

Article

Understanding Food Waste Produced by University Students: A Social Practice Approach

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Abstract: We use social practice theory to explore food waste produced by university students living in shared apartments. We use qualitative techniques including observation, fridge ethnography, garbology and interviews. The most important factors that led to food waste among university students were a lack of organisation related to the practices of meal planning and shopping, where students did not make lists, plan meals or conduct a food inventory before shopping. Observation of meal preparation revealed that students were unlikely to correctly sort food waste from other sorts of waste, as they did not always have appropriate bins to enable food waste separation. Thus, food waste was not properly disposed of (e.g., composted). Fridge ethnography revealed that both fresh food and leftovers were left or lost in the fridge until no longer edible. Finally, garbology analysis confirmed that a considerable amount of avoidable foods, such as fresh foods and leftovers, were wasted by students and not properly disposed of in curbside composting bins.

Keywords: food waste; avoidable food waste; curbside composting; garbology; fridge ethnography



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1. Introduction

Every year, approximately 1.3 billion tonnes, or one-third of the food that is produced globally, is wasted costing an estimated one trillion US dollars [1–3]. In New Zealand, the site of this study, there is an estimated 157,000 tonnes of food waste created annually or approximately 32 kg per person [4,5]. In addition, 30–50% of food produced worldwide each year never reaches a human stomach [6,7]. Not only is food waste an economic issue, it is also an environmental and ethical issue. Environmentally, with 25% of the world's freshwater supply and 50% of the world's habitable land used to produce food, when food is wasted this is a poor use of these natural resources [8]. Additionally, the production and disposal of food contributes to climate change [9]. Furthermore, although there is an abundance of food produced worldwide, not everyone has equal access to food [10,11].

Food waste refers to discarded food that is still fit for human consumption [12]. It occurs throughout all stages of the food supply chain, however, in developed countries, losses are predominantly in the final stages from a combination of surplus food generation and consumer behaviours [2,13]. Moreover, 60% of this waste is believed to be avoidable [14,15]. A waste hierarchy suggests reducing, reusing, recycling/recovering (e.g., composting), and sending to landfill, as the most to least environmentally friendly methods to mitigate food waste [12,16].

Consumer behaviour related to food waste is complex and many factors influence these practices [17]. However, typically food waste originates from plate waste, spoilage due to poor planning, and excess purchase due to impulse and bulk buying [18]. In addition, studies have shown that young adults are a group susceptible to wasting food, and are therefore one of the largest sources of avoidable food waste and in need of further study [19–21]. For instance, in several European studies young people were the segment most likely to waste food [22,23]. This may be attributed to heightened spontaneity levels, a desire for convenience and limited food management experience [18,24]. However, other research has found that

younger consumers are more likely to engage in food waste reduction behaviours [25,26], and point to the need for context-specific intervention strategies [27]. As previous research has found that student attitudes and attention to food waste differs between those living on-campus and off-campus, likely because those living off-campus have a more direct responsibility for food purchases [20].

Consumer food waste has been studied from a variety of perspectives. Research has explored demographics such as household composition and family income, knowledge of the impacts of food waste, perceptions of food waste, and the role of norms on the intention and action to reduce food waste, the role of packaging among other factors [28–33]. An emerging body of literature explores food-related practices in the context of food waste [34]. Specifically, these approaches adopt the lens of social practice theory (SPT) to examine food waste in relation to daily food related practices [18,35–38]. As Hebrok and Heidenstrøm [39] explain, “food waste cannot be seen as an activity in itself; rather, it is produced as a result of many practices” (p. 1437).

The main objective of this study is to determine the practices that lead to food waste among university students. We explore these practices in the unique context in which many university students live, the shared apartment. We use a variety of qualitative methods to determine what sorts of food are wasted and whether this food is being properly disposed of (i.e., composted). We respond to multiple calls for more research including identifying the categories of household food waste, focusing on curbside composting, and utilizing a multi-method approach to provide a more nuanced account of how and why food gets wasted by university students.

2. Literature Survey

Considerable attention focuses on domestic food waste produced by consumers and developing methods to mitigate this waste [30,40,41]. Several extensive reviews examine the diverse factors contributing to consumer-related food waste [17,34,42,43].

Schanes et al. [34] identify two social ontologies that can be used to characterise this literature. The psychology-oriented approaches aim to explore specific intra-personal, cognitive, motivational, intentional and structural factors and processes related to consumer food waste. However, research has found that intentions to not waste food do not significantly impact reported food waste, but instead food waste is a result of the daily routines that consumers perform [44]. Thus, sociological-oriented approaches focusing on food practices have recently gained traction in the literature [34]. As explained by Hennchen [45], when applying SPT, the focus of inquiry shifts from individual’s deliberate decisions to practices. SPT acknowledges “the individual as embedded in wider social, economic, and cultural facets of everyday life” [34], (p. 981). In this study, we adopt this approach and analyse the dynamics of everyday food practices of university students living in shared apartments and their impact on food waste.

Social Practice Theory

Rather than focusing on individual behaviours and motivations, SPT aims to explore the emergence of practices themselves, by looking at how practices are performed in relation to material, social, spatial, and temporal settings. To understand the theoretical underpinnings of SPT, we must consider the agency–structure problem, where scholars debate the merits of constructionism versus determinism as conduits for change. For example, it has been argued that neglecting to consider deterministic influences is “sociologically naïve” because “people do not develop ideas and ways of doing ‘from within’ by themselves” [46], (p. 814). Rather, people are born into situations with pre-existing materials that are reproduced or transformed through daily practices [47]. Although individuals take part in controlling external objects, these material structures can also influence human agency, so object and human agency become interdependent. Thus, rather than only exploring the individuals who perform practices (agency), or the social constructions that surround them (structure), SPT aims to explore the practice itself [48].

A practice is made up of several elements [49], which are assembled through regular performance of routinised behaviour. The linked components of a practice have been discussed using numerous terminologies, however the slightly differing conceptualisations are mostly similar [50]. We conceptualise a practice as being arranged by connected meanings [51], skills [49] and rules [52]. Meanings refer to the goals of certain practices and also the emotion and related symbolic values [45]. Skills refer to embodied competences which are acquired through repeated performance of a practice [53]. Rules refer to institutionalised knowledge and explicit guides of how things are done [50].

Materials are also a key component of SPT [51]. Materials are the objects, infrastructures, tools and technologies that practitioners mobilise in enacting a practice [49]. However, materials are only efficacious when individuals find meaning, gain skills, and make rules about them [53]. It is through this process of usage or doing that practices can either be reproduced, transformed, or abandoned. Thus, we conceptualise a practice as being enacted by individuals using materials in their everyday life, and their actions with these materials are guided by the interaction of meaning-skills-rules. Material contexts also play a key role in shaping food practices and thus consumer food waste [54].

In this study we utilise SPT to scrutinise daily food related practices in the shared student apartment, to understand how food waste is produced in this context [38]. Given the complex nature of consumer food waste, household food related practices are seen as a sequence of integrated activities, which include planning, shopping, cooking, storing and disposal; that each play a role in food waste generation [17,35,41]. We also respond to calls for research to identify the categories of food that become waste [1] and more research on curbside composting [55]. Moreover, we respond to Schanes et al. [34] call for research that adopts a social practice approach to explore household food waste and uses a multi-method approach to “capture lived experiences and provide a nuanced account of how and why food gets wasted” (p. 989).

3. Methodology

We use multiple qualitative research techniques to understand the food related practices of students living in shared apartments. We explore how they plan and shop for food, prepare food, store food and assess edibility, and how they dispose of the food that they do not eat. The study included observation of an evening meal being prepared in the apartment, fridge ethnography, and garbology, and was complimented by semi-structured interviews. The study received ethical approval from the review board at the University.

The study was conducted in Christchurch, New Zealand between October and December 2019. Christchurch is unique in providing all households with weekly curbside organics waste collection, with three bins provided for rubbish, recyclables, and compostable food and garden waste [56]. The three-bin waste system came into effect in 2009 with the Christchurch City Council Waste Management Bylaw [57]. The use of the system is communicated on the council website, through videos, a booklet provided in 13 languages, the Bin Good app, transit advertising and periodic direct mail to residents. Thus, this site provides a unique material context where households have the ability to easily compost their food waste at the curbside.

In order to conceptualise our findings, we adapt the framework provided by Schanes et al. [34] that depicts household food practices involved in food provisioning. Specifically, we examine the practices of planning, shopping, cooking, storing and assessing edibility, and disposal to understand where food waste originates and the types of food waste. In addition, we use the approach by Hennchen [45] who delineates the elements of each food provision practice—rules, skills and competencies, meaning and materials (see our conceptual framework depicted in Figure 1).

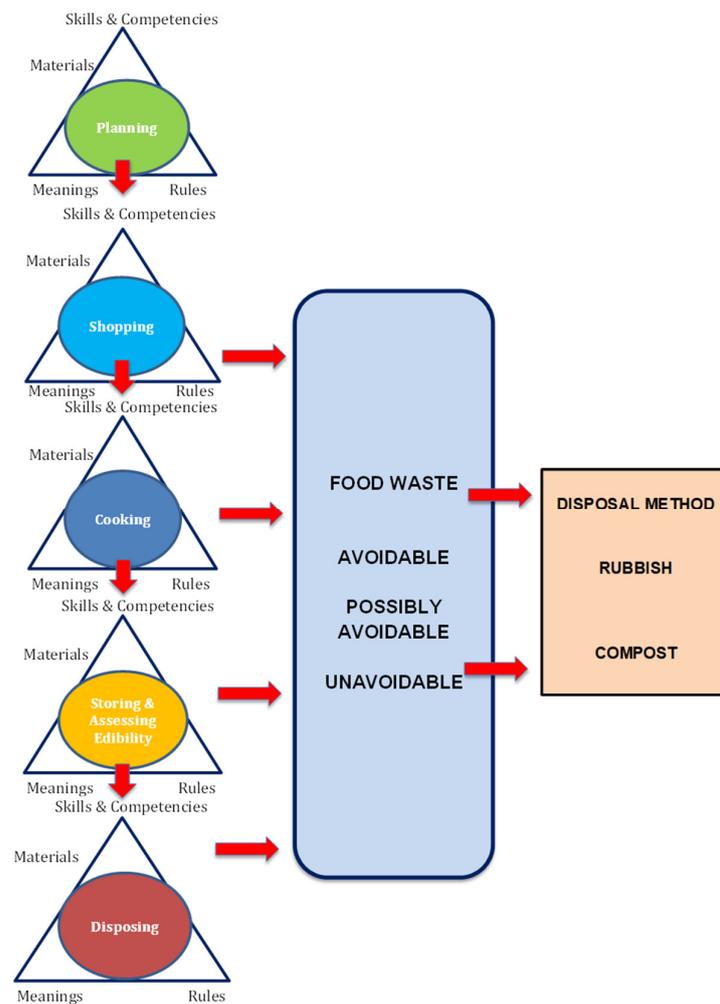


Figure 1. Conceptual Framework.

3.1. Participants and Sampling

Participants were selected if they met the following criteria: University student, over 18 years old, attending one of the three university providers in the city; residing in a shared apartment; and responsible for some portion of the grocery shopping and meal preparation. Non-probability convenience sampling was used where a sample is drawn from the population that is close to hand [58]. Recruiting participants was achieved through postings made on the three university providers' student association Facebook pages. An inducement in the form of a \$20 supermarket voucher was offered to participants. Data saturation occurred when no new categories, concepts, dimensions or incidents emerged [59], which was reached after 19 participants.

3.2. Research Design

The research was conducted in participants' apartments and took approximately one and a half hours. Deception was used, in that participants were told the study was about food preparation, in order to minimise changes in participants' behaviour during the observation and to ensure that the data gathered was reliable [60]. No participants chose to withdraw after the true purpose of the study was disclosed. There were four stages to the research design.

First, we observed the preparation of an evening meal. Participants were asked to perform their usual meal preparation. This technique allowed us to observe the types of food waste, how the waste was treated, and the disposal methods which were in place

within the apartment. Note-taking occurred throughout this process. After the observation, the participants were given a debrief sheet in order to disclose the true study purpose.

Second, a fridge ethnography was conducted. This is a tool designed to gain insight into food storage practices through the materials embedded within them, but also the kitchen infrastructure, technologies and products [39,61,62]. The household refrigerator was selected due to previous studies finding that the majority of expired food waste is housed here [63]. This can be achieved through an unstructured 'rummage', where the researcher touches, photographs and asks questions about the items present [39]. Items were checked in terms of whether they had passed their best-before or use-by dates, and this information was recorded for dairy items and condiments, and participants were questioned about items, such as leftovers found in the fridge.

A garbology analysis was utilised to examine food waste and to determine the composition of food waste in the kitchen bins [64,65]. Garbology has the advantage of studying consumer behaviours directly from the material realities they leave behind rather than from self-reports, as self-report has been shown to underestimate food waste [65,66]. Participants were asked if the researcher could go through their kitchen bins. This process involved taking the kitchen rubbish bin and, if present, the organics bin into the back garden and spreading the contents separately onto a tarpaulin. Once the rubbish was spread, a photo was then taken of the rubbish and all food waste present was recorded. This technique also allowed us to categorise food waste into avoidable, possibly avoidable, or unavoidable food waste [9,67].

Finally, semi-structured interviews were conducted to explore factors that lead to food waste. The questions related to: planning, shopping, cooking, storing, disposal and overall waste behaviours, such as the use of expiration dates, consumption of leftovers, management of bins, among other questions. The interviews were audio taped and then transcribed verbatim. The interview data was analysed by way of thematic analysis [68].

4. Findings

In order to present our findings, we combine the results from the various methods used to collect data, and discuss our findings according to the practices of planning, shopping, cooking, storing and assessing edibility, and disposal. For the practices of cooking, storing and assessing edibility, and disposal, materials are discussed separately.

A total of nineteen university students participated, including nine female and ten male participants between the ages of 20 to 25 years old (See Table 1). The average number of individuals sharing an apartment was six, but ranged from three to ten individuals. Sharing the evening meal was common within the apartment, with 13 out of the 19 apartments sharing most weeknights. Those apartments that did not share meals tended to have individuals with special diets (e.g., vegetarian, vegan). Next, we discuss each of the practices beginning with meal planning.

4.1. Meal Planning

Rules. Planning routines may help to decrease unplanned purchases and limit food waste [69]. Only 13 of the 19 participants stated that they put in effort to plan their meals or to plan before shopping. However, some participants do plan the evening meal, "Just dinners. I do not really ever plan my lunches" (P10). In terms of other planning rules, ten participants stated that they never took a list to the supermarket. Only two indicated they regularly use a list (10.5%) and seven (36.8%) said they sometimes use a list (see Table 2), so less than half (47.4%) of our participants use lists. Some participants would prepare a list if they planned to shop for the whole apartment or the shared meal, "If I do my personal shop at the same time as the apartment shop, so in that case it would be pretty extensive (the list)" (P14). When lists were used, this might take the form of a physical list or one on their phone. Two participants planned the evening meal using a recipe (e.g., materials). Rather than using lists, participants were more likely to make decisions while at the supermarket, "No. Just decide when I get there." (P13). Along with not using lists, none of the students

checked food stocks before shopping. Poor planning practices may result in buying too much food in the shopping stage [43], and poor food supply knowledge can result in food waste [63].

Table 1. Participants.

Participant	Gender	Apartment Composition	Number in Apartment	Share Evening Meal #/Week	Use of List	How Often Shop/Week
1	Female	Mixed	7	0	No	1
2	Female	Female	7	1–3	No	7+
3	Male	Male	4	0	Sometimes	3
4	Female	Female	7	1	Sometimes	5
5	Female	Female	6	6	No	2
6	Male	Male	6	7	No	2–3
7	Male	Male	6	7	No	1
8	Male	Mixed	4	7	Sometimes	2
9	Male	Mixed	6	5	Yes	1
10	Female	Female	5	5	Sometimes	3–4
11	Male	Male	10	5	No	1
12	Male	Mixed	4	5	No	2
13	Female	Mixed	4	5–6	Sometimes	7
14	Male	Male	8	7	Sometimes	1–2
15	Female	Female	4	7	Sometimes	2
16	Male	Male	6	5	No	1
17	Female	Female	3	0	Yes	2–3
18	Female	Female	5	1	No	7
19	Male	Male	5	4	No	2–3

Skills and Competencies. For those who use a list, often this entailed the skill of just writing a few things down, “*Sometimes, when I’m feeling organised . . . Just a few things so I don’t forget*” (P4). However, a few participants showed competencies in planning for the evening meal, the entire apartment, or their whole week of shopping, “*Yep, so we have this apartment list for what we want to do for dinners . . .*” (P9), “*Ahh well it’s like everything we need for the week*” (P15). Although a high degree of skill in planning was rare, it did enable one apartment to reduce food waste:

Well we try and plan out the meals so if we are using certain ingredients which we know may go off, we make sure we use them at the start of the week so we’re not buying something that’s going to be used for the Thursday night dinner, buy it on Monday and the have it go off, so we’ll try and arrange it so we just avoid that (waste) (P9).

Meaning. In terms of the meaning of meal planning, a few participants described their lack of planning as enabling them to take a more novel approach to their meal provision.

“And then I also quite like food so I like to get new ideas and be like oh I actually feel like this tonight so I go and get that as opposed to having food and having to eat that.” (P13)

Another participant suggested the lack of planning was more a lifestyle choice, “*Very like, live life on the edge sort of living*” (P16). It is suggested that the food practices of young consumers are characterised by pleasure and improvisation [70].

4.2. Shopping for Food

Rules. Overprovisioning of food during shopping is a key reason leading to superfluous food [35,36,71], with recent research finding that provisioning has the greatest influence on food waste [72]. An organised structure to the practice of shopping appeared to be lacking for most participants. Rather, participants shop frequently, with nine shopping three or more times per week (see Table 2), and one stating they shop “every day, sometimes more than once a day” (P2). In most apartments, individuals shop for themselves, although some apartments share the shopping. Some have rules around what is shopped for distinguishing between an apartment shop or an individual shopping trip, “Like someone just does like a shop for the apartment” (P12). And some shop for the shared meal, “... every pair goes and buys their food before making their meal” (P11). A few of the participants indicate they purchase what is on special but this was not common.

Skills and Competencies. As participants generally do not do extensive meal planning, when shopping they need skills to make purchase decisions in store. However, planning in store may lead to the purchase of something that is already at home. Participants need to have skills to shop for themselves, a shared meal or the apartment. As one participant describes:

“Normally I get an idea of what I want for the next one or two meals in my head and then go and get the stuff, and then do the same when it’s run out.” (P3).

For those students that shop together, they need to be able to manage the finances for these shopping trips, “one person will usually go and get it and then we will transfer that person later, or split it up later” (P2).

Meaning. Some participants do the apartment or individual shop together with the goal of sharing the task, “Ahh, sometimes we all go, but like if some of us are busy then just one will go” (P15). However, this is not a very satisfying way to shop as they are not always diligent in repaying each other, “But I feel like it’s not a very efficient way of doing it because sometimes we forget (to transfer funds)” (P2).

4.3. Cooking the Meal

Rules. For the shared evening meal, participants have rules around how often they cook, who cooks, how cooking tasks are divided and what is cooked. Cooking in the apartment is more organised and usually planned on a rotation, “It’s a rotation. So umm yea, once every six times” (P7). However, a greater frequency of cooking may enhance cooking skills such as more precise portion control, which may lead to less waste [31,71,73]. In most of the apartments, individuals cook the shared meal individually doing all of the tasks of cooking and cleaning up, “Mostly just one of us but like if we want to help each other out we can” (P9). However, in some apartments, students divide up the tasks. In terms of what is cooked, most participants describe cooking the same thing regularly with only a few trying new things, “yea I don’t branch out very much, generally just stick to what I’m used to” (P5). Research has found that the more repeatable the diet the less food is wasted [65,74].

Skills and Competencies. In preparing the meal, students obviously need cooking and cleaning skills. Yet, most consumers possess limited skills in cooking [32,73]. For those who use a roster, they need to be able to prepare the roster to determine when they will cook shared meals, which may be done on a mobile app (e.g., materials). Several describe how they determine what to cook around what protein (e.g., materials) they have available, “Well we have meat in the freezer, so we decide depending on what kind of meat we pull out” (P6). In addition, a number of participants describe how they plan for leftovers (e.g., materials) when they prepare the evening meal, “... just cause you can save it for a few days and it’s quite a few meals, and you can take it for lunch” (P17). However, over provision of leftovers can lead to food waste when not eaten [75], but those who regularly eat leftovers produce less food waste [44,76].

While cooking, participants need skills to determine how to deal with food waste, with composting the more appropriate option to dispose of food rather than placing it in the rubbish [16]. During the meal preparation, all but one participant created food waste,

with only eight of the participants properly disposing of the waste by putting it into an organics bin and ten putting the food into the rubbish (See Table 2).

Meaning. Participants attributed various meanings to the practice of cooking. For instance, some enjoyed the social aspect of cooking together, “... we just kind of do it in groups cause we find it funny” (P7). Others saw it as a way to support each other in the apartment while generating positive affective feelings.

Just the sort of raw feeling you get from providing for your friends, and the joy on their faces when you put something nice in front of them knowing that they don’t have to cook that night and can just come home to a warm meal (P16).

Some stated that their favourite aspects of cooking was the rewarding feeling from making a good meal for yourself, and that your flat mates “appreciate” (P7), or “just the smile on their (friends) face after having a good meal” (P6). Although some perceive it as a rewarding activity, others describe it as an effort that takes a lot of time. As one explained, “I only do it (cooking) so I have something to eat, I don’t do it cause I enjoy it” (P19).

Participants generally strived to cook tasty or healthy meals, “Like making nice food, and trying to make it a bit healthy” (P5). While many prepared simple, easy and low-cost meals to save time and money. For example, one informant regularly cooked a pork roast because “It’s easy to cook, it’s delicious and it’s cheap” (P14), and another regularly made venison burgers because “that’s like the easiest thing to make” (P5). Cooking was also seen as a means to “express myself” and “try new things” for some. The final aspects of the cooking practice, cleaning up and doing the dishes, was unsurprisingly the least favourite part of the process for almost all participants.

Materials. As discussed previously, all participants, except one, created food waste during meal preparation. Most of the waste created during cooking is classified as unavoidable, consisting of inedible skins (e.g., garlic), stalks (i.e., capsicum, carrot), cores (i.e., cabbage), and rinds. In comparison, very little avoidable food waste was created. However, there was some waste that could be classified as possibly avoidable. This consisted of skins from meat (i.e., chicken) and vegetables (i.e., potato skins); stalks (i.e., broccoli and cauliflower stalks); and cores (i.e., cucumber seeds). Although these items were not utilised at this meal, they can easily be prepared and consumed yet this may require cooking skills students lack [36].

Table 2. Results of Meal Preparation Observation, Refrigerator Ethnography and Garbology.

Participant	Food Waste Created during Meal Prep	Rubbish Bin in Kitchen	Organics bin in Kitchen	Food Waste Properly Disposed of during Cooking	Leftovers in Fridge	Avoidable or Possibly Avoidable Food Waste Found in Rubbish Bin ¹	Avoidable or Possibly Avoidable Food Waste Found in Organics Bin ¹
1	Yes	Yes	Yes	Yes	Yes	Potato wedges, muesli bars, blue cheese	No
2	Yes	Yes	Yes	Yes	Yes	Chicken breast, steak, cooked rice, cucumber, brownie	Apple, asparagus, kiwi fruits, garlic bulbs, broccoli stalk
3	Yes	Yes	No	No	Yes	Green curry, burger, cooked rice, broccoli stalk, bread crusts, ginger	NA
4	Yes	Yes	Yes	Yes	Yes	Whole pie, fried rice, cream cheese, cucumber, hummus, chicken, wraps, feta, salmon skin	Tomato, pear, mushrooms
5	Yes	Yes	Yes	No	Yes	Carrots, apples, cooked rice, cucumber pieces	Cooked corn, rice, and beans
6	Yes	Yes	Yes	Yes	Yes	Bag spinach, packet crackers, avocado, cheese sandwich, spring onions, container mussels, lettuce, 2 hummus, bag of onions, wedge cheese, bag couscous, tomato	Tomato, red onion, cooked porridge
7	Yes	Yes	No	No	No	Pumpkin, whole broccoli, cooked rice, tortillas, lemon, cooked pasta	NA

Table 2. Cont.

Participant	Food Waste Created during Meal Prep	Rubbish Bin in Kitchen	Organics bin in Kitchen	Food Waste Properly Disposed of during Cooking	Leftovers in Fridge	Avoidable or Possibly Avoidable Food Waste Found in Rubbish Bin ¹	Avoidable or Possibly Avoidable Food Waste Found in Organics Bin ¹
8	Yes	Yes	No	No	Yes	Half broccoli, eggs, corn chips, cooked mince, chips, garlic, bag of grated cheese, slices of bread, sushi, potato skins, broccoli stalk, bread crusts	NA
9	Yes	Yes	Yes	Yes	Yes	Takeaway salad, wrap	Potato skins, broccoli stalk, carrot
10	Yes	Yes	Yes	Yes	No	No	Cooked rice
11	No	Yes	No	No food waste created	Yes	Lemon, bananas, peppers, onions, $\frac{1}{2}$ bag of granola, carton of eggs, muesli bar, cheese, pizza crusts, bottle of soda, $\frac{1}{2}$ tin baked beans	NA
12	Yes	Yes	No	No	No	Cucumber, packaged lettuce	NA
13	Yes	Yes	Yes	Yes	No	Cooked mince, cooked chicken, lettuce, salad, broccoli stalk	Cucumber
14	Yes	Yes	No	No	Yes	$2 \times \frac{1}{2}$ loaf bread, cooked mince, pasta, rice, spaghetti, lentil curry, sandwich, canned peaches, onion, mandarin, vanilla custard	NA
15	Yes	Yes	No	No	No	Carrot, $\frac{1}{2}$ loaf bread, $\frac{1}{2}$ lettuce, tomato, chicken skin	NA
16	Yes	Yes	Yes	No	Yes	Bread slices, ham, cooked mince, chicken skin, bread crust	Bacon, cooked pasta, broccoli stalk, bread crust
17	Yes	Yes	No	No	No	Broccoli stalk Rubbish bins emptied that morning	NA
18	Yes	Yes	Yes	Yes	Yes	Chips, salad dressing	Cooked noodles, leftover curry, broccoli stalk, salmon skin
19	Yes	Yes	No	No	No	Cherry tomatoes, salad, corn, dried noodles, bread crusts, canned tomatoes	NA

¹ Avoidable food waste includes foods or parts of food that are considered edible by most people. Possibly avoidable food waste is food that some people eat and others do not (e.g., bread crusts, potato skins). Unavoidable food waste is food that is not, and has not been, edible under normal circumstances, such as vegetable peel, bones, egg shells and coffee grounds [9,67].

4.4. Storing and Assessing Edibility

Rules. When conducting the fridge ethnography, we found a few of the participants diligently tried to use leftover stored ingredients to avoid waste, “I don’t like wasting food. I will use every vegetable . . . like roast it or put it in a soup” (P13). However, a barrier to cooking with what is found in the fridge requires time, knowledge and cooking skills to better utilise food creatively [35,36,63,77]. In addition, many admitted throwing away produce as soon as it showed signs of losing freshness, as one explained “I’m pretty quick to put it in the bin. I don’t really try and salvage it, but if it looks like it’s going off then it’s gone” (P18) and another saying “they’d (produce) probably go in the bin,” and when asked if they would try and salvage any of the item they said “F*ck no. Binned” (P19). Most people do not want to risk getting ill and dispose of food that could be edible rather than take that risk [31], with concerns about food safety being a reason for food waste [34].

In terms of rules for expiration dates, most participants stated that instead of using them they were more likely to do a smell and/or taste test to assess edibility, and then check the date if they suspected the item had gone off. The literature shows that people have different ways of judging if food is still fit for consumption [78]. For instance, one

explained, *"I'd normally go off smell, look and taste more than that, but I'd use it (dates) as an indicator"* (P3) and another saying they would use the dates *"more for spoilage, like I'm just really worried about the taste"* (P16). However, meat and dairy were an exception to the *"sniff test,"* as many were worried they would get sick if they consumed them after the expiry date.

Skills and Competencies. A few participants tried to reduce waste by using ingredients in subsequent meals after they had been stored, *"No I try and make something out of it. Like I cooked some mushrooms the other day which had been in the fridge for three weeks"* (P2). Others describe being quite systematic in using stored food, *"We will use it in a meal and then replace it. So say there was that onion in that meal which was half used. So I just replaced it with a full onion and use theirs"* (P10). Most consumers possess limited skills in properly storing food [25,32], with edible food parts discarded [79] when consumers lack the skills to use such food [80].

Meaning. A majority of the participants often had leftovers after cooking a meal, with 14 claiming to regularly have leftovers. Most explained that leftovers rarely went to waste explaining that, *"I'm usually pretty good at eating them yep, as I said I usually take them for lunch the next day (P4)"* and *"Yes. Very good at eating them"* (P13). Male participants were more likely to claim that they ate leftovers with five of the participants from all male apartments stating that they were 'good' at eating leftovers despite all having some form of leftovers in their rubbish or organics bin. Many participants fail to consume leftovers due to losing the desire to eat it or disgust, which have been shown to be a contributing factor to food waste [32,63,81]. For instance, one explained, *"I have had a couple of instances with soup and you just make so much and then you get bored of it, that's why I don't really tend to bulk cook anymore, cause I just get sick of it"* (P7). This often results in the food being thrown out, *"I had enough for lunch and then another meal and by the time I had it for dinner and then lunch . . . I was just like oh I don't feel like that so I just threw that out"* (P3). The garbology, discussed later, show a considerable amount of leftovers are not eaten.

Materials. The fridge ethnography showed that refrigerators and freezers were typically quite full. Food items that had spoiled tended to have been pushed to the back of the fridge and forgotten as they were blocked from view by newer items, which can lead to avoidable food waste [32]. As one participant explained, *" . . . lots of shit gets left in there for months"* (P7). Storage practices have been found to be a significant factor leading to food waste, with poor refrigerator organisation resulting in food becoming easily lost and often expiring before being relocated, while systematically storing and categorising food can lower food waste [63,82].

Only six apartments had fruits and vegetables in their fridge which all appeared to be relatively fresh. Fruits and vegetables which were hidden from view, such as at the back or in a fridge drawer, were likely to have started going off. Carrots, lettuce and pre-packaged salads were found to be one of the most common items left lingering in the refrigerator. This is likely because they are often purchased in bulk or larger amounts than what is desired, with excessive packaging sizes a cause of food waste [83]. Dairy products were typically within the expiry date. When dairy products had expired, they had been sitting in the fridge for a considerable period of time. In comparison to dairy products, condiments were more likely to have passed their best-before dates with only five apartments having all condiments within their expiry dates.

Leftovers are one of the largest categories of food waste second only to fresh foods [70,75]. Seven apartments had no leftovers in the refrigerator, however the remaining twelve had leftovers of some kind. Three of the apartments had some leftovers which were one to two days old. Seven had leftovers which were thought to be up to a week old, and participants were unsure of who they belonged to or when they would be eaten.

4.5. Disposal

Rules. Curbside organics collection programmes require households to separate food and organic materials from household waste [84]. In terms of rules for separating food waste from general rubbish, although ten of the apartments had some form of organics bin

in the kitchen (See Table 2), many participants admitted that the bin was not always used, and food waste often ended up in the general rubbish, which we also observed during the meal preparation. One informant stated *“well if the compost bin is full I’ll probably just put it in the rubbish”* (P2) and another saying *“we sometimes get a bit lazy (using the organics bin)”* (P4). Furthermore, some said they had tried to implement an organics bin system however their roommates had not accepted it, *“I tried at the start to do it (use a organics bin) but it’s more just the fact that no one can be f*cked doing it”* (P7).

In terms of rules for taking the rubbish out, a majority of the participants stated that their apartment had no set rotation with only two having a set rotation for the task. Most explained that someone would just *“use their initiative”* and do it when it was time with one saying *“like if you can’t stack it without something falling out then you’ve got to take it out”* (P12). Another explained *“I don’t think there is actually a specific way of deciding who does it. We kind of just get it done”* (P6).

Skills and Competencies. In terms of skills for disposal, students have to know the Council rules in terms of what waste can be recycled, composted or put directly into the rubbish, and when the different bins are collected, as not all bins are collected each week. Research finds that perceptions about the difficulties related to composting are an important determinant of the effort people are prepared to make [85]. One student whose apartment has mastered this system explains, *“So we have a bin in our kitchen, that we put or scraps or waste into and that goes out into the green bin which gets collected every week”* (P9). They also have to have skills to create an in-house waste system and to create a rotation system for who takes these bins out, *“I have a reminder set on my phone weekly to take the bins out”* (P17). One participant explains their system, *“Rubbish, recycling and organics bins in the kitchen. In the green, red and yellow bins, and there’s the compost bin (green) . . . ”* (P16). Having material infrastructure, both inside and outside the home, is key to supporting curbside composting [86–88].

Meaning. Disposal of waste may be impacted by meanings participants attribute to or feelings about the practice. Some of the participants saw the importance of minimising food waste and managing it properly, *“food scraps or anything we make sure it goes in that little jar, container thing and we put it straight into the green bin”* (P10). However, many participants perceived little value in the practice and describe that they *“just chuck it (food) out”* (P15). As composting involves interaction with food waste in the kitchen, some argue that composting is perceived as a difficult behavior for participants [84]. For instance, one participant explained, *“the compost bin is just getting soaked at the moment cause it was getting a few too many flies in it . . . ”* (P13). Another explained, *“Nah we don’t actually have a compost bin inside . . . Food compost bins are disgusting, they smell and get flies”* (P8). Prior research has found challenges with implementing composting practices due to concerns about the possibility of attracting vermin and causing odors [89].

Materials: In Christchurch, an in-house waste system should include three separate bins: one for general household rubbish, one for recycling, and one for organic compostable waste [90]. However, this was not the case for most of the apartments that did not have all three types. Unsurprisingly, all apartments had some form of bin to dispose of kitchen and household waste (See Table 2). A majority of these bins were quite full, and it appeared that the system in most apartments was to fill the rubbish bin until it was overflowing before taking it out. Recycling bins were not as common with 14 out of the 19 apartments having a recycling bin, usually a large cardboard box. Organic bins were the least common, with only ten of the 19 apartments having one (See Table 2). These bins were usually a small plastic bin.

Garbology was utilised to determine what categories of food students waste and whether these materials are properly disposed of. Although ten apartments had a designated organics bin in the kitchen, it did not mean it was always used. As the organics bin was typically quite small it filled up quickly, and thus it was easier for participants to put food waste that did not fit into the organic bin into the rubbish bin instead, as previously discussed.

We found that all of the apartments, except one, had some form of avoidable or possibly avoidable food waste in the kitchen rubbish bin (See Table 2) [9]. Avoidable food waste was the largest portion of food material found in the rubbish bins. Most of the food was used or partially used and included a range of items from the fruits/vegetables, dairy, leftovers and other. In terms of fruits and vegetables, many of the items had gone moldy, however many appeared to be edible with either few or no bruises. For example, we found whole apples, pumpkin, heads of broccoli, carrots and capsicums. Many researchers argue that one of the essential causes of food waste in households is consumers' unwillingness to consume imperfect foods [42,91]. In regard to dairy products, these were all partially used and included different types of cheese. Although some had gone past their best-by date, none of the items were moldy. Condiments were less common. Of the discarded leftovers, a majority were meals that had been cooked in the apartment and were then half eaten, which is similar to previous research which found vegetables and home-cooked food were the largest categories of food waste [92]. There were also a variety of 'other' avoidable food waste items found in the rubbish including bread, cooked and uncooked meats, and whole eggs including one apartment that had thrown away an entire carton.

Of the ten apartments with an organics bin, only one was found to have no avoidable food waste in their organics bin. Fruits and vegetables and leftovers were the most common categories of avoidable food waste we found. There was a mix of partially used and unused materials, with many of the fruits and vegetables being thrown away due to having gone moldy. In terms of leftovers, cooked carbohydrates such as rice and pasta were common. This is not surprising, however, as it can be hard to estimate the desired portion of these types of food. Previous research has found avoidable waste makes up the largest category of food waste, with the highest avoidable waste including bread, cereals, potatoes, unprocessed vegetables, fruits, rice, and pasta [93–96].

Possibly avoidable food waste was less common than avoidable food waste. This category is also difficult to judge as the criteria for determining what is 'possibly avoidable' is ambiguous and changes from person to person [97]. However, the possibly avoidable food waste found in the general rubbish and organics bins consisted mostly of skins and peels from kiwi fruit, pumpkin, kumara, potato, carrot, salmon and chicken, as well as broccoli stalks and bread crusts (See Table 2).

5. Discussion

This research explored food waste in the context of university students living in shared apartments. Despite being one of the largest food wasting groups, university students are often overlooked when it comes to food waste prevention [19,20]. Previous research has focused on the knowledge, awareness and concern about food waste of university students and self-reported behaviour [20,21,98–100], how waste is generated in University canteens [47,101–104] or among those living on campus. We used multiple qualitative methods to explore three research questions: the factors that lead to food waste among university students living in shared student apartments; what sorts of foods are wasted; and whether food waste is being properly disposed of (i.e., composted). We utilised SPT to conceptualise daily food related practices related to preparing a meal in the apartment, which include planning, shopping, cooking, storing and assessing edibility, and disposal, to understand how food waste is produced by identifying the rules, skills, meanings and materiality in this context.

We find a number of factors lead to edible food becoming waste. Like other consumer groups, students exhibit poor meal planning. We found students fail to create rules or learn skills to organise for the meal. Few of our participants regularly use a list. Our findings are less than previous research by Di Talia and colleagues [30] who found that 28% of respondents regularly use lists. Failure to use shopping lists can lead to too much food being purchased [30,105] contributing to food waste [32,63]. This corresponds to previous research that found many individuals neglect to use shopping lists with younger respondents, the least likely [75].

Our participants also failed to take an inventory of food at home before shopping and plan meals while in-store, which also leads to too much food being purchased [20,106]. Surplus food was evident in the fridge inventory where useable food was lost behind other items leading to spoilage, which has been found to lead to avoidable food waste [21,32], and was also evident in the garbology analysis where useable food was found in both rubbish and organic bins. Stefan et al. [44] found that planning and shopping practices have the largest influence on food waste creation, and suggest students need to develop skills around shopping routines (e.g., buying only what is necessary, lists, taking food inventory) to lower food waste.

All participants were responsible for purchasing some portion of the food. Often students were only shopping for themselves or the shared meal with little effort to fully coordinate purchases. This meant there was too much food being purchased for the apartment and ultimately food waste. Students shopped frequently, which could lead to less food waste as only what is needed is purchased during each trip [73,83] however we did not find evidence of this with frequent shoppers (5+ per week) also having edible food in the rubbish or organic bins.

While cooking, food waste was created but most was classified as unavoidable waste (e.g., skins, rinds) with only a small amount considered avoidable (e.g., dressing). Thus, cooking was not the source of avoidable food waste. However, the issue was that many students did not properly dispose of the cooking food waste (e.g., compost) but rather placed it in the rubbish bin. In terms of the rules of cooking the evening meal, many participants described cooking the same meals, which could lead to less waste [65,74]. However, this did not align with what we found in the garbology analysis where we discovered considerable amounts of cooked items in the rubbish and organics bins. Furthermore, many participants said they cooked larger amounts to ensure there were leftovers [107]. However, leftovers are one of the largest categories of food waste [70]. Our participants claimed to regularly eat leftovers, especially males, which should produce less food waste [44,76], however this did not correlate with the garbology findings with leftovers being one of the largest categories found in the waste. Moreover, many respondents expressed having no desire to consume leftovers once they had eaten them several times, often getting sick of them or leaving them for too long and then throwing them away. Food that is considered as imperfect, non-edible, or socially embarrassing, such as leftovers, may end up being wasted [108].

In terms of disposal practices, many students did not dispose of wasted foods in the correct manner because they had simply not set up an organics bin in their kitchen. Only half of the apartments had some form of bin specifically for organics. Past research points to having material infrastructure, both inside and outside the home, to support correct disposal and recycling practices [86,87,109]. Moreover, even if a particular apartment had an organics bin in their kitchen, it did not mean it was used. Proper sorting of food waste from other rubbish was influenced by laziness in not regularly dumping the organics bin into the curbside organics bin, and some roommates who refused to use kitchen organic bins. This was found in the garbology stage where all of the apartments had some food waste contamination in their general rubbish bin, with some apartments general waste being made up predominantly of food waste. Wu et al. [55] find that perceived lack of time and inconvenience are reasons consumers do not use composting.

In terms of storage and assessing edibility practices, the desire for quality held by many of the students meant that they were quick to throw away produce as soon as it lost freshness or showed any cosmetic deterioration. The aesthetics of food products and the view that what is ugly is bad [79,110] causes food waste, especially of imperfect or unattractive (e.g., misshapen, blemished) food [111]. This was confirmed by the garbology analysis where many fruits and vegetables were found to still be edible despite visual imperfections. When it comes to food, contagion operates very powerfully as individuals show strong aversions to foods that are deemed disgusting or harmful [79]. Therefore, superficial imperfections such as a small bruised spot on a piece of fruit can act as a

contamination cue, which triggers thoughts of health and safety [79] leading to food being discarded. Thus, storing food for too long, as too much food has been purchased or food is lost in the refrigerator, is a source is an important source of food waste among students, and has been found among other consumer groups [67].

A common factor that drives consumers to discard leftover food is the risk of foodborne illness and the desire to eat only the freshest foods, with some consumers using date labels to make decisions on when to discard food [42,78]. In addition, misreading or misinterpreting packaging information such as expiration dates may facilitate food waste [32]. However, most or our participants did not initially take notice of expiration dates on stored food. Instead visual or sensory cues were used to determine freshness and edibility. Expiration dates were used as a secondary cue to confirm this initial assessment. Thus, it appears that students in our study are not disposing of food due to expiration dates, and are willing to taste and smell the food and to eat food beyond these dates, as other research has found [83].

We find that food waste is influenced by an individual's characteristics, including their living arrangements and their age [30,55]. Living in an apartment environment appears to have a significant impact on food practices and resulting food waste; others have suggested the importance of the specific context in the generation of food waste [112]. Students have not developed planning, shopping, cooking, storage, and disposal rules, skills or meanings that encourage or enable them to minimise food waste. This finding is similar to Wu et al. [55], who found that young people are unlikely to use curbside composting, and students in our study did not set up in-house systems to allow them to use the provided curbside composting bins.

Furthermore, due to the generally large number of roommates living in the shared apartments, it appeared that many students lacked personal responsibility and rules when it came to food and general rubbish practices. This was due to the perception that other people in the apartment would engage in food waste minimisation practices rather than themselves (e.g., fridge inventory or clear out, separating waste, taking out bins), or they had not developed rules around who was responsible for these practices. Many of the apartments were noted as having extremely full rubbish bins, across all three types (rubbish, recycling, organics). As food related practices can be time consuming, and therefore, an inconvenience, many students are unlikely to engage in them [44], or due to their busy lifestyles may not prioritise them.

Our findings also correlate to those of Stefan et al. [44] who found that food waste behaviours are derived from a consumer's established behaviours and routines. Thus, an individual's day-to-day activities that become routine practices, such as meal planning, inventory checking, and use of shopping lists impact food waste. This was reflected in findings where many students had no real structure throughout the entire food provisioning process, especially when it came to meal planning, shopping, and food storage responsibilities [106]. In many instances this can lead to the over-purchase and waste of food, particularly when individuals misestimate inventory at home and consequently purchase food they already have on hand. In addition, individuals may over-purchase foods based on the underestimation of time required to consume all the food they have in their basket or trolley, therefore foods go unused and go to waste [113].

Marketing and Policy Implications

Our findings have implications for marketers who seek to develop tools to promote food waste reduction strategies [114]. Firstly, participants had a desire for quality produce and quickly reject foods with any cosmetic defects or deterioration [91]. This may be reinforced by marketers offering 'picture perfect' fresh and packaged foods [91]. In many circumstances however, produce that is cosmetically undesirable is still edible. Therefore, marketers could educate young consumers that imperfect food is still edible, but also make imperfect produce more common in supermarkets, perhaps at a reduced price which may be attractive to students on limited budgets. Retailers who market imperfect foods as an

irregular assortment or at a discount have been found to be successful with this tactic [10], and is an approach that is currently being used in New Zealand in Countdown stores to market imperfect produce under “The Odd Bunch” brand. Imperfect foods could also be marketed highlighting their positive aspects, such as having their own unique identity or being natural and authentic [115], which has also been found to be an effective tactic [42].

Our findings also have implications for policy makers or other groups who seek to develop tools to promote food waste reduction strategies. In order to counteract students’ desire for quality as well as their secondary use of expiration dates, policy makers could also look to reconsider date labels on food. This could be achieved through reconstructing the current date labelling regulations in order to help reduce the complexity of the system and ensure labels are easy to read and understand. Another option is to provide a freeze-by date on perishable items such as meat and bread, to give consumers an opportunity to save surplus items for a later date [116]. Policy makers could also partner directly with Universities or bodies who represent students (e.g., student associations) to educate students on local recycling and composting initiatives and waste reduction behaviours.

Another option is the use of mobile applications (i.e., apps) [63,117], which may be particularly effective for students who we found use their phone for list making. At present there are a range of publicly available mobile applications for helping with the creation of shopping lists (e.g., Out of Milk) and some that allow sharing of shopping lists (e.g., Bring! Grocery Shopping List), which could be useful for students living in shared apartments. However, more attention could be given to the pre-shopping stages including home inventory or meal planning. This could include information, interactive games and reminders on how to complete and make use of a successful home inventory, including the pantry, refrigerator and freezer. This could assist students in purchasing only what they need in order to minimise the amount of food waste. Additionally, students could be provided with online recipes of how to use excess foods [94], or cooking demonstrations in stores or on University campuses which have been shown to be successful in reducing food waste [118].

Our participants often neglected to sort their food waste from their rubbish. Policy makers could combat this through education campaigns focusing on the ability to save money by not wasting food, which may be particularly relevant to students on limited budgets. Education could also focus on the environmental impacts of food waste, which may also be relevant to students [119]. They could also stress not only the importance of minimising food waste, but also the importance of using appropriate waste bins, when provided, to ensure food waste is composted. To achieve this it is critical that students are educated on the need to set up separate kitchen bins for compostable food waste. Education campaigns might occur before students move into their first apartment to ensure they have sufficient knowledge and instill favourable meal preparation practices that minimise food waste (e.g., using lists, planning meals, conducting pantry inventories before shopping). This could be achieved by targeting high school aged students, before they leave to begin university studies, or alternatively first year students living in halls of residence. Policy makers could employ social media influencers to promote favourable food waste behaviours through online platforms such as Instagram and Snapchat. In addition, as curbside composting is rolled out more widely, education is key to successful adoption of these programmes, especially during the implementation stage. Finally, as they launch such programmes, policymakers might consider giving some households, such as students, an in-house composting bin as providing this material can make composting convenient and easy and remove a barrier to this practice [87–89], as a lack of institutional support was found to be a critical obstacle among students surveyed about separating waste [119].

The research has a number of limitations, which present opportunities for future research. As participants were recruited through convenience sampling participants may not be representative of all students. Future research could recruit a more ethnically diverse group of students to see if there are different results. Moreover, due to the time constraints, each participant was observed just once. In order to gain more trustworthy

results, especially in terms of fridge ethnography and garbology, informants could have been observed a second or third time with the volume of food waste recorded each time. This would have also helped to reduce the risk of the bins having just been emptied. In addition, we only had 19 participants, limiting our ability to generalise to the university student population. Future research should replicate the research using a larger sample. This could involve observing a greater number of student apartments in order to gain a deeper insight or alternatively implementing recurring observations of student apartments. Although we used actual measures of food waste, we did not quantify the amount of food waste. Future research could include weighing the food waste found during the garbology stage in order to quantify the amount of contamination found in the general rubbish. Another option would be to ask participants to record personal food diaries. It could also be of interest to perform the study in alternative demographic locations to see how the findings compare to university students in areas which do not have municipal organics curbside collection. This would help to provide a comparison between the food waste practices of university students who have extra material resources available to them (i.e., the curbside organics collection), to those students who do not. Ultimately, it would provide information as to whether university students in Christchurch are unique in their food provisioning practices and resulting food waste. Finally, we did not record whether students were from Christchurch, so we could not determine their level of familiarity with curbside composting. Thus, future research might compare students who were familiar with curbside recycling with those who were not to determine how this impacts their food waste practices.

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