

# **Food waste management: a review of retailers' business practices and their implications for sustainable value**

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## **Abstract**

Food waste is a global challenge that has significant environmental, social and economic implications. Food retailers are in a powerful position to influence food waste reduction by producers, manufacturers and consumers. There is a paucity of worldwide understanding regarding the scope and scale of operations by retailers in minimising/managing food waste. The aim of this research was to develop a systematic understanding of how food retailers deal with food waste both internally and externally, within a five-tier 'food waste hierarchy' framework. This study is based on a qualitative synthesis of 460 articles systematically gathered from nine bibliographic databases and eight grey literature sources and published in English between 1998 and 2019. The review suggests a growing research/reporting interest in retail food waste management. The review identified 199 named and unnamed retailers from 27 countries that have reported some form of the 35 types of food waste management activities. There is evidence of retailers following the food waste hierarchy in reporting their practices with more focus on reducing food waste and redistribution of surplus food for human consumption, and less on recycling and energy recovery by incineration. The wide range of practices adopted by food retailers to mitigate food waste were mapped in a sustainable value framework which showed a typology of five approaches: repositioning, reallocating, reacting, re-engineering and relating. This demonstrates that economic, social and environmental benefits can be realised by retailers' food waste management, but not in a homogeneous way. Further empirical work should be

undertaken to see how different retail business models aligns with the different approaches in the sustainable value framework.

**Keywords:** food waste hierarchy, retail sector, food waste prevention, surplus food redistribution, sustainable value

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## **Highlights**

- A systematic overview of food waste management practices by retailers.
- There is growing research interest in retail food waste management.
- A wide range of retailers follow the food waste hierarchy.
- Sustainable value created by retail food waste management but not in a homogenous way.
- A typology of 5R approaches of food waste management mapped in sustainable value framework.

## 1. Introduction

Food waste is a global challenge that is unequivocally linked to food security and resource management (FAO, 2017) and has significant environmental, social and economic implications (Kowalska and Manning, 2020). It is estimated that over a third of all food produced worldwide goes to waste (Gustavsson et al., 2011). The United Nations have recognised this challenge in Sustainable Development Goal (SDG) 12 ‘Ensure sustainable consumption and production patterns’. This goal includes a specific target (12.3) to:

*by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses (United Nations, 2015).*

In its Resolution of 24 February 1997 on a Community strategy for waste management, the European Council confirmed that *waste prevention* should be the first priority of waste management, and that reuse and material recycling should be preferred to energy recovery from waste, where and insofar as they are the best ecological options (2008/98/EC). The European Waste Framework Directive, revised in 2008, implemented this framework into a new five-step hierarchy of waste management options to its waste legislation (Article 4 of Directive 2008/98/EC), which includes: waste prevention/reduction, as the preferred option, followed by reuse, recycling, recovery (including energy recovery) and, as a last least preferred option, disposal. It should be noted that levels and terminologies in food waste management hierarchies used in other countries may vary, and sometimes the same term may be defined differently. Mourad (2016) for example provides a four-level framework including strong prevention and weak prevention (minimising surplus at source), recovery (reuse for human consumption) and recycling (feeding animals, creating energy or compost). Environmental Protection Agency in the United States (nd) presents a six-tier framework moving from source reduction, to feed hungry

people, feed animals, industrial uses, composting and lastly, landfill/incineration. In this study, a five-level framework for the management of food surplus and food waste adapted from Papargyropoulou et al. (2014) and the above-mentioned options will be applied. This framework shares the key elements of most food waste hierarchies: ‘reduce’ food surplus and avoidable food waste at source, being the first priority, followed by ‘reuse’ of edible food for human consumption, ‘recycle’, ‘recover’ for energy by incineration and ‘disposal’. Recycling of food waste includes feeding animals with food surplus and/or unavoidable food waste, recycling food waste for industrial use such as rendering (i.e. extraction of useful compounds such as proteins and fats) and anaerobic digestion and composting. The least preferred option is ‘disposal’ for example, incineration without energy recovery and sending waste to landfill.

Research on quantification of food waste suggests that only a small proportion of the overall food waste is generated at retail level, e.g. 2% in the UK (WRAP, 2016) and 5% in the EU (Stenmarck et al., 2016). Food retailers, however, are in a powerful position to influence food waste management in the supply chain both upstream (producers and manufacturers) and downstream (consumers) (de Moraes et al., 2020). Much research has highlighted how food waste arises as a result of retailers’ business practices (de Moraes et al., 2020), for example via products not meeting their quality requirements (Mena et al., 2011), food safety concerns (Gruber et al., 2016), use of confusing date labelling (Aschemann-Witzel et al., 2016), lack of staff training and available resources (Goodman-Smith et al., 2020), and marketing that encourages over-purchase (Mena et al., 2011). Retailers are increasingly aware of the need to take actions to manage food waste, not only for compliance and reputational gains, but also for business efficiency. There are initiatives to reduce supplier and consumer waste such as marketing cosmetically imperfect fruit and vegetables (de Hooge et al., 2018), and working with charities to redistribute surplus food (Lebersorger and Schneider, 2014). Indeed, some waste may go simply unrecorded (Cicatiello and Franco, 2020). Governments and non-governmental organisations have also published guidelines

on how retailers can minimise food waste in the whole supply chain (WRAP, 2016). Other studies tend to look at the reporting aspect (Bobe and Dragomir, 2010) or communication to influence consumers (Young et al., 2018) or consumers' attitudes (Louis and Lombart, 2018). Most research on retail food waste management has been based on samples of large retailers in one country such as those in the UK (Arsand and Parry, 2017) and in Sweden (Ghosh and Eriksson, 2019). Where case study approaches have been predominant, the number of retailers studied is still quite small (e.g. Cicatiello et al., 2017). Indeed, there is a paucity of understanding regarding the scope and scale of operations undertaken by retailers in seeking to minimise food waste.

The aim of this review was to develop a systematic understanding of how food retailers address food waste, within the context of the 'food waste hierarchy' framework. The review was based on a qualitative systematic synthesis of published and unpublished literature, to provide an overview of existing practices and areas for future research based on the evidence collated.

## **2. Material and methods**

This review followed the methodology for systematic mapping (James et al., 2016) to collate and then screen the literature relevant to this broad topic. Using a systematic mapping methodology ensures rigorous, comprehensive and objective processes for collating, and screening literature to reduce reviewer selection bias and publication bias, and provide transparency with regard to the decisions made for inclusion of evidence (James et al., 2016). A qualitative synthesis approach was adopted to review the included articles. Whilst the FAO (Gustavsson et al., 2011) distinguishes food loss prior to retailing stage and food waste typically (but not exclusively) occurring at retail and consumption stages, this research has taken a broad perspective in line with Ingraio et al. (2018) and Närvänen et al. (2020) to include both food loss and food waste. Food waste as a collective term is defined in this research as any food which has been produced for human consumption but does not get consumed. This includes the decrease in

volume of edible food reaching consumption stage and the food surplus occurred at any stage in the process of food production, distribution and consumption. Food retailers in the context of this study refers to business entities selling food to households for consumption regardless of size and mode of delivery. Only the food retailers that were mentioned in the sources collated within the scope of this research are included.

## 2.1 Searches for published and grey literature

A comprehensive search for published and grey literature was undertaken using multiple information sources to maximise the likelihood of retrieving relevant records. Search terms were formulated by the review team after a scoping search was undertaken. A scoping search is a process carried out “to understand the scope and the scale of the literature” (Glanville, 2019, p. 82). It normally includes exploring the types and places of publication available to address the review question and databases they are indexed; testing and refining the search terms for enhanced search sensitivity. Keywords were tested for specificity and sensitivity using Science Direct and Thomson Reuters Web of Science Core Collection and a test list of articles was used to evaluate the performance of the search string. Details of the scoping search procedure including **alternative search terms** tested but not included in the final search string can be found in Appendix 1. The following search string was used to capture evidence in bibliographic online databases, organisational websites and a web-based search engine:

(retail\* OR supermarket\* OR store\* OR shop\* OR grocer\* OR baker\* OR superstore\* OR outlet\*) AND (“food waste\*” OR “food surplus\*” OR “surplus food” OR “food loss\*” OR “food redistribut\*” OR “food shar\*” OR “food recover\*” OR “food rescu\*” OR “food bank\*” OR “wast\* food”)

Where possible the first part of the search string (retail\*....) was searched for in the title, abstract and keyword field and combined with the Boolean operator AND with the second part of

the search string (“food waste\*” ....) in the all text field. The search string was adapted to the syntax of each database. Simplified search strings were required for specialist/organisational website searches. The following sources were searched:

- *Bibliographic databases:* Science Direct; Thomson Reuters Web of Science Core Collection; Scopus, EBSCOhost (including CAB Abstracts; Greenfile, Food Science Source & Business Source Complete); Emerald; and AgEcon.
- *Organisational websites:* World Resources Institute; Food and Agriculture Organisation; IGD; World Bank; Organisation for Economic Co-operation and Development (OECD), European Commission (Food Waste); Open-access government; and
- *Search engines:* The first 100 search results of Google scholar were screened for relevant results.

The results captured were imported into and combined in Endnote and all duplicates removed using the automated duplicate removal function. The Endnote file was then manually screened for duplicates and once all duplicates were removed the file was uploaded into Eppi Reviewer 4: systematic review software for screening articles against inclusion criteria.

## **2.2 Screening captured literature for inclusion in the review and data synthesis**

All retrieved studies were screened (assessed) for relevance against inclusion criteria (what the article must contain to be included) developed by the review team. The inclusion criteria were as follows:

- No geographical limits for included articles;
- Only publications in the English language were included;
- Literature was captured from 1998 (following the European Councils resolution of 24 February 1997 Directive 2008/98/EC) to December 2019;
- Evidence from books, book chapters and audio-visual sources were excluded;



- Food waste (as defined above), including milk and milk-based drinks and fruit juice but excluding fish and all other drinks;
- All food retailers (as defined above);
- All food waste management initiatives practised by food retailers (Only findings which are directly associated with food waste were included which means any lean process management practices such as stock management without mentioning food waste were excluded);
- Primary evidence of food retailers' (named and unnamed) food waste management activities reported in academic articles and reports from government and non-governmental organisations; and
- Industry trade and market intelligence publications reporting food waste management activities by named food retailers only.

The collated evidence was screened against the inclusion criteria at title and abstract and then at full text using Eppi Reviewer 4. Ten percent of all the articles collated were screened by two reviewers at title and abstract and a Cohen's Kappa analysis was performed to ensure that bias was reduced, and inclusion criteria were being applied consistently. Where there was uncertainty about inclusion of an article, both reviewers examined the text and a consensus agreement was made. A Cohen's Kappa statistic of 0.6 or higher was considered acceptable indicating substantial agreement between reviewers (Landis and Koch, 1977). This review's Cohen's Kappa statistic for screening on title and abstract was: 0.65. After the consensus was reached, one reviewer completed the screening with any uncertainties discussed and finally agreed with two other members. The number of articles included and excluded at each screening stage was recorded.

All eligible articles included for full text coding were coded using NVivo 12 software. The coding was completed by one member of the review team first and checked by another member. Any disagreement was discussed with a third member until a consensus was achieved. A fourth

member did the final checking of all coding to ensure high consistency and accuracy. At full-text level, the coding comparison of 60 percent of codes in NVivo between two reviewers showed a mean Kappa score of 0.75 (ranging from 0.36 to 0.99). The mean percentage of agreement was 97.8% (ranging from 73.8% to 99%). Pre-defined categories were developed based on the food waste hierarchy as defined in the introduction section, using overarching headings as first level coding: prevention (reduce), reuse, recycling, recovery and disposal. Within each of these main categories, sub-themes of individual activities were captured using in-vivo coding with codes derived directly from the literature. Coding followed an iterative process. Qualitative content synthesis was deemed most appropriate for this review as the aim was to map out the retail food waste management practices rather than looking at any causal relationships.

### **3. Results**

#### **3.1 Searching and screening literature**

A total of 7,693 articles were identified through online bibliographical database searches and Google Scholar. Literature included and excluded at each stage of the review process is detailed in Figure 1.

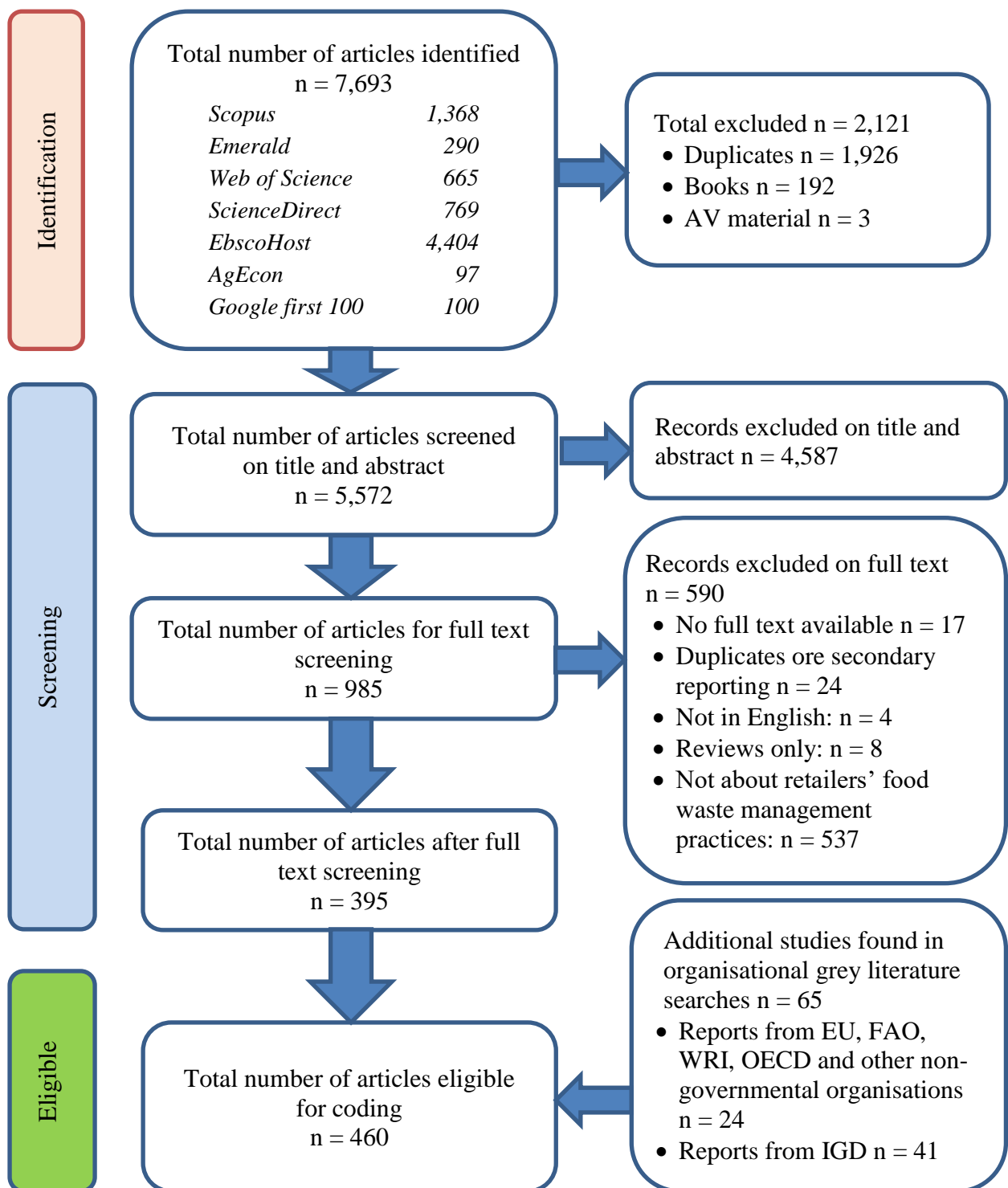


Figure 1. Literature included and excluded at each stage of the review process

Following duplicate removal and exclusion of books, book chapters and audio-visual evidence, the remaining unique 5,572 articles were imported into Eppi Reviewer 4 for screening against inclusion criteria. A total of 4,587 articles were excluded at title and abstract level, leaving 985 articles to be screened at full text. Full text screening against inclusion criteria resulted in a further 590 articles being removed. The reasons for excluding articles at full text were shown in Figure 1. An additional 65 articles were identified in searches of organisational websites. In total, 460 articles were eligible for coding at full text (Figure 1).

### 3.2 Characteristics of included articles

The literature was comprised of 48 peer reviewed articles, 24 reports including those commissioned or initiated by governments and inter-governmental organisations (e.g. EU, OECD, FAO, World Resources Institute and WRAP), and 388 articles from industry/trade publications including those for the retail sector (e.g. Checkout, Grocer and IGD), environment, management, general food sector and trade magazines for other sectors such as packaging, logistics and third sector. The detailed breakdown of articles by type and year of publication is presented in Figure 2.

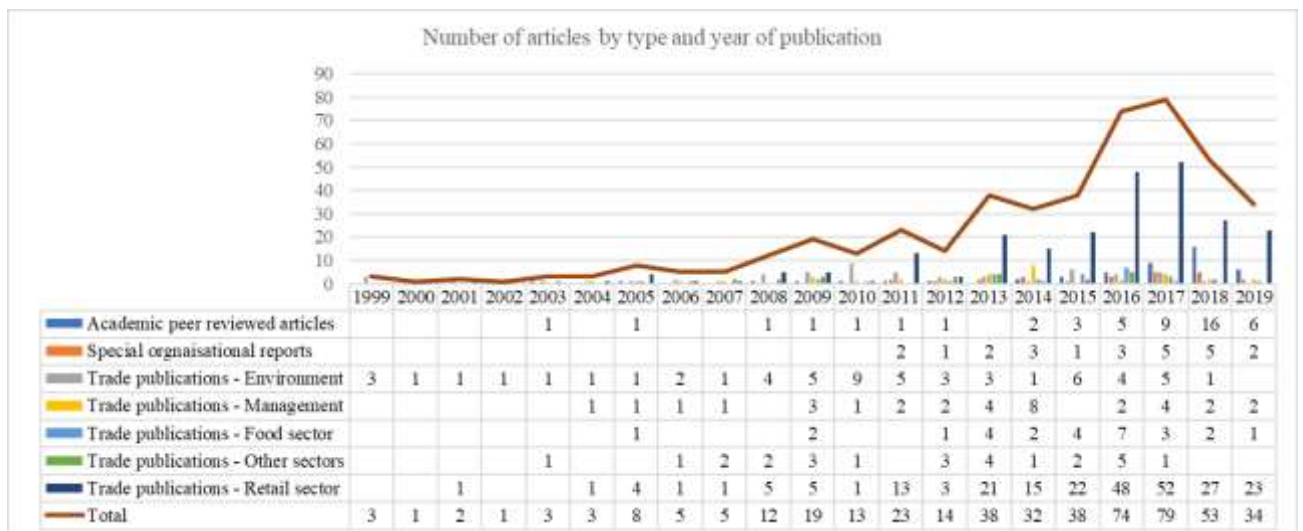


Figure 2. Number of articles captured by year of publication

Figure 2 shows an increase in research/reporting interest in retail food waste management. The highest number of peer reviewed articles was in 2018 with 16 publications. However, peer reviewed articles normally have a time lag (one or two years) of publication so it is realistic to assume that the actual peak of interest in this topic was in 2016 and 2017 which aligns with the peak years of publication of other types of literature. Academic studies were published in 26 journals with the most papers being published in Resources, Conservation and Recycling (n = 9), Journal of Cleaner Production (n = 5) and Sustainability (n = 4). Specific journals where the academic articles were published can be found in Appendix 2.

Regarding the number of retailers reported, in total, 181 named retailers and 18 unnamed retailers were coded (including one category for unnamed European country and one for unnamed developed country, both from the peer reviewed category of sources). Overall, the retailers reported in this study are from 27 named countries with the highest number from the United States (USA) (n = 56) and the United Kingdom (UK) (n = 42), followed by Denmark (n = 21), Netherlands (n = 9), Canada (n = 7), France (n = 7) and Sweden (n = 7). Whilst the majority of the literature reported food waste management approaches that were matched against named retailers, 24 out of the 48 academic articles (from 9 named countries and 2 unnamed countries) and 22 grey articles/reports used either aggregated data or did not name retailers. Where retail chains operate in more than one country (n = 13), each brand was coded as a unique retailer in the specific country/region of operation. Unnamed retailers for each country were coded as one category for the respective country (e.g. unnamed\_USA) and counted as one retailer only. The grey literature reported a much wider range of named retailers (i.e. 115 retailers reported in 412 sources) compared to peer reviewed articles (56 retailers from 48 sources). The detail on the number of retailers reported by country and type and number of publications can be found in Appendix 3.

### **3.3 Retail food waste management practices reported**

As outlined in the methodology, reported waste management activities deployed by food retailers were categorized according to the ‘food waste hierarchy’ using overarching headings as first level coding: prevention (reduce), reuse, recycling, recovery for energy by incineration and disposal. Following this process, sub themes of individual activities within each of these main categories were iteratively captured to provide more in-depth detail.

#### **3.3.1 Overview of the coding structure**

Overall, in terms of themes derived from the hierarchy, the most commonly reported approaches used by food retailers were surplus food reuse (65% of 199 retailers), followed by reduce/prevention measures (62%) and then food waste recycling (45%). Less evidence was reported for energy recovery (9%.) and for the disposal category (6%). Table 1 presents the breakdown of the number of retailers by reported food waste management approaches and by country. If different sources refer to the same reported retailer’s practice(s), the retailer was only accounted once (shown in Appendix 3).

Table 1: Number of retailers by country and food waste hierarchical approaches

Country/Region	Reduce	Reuse	Recycle	Recover for energy	Disposal
Australia	3*	3*	3*		
Austria	1	2*			
Belgium		1*	1*		
Canada	2	6	3		
Chile		1			
Czech	1				
Denmark	20	11*	5	4	4
Finland	2*	2*	1*		
France	5	5	3		
Germany	3	5*	1*		1*
Hong Kong		1			
Hungary	1	5	2		
Ireland	2	2*	1	1	
Italy		3*	2*		
Japan	3*	2*	2*		
Lithuania	1*	1*	1*		
Netherlands	8*	4*	1		1*
New Zealand		1			
Norway	1*	3*	2*	3*	2*
Poland	2	1	1		
Portugal	1				
Puerto Rico		1	1		
Spain	3*	2*	2*		1*
Sweden	4*	2*	6*	2*	
Switzerland	1*	2			
UK	30*	27*	12*	5	
Unnamed Developed	1*	1*	1*		1
Unnamed Europe	1*	1*	1*		
USA	28*	34*	39*	2	2
Total number of retailers reported	124*	129*	91*	17*	12*

\*Including a category of unnamed retailer which may be more than one retailer but is counted as one only. The unnamed retailer may or may not be the same as one or many of the named retailers in the specific country.

The number of retailers (both named and unnamed) reported to have engaged in each type of food waste management activity within the hierarchy was mapped against year of publication as presented in Figure 3. There is a clear trend of increased reporting of activities focusing on reducing and reusing food waste, the top two most preferred options in all food waste frameworks.

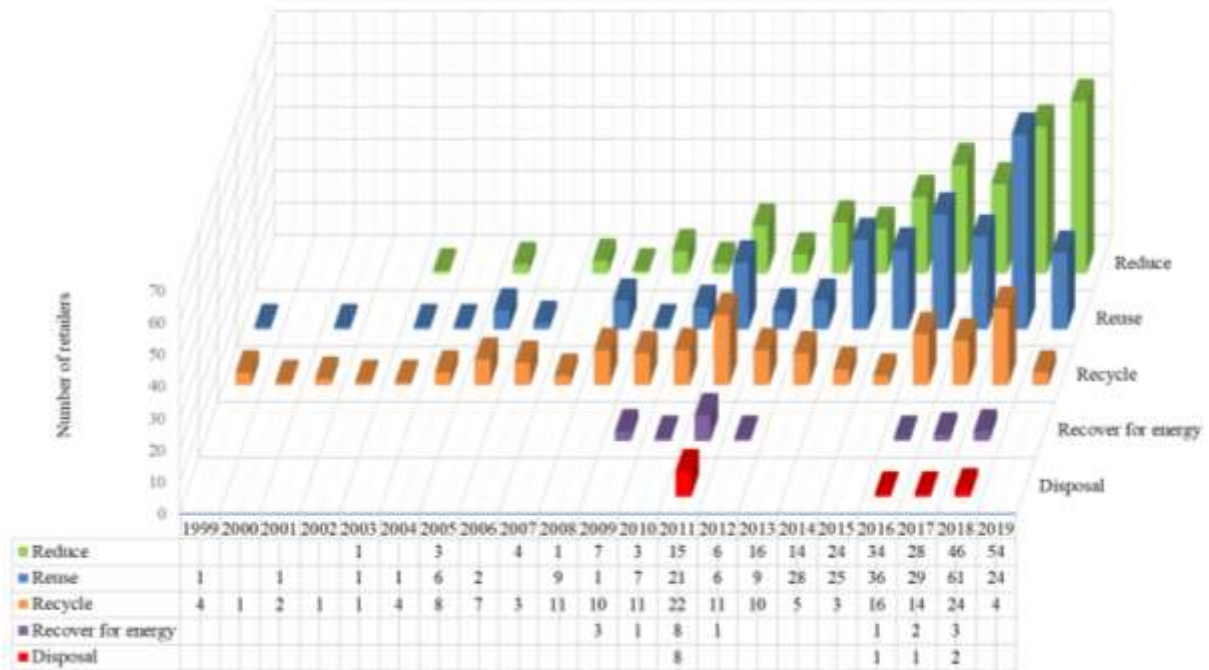


Figure 3. Number of retailers by year and food waste hierarchical approaches

Iterative coding was undertaken under each of the first order categories. Table 2 provides a summary of the coding structure against the number of retailers and number of articles for each category and sub-category. An extensive range of activities were reported for reduce/prevention practised by retailers. List of articles coded for each practice in the sub-categories can be found in Appendix 4. The following sections provide more detailed explanations of the reported activities practised within each main category within the food waste hierarchy.



**Table 2. Retailers' food waste mitigation activities reported between 1999 and 2019**

Food waste management practices by retailers reported in the literature		Retailers	Articles
Reduce		124	240
	Internal	121	209
	Operational changes	117	171
	Change what to offer	60	68
	Sell cosmetically imperfect produce	58	66
	Cut product range or sell long life product	3	5
	Change promotion	63	63
	Reduce price for near expiry date food (in store)	48	29
	Change multi-buy offers	16	28
	Change how products are offered	40	53
	Packaging changes	28	39
	Change date mark	19	15
	Product display rotation	16	8
	Change internal process	48	60
	Training on food waste reduction practices	16	16
	Technical solutions for dynamic pricing and tracking	21	19
	Better temperature control in store	9	10
	Better forecasting	20	15
	Keep record of food waste	11	15
	Help households to reduce food waste	42	66
	Campaigning to raise awareness	37	43
	Cooking guidance and meal planning tools	15	25
	Guidance on storage and freezing	19	20
	External	42	84
	Work with other stakeholders	31	29
	Work with suppliers	25	61
	Change ordering system	17	25
	Loosen cosmetic standards for fresh produce	8	13
	Fixed order or whole crop or bumper crop taking guarantee	5	5
	Streamline supply chain processes	12	33
	Review process with suppliers to reduce waste	10	17
	Review expiry date and extend shelf life	4	8
	Reduce transit time	4	4
	Reuse for human consumption	129	222
	Redistribute surplus (unsold) food to charities	109	192
	Redistribute through partnership arrangement (including through apps and internet platforms)	106	162
	Redistribute to local charities and communities	31	46
	Re-processing unsold food	31	20
	Resell through specialist retailers	22	13
	Through social stores/supermarkets	12	12
	Through apps	11	14
	Reuse for staff at store	7	10
	Suppliers to exchange/redistribute surplus food	4	7
	Recycle	91	131
	Redistribute to feed animals	35	40
	Industrial use		
	Anaerobic Digesting	36	46
	Rendering (for biofuel mainly)	19	13
	Composting	74	72
	Recover for energy by incineration	17	12
	Disposal without energy recovery	12	6

### 3.3.2 Reduce practices by retailers

Within “**reduce**” as a practice, two prevention themes emerged, determined here as **internal** and **external** food waste prevention practices. Tertiary level coding identified the distinct activities in each of these areas. Internal operations were those measures that the retailers used within their own organisation to prevent/minimise food waste. These included making operational changes and initiatives to influence customers to reduce food waste. External facing activities were measures whereby retailers reported engaging with suppliers and other key stakeholders to prevent or reduce food waste.

Four categories of **internal operational changes** were reported. They are: 1) changing what products to offer, 2) changing promotion, 3) changing how products are offered, and 4) changing internal processes.

**Change what to offer:** About half of the retailers which deployed international operational changes were reported using this measure to prevent or reduce food waste. The most commonly reported practice was to ‘sell cosmetically imperfect produce’, also labelled as ‘wonky’ or ‘malformed’ or ‘ugly’ or ‘perfectly imperfect’ fruits and vegetables (Aschemann-Witzel et al., 2016). Some reported that innovative start-up companies such as Imperfect and Hungary Harvest in the USA (Mourad, 2016) have designed their business model based on purchasing and distributing produce rejected by major supermarkets. Cutting the range of products stocked in store was also a mitigation measure reported by a small number of retailers (Stuffco, 2015).

**Change promotion:** Forty-eight retailers were reported to use price reduction to encourage customers to buy products nearing their food duration dates, for example using ‘bargain shelves’ or a ‘reduce to clear’ policy with big price markdowns in store. Some convenient retailers were reported to even sell produce beyond its ‘best before’ date (Tatum, 2017, TP175). Another change was on multi-buy offers. Retailers were reported to have either modified the promotion to ‘buy one

get one free later' (Gilbert, 2011) so that customers stagger purchases over time or completely abolished 'buy one get one free' for certain products (Aschemann-Witzel et al., 2016).

**Change how products are offered:** Forty retailers were reported to have changed 'how products are sold/offered'. Twenty-eight changed packaging to enhance functionality such as using resealable bags, designing packing to avoid handling damage and extend shelf life. Furthermore, some retailers were reported to sell loose produce so that the customer can pick exactly how much they want thereby reducing wastage (FAO, 2013). Eleven retailers adopted smaller sizes including single pack or smaller multi-pack pods (Kulikovskaja and Aschemann-Witzel, 2017). In response to concerns about customers being confused about date labelling which is known to be a factor in causing food waste (WRAP, 2016), 19 retailers were reported to have changed date labelling on food by using more unified date labelling (Stenmarck et al., 2011) or even replacing "best before" date with packaging codes only (Filimonau and Gherbin, 2017). There were also reports of using product display rotation practices to better manage shelf life (IGD, 2015a).

**Change internal process:** Measures involving improving internal process efficiency to prevent food waste in store were reported in 60 sources on 48 retailers. These include training staff, using relevant technology, controlling temperature in store and in warehouse, improving forecasting and recording food waste. Staff training is seen by some retailers as a vital measure to prevent food waste for example, to ensure accurate ordering, stock rotation or reducing food on display, proactive price reductions (Patel, 2011), damage reduction (IGD, 2015b), and food waste tracking (Molidor et al., 2018). Twenty-one retailers were reported to have used software for dynamic pricing by monitoring in store shelf life (Stenmarck et al., 2011) and RFID tracking (Kärkkäinen, 2003). Netto went one-step further by rolling out an APP Mad Skal Spises (Food should be eaten) to enable consumers to find what products had major price reductions in which store (IGD, 2017a). Better temperature control has been reported to be an effective way of reducing food waste in ten sources. Computer assisted ordering (Kiil et al., 2018) through improved forecasting and accurately

estimating orders and stocking the amount of products the retailer needs is also used as part of reported waste prevention strategies.

**Helping households to prevent food waste** were reported to have been used by 42 retailers, mostly large retailers. This involves campaigning to raise awareness, providing guidance on cooking and meal plans, and providing storage and freezing guidance. Thirty-seven retailers were reported to run food waste campaigns such as Kroger's 'Zero Hunger, Zero Waste' in the US (Molidor, 2018), Morrison's 'Great Taste Less Waste' (Jones et al., 2012). Sainsbury's UK, for example, have provided free tools to customers such as fridge thermometers to help households to manage refrigeration (IGD, 2017b). Channels used by retailers to encourage customers to prevent food waste include in-store displays, pamphlets, and websites that contain recipes to use up food, storage tips (Kulikovskaja and Aschemann-Witzel, 2017) and information on freshness and shelf lives of food products (Fisher et al., 2019).

**External** facing activities involved working with 1) charities, industry or policy stakeholders and/or 2) suppliers to reduce food waste in the supply chain. Forty-two retailers were reported in this category.

**Working with suppliers** entails improving ordering system and streamlining the food supply process. Seventeen retailers reportedly tried to improve their food ordering system with suppliers by sharing planning and improving forecasting information with suppliers (IGD, 2015a), buying bumper crops (Molidor, 2018), guaranteeing to buy a fixed percentage of an order or a whole crop, regardless of changes in demand (House of Lords, 2014), and lowering cosmetic standards (White, 2015). Another type of commonly reported practice is collaboration with suppliers to streamline the supply chain (IGD, 2017c). This involves reviewing the process with the suppliers by jointly identifying ways to extend product shelf life and reviewing expiry dates, particularly for long life products as reported by CGC Japan (Parry et al., 2015). Others have worked with suppliers

to reduce time in transit so that food can have longer shelf life at stores and at households. This may also mean buying directly from suppliers, bypassing intermediaries.

**Working with other stakeholders:** One driver for greater adoption of prevention measures could be the influence of external stakeholders and the use of policy instruments to enact change. In the UK, the WRAP works with food retailers to reduce food waste through voluntary agreements such as the Courtauld Commitment which has set a target of reducing UK food waste by 2025, and initiatives including the ‘Love Food, Hate Waste’ campaign designed to help food retailers develop their own campaigns to reduce consumer household waste. In France, Carrefour, has signed the French Ministry of Agriculture’s ‘national pact to combat food waste’ by changing the labelling of products to ‘preferably’ consumed before a certain date and will permit retailers to leave items on shelves for longer cutting down on food waste. Other influencer groups include farmers unions, food waste NGOs, trade publications such as The Grocer and IGD, retail trade associations. For example, the "Food Waste Opportunities and Challenges" was led by the Grocery Manufacturers Association and Food Marketing Institute in the USA and retail participants committed to assess the sources and causes of food waste and identify beneficial policy initiatives, solutions and other best practices (Orgel, 2011).

### **3.3.3 Reuse practices by food retailers**

**Reuse** means any operation by which edible food products are used again for the same purpose for which they were conceived (i.e. for human consumption). Reuse of surplus food (food unsold in store) was the most reported food waste management practice, used by 129 retailers. This is achieved in a variety of ways including donating to charities, re-processing unsold food, resell through specialist platforms or stores, reusing for staff at store and having suppliers to swap for reprocessing or redistribution.

**Redistribution by donation:** Most retailers donate through large schemes by working with food charities such as Fareshare (UK), Feeding America (US), Food2Change (Sweden), Second

Harvest (Japan) and Magyar Élelmiszerbank Egyesület (Hungary). Donation through this channel requires in-time communication between stores and surplus food collectors. Apps such as FoodCloud and Olio have been used by retailers to broadcast what surplus food items they have in store for donations. A novel initiative by one retailer (Sainsbury's) in the UK trialled donating fresh produce to a community fridge, that could be picked up by local organisations and residents (Weinbrein, 2016).

**Reprocessing:** Retailers were also reported to have re-processed food including turning surplus food into another product. For example, Albert Heijn in the Netherlands experimented turning surplus fruits into “juice of the day” (IGD, 2018); Biddles simply Fresh in Worcestershire, UK turn fresh produce nearing the end of its shelf life into fruit pots or homemade pies (Walker, 2016).

**Resell:** Some specialist discounters such as Company Shop (UK) and WeFood (Denmark) have been set up to sell surplus food collected from conventional retailers (Kulikovskaja and Achemann-Witzel, 2017). More recently, retailers have been reported to work with partners so that edible surplus food can be sold through apps such as “Too Good To Go” (various European countries) (Devlin, 2019), Karma (Sweden) (IGD, 2017a) and Flashfood (US and Canada) (Samuel, 2019). This model is different from direct instore price mark down as consumers normally pay through the app at greater price reduction and collect the food packs from stores.

Others offer surplus food for free or at a nominal price for employees, or use it for meals in the staff canteen. Some retailers were reported to have suppliers to take back surplus food for reprocessing or redistribution (Gruber et al., 2016). In the UK, one food retailer (Asda) developed an online ‘surplus swap’ marketplace for suppliers to redistribute unwanted product to other suppliers who will be able to either re-process or sell by alternative stores (Quinn, 2017).

### 3.3.4 Recycle, recover for energy and disposal of retail food waste

Further down the hierarchy, food unsold and un-reused for human consumption would be diverted into one or all of the three main channels: recycle, recovery for energy by incineration and disposal without energy recovery.

**Recycle:** Food waste can normally be recycled for three types of uses: feeding animals, being converted for industrial use (via AD and rendering) and composting. Thirty-five retailers were reported to have redistributed food unsold and/or no longer suitable for human consumption to feed livestock either directly or to be reprocessed as animal feeds (Pulker et al., 2018). Some retailers donate excess food to local zoos (Cutler, 2016). Anaerobic digesting (AD) involves a biological treatment process where the food waste is fermented in airtight tanks. This generates two products: biogas and a nutrient-rich digestate (used as biofertiliser) (Bong et al., 2018). Thirty-six retailers were reported to have used this method to deal with food waste. Rendering is a process which involves cooking liquid fats and solid meat products at high temperature, sometimes under pressure, allowing water to be removed and tallow to be separated from the proteinaceous material. This produces biodiesel and other products such as ingredients for cosmetics and soap (EPA., n.d.). Nineteen retailers were reported to have diverted their food waste to this channel. Eighty-six retailers were reported to have used some form of recycling. Finally, food waste can be converted into compost as soil amendment, a method reportedly used by 74 retailers.

Channelling food waste for recycling requires manually separating food waste from general waste, including de-packing food. Retailers often partner with waste treatment companies such as Klines in the USA and PDM in the UK. Some retailers, particularly smaller ones, rely more on municipal collection. Some retailers (e.g. Sainsbury's UK, Kroger, USA) installed anaerobic digestion system onsite which can generate electricity for own stores or warehouses.

**Recover for energy by incineration:** Food waste not sorted for recycling would normally be incinerated with energy recovery (Stenmarck et al., 2011). As shown in Table 2, only a small

number of retailers were reported to have diverted their food waste this way ( $n = 17$ ). Packed food has often been reported to have gone down this channel because the labour costs of de-packing and sorting food waste from other waste is too high (Stenmarck et al., 2011).

**Disposal:** This is by far the least reported food waste management option with retailers being identified from the literature reviewed. This typically involves incineration without energy recovery and/or landfill.

The much less reporting of retailers diverting their food waste to the lower three levels of measures is almost certainly not a reflection of the reality (Cicatiello and Franco, 2020). For example, WRAP (2019) found that the UK retail sector generated around 277,000 t of food wastes in 2018, but the total redistributed from retail via charitable and commercial routes in 2018 was around 25,000 t. The implication is that this food waste would have been sent for recycling, energy recovery and disposal. This type of reporting bias is further discussed below.

### **3.4 Limitations of the review**

This review is subject to several biases and this influences how the results can be interpreted. First of all, this review is limited to the literature being captured within the scope specified earlier. Searches for literature were only undertaken in English and our resources did not allow for translation of articles from other languages. The fact that the majority of the evidence collated was from the UK and the USA reflects this language bias. Availability of literature for inclusion in the review may have biased the results, but only 17 articles were not available at full text in this review, a small proportion when compared to those that were included ( $n = 460$ ). Selection bias is also reflected in the fact that this review excluded books which may have included relevant articles on retail food waste management (e.g. Schneider and Eriksson's article in Reynolds et al., 2020).

A major limitation of this review is the risk of reporting bias. Half of the academic peer reviewed articles reported with anonymity, with some retailers not wanting to make either their practices or their food waste data publicly available. This reflects one of the concerns about the publication bias



of peer reviewed journal articles (Denyer and Tranfield, 2009). On the other hand, the evidence utilised from the grey literature can have both intentional and unintentional bias. Such biases can include green-telling i.e. over reporting aspects of food waste practices that show the business in a good light whilst also green-hushing – failing to disclose (under-reporting) those activities which could show the organisation in a bad light. This risk of greenwashing or green telling is significant. For example, the vast majority of retail strategies reported and included in this review were either preventative measures or redistribution of surplus food to those in need. Limited reports were identified about retailers using recovery and disposal measures. However, Molidor (2018) reported that 72 percent of food waste in 2016 were recycled globally. It should also be recognised that such reporting is driven by factors such as corporate governance or social responsibility strategies and thus the data collated and analysed may be skewed towards larger businesses that have implemented formal processes and as such may not reflect all retailers in all circumstances. It is possible that small independent retailers may have already operated in a more resource efficient way as part of their business model but do not see such activities are worth reporting. Such differences were not picked up in this review. Finally, while the retailers may say that a practice is in operation, the reality may be that that practice is not applied uniformly across the whole retail chain. This means that what has been reported and what has been actually implemented may diverge significantly.

It is important when this type of data is used that researchers exercise the appropriate level of caution when drawing inference between reported and actual practice. Despite the above-mentioned limitations, this work is of value to the field of literature on waste management in considering the reported response of food retailers to managing food waste.

#### **4. Discussion**

The aim of this review was to develop a systematic understanding of the scope and scale of how food retailers address food waste. This systematic review of existing academic and grey literature has considered “practices as reported” with regard to retailers’ waste management processes and

then mapped these to accepted food waste hierarchies. It has provided in depth detail about the type and frequency of reported waste mitigation practices employed by food retailers.

What are the implications of the findings here on reported retailer food waste management practices? As any retailer would agree that food wasted is a financial loss to the shareholders. Any food intended for human consumption but is left unsold and unused has also significant environmental impact (Albizzati et al., 2019). This may also be reflected as a cost to retailers where landfill tax and other compliance duties are applied. If managed effectively, food waste issues can be an opportunity for retailers to create true sustainable values (Ribeiro et al., 2018). However, Mourad (2016) argued that economic, environmental and social interests in reality often compete with each other. Many food waste management practices are related to retailers' fundamental goal of economic sustainability and this means there can be a potential disconnection between retailers' economic drivers and social and environmental goals. Based on the food waste management practices identified in this review, this section illustrates how this disconnection can be alleviated within a sustainable value framework. Figure 4 maps retailers' food waste management practices within the broad sustainable value framework which considers economic value alongside both environmental and social value.

Sustainable value is multi-dimensional and “occurs only when a company creates value that is positive for its shareholders and its stakeholders” (Laszlo, 2008, p.120). The most commonly accepted framework is that of triple bottom line (Elkington, 1997) which includes economic, environmental or ecological and social value. Economic value is also referred to as ‘shareholder value’ and environmental and social value as stakeholder value (Laszlo, 2008). Economic value is often seen as comprising ‘perceived use value’ and ‘exchange value’ with the difference being labelled ‘consumer surplus’ or ‘value for money’ (Bowman & Ambrosini, 2000). Exchange value refers to price paid for the use value created, which is realised when the sales take place. Perceived surplus value refers to value subjectively perceived by customers beyond exchange value. Additionally, there is a hidden element of shareholder value which is incurred in the process of

creating and delivering exchange value and perceived surplus value. We term this as mitigation value, which is associated with cost efficiency, compliance, tax duties and licence-to-operate. Mitigation value is created when associated cost is reduced, and compliance and licence-to-operate are maintained. Environment and social value refer to increased positive and/or reduced negative long-term and short-term impact on natural environment and human society caused by operations/behaviour of the business and the upstream and downstream actors the business can influence.

Figure 4 shows a typology of 5R approaches of retail food waste management practices in sustainable value framework. They are categorised here as: repositioning, reallocating, reacting, re-engineering and relating.

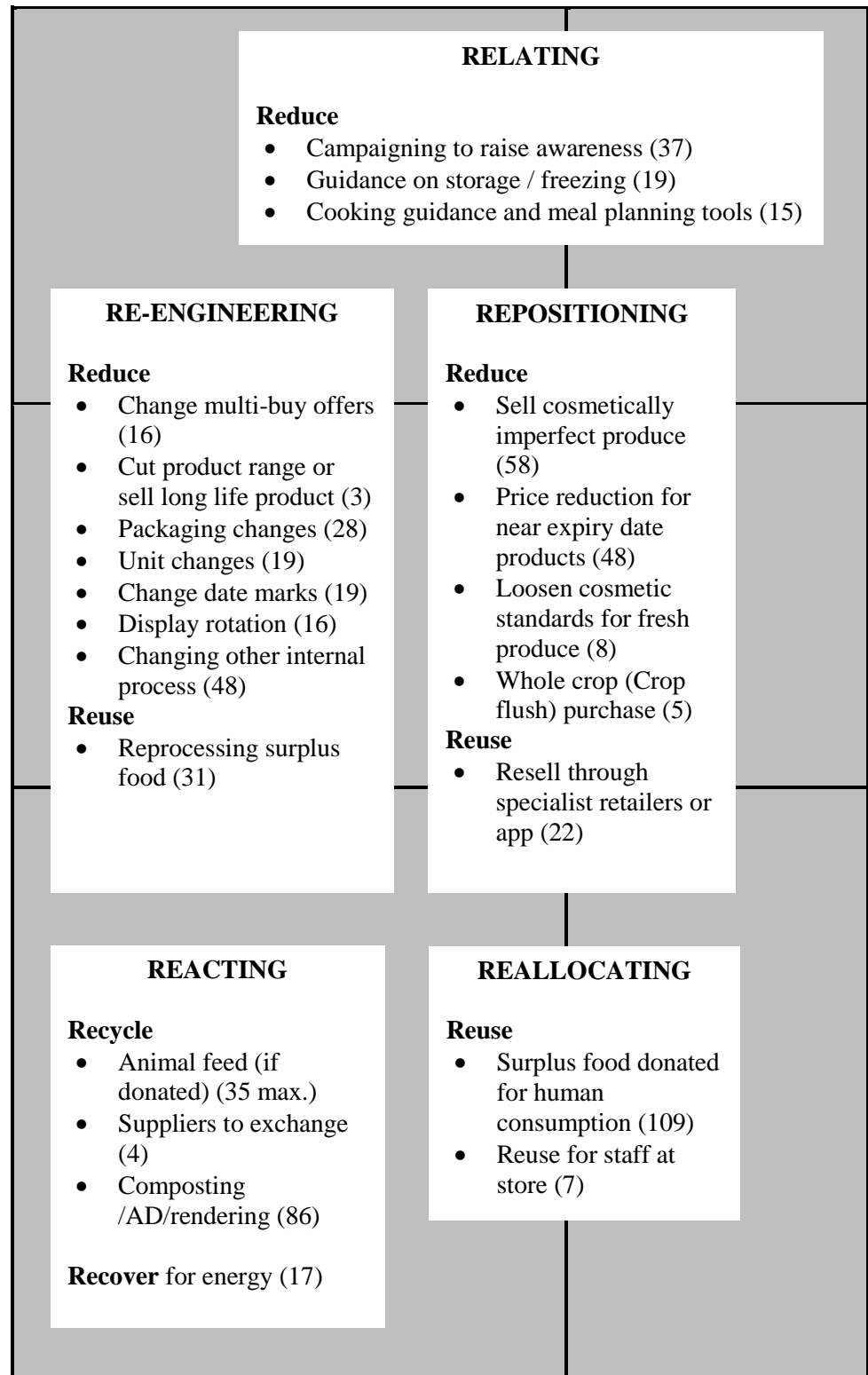
**Economic value**  
**(Shareholder value)**

Perceived surplus value

Exchange value

Mitigation value

**Legend:**  
Number in brackets:  
number of retailers  
reported to have  
used the practice



**Environmental value**

**Social value**

**(Other stakeholder value)**

Figure 4. Retail food waste management: 5R approaches of sustainable value creation

**Repositioning approach** involve practices where retailers reposition their product offering to enable them achieve true sustainable value, i.e. achieving all three dimensions of the triple bottom line. Two types of value propositions are: 1) the offering of cosmetically imperfect produce and its underpinning practices of taking whole crops or bumper crops from producers; 2) the offering of edible food nearing or beyond expiry date either sold in store or sold through apps such as ‘Too Good To Go’ and ‘Mad Skil Spices’ with major price reductions. These offerings create a new purchase proposition for consumers, hence a new income stream for the retailers (to achieve exchange value) albeit that it is offset by income reduction when they would normally purchase “perfect produce”. However, some retailers state that by introducing this range they were able to increase traffic to the store, particularly attractive to cost-conscious consumers (social value). For example, in 2014 French retailer Intermarché introduced ‘Inglorious Fruits & Vegetables’. It was reported that they sold 1.2 t of fruit per store in just two days and increased store traffic by 24% (Martin, 2014). Retailers also increased perceived surplus value through their values-driven communication with consumers who perceive such produce as “value for money”. Social value is also created through supporting producers who otherwise would have faced substantial income loss due to rejection or takeback agreements. Tesco UK reported that their ‘Perfectly Imperfect’ range enabled them to take 10% more apples and 7% more strawberries from growers (Quinn, 2016a). Environmental value is achieved as less resource is wasted. In 2016, Aldi declared that 34,000 t of potatoes were saved from going straight back into the ground as waste (Quinn, 2016b).

**Reallocating** means relocating the value associated with surplus food that is still suitable for human consumption from exchange value to social value (i.e., not achieving exchange value for the retailers, but being used by people in poverty). Social value is captured by donating food for human consumption in redistribution supply chains or in store, or for staff to take away. For example, FWR Alliance (2014) reported that 23.3% of the retail food waste were donated in the USA, an equivalent of 800 million pounds of food in 2012. An unnamed UK large retailer chain reported a donation of food through approximately 2,000 charities to 149,000 vulnerable people each week in 2016

(Midgeley, 2019). WRAP (2019) reported an increase of retail surplus food donation by 257% from 2015 to 2017, contributing 44% (24,767 t) of the total food redistributed in the UK in 2018 (WRAP, 2019). Reallocating delivers environmental value by diverting food from incineration and landfill, delivering a substantial environmental savings as calculated by Albizzarti et al. (2019). Although it does not create exchange value, redistribution of surplus food will minimise the costs associated with mitigating negative environmental impact such as landfill tax and non-compliance issues, and reducing costs of de-packing food for waste separation, and in doing so deliver mitigation value to the retailer. Albizzarti et al.'s (2019) life cycle assessment of surplus food management at twenty French retail outlets showed that surplus food donation could help retailers to achieve lower costs and higher environmental savings overall than recycling and recovering measures.

**Reengineering** drives food supply chain change through activities taken specifically to reduce/minimise food waste and re-process surplus food that would otherwise go to waste. This involves activities leading to process efficiency which enhances economic value through better meeting customers' needs (to achieve higher exchange value) and cost efficiency by wasting less food. It also achieves both mitigation value and environmental value through minimisation of food wasted (Brancoli et al., 2017). Reengineering in this context is focused on business processes though redesigning value creation and delivery systems. This includes changing marketing and operations management particularly inventory activities such as forecasting, warehousing, food display rotation, and monitoring. It can lead to substantial contribution to economic values and reduction of environmental impact as a result. Tesco, for example, reported a reduction of 17% of food waste through their internal process reengineering, representing 0.45% of its annual sales in 2018/19 (Quinn, 2019).

**Reacting**, by its nature, is an approach whereby the retailer is seeking to mitigate the impact of food waste that has already been created at retail level when unsold food is not reprocessed or reused for human consumption either by choice or by deterioration (not suitable for human consumption anymore). Examples of reactive activities include diverting human food to animal feed, composting,

anaerobic digestion, rendering or incineration with energy recovery. The main value created for retailer through this reactive approach would be mitigation value and environmental value by diverting food waste from landfill to avoid paying landfill tax and ensure compliance with laws and regulations. Energy generated through recycling may contribute to operational cost reduction. For example, Kroger's on-site food waste recovery system was estimated to offset more than 20% of the energy demand at one of their distribution centres (Garry, 2013).

**Relating** refers to activities that retailers undertake to communicate to consumers on food waste minimisation at both retail and household level. Examples of these activities include campaigning to raise food waste awareness either in store or on social media and websites; providing guidance on storage and freezing; and giving cooking guidance and providing meal planning tools to support the reduction of food waste in the home. Whilst this type of activities does not directly create exchange value or mitigation value, they create perceived surplus value by enhancing retailers' reputation, goodwill and stakeholder relationships. They also create environmental and social value indirectly through food waste reduction at household level and consumers donating surplus food to people in need as a result of consumers' increased awareness of food waste and food security issues.

It is important to note that there are several tensions within this sustainable value framework. Firstly, some retailers' business model may be more prone to generating food waste. The commercial need to keep customers loyal to the brand means that retailers try to provide a great variety, product range and full shelves. This strategy is implicitly more wasteful and in one study food retailers reported that nearly 95% of fresh retail food waste was caused by expired shelf life (Kliaugaitė and Kruopienė, 2017). Although many retailers have stopped or cut back direct buy-one-get-one-free offers, other variants of promotions have been used instead leading to waste at household level. Secondly, the cost of managing surplus food redistribution may be high and transactionally difficult compared with recycling via anaerobic digestion or composting in countries other than France. This means only a small percentage of food surplus is donated for human consumption. One view is that more public financial incentives are needed for food redistribution

across the supply chain in order to drive innovation in business practice these could be additional taxes / sanctions on the quantities of organic waste. Financial incentives to prevent or reduce food waste include avoiding taxes such as Landfill Tax or corporate tax deductions if a business is seen as a good citizen with regard to waste (Mourad, 2016). Regulations could make it mandatory for retailers to prevent waste and/or to redistribute their food, or it could be seen as a moral (social and environmental) responsibility of retailers to support redistribution of their products.

The shifting of food waste either back to suppliers (take-back policy) or to redistributors means retailers' reports of food waste reduction may be over-estimated as the disposal costs may be with the partners rather than the retailers themselves. The potential level of food surplus at retail level may also be underestimated because retailers may refuse delivery, or fail to call-off some products, especially short shelf life items such as fruit and vegetables, not only because of their appearance, but also due to variations in supply and demand. It is also important to note that redistribution of food does not negate the potential subsequent wastage of food due to inefficiencies within the food bank itself (McIntyre et al., 2016). Indeed, it is suggested that nearly 40% of food sent for redistribution eventually goes to disposal (Alexander and Smaje, 2008). In order to have a clear analysis of the exact nature of food surplus and food waste, more accurate or a life cycle recording and reporting of volumes of food redistributed, recycled and disposed of is needed. Technology can play a role in making this area more transparent for all stakeholders.

Despite evidence of many good practices in food waste mitigation by retailers, there are still many challenges facing the sector. This research has highlighted a number of factors that are of influence and frame the challenges of food waste management. Many of the issues raised cross boundaries and are outside of the internal management processes of individual retailers i.e. they operate at the supply chain level. FAO's latest progress report shows that, after more than a decade's effort in reducing food loss and waste, 13.8 percent of food is still lost globally (equivalent of over 400 billion USD per year) before reaching retailers (FAO, 2020). However, retailers' power and resource control in the supply chain influence food loss and waste generation, reduction and



elimination activities. Single actor measurement of food waste presents a limited view of retailers' responsibilities. A lifecycle approach to monitoring and reporting food loss and waste has to be taken.

Equally, downstream, food retailers have knowledge of the consumers' buying, cooking and even waste behaviour. Therefore, they are extremely well placed to promote sustainable consumption and could play a full part in the 'distributed responsibility' for solving food waste issues (Welch et al., 2018). The wide range of measures reported also demonstrates the role of cross-cutting policy drivers such as regulatory governance, NGO influence and wider stakeholder engagement. More research is recommended to understand the transformative power of such drivers in minimisation of food waste at the retail and consumer level in order to achieve the SDG 12.3.1 target of halving per capita global food waste by 2030.

## **5. Conclusion**

The literature suggests that there is a growing interest in academic studies and the grey literature in retail food waste management practices over the last 10 years. There is evidence of retailers following the food waste hierarchy in reporting their practices with a key focus on redistribution, reduction and prevention. The iterative analysis demonstrates the wide range of practices utilised by food retailers to mitigate food waste and these have been drawn together in this research in a new, novel typology in a sustainable value framework. Ultimately, economic, social and environmental benefits were realised by retailers, but not necessarily in a homogeneous way. Some redesigned value proposition and its underlining value creating processes. Some have made adjustment on their business processes to achieve greater efficiency. Others have operated in a business-as-usual way but react to external pressures to mitigate potential risks and costs. Further empirical work should be undertaken to see how different business models of retailers aligns with the 5R approaches described here as: repositioning, reallocating, reacting, re-engineering and

relating in the sustainable value framework, and how this framework can be used by business practitioners to analyse and develop strategies to achieve long-term sustainability.

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## Appendix 1: Scoping Search Procedure

Scoping search is a process carried out in systematic reviews to determine the nature and the scale of the review. It normally includes exploring the types and places of publication available to address the review question and databases they are indexed; testing and refining the search string for enhanced search sensitivity. This process informs the eventual decision on the search methodology used for the systematic review.

The scoping search for this review confirmed that no similar systematic review had been published and it informed the decision on:

1. Types of literature to be included for review - The initial scoping search of the peer reviewed articles showed that the scope of the retailers reported was limited as many peer reviewed articles presented data anonymously whilst many grey literatures reported retail food waste management practices with named retailers. This led to the decision to include both peer reviewed journal articles and grey literature.
2. Databases - The scoping search identified the extent of sensitivity and duplication of the databases available to the research team, which led to the final selection of the databases searched. This led to the decision to drop Wiley online as the search engine proved to be insensitive and returned largely irrelevant articles.
3. Search string – The initial collection of search terms related to “food waste” included: “food waste\*” OR “food surplus\*” OR “surplus food” OR “food loss\*” OR “food redistribut\*” OR “food shar\*” OR “food recover\*” OR “food rescu\*” OR “food bank\*” OR “wast\* food” OR “food salvag\*” OR “food reuse” OR “food recycl\*” OR “waste prevent\*” OR “waste valori\*” OR “waste manage\*” OR “anaerobic digest\*” OR “energy recover\*” OR “animal feed\*” OR glean\* OR landfill OR compost. **Each of those terms was tested in combination with** (retail\* OR supermarket\* OR store\* OR shop\* OR grocer\* OR baker\* OR superstore\* OR outlet\*). It was found that the terms underlined above generated too many irrelevant articles and all relevant articles from those search results were picked up by “food waste\*” OR “food surplus\*” OR “surplus food” OR “food loss\*” OR “food redistribut\*” OR “food shar\*” OR “food recover\*” OR “food rescu\*” OR “food bank\*” OR “wast\* food”. The scoping search led to the final decision of the search string which was:

*(retail\* OR supermarket\* OR store\* OR shop\* OR grocer\* OR baker\* OR superstore\* OR outlet\*) in any field*

**AND**

*(“food waste\*” OR “food surplus\*” OR “surplus food” OR “food loss\*” OR “food redistribut\*” OR “food shar\*” OR “food recover\*” OR “food rescu\*” OR “food bank\*” OR “wast\* food”) in title, abstract and keywords*

Databases vary in the use of wildcards and truncation symbols, limiters and search fields. The above search string was adapted to suit each database accordingly. To be as inclusive as possible,



it was decided that the string component about “food waste” was searched **in any field or all text** whilst the “retail” component was searched in **abstract** or equivalent (e.g title-abstract-keywords).

The search string was also tested for sensitivity by comparing a benchmark list of 10 articles known to be relevant to the review team and topic experts.

Power of the search string is shown in the number of titles retrieved from each database. All searches are refined by timespan between 1998 and 2019, English language only, and books excluded. The total number of titles retrieved was 7693.

The number of titles from each search is show below.

Scopus	1368
Emerald	290
Web of Science	665
ScienceDirect	769
EbscoHost	4404
AgEcon	97
Google	100
	7693

## Appendix 2: Journals of publication for the 48 included academic articles

<b>Name of Journals</b>	<b>Number of articles</b>
Resources Conservation and Recycling	9
Journal of Cleaner Production	5
Sustainability	4
British Food Journal	3
International Journal of Retail & Distribution Management	2
Journal of International Food & Agribusiness Marketing	2
Journal of Retailing and Consumer Services	2
Procedia Environmental Science, Engineering and Management	2
Society and Business Review	2
Academy of Management Annual Meeting Proceedings	1
Accounting & Management Information Systems	1
Acta Horticulturae	1
American Journal of Preventive Medicine	1
Business Strategy and the Environment	1
Environmental Research, Engineering and Management	1
Food Economy	1
Geoforum	1
Globalization and Health	1
International Food and Agribusiness Management Review	1
International Journal of Physical Distribution & Logistics Management	1
Journal of Business Ethics	1
Journal of Food Products Marketing	1
Journal of Public Policy & Marketing	1
Market-Tržište	1
Production Planning & Control	1
Waste Management	1

Appendix 3: Number of retailers reported and number of sources by country

	Total number of retailers reported (n=199)	Total number of sources (n=460)	Peer reviewed articles		Grey literature	
			Number of retailers reported	Number of sources	Number of retailers reported	Number of sources
Australia	3*	8	2	2	3*	6
Austria	2*	2	2*	2	0	0
Belgium	1*	1	1*	1	0	0
Canada	7	6	3	1	6	5
Chile	1	1	1	1	0	0
Czech	1	1	0	0	1	1
Denmark	21*	11	19	3	11*	8
Finland	3*	5	1	1	3*	4
France	7	14	6	5	3	9
Germany	5*	7	3*	4	2	3
Hong Kong	1	1	1	1	0	0
Hungary	4	1	0	0	4	1
Ireland	4*	10	0	0	4*	10
Italy	4*	11	4*	11	0	0
Japan	4*	5	1*	1	4*	4
Lithuania	1*	1	1*	1	0	0
Netherlands	9*	11	2*	3	9*	8
New Zealand	1	1	0	0	1	1
Norway	3*	4	1*	1	3*	3
Poland	2	2	1	1	1	1
Portugal	1	1	1	1	0	0
Puerto Rico	1	2	0	0	1	2
Spain	3*	5	2*	4	1	1
Sweden	7*	12	3*	6	7*	6
Switzerland	3	2	2	1	1	1
UK	42*	286	9*	11	42*	275
Unnamed developed countries	1*	1	1*	1	0	0
Unnamed European countries	1*	1	1*	1	0	0
USA	56*	108	6*	5	56*	103
Total	199	460	56	48	115	412

\*including a category of unnamed retailer which may be more than one retailer but counted as one only.

Appendix 4: supplementary file available on request