Sorting out sustainable food waste behaviour of households: A comprehensive survey of food waste disposal practices

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Introduction, Relevance to the Profession and Objectives

Globally, one-third of food produced is either lost or wasted along the supply chain (FAO, 2011). Addressing food waste issues at the household level is critical as households are responsible for a substantial proportion of food waste, especially in developed countries (Parfitt et al., 2010). For example, each year, 32% of Australia's food waste is generated by households, and 73% (or 1.8 million tons) of this is sent to landfill (Van Biene et al., 2021).

Household food waste that is avoidable (i.e., food that was edible at some point prior to disposal) continues to receive considerable attention due to the significant economic, social and environmental costs it imposes on current and future generations. However, sending unavoidable food waste (i.e., the parts of food that are not edible under normal circumstances such as meat bones and apple cores) to the landfill also contributes to these issues, including creating a serious environmental burden, especially in terms of greenhouse gas emissions (GHG). Food waste minimisation strategies that aim to prevent food waste altogether can reduce the economic loss for households and the adverse social and environmental effects (Parizeau et al., 2015; Van der Werff et al., 2019). However, even with such minimisation strategies, some food waste remains to be disposed of and needs to be managed (Ladele et al., 2021).

While there is a growing literature on the determinants of household food waste minimisation behaviour (Diaz-Ruiz et al., 2018; Stancu et al., 2016; Stefan et al., 2013), less is known about the determinants of household food waste sorting behaviour (Ladele et al., 2021; Wu et al., 2019). Generally, several food waste disposal options are available to households and, when available, these disposal options can be used simultaneously. Some disposal practices are more environmentally, socially and economically sustainable than others. No known previous research has examined behaviour with respect to a range of possible disposal options that may be available to households. Such an analysis can provide practical knowledge on factors that can promote sustainable household food waste disposal practices, therefore, reducing the volume of food waste sent to landfills.

The present study aims to increase understanding of where households dispose of their food waste, and what factors are associated with sorting food waste sustainably. A survey was designed to capture all possible disposal methods by proportions of food waste disposed to each destination. The proportional data allows a fractional multinomial logit (FML) model to determine the influence of various participant and household characteristics on the proportions of food waste sorted to different destinations. The food waste hierarchy was used to identify three sustainable food waste disposal behaviours of households (reusing food waste for animal feed, home composting, and sorting into the curbside green bin); and three unsustainable disposal behaviours (discarding into the general waste bin, the recycling bin, and sink/others) (Papargyropoulou et al., 2014). Based on a comprehensive review of the literature, three key factors were investigated as determinants of food waste sorting behaviour: psychosocial factors, behavioural and contextual factors, and socio-demographic and household characteristics.

Research Methods, Analysis and Results

A cross-sectional online survey of metropolitan Adelaide, South Australia households was conducted during April and May 2021 to understand subjective household food waste behaviour, as well as attitudes and understanding of various food-related issues. Participants were eligible to complete the survey if they were aged 18 years or over and lived in metropolitan Adelaide. A market research

company (Pureprofile) programmed and administered the survey. Sample quotas were set for gender and age to obtain a sample that closely matches the gender and age distribution of the general Australian population. Ethics approval for the study was provided by the University of Adelaide Human Research Ethics Committee (approval number H-2020-242).

A total of 1030 respondents completed the survey. Our data analysis consisted of three key steps. First, we calculated the proportion of each participant's total household food waste (in a typical week) that is sorted and discarded in six destinations: 1) general waste bin, 2) organic green bin, 3) recycling bin, 4) compost/worm farm, 5) feeding animals, and 6) sink and others. These six proportions add up to 100%. The largest proportion of food waste was disposed of in the general waste bin (36.3%). The green bin was the second most common destination for food waste (32.3%), followed by the recycling bin (11.5%), compost bin (10.1%), animal feeding (5.9%) and sink and others (3.9%).

Second, we conducted an exploratory factor analysis to reduce a pool of 10 attitudinal items, into two factors: 'Personal benefits' and 'Inconvenience and lack of control' (Table 1). Meanwhile, reliability analysis was applied to constructs drawn from previous studies, including 'Environmental self-identity' and 'Recycling habits' (Table 1) to assess the internal consistency of each construct. The Cronbach's alpha values for the two constructs are 0.93 and 0.81 respectively, indicating good internal consistency.

The third step involved estimation of a fractional multinomial logit model (FML) using the Stata fmlogit package developed by Buis (2008). The aim of this analysis was to understand how attitudinal, behavioural and contextual variables influence the proportion of food waste sorted and disposed of in each destination (green bin, compost, feeding animals, general waste bin, recycling bin and sink/other). Therefore, the dependent variables were the proportion of household food waste disposed of in each destination. The values of the dependent variables are proportions or percentages and they sum to 1 (i.e., 100%). The percentage values are negatively correlated and range between 0 and 1 inclusively. These characteristics of the data make the FML approach appropriate for the present analysis (Papke and Wooldridge (1996) Mullahy (2015). Robust standard errors were used in model estimation to, in-part, control for heteroskedasticity.

The average marginal effects from the FML model estimation are presented in Table 2. The presence of a kitchen caddy is associated with a significantly higher proportion of food waste sorted in the green bin and compost. Of all the predictor variables included in the model, access to a kitchen caddy has the largest impact on sorting behaviour. Further, factors that positively correlate with more food waste sorted in the green bin include perceiving benefits from using the green bin, stronger recycling habits, and university education. As for home compost, factors associated with more food waste sorted to compost include having a kitchen caddy, stronger environmental self-identity, having the ability to make and use compost, being older, higher share of life lived in Australia and larger household size. Characteristics associated with more food waste being reused to feed animals include having pets, being older, living a higher share of life in Australia and having the ability to make and use compost.

Overall, disposing a higher proportion of food waste in the general waste bin (unsustainable behaviour) is associated with stronger perceptions that sorting food waste into the green bin is inconvenient and out of personal control, living in a unit and a higher household income.

Conclusions and Potential for Generating Discussion

Households are responsible for a large proportion of total food waste. Household food waste needs to be managed through improving sustainable disposal practices. A comprehensive understanding of households' sorting behaviour is critical to promoting sustainable food waste disposal practices (e.g. reusing for animals, home composting, and sorting into the green organic bin for curbside collection) and avoiding unsustainable practices that lead to landfilling. Analysis shows that most household food waste is disposed of in the general waste bin even though the curbside organic bin is available. Further, a small fraction of food waste is home composted and/or fed to animals. We found that amongst the factors investigated, possession of a kitchen caddy was associated with a significantly higher proportion of food waste sorted sustainably. Perceived personal benefits promote the use of the green bin while

perceived costs of inconvenience hinder this practice. Consumers with stronger recycling habits (non-organic materials) are more likely to sort a higher proportion of food waste into the green bin.
The results of this study are expected to be of interest to local government and waste management industry that are working on the circular economy. Overall, the findings can help to inform strategies for promoting sustainable food waste disposal practices to divert food waste from landfills.

Key Words

fmlogit, green bin, home composting, curbside collection, disposal behaviour, waste hierarchy, waste management

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Table 1. Summary statistics of explanatory variables (n=1030)

Variable	Definition	Mean (std. dev.)	Min	Max
Women	1=Women; 0=Otherwise	0.50 (0.50)	0	1
Age	Years old	46.4 (17.0)	18	92
University educated	1=University education; 0=Otherwise	0.35 (0.48)	0	1
Household income[a]	Thousands of AUD per year	85.23 (52.53)	12.25	222.30
Share of life in Australia	Proportion of number of years living in Australia over their age (years)	0.52 (0.32)	0.03	1
Working full-time	1=Yes; 0 =No	0.39 (0.49)	0	1
Live in a unit	1=Yes; 0 =No	0.13 (0.34)	0	1
Household residents	Number of residents in the household	2.79 (1.31)	1	10
Having children younger than five years old	1=Yes; 0 =No	0.13 (0.33)	0	1
Have a kitchen caddy	1=Yes; 0 =No	0.56 (0.50)	0	1
Ability to compost	1=Have the ability to make compost, and use the compost generated; 0=Otherwise	0.57 (0.49)	0	1
Have pets	1=Yes; 0 =No	0.65 (0.48)	0	1
Index variables	**Construction variables**			
Personal benefits of sorting food waste to the green bin	To what extent do you agree: (1=Strongly disagree; 2=Disagree; 3=Somewhat disagree; 4=Neither agree nor disagree; 5= Somewhat agree; 6=Agree; 7=Strongly agree)			
	Putting food waste into the Green organics is the right thing to do	5.36 (1.13)	1	7
	I feel good when I sort and dispose of food waste correctly into the Green organics bin			
	By using the Green organics bin for food waste, my general waste bin (e.g.Red or Blue bin stays cleaner and does not need to be taken out as frequently).			
Inconvenience and lack of control in using the green bin	To what extent do you agree: (1=Strongly disagree; 2=Disagree; 3=Somewhat disagree; 4=Neither agree nor disagree; 5= Somewhat agree; 6=Agree; 7=Strongly agree)			
	I do not have sufficient information regarding food waste going into the Green organics bin	3.40 (1.37)	1	7
	It is expensive to buy supplies (e.g. compostable bags, kitchen caddy, etc.) to sort food waste into the Green organics bin			
	I do not want to deal with the smell and the mess of food when sorting food waste			
	It takes too much time and effort to sort and dispose of food waste into the Green organics bin			
	I have no control over food waste as other people in the house are the ones disposing food waste			
Environmental self-identity	Acting environmentally friendly is an important part of who I am	5.25 (1.17)	1	7
	I am the type of person who acts in an environmentally friendly way			
	I see myself as an environmentally friendly person			
Recycling habit	Typically, how often does your household do: (1=Never; 2=Rarely; 3=Occasionally; 4=Half of the time; 5=Frequently; 6=Usually; 7=Always			
	Sort and recycle glass bottles	6.20 (1.11)	1	7
	Sort and recycle paper/cardboard			
	Sort and recycle rigid plastic packaging (e.g. milk bottles, yoghurt containers, fruit punnets)			

Note: [a] Household income is a semi-continuous variable

Table 2. Average marginal effects for fractional multinomial logit modelling of household food waste disposal.

Variable	Sustainable food waste behaviours						Unsustainable food waste behaviours					
	Green bin		Compost		Animal feed		General waste bin		Recycling bin		Sink and other	
Perceive benefit from sorting food waste	0.072***	(0.009)	-0.020***	(0.006)	-0.003	(0.004)	-0.055***	(0.009)	0.003	(0.005)	0.003	(0.004)
Inconvenience and out of control	-0.068***	(0.007)	-0.015***	(0.005)	0.004	(0.003)	0.063***	(0.006)	0.008*	(0.004)	0.009***	(0.002)
Environmental self-identity	-0.042***	(0.010)	0.031***	(0.007)	0.005	(0.005)	0.002	(0.009)	0.003	(0.006)	0.002	(0.002)
Have a kitchen caddy	0.164***	(0.021)	0.032**	(0.015)	0.016	(0.010)	-0.200***	(0.020)	-0.007	(0.011)	-0.005	(0.005)
Recycling habit	0.027***	(0.010)	0.000	(0.008)	-0.002	(0.004)	-0.005	(0.009)	-0.015**	(0.006)	-0.006***	(0.002)
Have the ability to compost	-0.136***	(0.019)	0.146***	(0.011)	0.029***	(0.008)	-0.034**	(0.017)	-0.013	(0.011)	0.009	(0.005)
Have pets	-0.011	(0.020)	0.001	(0.015)	0.068***	(0.007)	-0.054***	(0.019)	-0.007	(0.012)	0.002	(0.006)
Female	-0.016	(0.018)	-0.012	(0.013)	0.014	(0.009)	0.016	(0.017)	-0.006	(0.011)	0.003	(0.005)
Age	0.000	(0.001)	0.002***	(0.000)	0.001**	(0.000)	-0.002***	(0.001)	0.000	(0.000)	-0.001***	(0.000)
University educated	0.043**	(0.020)	0.007	(0.015)	0.001	(0.010)	-0.022	(0.019)	-0.021*	(0.013)	-0.008	(0.005)
Share life in Australia	0.038	(0.038)	0.068**	(0.027)	0.045**	(0.018)	-0.074**	(0.033)	-0.063***	(0.018)	-0.014	(0.009)
Household size	-0.010	(0.008)	0.013**	(0.005)	0.003	(0.003)	-0.009	(0.007)	0.002	(0.004)	0.000	(0.002)
Live in a unit	-0.083***	(0.027)	0.010	(0.021)	-0.001	(0.011)	0.054**	(0.025)	0.004	(0.015)	0.016*	(0.008)
Have a child younger than 5 years old	0.019	(0.029)	-0.037**	(0.018)	0.021	(0.015)	-0.005	(0.023)	-0.001	(0.017)	0.003	(0.007)
Household income	3.7E-08	(1.8E-07)	-2.3E-07	(1.5E-07)	-5.9E-08	(9.4E-08)	4.4E-07***	(1.7E-07)	-1.7E-07	(1.2E-07)	-1.7E-08	(4.9E-08)
Number of observations	1030											
Wald χ^2	1028.09											
Log pseudolikelihood	-1295.56											
Prob > χ^2	0.000											

Note: ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1; Robust standard errors in brackets.