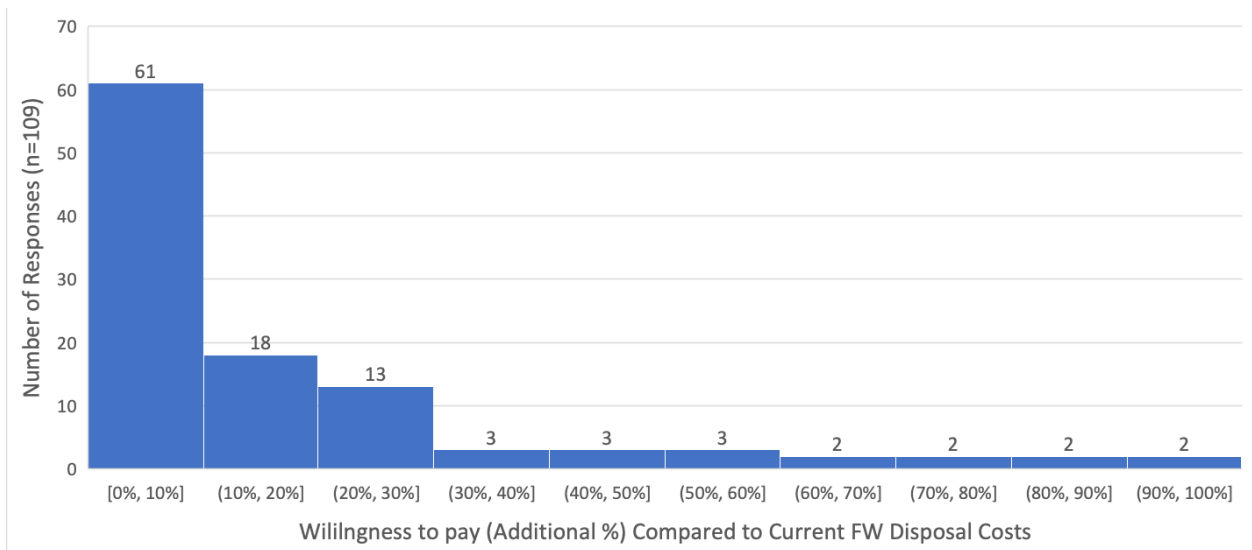

Figure 16. Frequency of Responses for Willingness to Pay for Food Waste Diversion
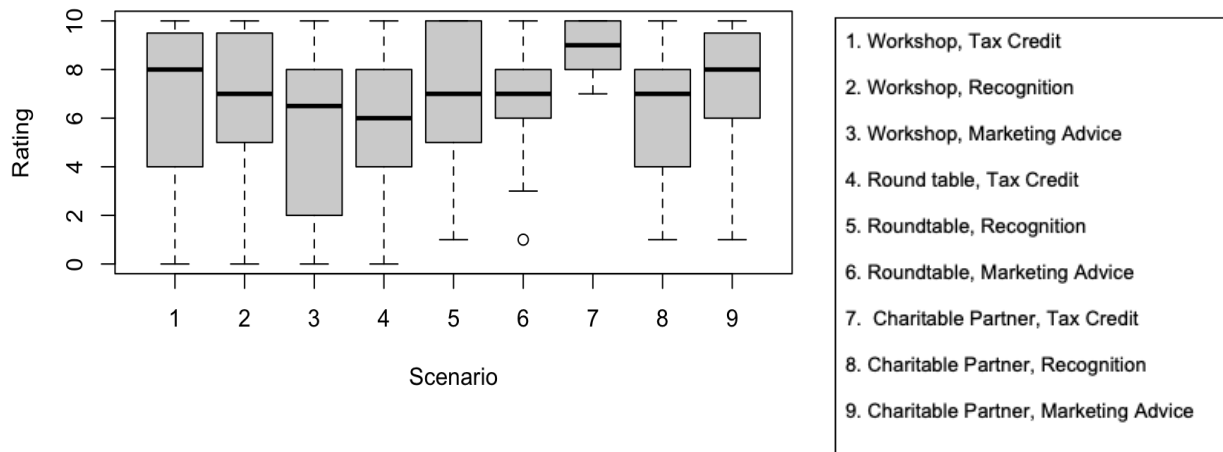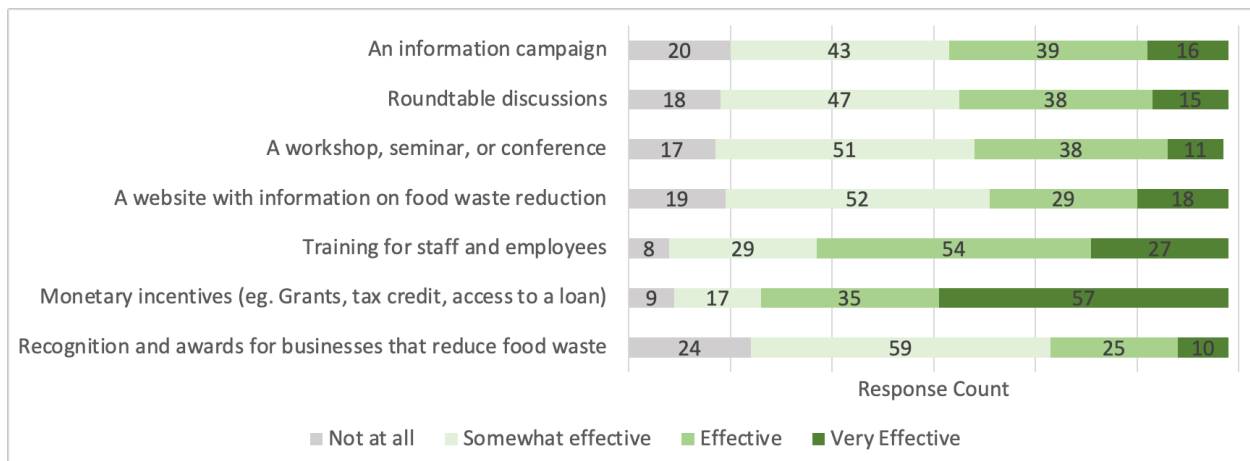
Figure 17. Average Vignette Scenario Ratings

Figure 18. Average Industry Ratings of Potential Intervention Effectiveness

Chapter 5 – Conclusions

5.1 Study Implications

This study addresses many facets of how food waste reduction is being acted on and perceived by the commercial sector, from attitudes to practices, collaborations, and potential programs. It contributes a breadth of findings to the growing knowledge of commercial food waste by surveying food manufacturers, retailers, and hospitality establishments in the province of Alberta, Canada. From a pro-environmental literature standpoint, this study utilized a novel approach to the extended theory of planned behaviour by generating and testing economic, collaborative, and environmental belief variables, attitude, subjective norm, perceived behavioural control, and intention. The effect of these intrinsic variables on the propensity to adopt diversions was investigated. The models, tested with varying forms of probit regressions, agreed with previous literature that many of these constructs are significant, but they were not influential across all the behaviours tested. This study also conducted preliminary evaluations of potential programs that may encourage food waste reduction.

Generally, the findings echo previous literature, and constructs in the theory of planned behaviour produced expected effects. Stronger subjective norms, perceived behaviour control, and years of experience of the respondent increased the probability of stronger intentions to reduce food waste. Larger size and stronger environmental beliefs increased the likelihood that a business measured its food waste. The relationship between stronger environmental beliefs and pro-environmental behaviour agrees with findings of similar literature (Mak et al., 2018) (Papagiannakis and Lioukas, 2012) (Jang et al., 2017) (Raineri and Paillé, 2015). However, environmental beliefs were only shown to influence a few behaviours and were not shown to be reliable predictors for most of the metrics studied. Factors that managers likely do not have control of, such as the availability of diversion services and the type of foods being produced in the business, are drivers of how food waste is managed and if it is diverted. Years of experience of a manager or owner also influence how active a business is in reducing food waste.

There are a few takeaways for industry and policymakers. Diversion methods, especially those at higher levels of the food recovery hierarchy, are of great interest but have low adoption rates. Methods like recycling into animal feed and biobased materials are areas to explore, as the results indicate that a high level of uptake might be expected if those services become available and accessible. Although food waste sent to landfill appears to be relatively low for the population studied (29.6% in Edmonton, 13.5% in Calgary, and 13.6% in other municipalities), efforts could be made to eliminate disposal. Bylaws around the separation of organic waste for the Industrial, Commercial, and Institutional sector may have contributed to lower rates in Calgary, as well as having more options for commercial organic waste management. Managers and owners already seem to perceive that people important to their business would want them to reduce their waste and report having control over it. As such, the issue may not be that intrinsic motivations for reducing waste are not strong but that there are limited opportunities for doing so, or those options are not accessible or suitable for the business, creating an "intention-behaviour gap".

Some food waste will always be inevitable due to the nature of the services food businesses provide, but there are some ways to reduce waste that businesses have control over. Although these may require additional resources, businesses may see economic returns by increasing the amount of food sold and reducing disposal costs. Human error, technical malfunctions, overproduction, overordering, and inaccurate forecasting can be prevented to some degree. Providing businesses with information that addresses how to reduce the impact of these causes of food waste, food handling procedures, and how to donate (especially the safety and legal frameworks in place to encourage it) may be a cost-effective way of empowering staff (Sakaguchi et al.,2018). Most respondents appear receptive to new diversion methods and processes that could reduce waste. 78.9% were willing to switch to a new process or technology to reduce waste, and 27.3% were willing to switch if costs increased. However, willingness to pay for waste diversion services is low. Considering that economic values were positively associated with the percent of food waste sent to landfill, landfilling may be seen as the most economic solutions currently. Solutions to prevent and divert waste should therefore aim to be cost-effective to capture

participation from as many businesses as possible. As for policy, monetary incentives seem to be motivating, but determining how to enact them (through grants, funds, or other instruments) is another question to explore entirely. Seeing that most respondents already report high intention to reduce waste, proponents of "motivation crowding theory" (discussed in section 1.6) may caution against relying on monetary incentives, despite respondents viewing them positively.

5.2 Study Limitations

This study has several limitations due to its small scale, testing of novel approaches, and broad conceptual scope. The limited number of participants affects the validity of the results, and the recruitment method likely affected how representative the sample is. The unequal numbers of respondents from each establishment type and location group meant that some groups were more represented in the sample. Surveys, in general, but perhaps those that are self-administered, are subject to various biases, including social desirability bias, non-response bias, and order effects. Social desirability bias would be at play due to the nature of this subject and the respondent's responsibility to represent their business. This is especially so for questions that reveal how much waste is occurring. Attrition may create bias through self-selection, and the order in which questions appeared in the survey may have influenced responses later in the survey. The survey did not contain reliability checks such as retests. Since results on this topic depend heavily on the existing context of participants, caution should be taken if an attempt is made to generalize these findings, which are specific to Alberta, to any other region.

Novel scales were used that were not previously validated in the literature. It is not easy to ascertain with the analysis methods chosen whether the belief scales were valid indicators of the constructs. It is very likely that they could have been made more robust by adding additional scale items that addressed other aspects related to those beliefs. Decisions on food waste management are complex and only a limited number of variables were used to generate models for this study. Many confounding, mediating, and moderating variables have most likely not been accounted for.

5.3 Next Steps and Future Work

This area of work can be expanded in many ways, both in scope and methods used. A few

potential research areas are 1. Further exploring internal and external motivations of commercial food

waste reduction by collecting qualitative data collection 2. Investigating the outcomes of interventions by

conducting intervention studies or by studying natural experiments, and 3. Focusing on food waste

prevention.

Many factors that potentially motivate food waste reduction were not explored to their full

potential in this study. Gathering more qualitative data through interviews and focus groups may provide

richer responses and answers to unanswered questions from this study, such as impressions on how

business operations and the external environment could be changed to reduce FW. This data could

describe if reducing food waste is a priority, why it is being done or not being done, and what already has

been done to reduce waste. This could shed light on external motivation that did not receive significant

attention in this study, such as current costs of waste management, the number of employees (if any)

dedicated to handling food waste prevention and reduction, and any company incentives (similar to Mak

et al., 2018). Barriers to translating intention into behaviours and overcoming the "intention-behaviour

gap" could be investigated. Other psychological factors which are present in consumer food waste

literature could be applied to study commercial waste, whether in a Theory of Planned Behaviour model

or not, such as moral attitudes, routines, and knowledge (Stancu et al., 2016) (Visschers et al., 2016).

These factors should seek to use validated scales, such as the New Environmental Paradigm scale, to

make constructs more comparable among studies. Studies can also apply a mix of both qualitative and

quantitative approaches. Mak et al. (2018) use semi-structured interviews to identify motivators prior to

conducting a survey to measure TPB relationships. Goodman-Smith et al. (2020) combine semi-

structured interviews with waste audits.

Studying interventions and natural experiments could very clearly determine effective pathways

for reducing waste reduction. For an intervention study, businesses could be invited to take up a new

method of preventing or diverting waste, and the outcomes of that could be studied. Ideally, the amount and types of food waste could be quantified before and after the intervention, and any additional costs or cost savings would be recorded. Waste audits would be helpful in ascertaining how much waste is actually being produced, as opposed to having participants provide their best guess. Information provision shows promise as a low-cost strategy that could increase food waste prevention and donation of surplus food (Sakaguchi et al., 2018). More precise experimentation would be necessary, beyond Likert-questions and vignette experiments, to understand the impacts of external monetary incentives and the potential influence of social appraisal (e.g. recognition, awards, etc.) Intervention studies could identify the advantages, disadvantages, and considerations for applying these interventions more broadly. In places such as Calgary where there have been changes to waste management bylaws and services, businesses could be engaged to learn how their experiences with managing food waste have changed, if their waste management costs have increased, and if their perceptions of waste have changed. Changes in behaviour by businesses in regions where waste disposal costs or "dumping fees" have increased would be interesting to investigate. The experiences of businesses that have recently adopted methods of preventing waste, such as a new technology or business model could also be studied.

There is a lot more to explore both in solutions to reduce food waste and what will motivate businesses to take on solutions. However, preventative measures deserve greater attention in future work, as preventing food waste minimizes its environmental impacts and should therefore be considered a priority.

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Appendices

Appendix A. Definitions and Additional Information

Table A1. Definitions of Food Loss, Waste, and Surplus

Source	Concept	Definition
Food and Agriculture Organization, 2019	Food Loss	The decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retail, food service providers and consumers.
	Food Waste	The decrease in the quantity or quality of food resulting from decisions and actions by retailers, food services and consumers.
United Nations Environment Programme, 2021	Food Loss	All the crop and livestock human-edible commodity quantities that, directly or indirectly, completely exit the post-harvest/slaughter production/supply chain by being discarded, incinerated or otherwise, and do not re-enter in any other utilization (such as animal feed, industrial use, etc.), up to, and excluding, the retail level. Losses that occur during storage, transport and processing, also of imported quantities, are therefore all included.
	Food Waste	Food (including drink) and associated inedible parts are removed from the human food supply chain in the following sectors: manufacturing of food products, food/grocery retail; food service; and households. "Removed from the human food supply chain" means one of the following end destinations: landfill, controlled combustion, sewer, litter/discards/refuse, co/anaerobic digestion, compost / aerobic digestion or land application.
	Food Surplus	Food that is redistributed for consumption by people, used for animal feed or used for bio-based materials / biochemical processing.
United States Department of Agriculture	Food Loss	The edible amount of food, postharvest, that is available for human consumption but is not consumed for any reason.
	Food Loss and Waste	Reductions in edible food mass anywhere along the food chain.
FUSIONS EU	Food Waste	Any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed of (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)
Gustavsson et al. (2011)	Food Loss and Food Waste	The decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food losses take place at production, postharvest and processing stages in the food supply chain, while food waste occurs at the end of the food chain (retail and final consumption).

Table A2. Factors of Food Waste, Adapted from Yetkin Özbük & Coşkun (2020)

INTERNAL FACTORS		
Organizational Factors	Staff-related factors: - Insufficient training - Lack of employees' knowledge/awareness/concern - Limited time availability - Lack of employee motivation and concentration - Employee attitude towards food waste - Personnel management	
	Organizational characteristics: - Lack of skills and competencies - Service environment - Type/size of the organization - Larger product variation	
	Management: - Managers' perception - Managers' limited knowledge/awareness - Managements' style - Organizational policy and tactics	
Operational Factors	Planning, purchase, production/cooking: - Inaccurate forecasting/poor demand planning - Lack of menu planning	
	Storage and inventory management: - Poor storage operation - Dropped items/poor handling - Incorrect refrigeration	
	Serving: - Inappropriate presentation - Portion size - Plate size - Time of the meal/time allotted for eating - Type of serving	
Marketing-Related Factors	- Lack of marketing orientation - Sales promotions - On-shelf availability - Packaging/labeling - Lack of communication - Lack of suboptimal product markets	
Product-Related Factors	- Strict/unmet product quality standards - Product category/type - Product defects	
Food Waste Handling Practices	- Absence of food waste handling strategy - Incorrect monitoring of food waste	

MICRO-ENVIRONMENTAL FACTORS	
The company	Lack of/inferior communication
Competitors	Competitors
Customers	- Consumer expectations - Consumer characteristics - Demographics - Lack of knowledge/awareness/concern - Varying consumer demand - Customer behavior - Consumer-environment interaction
Suppliers	- Supply chain design - Insufficient communication - Poor management - Relations among the entities - Contractual agreements/requirements - Attitudes of the entities - Lack of knowledge
MACRO-ENVIRONMENTAL FACTORS	
Natural factors	- Weather fluctuations that impact quality of product - Transit time due to weather conditions - Unexpected weather changes that affect consumer behavior
Political factors	- Regulations and government initiatives (eg. Food safety, food donations, food serving)
Economic factors	- Purchasing power of consumers
Sociocultural factors	- Eating habits - Socioeconomic status - Culture of food sharing

Challenges with Quantifying Food Waste

Estimations of food waste have propelled awareness of the issue and inform public policy, but also pose a challenge. The previously mentioned statistic that "one-third of all the food produced for human consumption is not consumed" comes from 2011 a study from the Food and Agriculture Organization (FAO) (Gustavsson et al., 2011). This statistic was the first global cradle-to-grave quantification of food loss and waste (Porter et al., 2016). The report has been widely-cited and contributed to an increase in publications on the topic; however, the accuracy of the "one-third" statistic has been challenged due to the many assumptions and estimations used in the report (Alexander et al., 2017). The quantification of food loss and food waste is vital to understanding the issue and to a degree which effective policies can be developed, yet this data is incomplete across supply chain stages and sectors (Redlingshöfer, B. et al., 2017) (Beretta, C. et al., 2013) (Thyberg and Tonjes, 2016).

There are a few methods that have been used to obtain measurements. Curbside waste audits and analyses of municipal solid waste have estimated household food waste (Parizeau et al.,2015). On-site audits, observations, and semi-structured interviews have been used to estimate waste occurring at a single location, such as at a processing plant or retailer (Dora et al., 2019) (Goodman-Smith et al., 2020). These quantification methods can be time-consuming and tedious, leading many studies to simply generalize these findings to other scenarios (Garrone et al., 2014). However, supply chains and consumer behaviour can differ greatly by location, and a lack of data for specific commodities may necessitate an increase in assumptions, resulting in inaccuracies (Garrone et al., 2014). Competing definitions, as discussed in section 1.1, heighten differences in these methodologies. The inclusion and exclusion of types of food from these varying definitions may make it a challenge to compare different studies, regions, and sectors. Attempts to standardize quantification have emerged, but there are also a few that exist. Available waste accounting methodologies include the "FLW quantification ranking tool," FLW Standard, FUSIONS quantification manual, and "Food waste measurement principles and resources guide" (Corrado et al., 2019).

Appendix B. Summary Statistics and Supplementary Results Tables

Table B1. Summary Statistics

Variable Name	Description	Metric	Obs	Mean	SD	Min	Max
Retailer	Establishment identifies itself as a retailer	0 = no, 1 = yes	134	0.172	0.378	0	1
Hospitality	Establishment identifies itself as a hospitality business	0 = no, 1 = yes	134	0.306	0.463	0	1
Manufacturer	Establishment identifies itself as a food manufacturer	0 = no, 1 = yes	134	0.522	0.501	0	1
Located in Edmonton	One or more location in the Edmonton Metropolitan Area	0 = no, 1 = yes	134	0.612	0.489	0	1
Located in Calgary	One or more location in the Calgary Metropolitan Area	0 = no, 1 = yes	134	0.224	0.418	0	1
Located in another Municipality in Alberta	One or more location in a municipality in Alberta that is not Calgary or Edmonton	0 = no, 1 = yes	134	0.201	0.403	0	1
Manager	Participant has a managerial role in the establishment	0 = no, 1 = yes	134	0.231	0.423	0	1
Owner	Participant has ownership of the establishment	0 = no, 1 = yes	134	0.701	0.459	0	1
Production	Participant has a production role in the establishment	0 = no, 1 = yes	134	0.037	0.19	0	1
Quality Assurance	Participant has a quality assurance role in the establishment	0 = no, 1 = yes	134	0.022	0.148	0	1
Research and Development	Participant has a research and development role in the establishment	0 = no, 1 = yes	134	0.007	0.086	0	1
Size	Number of employees	1 = 1-9, 2 = 10-29, 3 = 30-49, 4 = 50-99, 5 = 100-199, 6 = 200-299, 7 = 300 or more	134	2.097	1.667	1	7
Experience	Years of Experience	1 = 1-5, 2 = 6-10, 3 = 11-15, 4 = 16-30, 5 = 30 or more	134	2.821	1.408	1	5

			N	Mean	SD	Min	Max
Vignette Number Assigned	Random assignment of Vignettes	(See table 2)	129	4.806	2.547	1	9
Vignette Rating	Rating of "How likely would your business be to participate in this program?"	Slider from 0 (Very Unlikely) to 10 (Very Likely)	129	6.574	2.971	0	10
Recognition Benefit	Rating of how effective a program with this benefit would be at reducing food waste at your business: Recognition and awards for businesses that reduce food waste	0 = Not at all, 1 = Somewhat effective, 2 = Effective, 3 = Very Effective	116	2.164	0.844	1	4
Monetary incentives	Rating of how effective a program with this benefit would be at reducing food waste at your business: Monetary incentives (eg. Grants, tax credit, access to a loan)	0 = Not at all, 1 = Somewhat effective, 2 = Effective, 3 = Very Effective	116	3.172	0.953	1	4
Training Benefit	Rating of how effective a program with this benefit would be at reducing food waste at your business: Training for staff and employees	0 = Not at all, 1 = Somewhat effective, 2 = Effective, 3 = Very Effective	116	2.845	0.851	1	4
Website Benefit	Rating of how effective a program with this benefit would be at reducing food waste at your business: A website with information about how your business can reduce food waste	0 = Not at all, 1 = Somewhat effective, 2 = Effective, 3 = Very Effective	116	2.414	0.924	1	4
Workshop Benefit	Rating of how effective a program with this benefit would be at reducing food waste at your business: A workshop, seminar, or conference	0 = Not at all, 1 = Somewhat effective, 2 = Effective, 3 = Very Effective	115	2.374	0.853	1	4
Roundtable Benefit	Rating of how effective a program with this benefit would be at reducing food waste at your business: Roundtable discussions	0 = Not at all, 1 = Somewhat effective, 2 = Effective, 3 = Very Effective	116	2.422	0.886	1	4
Information Campaign Benefit	Rating of how effective a program with this benefit would be at reducing food waste at your business: An information campaign	0 = Not at all, 1 = Somewhat effective, 2 = Effective, 3 = Very Effective	116	2.448	0.926	1	4
Percent of FW Sent to Landfill	Approximate amount of food waste produced at the business that goes to landfill (in percent)	0-100% in increments of 10%	115	0.226	0.299	0	1

Switch Tech	Would your business switch to a new process or technology that reduces food waste?	0 = no, 1 = yes	115	0.817	0.388	0	1
Pay for FW Reduction Process	Would you still switch if the overall costs of the new system are more than your waste disposal costs?	0 = no, 1 = yes	94	0.351	0.48	0	1
Cost Savings to Switch	Cost savings necessary to switch (% of current total)	Slider from 0-100% of cost savings	58	0.326	0.235	0	1
WTP for FW Diversion	Willingness to pay for a diversion service (additional % of current total)	Slider from 0-100% of additional amount spent	109	0.19	0.228	0	1
Low quality inputs	Level of concern of low quality inputs as a cause of food waste	1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Very	103	2.029	1.024	0	4
Tech malfunction	Level of concern of technical malfunctions as a cause of food waste	1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Very	103	1.942	0.968	0	4
Human error	Level of concern of human error as a cause of food waste	1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Very	103	2.311	0.97	0	4
Forecasting and ordering	Level of concern of forecasting and ordering as a cause of food waste	1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Very	103	2.175	1.192	0	4
Customers waste	Level of concern of FW caused by customers as a cause of food waste	1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Very	103	1.816	1.281	0	4
Negligible FW	We produce a negligible amount of food waste	1 - 5 Likert	103	3.592	1.324	1	5
Benefit from reducing FW	Our business would benefit from reducing its food waste	1 - 5 Likert	103	3.515	1.212	1	5
Subjective Norm of reducing FW	Most people who are important to the business believe that reducing food waste is important	1 - 5 Likert	103	4.097	0.995	1	5
Perceived Behavioural Control of FW Production	We have control over how much food waste we produce	1 - 5 Likert	103	4	0.98	1	5
Actively looking for ways to reduce FW	We actively look for ways to reduce our food waste	1 - 5 Likert	103	4.243	1.062	1	5
Measure FW	We measure the amount of food waste we produce	1 - 5 Likert	103	3.136	1.415	1	5
Know FW Causes	We know the causes of food waste within our operations	1 - 5 Likert	103	4.32	0.888	1	5

Variable	Description	Scale	N	Mean	SD	Min	Max
Encourage FW Reduction	Managers encourage employees to reduce waste	1 - 5 Likert	103	4.214	0.987	1	5
Donation	Working with organizations that donate surplus food to community organizations	0 = no, 1 = yes	103	0.32	0.469	0	1
Animal Feed	Working with businesses that convert food waste to animal feed	0 = no, 1 = yes	103	0.146	0.354	0	1
Biobased	Working with organizations that convert food waste to biobased products (eg. bioenergy)	0 = no, 1 = yes	103	0.058	0.235	0	1
Give for Sale	Working with businesses that convert food waste into products that they sell	0 = no, 1 = yes	103	0.049	0.216	0	1
Take Home	Giving extra food to employees	0 = no, 1 = yes	103	0.612	0.49	0	1
Recycling	Recycling surplus food into products that your business sells	0 = no, 1 = yes	103	0.291	0.457	0	1
Consultant	Working with consultants to improve food waste management	0 = no, 1 = yes	103	0.058	0.235	0	1
# of Diversions	Sum of total number of diversion methods adopted	0 - 7	103	1.476	1.211	0	5
Interest in Donation	Interested in, but not currently working with organizations that donate surplus food to community organizations	0 = no, 1 = yes	70	3.1	1.169	1	4
Interest in Animal Feed	Interested in, but not currently working with businesses that convert food waste to animal feed	0 = no, 1 = yes	88	3.33	1.036	1	4
Interest in Biobased	Interested in, but not currently working with organizations that convert food waste to biobased products (eg. bioenergy)	0 = no, 1 = yes	97	3.433	0.912	1	4
Interest in Giving for Sale	Interested in, but not currently working with businesses that convert food waste into products that they sell	0 = no, 1 = yes	97	3.113	1.108	1	4
Interest in Take Home	Interested in, but not currently giving extra food to employees	0 = no, 1 = yes	39	2.795	1.128	1	4
Interest in Recycling	Interested in, but not currently recycling surplus food into products that your	0 = no, 1 = yes	73	2.822	1.194	1	4

	business sells						
Interest in Consultant	Interested in, but not currently working with consultants to improve food waste management	0 = no, 1 = yes	97	2.897	1.015	1	4
# of Diversions of Interest	Sum of total number of diversion methods of interest	0 - 7	103	2.437	1.824	0	6
Lack of Info	Lack info on donation is a barrier	0 = no, 1 = yes	100	0.24	0.429	0	1
Lack of employee info	Lack of employee info on donation is a barrier	0 = no, 1 = yes	100	0.09	0.288	0	1
Lack of Organizations	Lack of organizations accepting donations is a barrier	0 = no, 1 = yes	100	0.18	0.386	0	1
Safety/legal concerns	Safety/legal concerns of donation	0 = no, 1 = yes	100	0.59	0.494	0	1
Cost of donating	Cost of donating is a barrier	0 = no, 1 = yes	100	0.24	0.429	0	1
Type of food constraint	Type of food is a barrier to donation	0 = no, 1 = yes	100	0.52	0.502	0	1
Donation restrictions	Restrictions are a barrier to donation	0 = no, 1 = yes	100	0.25	0.435	0	1
Organizational capacity constraint	Org capacity is a barrier to donation	0 = no, 1 = yes	100	0.19	0.394	0	1
Meat, Dairy, Seafood	Processes/manufacturers meat, dairy, seafood products	0 = no, 1 = yes	55	0.309	0.466	0	1
Bakery and Confectionary	Processes/manufacturers bakery and confectionary products	0 = no, 1 = yes	55	0.436	0.501	0	1
Grain and Oilseed	Processes/manufacturers grain and/or oilseed products	0 = no, 1 = yes	55	0.073	0.262	0	1
Beverage	Processes/manufacturers beverages	0 = no, 1 = yes	55	0.055	0.229	0	1
Fruit and Vegetable	Processes/manufacturers fruit and/or vegetable products	0 = no, 1 = yes	55	0.036	0.189	0	1
Fresh Food	Establishment processes/manufactures fresh food	0 = no, 1 = yes	54	0.407	0.496	0	1
Frozen Food	Establishment processes/manufactures frozen food	0 = no, 1 = yes	54	0.389	0.492	0	1
Ambient Food	Establishment processes/manufactures ambient food	0 = no, 1 = yes	54	0.444	0.502	0	1

Appendix C. Survey Questionnaire

Information Letter

Please read the following information before proceeding with the survey. You are invited to participate in this research study about perspectives of food business towards programs that may improve operational efficiencies. You have been asked to participate because you represent a food business in Alberta. This research is being conducted as part of a master's thesis at the University of Alberta.   Survey information: In this survey, we will ask for your opinions and knowledge about the food industry in Alberta. There will be a series of scenario questions about programs that may support your business.

Time commitment: We estimate that the survey will take you 15 minutes to complete.

Voluntary Participation: Participation in this survey is voluntary. You may decline to answer questions even if participating in the survey. You may decide to exit the survey at any time. As no personal identifiers will be collected with your data, you will not be able to withdraw. Confidentiality and Anonymity: The information that you share will remain strictly confidential. At the end of the survey, there is an optional question to include your email for follow-up purposes and for survey results. Except for this question, no personal identifiers will be collected. Any identifiers that are collected (i.e. your email) will be replaced when data collection is complete.   Further Information: If you have any questions or require more information about the study, please contact the investigators at the following information: [Investigator and Supervisor contact information provided]

The plan for this study has been approved by a Research Ethics Board at the University of Alberta. If you have any questions regarding your rights as a research participant or how the research is being conducted, you may contact the Research Ethics Office at 780-492-2615. UofA Ethics ID: Pro00110760

Consent Statement By agreeing to participate, you are confirming that you have read the participant information letter and are giving your consent to participate.

- ❑   Yes, I agree
- ❑   No, I do not agree

Part A. Background Questions

Please select the option that best describes your business. [Select one]
- ❏ Food manufacturer or processor
- ❏ Food retailer or grocer
- ❏ Restaurant and hospitality
- ❏ Agriculture
- ❏ Other:____

Where is your business located? [Check all applicable]
- ❏ Edmonton Metropolitan Area
- ❏ Calgary Metropolitan Area
- ❏ Other municipality within the province of Alberta
- ❏ Outside of the province of Alberta

Please select the option that best describes your main role in the business you represent. [Select one]
- ❏ Owner
- ❏ Management
- ❏ Production
- ❏ Quality Assurance
- ❏ Other:_____

How many employees does your business have? [Select one]
- ❏ 1-10
- ❏ 11-30
- ❏ 31-50
- ❏ 51-100
- ❏ 101-200
- ❏ 201-300
- ❏ 300+

How many years of experience do you have within the food business industry you currently work? [Select one]
- ❏ 1-5 years
- ❏ 6-10 years
- ❏ 11-15 years
- ❏ 16-30 years
- ❏ More than 30 years

Part B: Vignette Scenario

In this second section, you will be shown a scenario related to the reduction of food waste for businesses. For the purposes of this study, food waste is defined as food that was originally produced for human consumption but is sent to landfills, composted, anaerobically digested, combusted, or fed to animals. Common examples include unsold or unused products, plate waste, spoiled food, and peels and trimmings.

Scenario: Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to _____
  1. participate in workshops led by experts to learn how to better prevent and manage food waste.
  2. sit on a roundtable with other businesses in the area to collaborate, discuss, and share ideas.
  3. partner with a local charitable organization that will redirect surplus food that you produce to community members in need.
Participating businesses quality for _____
  1. a tax credit granted by your municipality for surplus food that is donated and food waste that is diverted towards animal consumption, or the creation of biobased materials.
  2. a new recognition award for sustainable food management in your community.
  3. access to expert marketing advice that may reduce costs and lead to income streams and market access

[One of nine scenarios will be randomly assigned]
  1. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to participate in workshops led by experts to learn how to better prevent and manage food waste. Participating businesses qualify for a tax credit granted by your municipality for surplus food that is donated and food waste that is diverted towards animal consumption, or the creation of biobased materials.
  2. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to participate in workshops led by experts to learn how to better prevent and manage food waste. Participating businesses qualify for a new recognition award for sustainable food management in your community.
  3. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to participate in workshops led by experts to learn how to better prevent and manage food waste. Participating businesses quality for access to expert marketing advice that may reduce costs and lead to income streams and market access.
  4. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to sit on a roundtable with other businesses in the area to collaborate, discuss, and share ideas. Participating businesses qualify for a tax credit granted by your municipality for surplus food that is donated and food waste that is diverted towards animal consumption, or the creation of biobased materials.
  5. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to sit on a roundtable with other businesses in the area to collaborate, discuss, and share ideas. Participating businesses quality for a new recognition award for sustainable food management in your community..
  6. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to sit on a roundtable with other businesses in the area to collaborate, discuss, and share ideas. Participating businesses quality for access to expert marketing advice that may reduce costs and lead to income streams and market access.
  7. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to partner with a local charitable organization that will redirect surplus food that you produce to community members in need. Participating businesses qualify

for a tax credit granted by your municipality for surplus food that is donated and food waste that is diverted towards animal consumption, or the creation of biobased materials.

8. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to partner with a local charitable organization that will redirect surplus food that you produce to community members in need. Participating businesses quality for a new recognition award for sustainable food management in your community..

9. Imagine that a food waste mitigation and diversion program is launching for food businesses in Alberta. Through this program, your business has the opportunity to partner with a local charitable organization that will redirect surplus food that you produce to community members in need. Participating businesses quality for access to expert marketing advice that may reduce costs and lead to income streams and market access.

How willing would your business be to participate in this program?
[Scale: 0% (extremely unwilling) - 100% (extremely willing)]

Part C: Program Preferences

Who do you think should be responsible for taking action to reduce food waste? [Check all that apply]
❏ Government
❏ Industry and Businesses
❏ Consumers
❏ Non-governmental Organizations
❏ Other: ____

Next, we will show a few components of potential programs that may motivate your business to reduce food waste. Please evaluate these options based on how important they might be for your business.
[Scale: Not important, Important, 3. Very important]
❏ Recognition
❏ Award system
❏ Monetary incentive (eg. A grant, access to a loan, tax credit)
❏ A website with information about how your business can reduce food waste
❏ A workshop, seminar, or conference discussing how your business can reduce food waste
❏ A series of roundtable discussions with other businesses in the area to collaborate, discuss, and share ideas
❏ Training for staff and employees

What is the approximate percentage of your business's food waste that goes to landfill?
[dropdown] 0-100 10 increments

The disposal of food waste can be a significant cost factor for food businesses. Imagine that your business had the opportunity to internally adopt a new food waste mitigation and diversion process. Compared to your current food waste disposal costs, what is the minimum cost savings that this process would have to offer for your business to implement this new system? [0- 50% cost savings]

Now, imagine that an organization that diverts food waste approaches your business and offers to take all of your food waste and divert it from landfill. How much more would you be willing to pay for this service compared to your current food waste disposal costs? [0-50% more]

Part D: Management and Diversion of Food Waste

For this section, please consider where food waste may occur in your operations. For the purposes of this study, ***food waste is defined as food that was originally produced for human consumption but is sent to landfills,***

composted, anaerobically digested, combusted, or fed to animals. *Common examples include unsold or unused products, plate waste, spoiled food, and peels and trimmings.*

Below is a list of common reasons for food waste. Please rate each cause based on how concerning this cause is for your business. If applicable, please add other causes of food waste that your business experiences.
[Scale: 0: Not sure 1: Not at all concerning, 2: A little concerning, 3: Somewhat concerning, 4: Quite concerning, 5: Very concerning]
- ➢ Products/ingredients arriving are of lower quality than expected
- ➢ Technical malfunctions
- ➢ Human error
- ➢ Overproduction, overordering, and inaccurate forecasting
- ➢ Other:___

Please rate the following statements based on how strongly it pertains to your business. [Scale: 1: Strongly disagree; 5: Strongly agree]
- ➢ We produce a negligible amount of food waste
- ➢ Reducing food waste is beneficial
- ➢ Most people who are important to the business believe that reducing food waste is important
- ➢ We have control over how much food waste we produce
- ➢ We actively look for ways to reduce our food waste
- ➢ We measure the amount of food waste we produce
- ➢ We know the causes of food waste within our operations
- ➢ Managers encourage employees to reduce waste

Next, we will show potential programs that may reduce food waste through collaboration. Please indicate if your business has already implemented this form of collaboration or if it would adopt it.
[Multiple choice grid:Have already adopted, Interested in adopting, Unsure, Unlikely to adopt, Would not adopt]
- ➢ Collaborating with organizations that donate surplus food to community organizations
- ➢ Collaborating with businesses that convert food waste to animal feed
- ➢ Collaborating with organizations that convert food waste to biobased products (eg. bioenergy)
- ➢ Working with businesses that convert food waste into products that they sell
- ➢ Giving extra food to employees
- ➢ Recycling surplus food into products that your business sells
- ➢ Working with consultants to improve food waste management

What constraints or barriers limit your business's ability to collaborate to reduce food waste?
[Check all that apply]
- ❏ Lack of information about how to donate or divert waste
- ❏ Employees are not informed about donation procedures
- ❏ Lack of organizations in my area who divert food waste
- ❏ Safety concerns and legal liability
- ❏ Donating is costly. There is limited time, money, resources, and/or there are logistical difficulties
- ❏ The type of food waste produced is not suitable for human consumption (eg. Shelf-life and product related factors)
- ❏ There are too many restrictions or requirements for donating
- ❏ Organizations that accept food donations do not have the infrastructure or capacity to collaborate with us
- ❏ Other :___

Part E: Attitudes

In this section, we will ask about the perspective of the business you represent. Please rate the following statements as they pertain to your business. [Scale 1. Strongly disagree; 5: Strongly agree]

➢ Dollars and cents is what running a food business is all about.
➢ Most people who are important to my business think that generating profit is essential to running the business.
➢ My business has control over the profits it receives and the costs it incurs.
➢ When planning future activities, maximizing returns is the most important aim.
➢ In the past three years, my business has made improvements that improved profitability and/or reduced costs.
➢ Being environmentally conscious is important to run a food business.
➢ Most people who are important to my business think that being environmentally responsible is essential to running the business.
➢ My business has control over its impact on the environment.
➢ When planning future activities, being environmentally responsible is the most important aim.
➢ In the past three years, my business has made changes which made our business more environmentally sustainable.
➢ Collaboration is important to run a food business.
➢ Most people who are important to my business think that being collaborative is essential to running my business.
➢ My business has control over what types of collaborations and partnerships it has.
➢ When planning future activities, taking a collaborative approach is very important.
➢ In the past three years, my business has maintained or actively pursued collaborations or partnerships with other businesses or organizations.

Part F: Additional Background Information
In this last section, we would like to learn more about yourself and the business you represent.

Years of employment with current business [Select one]
❏ 1-5 years
❏ 6-10 years
❏ 11-15 years
❏ 16-20 years
❏ 21 years or more

IF A FOOD MANUFACTURER - **Please select the industry of the processing/manufacturing business you represent. Please check all that apply**[Check all that apply]
❏ Meat
❏ Dairy
❏ Bakery
❏ Beverage
❏ Grain and oilseed
❏ Fruit and vegetable
❏ Seafood
❏ Sugar and confectionery
❏ Other: ____

IF A FOOD MANUFACTURER - **What types of foods does your business manufacture?** [Check all that apply]

- ❏ Fresh
- ❏ Frozen
- ❏ Ambient/ shelf-stable (eg. dried, canned, jarred)
- ❏ Ready meal
- ❏ Ingredients
- ❏ Other : ____

IF A FOOD MANUFACTURER - **Where are your products sold?** [Check all that apply]
- ❏ Edmonton Metropolitan Area
- ❏ Calgary Metropolitan Area
- ❏ Other municipality within the Province of Alberta
- ❏ Across Alberta
- ❏ Alberta and Other Canadian province(s)
- ❏ Another province not listed
- ❏ National Market
- ❏ Exported to other country/countries

IF A RESTAURANT or Retailer - **How many locations does the business you represent have?** [Select One]
- ❏ 1
- ❏ 2
- ❏ 3
- ❏ 4
- ❏ 5+

Please select your approximate annual sales/revenue (in CAD) [Select one]
- ❏ Less than $50,000
- ❏ $50,000 - $99,999
- ❏ $100,000-$249,999
- ❏ $250,000-$499,999
- ❏ $500,000-$999,999
- ❏ $1,000,000-$5,000,000
- ❏ $5,000,000 or more
- ❏ Prefer not to answer

Did this survey change your thinking about the use of collaboration to address food waste management?
[Scale: 1: Strongly disagree; 5: Strongly agree]