



QUICK SERVICE RESTAURANT SECTOR ACTION PLAN 2026

LITERATURE REVIEW

Executive Summary

Food waste is a major global and national challenge associated with economic losses, environmental impacts and food insecurity. In Australia 7.6 million tonnes of food is wasted per year, of which 70% is edible (FIAL 2021a). Food waste costs the Australian economy \$36.6 billion annually. It also generates 3.5% of the nation's total greenhouse gas emissions, using 2,600 gigalitres of water and a landmass greater than Victoria (27.3 million hectares). Meanwhile, food insecurity is an ongoing issue in Australia, with 33% of households affected in 2025 (Foodbank 2025). It is clear that greater action is needed to reduce food waste across Australia. End Food Waste Australia is leading the way through Sector Action Plans developed to reduce food waste across the different food industry sectors. Sector Action Plans work with key stakeholders across a food industry sector or along a food commodity supply chain to understand where food waste is generated, why it occurs and what can be done to reduce it.

The Quick Service Restaurant (QSR) Sector Action Plan (SAP) was developed to help address food waste in the QSR sub-sector and is part of a suite of foodservice or hospitality SAPs by End Food Waste Australia/Cooperative Research Centre. QSRs refer to foodservice businesses that serve quickly prepared food with minimal table service, including fast food and takeaway outlets but not cafes. Included businesses may operate under a corporate franchise model and may provide food delivery through online platforms. These foods include burgers and chips, pizza, burritos, sushi rolls, rice paper rolls, salads, and grilled proteins.

The QSR sector is a major player in the Australian hospitality industry. The sector generated \$25.3bn in revenue in 2024, accounting for nearly a quarter of the total revenue in the wider hospitality industry (EMR 2025; IBIS World 2025). The sector is large and fragmented, with extremes in the concentration of market share, business types, and business locations. Business types include multinational-chain, Australian-chain and family-owned. The eastern seaboard contains the highest concentration of QSR business. There were 26,630 QSR businesses in Australia as of January 2025, employing 226,000 people. Major fast-food chains comprised the five largest QSR businesses, commanding 43.2% of the sector's market share in 2024 (IBIS World 2025).

The Australian foodservice and hospitality industry generates 1.2 million tonnes of food waste annually, with the majority disposed to landfill (FIAL 2021a) – over 324,000 tonnes are generated in hospitality. Of the total Australian hospitality sector, takeaway food outlets (incl. quick service restaurants) contributes 40% (130,600 tonnes) of food waste per year with 95% disposed to landfill (ARCADIS 2019, p. 76). Yet limited research has been conducted on food waste within QSRs (ARCADIS 2019; FIAL 2021b). This research project identified food waste hotspots within the QSR sector, focussing on insights from food/beverage retailers and corporate office/franchise outlets, to create a sector-wide action plan to address food waste. Reducing food waste within the QSR sub-sector will benefit businesses, decrease environmental impacts and help Australia to halve food waste by 2030 — in line with the United Nations Sustainable Development Goal (SDG) 12, Target 12.3.

This report focusses on the literature review stage of this research project, a part of the overall methodology which included:

- Literature review of existing research on food waste generated in QSRs, published in Australia and internationally.
- In-person interviews and onsite observations of food practices and waste for a QSR chain in Melbourne.
- Survey of individuals who work at QSRs across Australia.
- Survey of managers and owners of QSRs across Australia.

The literature review provides a 14-year overview (March 2010–March 2024) of research and industry publications pertaining to food waste generated back-of-house within the QSR sector. Key insights from the literature review stage of this research include:

- Under-researched area: Food waste in QSRs, especially in Australia, is an under-researched area, with a significant lack of academic studies. There is an opportunity to conduct and publish more research.
- Publication trends: A greater number of industry publications were identified compared to research publications. Industry publications, particularly press releases, outnumber research publications reporting on back-of-house food waste by a ratio of 5-to-1.
- Geographic focus: North America had the highest number of overall publications, largely driven by industry publications. Australia is a leader in research publications but few focussed specifically on QSRs.
- Limited quantification: Only 16% of the publications reviewed quantified the amount of food wasted in QSRs. The small sample sizes and patchy information limit the usefulness of existing data. There is an opportunity to conduct research to quantify what food and how much food is wasted back-of-house in QSRs.
- Key waste stages and reasons: The most-mentioned food waste hotspots were the food preparation and service-ready stages. The most-mentioned reason for waste was forecasting issues, specifically preparing too much food.
- Key actors: Management and employees were overwhelmingly identified as the key actors associated with addressing back-of-house food waste. Future research could focus on a range of actors working across all levels QSR businesses.
- Solutions and barriers: Technology was the most-mentioned solution for reducing back-of-house food waste, particularly in industry publications. The most-mentioned barrier to implementing solutions was cost. Reputational risk associated with food donation was also mentioned as a significant barrier.
- Terminology misalignment: There is a difference between how researchers and the industry define the QSR sector, which could hinder effective communication and collaboration.

These literature insights informed research to create a sector-wide action plan to reduce back-of-house food waste in the QSR sector. By taking meaningful steps to reduce food waste, QSR businesses can align operational strategies with sustainability goals and contribute to Australia's efforts to halve food waste by 2030.

Please see the Quick Service Restaurant Sector Action Plan Final Report (Francis et al. 2026a) for the full project results and the complete QSR Sector Action Plan (Francis et al. 2026b).

The Quick Service Restaurant's Sector Action Plan was co-funded by the New South Wales Environmental Protection Authority and the Queensland Government. The research was conducted by RMIT University. Project partners included the Australian Retailers Association and National Retail Association.

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1. Introduction

Food waste has wide ranging environmental, social and economic impacts, including costing the Australian Economy \$36.6 billion per year (FIAL 2021a). The hospitality sector plays a significant role in these impacts, generating 1.22MT of food waste annually with the majority going to landfill (FIAL 2021a). Greater action is needed to reduce food waste across Australia. Despite this, limited research has been conducted on food waste generated within subsectors of the hospitality industry, including the Quick Service Restaurant (QSR) subsector, particularly in the Australian context (ARCADIS 2019; FIAL 2021b). End Food Waste Australia is leading the way through Sector Action Plans developed to reduce food waste across the different food industry sectors. Sector Action Plans work with key stakeholders across a food industry sector or along a food commodity supply chain to understand where food waste is generated, why it occurs and what can be done to reduce it. This literature review presents insights from publications on food waste in the QSR sector, forming a baseline of knowledge to inform research into a Sector Action Plan (SAP) to reduce food waste in the Australian QSR sector. For this project, QSR refers to foodservice businesses that serve quickly prepared food with minimal table service, including fast food and takeaway outlets but not cafes. Included businesses may operate under a corporate franchise model and may provide food delivery through online platforms.

The QSR sector in Australia generates \$25.3bn in revenue per year and employs 226,000 people, making it a significant player in the broader Australian Hospitality (IBIS World 2025). The five largest QSR companies commanded 43.2% of the market share in 2024, yet besides these five major companies, the sector is highly fragmented (IBIS World 2025). The sector has remained strong despite challenges which have impacted the sector since 2020. Key challenges include the COVID-19 pandemic, the growth of online delivery, competition from adjacent hospitality and retail subsectors, and shifted consumer expectations (IBIS World 2023, 2025). Continued competition from restaurants, supermarkets and convenience stores is expected to drive QSR businesses to look for ways to minimise operating costs, such as through waste reduction (IBIS World 2023, 2025). Increased consumer consciousness about health and environmental concerns is expected to continue to drive the QSR sector towards more sustainability initiatives (IBIS World 2023).

It is acknowledged that QSRs are embedded in a broader food system, where actions and decisions from QSRs can contribute to waste throughout the food chain. Within individual QSR businesses, food waste can be divided into two main categories: front-of-house or consumer food waste, generated after the food is sold to consumers; and back-of-house (BOH) or pre-consumer food waste, generated before food is sold to consumers. This research project focusses on food waste generated BOH in QSRs. When addressing food waste, prevention is the most ideal outcome according to the Food Waste Hierarchy (Fight Food Waste CRC 2019). Due to the constraints of this research project, the scope of the overall research and the resulting SAP focusses on what QSRs can do within their operations to reduce food waste within their stores. This literature review identifies and presents drivers and solutions to food waste generated BOH in QSRs, forming a foundation from which to conduct further research.

1.1 Positioning this literature review

Food waste in the hospitality industry and related sub-sectors is an under researched area (Jayasekara et al. 2024). Thus, collating academic and industry literature is helpful to identify best practices and determine feasible areas for action and further research in the QSR industry. This literature review identifies hotspots where food waste has been generated in the QSR sector and where QSR businesses can take tangible action to reduce food waste. Finding tangible and viable solutions is important, as QSR businesses generate a significant amount of food waste. In 2016/17 takeaway food outlets (incl. quick service restaurants) contributed to 40% (130,600 tonnes) of all food waste generated in the Australian hospitality sector (ARCADIS 2019, p. 76). This literature review is also important in collating what gaps in knowledge currently exist to guide further research.

Existing literature reviews on how food waste is addressed in the hospitality and foodservice sector have not specifically focused on the QSR sector. Despite this, some reviews have outlined common themes. Dhir et al. (2020) outlined previous studies into food waste in the hospitality and foodservice sector, examining a range of topics such as outlining the causes of food waste, identifying food waste hotspots and stages of food waste generation and determining the impact of food waste and actions that can be taken to address these issues. Other reviews, such as Filimonau and De Coteau (2019), outlined actions that foodservice businesses can take to reduce waste generation that are well developed. However, the review did not explore how nuances in different sub-sectors of the hospitality industry, such as the QSR sector, can affect what suite of actions can be feasibly implemented and how. Other research gaps include data-related gaps such as generalisability problems and data collection issues and analysis related gaps, such as underestimation of waste and limited geographic scope (Dhir et al. 2020).

A key focus of this broader research project is engaging with industry, so attaining an understanding around industry attitudes and actions towards reducing food waste in the QSR sector is crucial. Hence this research project will also include analysis of industry publications. This aligns with the National Food Waste strategy framework for action under the EFW CRC Strategic Plan 2018–2028, of which a key priority is business improvements (Fight Food Waste CRC 2019). Business improvements refers to “improvement and adoption of technologies, processes and actions to reduce food waste” (Fight Food Waste CRC 2019, p. 24). Knowing what is in the industry zeitgeist through reviewing industry publications is key to guiding the focus of future actions to reduce food waste in the QSR sector.

1.2 Aims of this literature review and key contributions

This literature review compares and discusses extant food waste related research relevant to the back-of-house (BOH) food waste generated in the QSR sector, outlined in research and industry publications published globally between 2010-2024. In addition to research publications, industry publications were included to provide an industry-insider view into perceptions and attitudes toward food waste within the QSR sector. An industry view is relevant given the focus of this research on producing an SAP for the QSR sector. By examining the research and industry publications, this review documents extant knowledge on food waste in QSRs, including where and how the research has been conducted, quantities and reasons for food waste, the solutions and barriers to reducing food waste, and the key actors associated with this waste. The results and discussion of this review has been divided into 9 subsections each, with the results documented in Section 3 and the discussion presented in Section 4. An overview of key insights is provided in the next paragraph.

This literature review shows that despite a growing number of publications over the past 14 years, food waste in QSRs is still an under-researched area. Few studies (16%) quantified the amount of waste generated by QSR businesses, and these studies suggest that the service ready stage is a key food waste hotspot. Forecasting issues, particularly preparing too much food, was among the most mentioned reasons for food waste. Management and employees were the most mentioned as the key actors to addressing food waste. Even so, technology was the most mentioned solution for reducing food waste. Expense was the most mentioned barrier to implementing solutions. This literature review therefore contributes to the theory and practice of reducing food waste in the QSR sector, addressing an opportunity identified in previous reviews to present information specific to hospitality sub-sectors including QSRs.

2. Method

2.1. Literature search and scope

This literature review provides a 14-year overview of key developments pertaining to food waste reduction in QSRs. To capture the breadth of information across academic and industry research and practice, two sets of literature were included: (1) research publications and (2) industry publications. A total of 69 publications were identified as relevant to this research project, including 29 research publications and 40 industry publications. The relevant research publications included 16 journal articles, 1 conference paper, 2 theses and 10 industry research reports. The relevant industry publications included 5 white papers and 35 press releases. See Table 1 for a breakdown of the research publication and industry publication search and filtering process.

Research Publications	Industry Publications
Keyword search in RMIT Library Expanded Collections	Keyword search in Google search engine and key websites
Shortlist of 44 journal papers and 3 conference papers after reviewing title, keywords and abstract	Shortlist of key websites and industry press release platforms to identify relevant publications
16 journal papers and 1 conference paper classified as relevant after a full text reading	Identified 5 relevant industry white papers after a full text reading
2 thesis publications and 10 research reports added after additional website searches	Identified 35 relevant industry press release articles after a full text reading
29 research publications total: 16 journal articles, 1 conference paper, 2 theses, 10 research reports	40 industry publications total: 5 industry white papers, 35 industry press releases
Total tally of 69 publications in this review	

Table 1: Publication search and filtering of results

The review scope was limited to English language publications, published from March 2010 to March 2024. Selected keywords were used during the search to increase the chance of identifying relevant publications. The main keyword was ‘food waste’, in combination with; ‘QSR’, ‘quick service restaurant’, ‘on the go’, ‘take away’, ‘fast food’, ‘franchise’, ‘food delivery’, ‘reduce’ and ‘mitigate’. Publications were selected to address a key aim of this review, which is to establish research gaps in food waste within the QSR sector. The review targets BOH food waste and publications were selected for inclusion based on seven specific identifiers considered relevant to the project. Table 2 lists the food waste identifiers used as the inclusion criteria to assess for relevant publications.

Food waste identifiers used as publication inclusion criteria

1	Pre-consumer / back-of-house food (BOH) waste at QSRs
2	Quantifies food waste at a QSR establishment
3	Identifies what food is wasted at QSRs
4	Identifies reasons for food waste at QSRs
5	Identifies key actors associated with producing or reducing food waste at QSRs
6	Suggests strategies for reducing food waste at QSRs
7	Identifies barriers for implementing food waste reduction strategies at QSRs

Table 2: Food waste identifiers used as inclusion criteria for the reviewed publications

The RMIT University online library was used as the primary search platform for collating the research publications. This enabled a streamlined and comprehensive search process as the 'expanded beyond library collections' feature enabled multiple databases to be searched at once. These databases included Science Direct (Elsevier), Wiley Online, SpringerLink, SAGE Journals, Emerald Insights, Taylor & Francis Online, Nature Journals and ProQuest.

Topically relevant industry research reports and white papers were identified by searching the websites of key governmental, non-governmental, and research organisations that have published food waste related research. This included reports published by Champions 12.3 and WRAP (Waste Resources Action Program) in the UK; ReFED in the USA; and NSW EPA (New South Wales Environment Protection Authority), FIAL (Food Innovation Australia Limited), and End Food Waste CRC (formerly Fight Food Waste CRC) in Australia. An industry perspective is crucial in a research project focussed on developing an SAP for the QSR industry, beginning with the literature review which forms the foundation of the research project.

QSR industry press releases were collated and analysed as they provide insights into what issues the QSR industry consider to be important and attitudes toward these issues. QSR Australia, QSR Web, and QSR Magazine were chosen as the online magazine platforms or websites to source these industry press releases, as they have published information and news on industry developments pertaining to food waste management and reduction. The readily accessible online archive of industry press releases for these platforms enabled a systematic search (and analysis of publications) in a similar manner to the research publications, which helps to add rigour to this literature review.

2.2. Literature comparative analysis

The Systematic Quantitative Literature Review (SQLR) method (Pickering and Byrne 2014) was used to carry out a comprehensive analysis of the publications in this review, providing detailed results on the state of food waste research in QSRs in a categorised manner. The SQLR method is a pragmatic and systemised approach that quantitatively identifies trends in a group of literature. This is achieved by mapping the number of publications relevant to different categories or themes identified within the group of literature (Pickering and Byrne 2014). A key benefit of this approach is that the results clearly show what the knowledge gaps are in relation to food waste in the QSR sector. In recent years, this approach has been used in a comparative literature study of packaging solutions for household food waste (Chan 2022).

Use of the SQLR method involved using a spreadsheet to extract and analyse information from the publications. The x-axis or rows of the spreadsheet were populated with category headings based on the identifiers listed in Table 2. The y-axis or columns were populated with relevant information associated with each category heading, with one row per publication. A binary system was used to indicate relevancy of each publication and searched categories, with “1” meaning relevant and “0” meaning irrelevant.

The categories for which information were collected included bibliometric information for the publications, how the QSR sector is defined, what stage food is wasted, how much food is wasted, what food is wasted, why food is wasted, key actors related to the food waste, ways to reduce food waste, and barriers to reducing the food waste. Each category was further divided into subcategories — generated from inductively analysing the publications — for comprehensive insights. This means that the categories can more accurately reflect the themes presented in the publications, which would not be possible if they were all pre-defined.

After information for all the publications was entered into the spreadsheet, each column was tallied to produce a total. This total represents the number of publications relevant for each category, sub-category or theme. As the information was collected by category, this allowed for data subsets to be generated for further analysis. This approach was beneficial to reveal trends across categories, especially when the tallies were visualised as tables and charts. The result of the analysis, including the tables and charts, is presented next in section 3.

3. Results

3.1. Research publications vs industry publications

3.1.1. Research vs industry publications by number of publications

Comparing the research publications and industry publications helps to identify where action to reduce food waste in QSRs should ideally be targeted. Figure 1 illustrates the percentage breakdown of the two publication groups, with an additional breakdown of the different publication types.

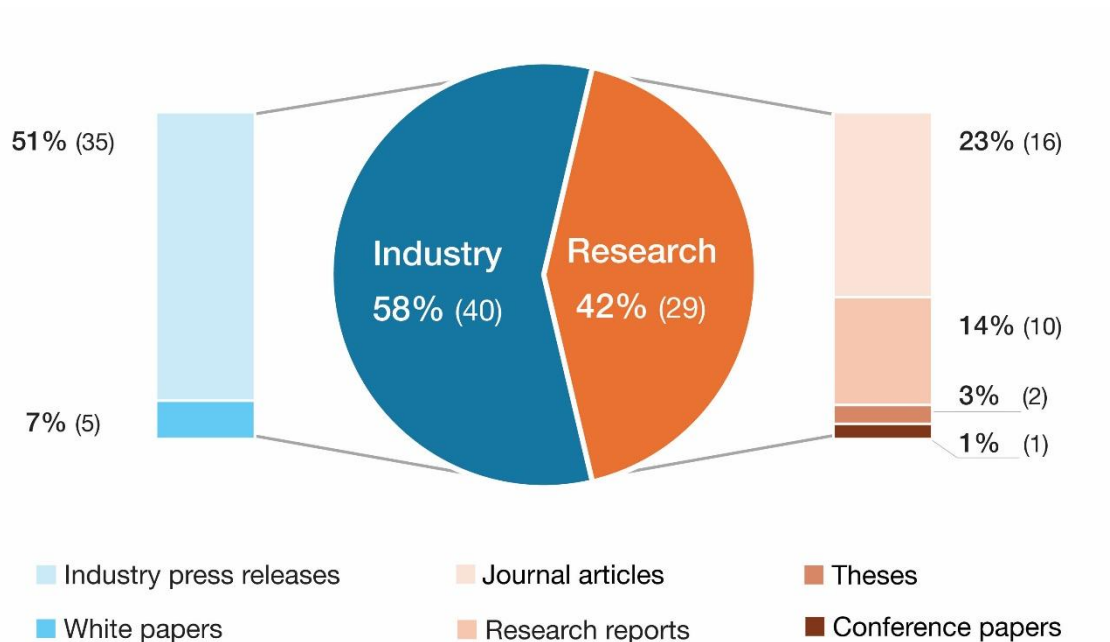


Figure 1: QSR and food waste publications.

Percentage breakdown of research and industry publications. Total number of publications was 69, sampled

2010 March to 2024 March, including 29 research publications (16 journal articles, 10 research reports, 2 theses, 1 conference paper) and 40 industry publications (35 industry press releases, 5 white papers).

A greater number of relevant industry publications were identified than research publications, with 40 to 29 respectively. Of those industry publications, 51% are industry press releases. These industry press releases focus on a range of topics including technologies to reduce food waste (Daninhirsch, 2022; QSR, 2023c) and strategies to alleviate business pressures (e.g. increasing wages) that are intertwined with food waste (QSR Media Aus, 2023b). In comparison, journal articles make up 23% of the total research outputs, suggesting a lack of academic research focused on food waste in the QSR sector. This result is in line with extant literature reviews focussed on food waste in the broader hospitality sector (Dhir et al. 2020; Filimonau and De Coteau 2019; Principato et al. 2021). Moreover, industry publications reporting only on BOH food waste in QSRs out represented that of research publications 5 to 1 (see Section 3.4). This suggests that the challenges of food waste generation are in the industry zeitgeist but as noted by Dhir et al., (2020), these challenges have been ‘investigated less rigorously’ in the QSR sector.

3.1.2. Research vs industry publications by year

Figure 2 shows the number of research and industry publications by year. Figure 3 (overleaf) shows a yearly breakdown of the research and industry publications by publication sub-type. This literature review covers a 14-year period (March 2010 to March 2024). March 2024 was the end point for the literature analysis period as this was when the research project began. The three-month window during 2024 explains the low publication count for that year. Even so, it includes one of the most relevant Australian research papers to have been published to date. This paper, Jayasekara et al., (2024), was published in January 2024 and focussed on BOH food waste in two Australian QSRs.

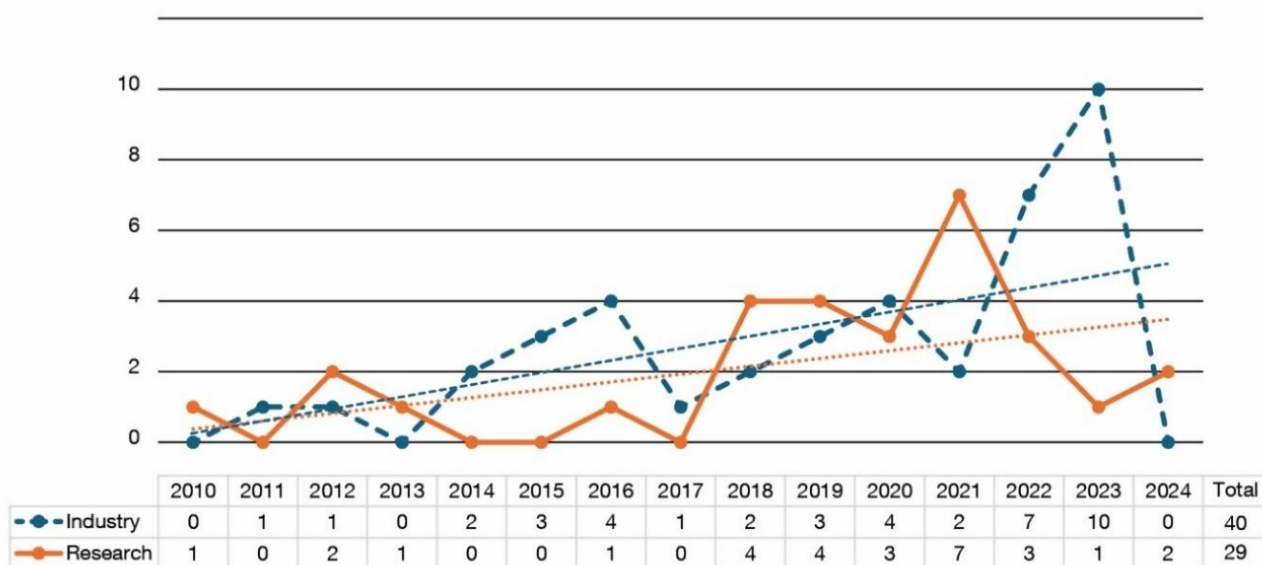


Figure 2: Number of research and industry publications by year.
Total number of publications was 69, sampled 2010 March to 2024 March.

Figure 2 and Figure 3 show a breakdown of the publications breakdown by year from the research publications and industry publications. Between the year 2010 and 2013, there is no significant gap in publication output between industry and research publications. There is a steady increase in industry publication output from 2014 to 2017. Industry articles in this period were mostly industry press releases (Cherryh 2015; QSR Magazine 2015; QSR Web 2016) (etc.) with only one industry whitepaper (ReFED 2016). Whilst there are increases in the amount of industry publications, the limited sample size means it is difficult to attribute a reason for this.

Moving into the 2018-2021 period there was a slight dip in the number of industry publications before an increase later in that period. In this same period a significant number of research publications was published (Dzumbunu 2018; Filimonau and Ermolaev 2021; McAdams et al. 2019) etc.). Along with analysing and reporting on BOH food waste in QSRs, these publications covered many areas. These ranged from the food waste reduction or broader sustainability actions by certain QSRs in specific countries (Filimonau and Ermolaev 2021; Marx-Pienaar et al. 2020; Mohamed et al. 2018), to broader hospitality sector comparisons of waste (Dhir et al. 2020; Filimonau and De Coteau 2019), through to highlighting the potential role of technology in reducing waste (Aytaç and Korçak 2021; Vo-Thanh et al. 2021). This period had a total of 16 research articles compared to the 9 of the industry press releases.

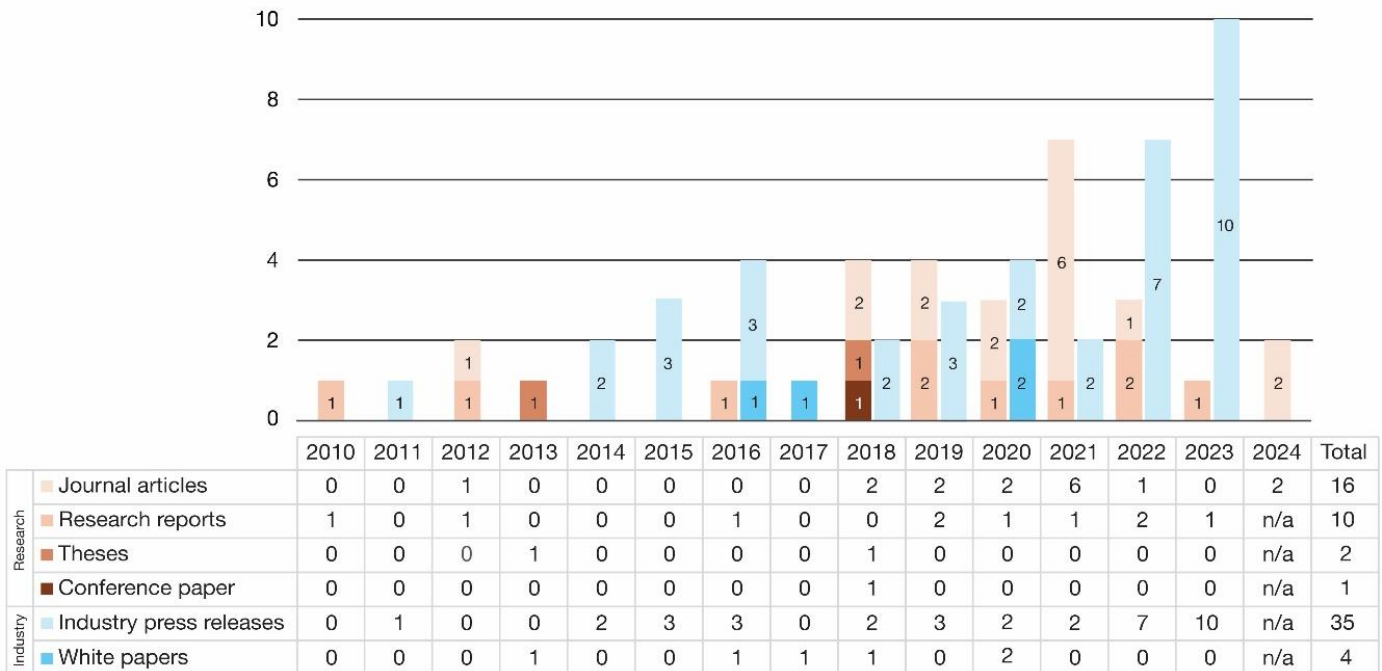


Figure 3: Breakdown of research and industry publications by year.
Total number of publications was 69, sampled 2010 March to 2024 March.

In more recent years there has been an increase in industry publications. In 2023 alone, there were a total of 10 industry publications captured by the search, a peak for a single year across the entire search. All of these publications were industry press releases and they covered a range of ways to address BOH food waste in QSRs. Suggested ways to address food waste included optimising efficiency in the kitchen (Davityan 2023a; QSR Magazine 2023b) and increased participation in food donation (QSR Magazine 2023a; QSR Web 2023). Press releases also tout the benefits or rewards that QSRs could by focusing on sustainability initiatives such as reducing food waste (Daus et al. 2023; QSR Media AU 2023c). Acting on food waste was touted as a way to navigate increased pressures such as wage inflation and staffing shortages (QSR Media AU 2023b). From these articles topics such as sustainability, social responsibility, resource efficiency and wage inflation/staffing shortages have entered the zeitgeist that relates to BOH food waste in QSRs.

There were no journal articles published in the 2023 period (see Figure 3) and this is well off the overall increasing trajectory of publications (Figure 2). As it can take multiple years from research to publication for journal articles, this lag in articles could be due to a legacy issue from the challenges that the COVID-19 pandemic provided in terms of being able to conduct in person research in QSR restaurants and kitchens. The more recent Journal publications such as Jayasekara et al., (2024) report on research conducted in the latter stages of 2022, which was a post-restriction environment in most countries.

3.1.3: Research vs industry publications by geographic location

Table 3 and Figure 4 show a breakdown of the geographic location of the research and industry publications. Specifically, Table 3 shows the specific number of publications and Figure 4 shows the percentage of total publications.

	Research Publications	Industry Publications	Total
North America	3	30	33
Australia	8	11	19
Europe	8	1	9
Asia	3	1	4
Africa	3	0	3
Global	3	0	3
Eurasia	2	0	2

Table 3: Publications by geographic location.

The research and industry publications were from North America (USA, Canada); Australia; Europe (France, Germany, Sweden, Switzerland, UK); Asia (China, India, Japan); Africa; (Egypt, South Africa); Eurasia (Russia, Turkey); and Global.

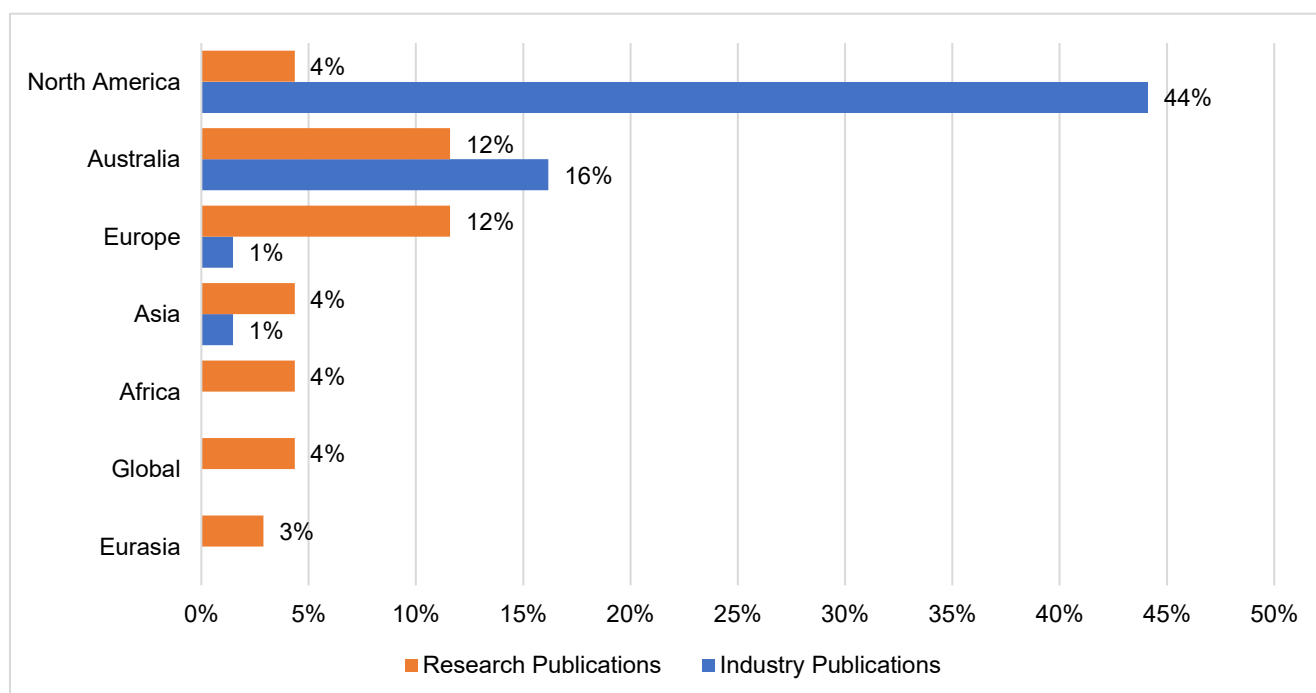


Figure 4: Publications by geographic location.
Percentage of research and industry publications calculated from the total 69 publications .

Geographically, North America (inclusive of the USA and Canada) produced the highest number of relevant publications (33) overall, with a majority of these being industry publications (30) (see Table 3). This is consistent with the landscape of the QSR restaurants and their growth across the world. The QSR, as it is envisaged today, emerged out of the USA and the concentration of the leading brands is still concentrated in North America (Nusair and Parsa 2006). Hence the huge outlier of 44% on Figure 4 of industry publications from North America.

This North American domination of industry publications is followed by Australia with 11 industry publications. The relatively high number of relevant industry publications in the Australian context could relate to the significant presence of QSR businesses in Australia as well as the fact that Australia has a dedicated news site for QSR news in QSR Media Australia (QSR Media Aus 2024). Figure 4 also suggests that Australia is a leader in research publications relating to food waste in QSRs. However this figure is slightly misleading as when analysed, this included larger research reports that weren't solely focused on the QSR sector but mentioned it in some way.

Although industry publications were lacking from other regions, there was a concentration of research publications in Europe (Groene and Zakharov 2024; Michalec et al. 2018). There was a particularly high concentration in the UK with four research publications (Filimonau et al. 2019; Hirth et al. 2021; Michalec et al. 2018; SRA 2010).

Geographically, the remaining publications report on food waste in QSRs across different regions across the world. From Asia, 3 research publications and 1 industry output was identified. From Africa, 3 research publications was identified. For Eurasia, 2 research publications. The 3 research publications are literature reviews in the form of journal articles, reviewing research published internationally.

3.2. Data collection methods and sample size of the publications

Examining the methods and data sampling research studies or publications is a way to understand their scope and boundaries. Out of the 29 research studies or publications analysed for this review, Table 4 (overleaf) documents methods and data sampling of the 23 studies which engaged in primary data collection. Information on the remaining 6 studies has not been provided as they did not include details on methods or sample size.

Table 4: Data collection methods and sample of the research publications or studies that engaged QSRs or related foodservices to collect primary data.
 Table includes relevant 23 research publications out of 29 examined for this review. Excludes research publications which do not specify data collection methods or sampling information.

	Reference	Publication title	# QSR locations	# Individuals	Country	Sample detail	Method & approach	
Directly engaged QSRs	1	ARCADIS (2019)	National Food Waste Baseline: Final Assessment Report	not specified	n/a	Australia	Unspecified how many of the 80,000 QSR businesses in Australia. Report highlights a lack of QSR food waste data,	Surveys and baseline methodology
	2	Ahmed Mohamed et al. (2018)	Green Practices in Quick Service Restaurants in Egypt	48	n/a	Egypt	McDonalds: 14 branches, 35 employees; Pizza hut: 9 branches, 23 employees; Tikaa 6 branches, 10 employees; KFC: 6 branches 32 employees; Hardees 3 branches 6 employees, Domino's pizza 1 branch 1 employee.	Survey with statistical analysis
	3	Akamatsu et al. (2022)	Restaurant managers' readiness to maintain people's healthy weight and minimise food waste in Japan	83	83	Japan	378 restaurant managers across the restaurant sector in Japan, including 83 from fast food restaurants	Survey with statistical analysis
	4	Austin Resource Recovery (2012)	Quick Service Restaurant Waste Composition Study	4	n/a	USA	4 QSRs	Waste composition study
	5	Aytaç and Korçak (2021)	IoT based intelligence for proactive waste management in Quick Service Restaurants	2	n/a	Turkey	2 QSRs	Built and real-world tested a self-learning IoT architecture to reduce back-of-house waste at two QSRs in Turkey

	Reference	Publication title	# QSR locations	# Individuals	Country	Sample detail	Method & approach
6	Drewitt (2013)	Food waste prevention in quick service restaurants: A comparative case study on the quantity, source, cost and cause	4	n/a	China and Sweden	The case study involved selecting two “higher performing” restaurants (Europe A and Europe B) and two “lower performing” restaurants (China A and China B) within the same QSR chain .	Interviews to inform a comparative case study. Material flow analysis
7	Dzumbunu (2018)	The causes of food waste in a quick service restaurant supply chain: A South African exploratory case study	not specified	9 managers	South Africa	Manufacturing and Managing Executive, Group Technical Manager, Quality Control Manager, Quality Assurance Manager, Group Quality Assurance Manager, Plant Manager, Warehouse Manager, Store Manager, Franchise Store Owner	Interviews to inform a case study
8	Hirth et al. (2021)	Unpacking food to go: Packaging and food waste of on the go provisioning practices in the UK	1	9 (from multiple organisations, including 1 QSR)	United Kingdom	Food ‘on-the-go’ stakeholders such as corporate practitioners, non-governmental campaigners, and academic interviewees.	Longitudinal study using a “Learning History” approach involving document analysis of journalistic columns and 9 semi-structured expert interviews.
9	Filimonau et al. (2019)	An exploratory study of managerial approaches to food waste mitigation in coffee shops	7 locations which are also coffee shops	7 from QSRS, out of 21 total sample size	United Kingdom	21 coffee shops, some of which are also QSRS	Interviews and content analysis
10	Filimonau and Ermolaev (2021)	A sleeping giant? Food waste in the foodservice sector of Russia	3	21	Russia	21 foodservice locations across casual dining, fine dining, fast casual and QSR, of which 3 are QSR	Interviews to inform a case study,

	Reference	Publication title	# QSR locations	# Individuals	Country	Sample detail	Method & approach
11	Groene and Zakharov (2024)	Introduction of AI-based sales forecasting: how to drive digital transformation in food and beverage outlets	1	n/a	Germany	Fast food franchise in Germany	Case study using 5 years of hourly sales data
12	Jayasekara et al. (2024)	Mapping pre-consumer food waste in quick service restaurants on a university campus: Two Australian case studies	2	2	Australia	2 owner-managers at 2 QSRs	Pre-consumer food waste at two QSRs collected and audited by trained staff. Managers interviewed.
13	Martin-Rios et al. (2018)	Food waste management innovations in the foodservice industry	not specified	17 from chain / takeaway restaurants (110 total sample size)	Switzerland	110 participants across two rounds. Round 1, 21 stakeholders and experts; and round 2, 89 foodservice managers (19.1% chain restaurant / fast food and takeaway)	Semi-structured interviews with managers
14	Marx-Pienaar et al. (2020)	The South African Quick Service Restaurant industry and the wasteful company it keeps	40	40<	South Africa	two respective manufacturing plants and 40 QSR stores in Gauteng, South Africa	Interviews to inform a case study. Material flow analysis. Exploratory Factor Analysis
15	McAdams et al. (2019)	A cross industry evaluation of food waste in restaurants	1	n/a	Canada	4 restaurants across sectors, but only 1 QSR restaurant. The QSR is a franchised unit of one of Canada's largest burger chains. The restaurant is open 24 hours a day, seven days a week and serves approximately 3200 dine-in, take-out and drive-thru customers per week	Exploratory interviews, developing a Food Delivery System Framework, on site observations and document analysis

	Reference	Publication title	# QSR locations	# Individuals	Country	Sample detail	Method & approach	
	16	Michalec et al. (2018)	Co-designing food waste services in the catering sector	18 fast food or takeaway establishments	18	United Kingdom	79 total participants including: 24 cafes, 23 restaurants, 18 fast food or takeaway establishments, 10 pubs, 4 bakeries.	Qualitative surveys conducted face-to-face, or responses provided via email
	17	Noone and Coulter (2012)	Applying Modern Robotics Technologies to Demand Prediction and Production Management in the Quick-Service Restaurant Sector	200	n/a	USA	200 outlets of a QSR chain Zaxby's	Tested a robotics management system at 200 outlets of a QSR chain Zaxby's
	18	Thong and Anich (2022)	Final Project Report: Foodbank Meals Via Y Waste App — Phase 2	4 QSRs	not specified	Australia	4 QSRs (Hungry Hearts, Elixbya, Daves bakehouse) across several locations. Also: 7 councils in NSW, 36 charities, 2 social media campaigns and 30 media outlets	Focus group and market testing of app
Study engaged restaurants, which may include QSRs	18	Clowes et al. (2019)	The Business Case for Reducing Food Loss and Waste: Restaurants	not specified	not specified	Belgium, China, Czech Republic, Denmark, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Sweden, United Kingdom	114 restaurants in 12 countries	Interviews and food waste reduction data from 114 restaurants across 12 countries used to calculate benefit-cost ratios, cost reductions, payback periods, and investments made. Interviews were also conducted with managers.

	Reference	Publication title	# QSR locations	# Individuals	Country	Sample detail	Method & approach	
	20	SRA (2010)	Too good to waste: restaurant food waste survey report 2010	not specified	not specified	United Kingdom	10 restaurants	Survey and lifecycle analysis
	21	Vo-Thanh et al. (2021)	How mobile app can become a catalyst for sustainable social business: The case of Too Good To Go	n/a	19 restaurateurs (of total 43 participants)	France	19 restaurateurs and 24 customers in Paris	semi-structured interviews
Limited information	22	FIAL (2021b)	National Food Waste Strategy Feasibility Study Final Report 2021	not specified	not specified	Australia	not specified	Interviews with (1) Best practice review, (2) update baseline and hotspots, (3) high-level scenario analysis, (4) recommended scenarios, (5) business case
	23	ReFED (2016)	A Roadmap to Reduce U.S. Food Waste by 20 Percent	not specified	not specified	USA	not specified	Interviews with (1) Baseline methodology, (2) Solutions evaluation, (3) cost benefit analysis of solutions, (4) data validation

3.2.1. Most research studies in this review directly engaged with QSRs

The research publications presented in Table 4 are divided into three categories: (1) research that directly engaged QSRs, (2) research that engaged restaurants which may include QSRs, and (3) research that provided limited information. This makes it possible to map the level of engagement the researchers had with QSRs. However, the differences in sample size reported across the research publications make it difficult to compare the results.

Consistent with the focus of this literature review, most research publications in this review (62% or 18 out of 29) directly engaged QSRs. The number of QSRs reported by the research in these publications engaged ranged from as few as 1 location to 200 locations, making it difficult to compare the results. See Table 4 for the specific research studies. Most of these research studies that directly engaged QSRs were smaller, over half (9 studies) engaged fewer than five QSRs and 4 studies engaged between 5-20 QSRs. There were 3 larger research studies that engaged between 40-50 QSRs (Marx-Pienaar et al. 2020; Mohamed et al. 2018) and 83 QSRs (Akamatsu et al. 2022). The research study with the greatest number of participants was by Noone and Coulter (2012), which engaged one QSR chain across 200 locations. The research study with the most diverse sampling was by Mohamed et al. (2018), engaging 6 different QSR chains across 48 locations.

The remaining 38 (11 out of 29) of the total research publications in this review were less clear about whether QSRs were directly engaged during the studies, referring to restaurants, hospitality or foodservice more generally. This makes it hard to compare the results of the research studies with those that directly engaged with QSRs. The differences in sample size adds additional difficulty. See Table 4 for the specific studies. 10% (3 out of 29) of the research publications reported on research that engaged restaurants, and these 'restaurants' may include QSRs (see Table 4). The sample size ranged from 114 restaurants (Clowes et al. 2019), 19 restaurants (Vo-Thanh et al. 2021) and 10 restaurants (SRA 2010). 28% (8 out of 29) of the research publications provided no specific information on the research sample size but mentioned hospitality or foodservice as a sector. Most of these 8 research publications were therefore excluded from Table 4 but for the two research publications (FIAL 2021b; ReFED 2018) that provided information on research methods.

3.2.2. Interviews the most common data collection method used across the research studies

A wide range of data collection and analysis methods was used in research studies reported in the research publications, involving both qualitative and quantitative approaches. A mixed-methods approach was used in some of these research studies. For example, Drewitt (2013) used a combination of interviews, comparative case study and material flow analysis in their investigation. Other combinations include food waste audits and interviews (Jayasekara et al. 2024); interview, observation and document analysis (McAdams et al. 2019); survey and baseline methodology (ARCADIS 2019); and survey and lifecycle analysis. See Table 4 for specific details.

Interviews was the most common data collection method used across the research studies reported in the research publications. Interviews represent 57% (or 13) of the research studies/publications documented in Table 4 or 45% of all research studies/publications in this review. Breaking this number down, this included 9 research studies/publications that directly engaged QSRs (Drewitt 2013; Dzumbunu 2018; Filimonau and Ermolaev 2021; Filimonau et al. 2019; Hirth et al. 2021; Jayasekara et al. 2024; Martin-Rios et al. 2018; Marx-Pienaar et al. 2020; McAdams et al. 2019) and 4 research studies/publications that focused on restaurants or the hospitality and foodservice sector in general (Clowes et al. 2019; FIAL 2021b; ReFED 2016; SRA 2010; Vo-Thanh et al. 2021).

For the research studies/publications that directly engaged QSRs, the second most common data collection methods were case studies (Drewitt 2013; Dzumbunu 2018; Groene and Zakharov 2024; Marx-Pienaar et al. 2020) and surveys (Akamatsu et al. 2022; ARCADIS 2019; Michalec et al. 2018; Mohamed et al. 2018), used by four research studies/publications each. The least used methods were market tests, used by 3 research studies/publications (Aytaç and Korçak 2021; Noone and Coulter 2012; Thong and Anich 2022); waste audits, used by 2 research studies/publications (Austin Resource Recovery 2012; Jayasekara et al. 2024); and focus groups, used by 1 research study/publication (Thong and Anich 2022).

For the research studies/publications that focused on restaurants or the hospitality and foodservice sector in general, the second most common method was a food waste solutions feasibility study with a cost/benefit analysis (Clowes et al. 2019; FIAL 2021b; ReFED 2016). The least used methods were surveys (SRA 2010; Vo-Thanh et al. 2021) and baseline methodology (FIAL 2021b; ReFED 2016), used by two research studies/publications each.

3.3. Use of the word “QSR” in publications and how the sector is defined

This section records the manner in which the reviewed publications has referred to or defined the QSR sector. Figure 5 provides an overview of QSR terminology used in research and industry publications. The top half of Figure 5 documents whether publications use the term “QSR” or another term to refer to the QSR sector. The bottom half of Figure 5 documents whether these publications offer a definition of the term “QSR” or other term. Figure 6 elaborates on Figure 5 by documenting the words used to define the term “QSR”. Both Figure 5 and Figure 6 report information by comparing across research and industry publications, with the presented percentages calculated from separate totals of 29 research publications and 40 industry publications in this study. This means the percentages represent either the research or industry publication category, rather than the cross category total of 69 publications. Additionally some of the research and industry publications feature across multiple categories.

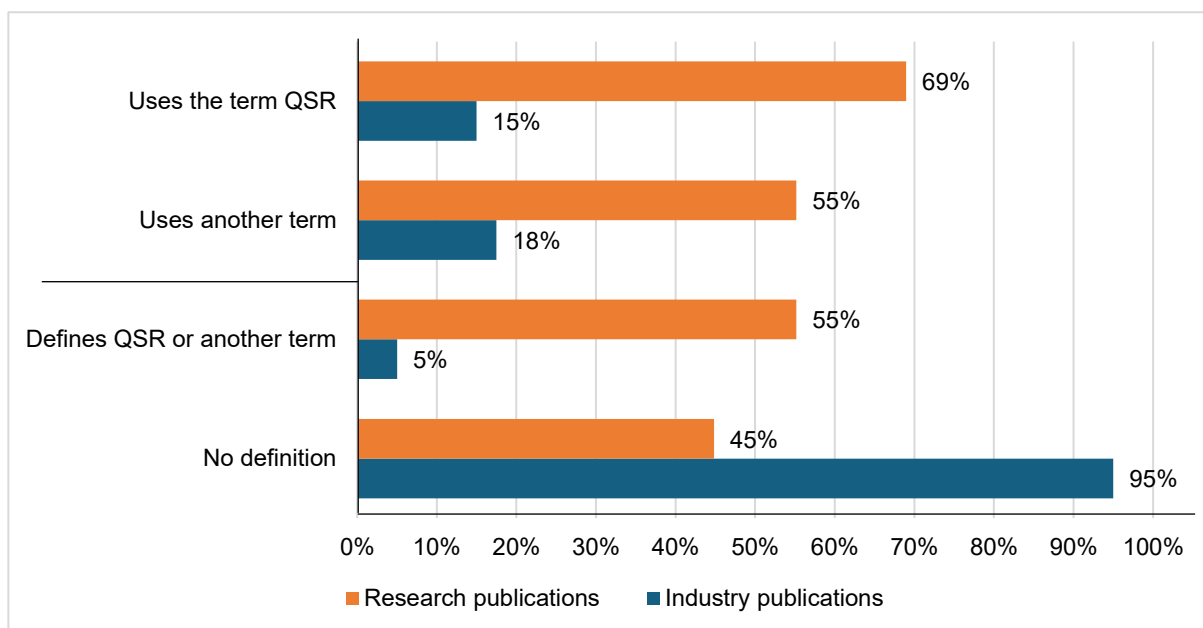


Figure 5: QSR terminology in publications.

Percentages calculated from a total of 29 research publications and 40 industry publications. Percentages represent the total within the publication category, rather than the total 69 publications. Individual publications featured across multiple categories.

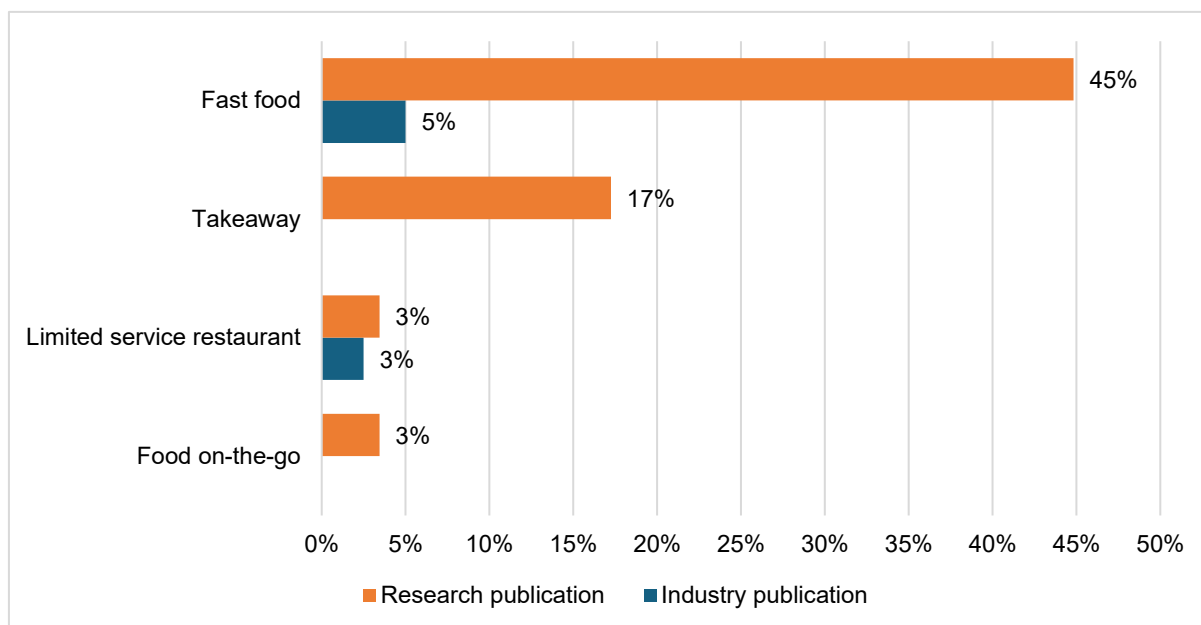


Figure 6: Words used to define “QSR” in publications.

Percentages calculated from a total of 29 research publications and 40 industry publications
 Percentages represent the total within the publication category, rather than across the total 69 publications. Individual publications featured across multiple categories.

3.3.1. A greater number of research publications mentioned word “QSR” and defined it

A greater number of research publications than industry publications mentioned the term “QSR” or another equivalent term when referring to the QSR industry (see Figure 5). Following a similar trend, a greater number of research publications than industry publications defined these terms (see Figure 6). To elaborate, over four times the number of research publications (69% or 20 publications) than industry publications (15% or 6 publications) used the term “QSR”. Over three times the research publications (55% or 16 publications) than industry publications (15% or 6 publications) used another equivalent term (see Figure 5). In addition to mentioning “QSR” or an equivalent term, there are publications that elaborated on the meaning of the term used. A greater number of research publications (55% or 16 publications) than industry publications (5% or 2 publications) defined the term “QSR” or an equivalent term. Notably, a majority of the industry publications (95% or 38) did not offer definitions. The potential reasons for the differences observed between research publications than industry publications is discussed in section 4.3.

A greater number of research publications (16 publications) than industry publications (2 publications) offered a definition of the QSR industry or the word “QSR” (see Figure 5). In terms of a definition, this excluded when the publication text expanded acronym “QSR” to “quick service restaurant”. Rather, this included other words used to refer to or define “QSR” and the associated sector. Four such words were identified across 18 publications. As shown in Figure 6, these words were “fast food”, “takeaway”, “limited service restaurant”, and “food on-the-go”.

The word “fast food” was identified across the greatest number of countries (11 countries) followed by “takeaway” (3 countries), “limited service restaurant” (1 country), and “food on-the-go” (1 country). “Fast food” was identified in research and industry publications from Australia (Anich and Thong 2022; IBIS World 2023; Thong and Anich 2022), China (Drewitt 2013), France (Vo-Thanh et al. 2021), Germany (Groene and Zakharov 2024), Japan (Akamatsu et al. 2022), South Africa (Dzumbunu 2018; Marx-Pienaar et al. 2020), Sweden (Drewitt 2013), Switzerland (Martin-Rios et al. 2018), Turkey (Aytaç and Korçak 2021), United Kingdom (Michalec et al. 2018), and the USA (Austin Resource Recovery 2012; Daus et al. 2023; Gunders 2012b). “Takeaway” was identified in research publications from three countries including Australia (ARCADIS 2019; IBIS World 2023), South Africa (Marx-Pienaar et al. 2020) and the United Kingdom (Michalec et al. 2018). The term “takeaway” was also used in a literature review of food waste in hospitality and foodservices (Dhir et al. 2020), which reviewed studies published across different countries. “Limited service restaurant” was identified in one industry publication from the USA (ReFED 2016). “Food on-the-go” was identified one research publication from the United Kingdom (Hirth et al. 2021). Please see section 3.1.3 for additional information on the geographic location of the publications in this review.

3.3.2. Research publication used a greater variety of words to define the QSR sector

In defining the QSR sector, research publications used a greater variety of words than the industry publications (see Figure 6). Four words were identified across 16 research publications, while two words were identified across 2 industry publications. The words identified in the industry publications were “fast food” and “limited service restaurant”. “Fast food” was identified in 1 industry press release (Daus et al. 2023) and 1 white paper (Gunders 2012b), “limited service restaurant” was identified in 1 white paper (ReFED 2016). The research publications also used the words “fast food” (e.g. Akamatsu et al. 2022; Groene and Zakharov 2024; Vo-Thanh et al. 2021) and “limited service restaurant” (e.g. Dzumbunu 2018; Marx-Pienaar et al. 2020; Thong and Anich 2022). The words unique to the research publications were “takeaway” and “food on the go”. “Takeaway” was identified in 2 research reports (ARCADIS 2019; IBIS World 2023) and 4 journal articles (Dhir et al. 2020; Marx-Pienaar et al. 2020; Michalec et al. 2018), and “food on the go” was identified in 1 journal article (Hirth et al. 2021).

3.3.3. The words “fast food” and “takeaway” used to describe the QSR sector

This review suggests that the term QSR is being used interchangeably with the term “fast food” and to a lesser degree “takeaway”. Out of the four words used to define “QSR”, “fast food” was the most mentioned (see Figure 6). “Fast food” was mentioned by 45% (or 13 publications) of all the research publications in this review and 5% (or 2 publications) of all the industry publications in this review. The second most mentioned word was “takeaway”, featuring in 17% (or 5 publications) of all the research publications in this review and none of the industry publications. For the remaining two words, “limited service restaurant” was mentioned by 3% of the research publications and industry publications, “food on-the-go” was mentioned by 3% of the research publications.

3.4. Publication focus by front and back-of-house food waste in QSRs

3.4.1. Publications mostly focussed on back-of-house food waste rather than both front/back-of-house

The focus of this literature review is BOH food waste generated in QSR. For additional context, the review recorded whether any of the studies also mentioned front of house food waste. Figure 7 shows the percentage of publications in this review that focus on BOH food waste only, or both front of house and BOH food waste.

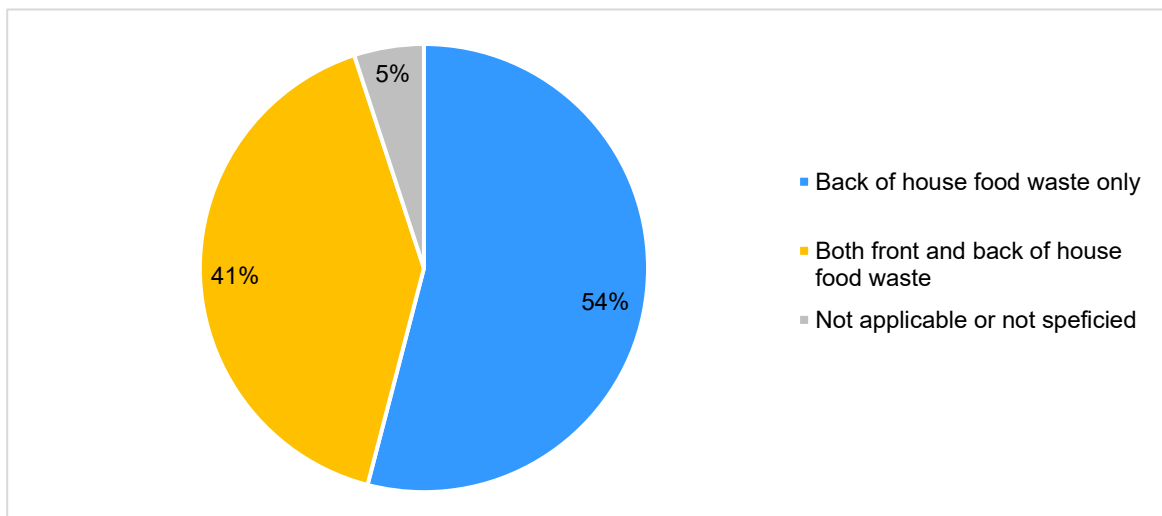


Figure 7: Publication focus by back and front of house food waste in QSRs.
Percentages calculated from the 69 publications in this review.

A greater number of publications focussed on reporting only BOH food waste in QSRs, as opposed to publications that focussed on reporting both front of house and BOH food waste in QSRs (Figure 7). 54% of the publications in this review (or 37 of 69 publications) provided information about BOH food waste in QSRs. 41% of the publications in this review (or 28 of 69 publications) provide information about both front of house and BOH food waste in QSRs.

3.4.2. Industry and research publications have a different focus for front/back-of-house food waste

Of the publications that focussed on reporting only BOH food waste in QSRs, there were five times more industry publications (31 publications) than research publications (6 publications). The industry publications included 30 industry press releases (e.g. QSR Magazine 2023b; QSR Web 2018; Wolf Detwiler 2022) and 1 industry white paper (Emerson 2020). The research publications included 6 journal articles (e.g. Jayasekara et al. 2024; Lal et al. 2021; Noone and Coulter 2012). This means that industry press releases dominated the publications that focussed on BOH food waste.

Of the publications that were reporting on both front and back-of-house food waste in QSRs, there were double the number of research publications (19 publications) than industry publications (9). The research publications included 9 journal articles (e.g. Martin-Rios et al. 2018; McAdams et al. 2019; Principato et al. 2021), 7 research reports (e.g. Austin Resource Recovery 2012; Clowes et al. 2019; SRA 2010), 2 theses (Drewitt 2013; Dzumbunu 2018), and 1 conference paper (Mohamed et al. 2018). The industry publications included 5 industry press releases (e.g. Daninhirsch 2022; QSR Magazine 2019; QSR Web 2022), and 4 white papers (e.g. Gunders 2012b; ReFED 2016; WRAP and Guardians of Grub 2020).

3.5. Back-of-house food waste in QSRs: how much, what and when

3.5.1. Publications that quantify food waste in QSRs

Breakdown of publications that quantify back-of-house food waste in QSRs.

There is currently a limited number of publications that report the amount of food wasted in QSRs, with 11 of 69 publications in this review (16%) providing relevant information. See Table 5 (overleaf) for a record of the information that these publications provide.

When examining the type of publications in this review that provided information on the amount of food wasted in QSRs, all publications but one white paper report this information on primary research data. However, when examining these publications by target audience, there is nearly double the number of relevant industry-oriented publications (7 publications) than academic-oriented publications (4 publications). The industry-oriented publications comprise of 6 research reports (ARCADIS 2019; Austin Resource Recovery 2012; FIAL 2021b; NSW EPA 2017; SRA 2010; Sustainability Victoria 2021) and 1 white paper (Gunders 2012b). 3 journal articles (Filimonau and Ermolaev 2021; Jayasekara et al. 2024; McAdams et al. 2019) and 1 Masters by Research thesis (Drewitt 2013). The relevant journal articles represent 4% of all publications in this review, highlighting the lack of formal academic publications that quantify food waste in the QSR sector.

Seven countries were covered across the 11 relevant publications that quantified food waste in QSRs. The greatest number of publications were in the Australian context, with these 5 publications representing just under half of the relevant publications (see Table 5). This is followed by the USA at 2 publications, comprising of 1 research report (Austin Resource Recovery 2012) and 1 white paper (Gunders 2012b). Of the Australian publications, there are four times as many industry-oriented publications as academic publications, comprising 4 research reports (ARCADIS 2019; FIAL 2021b; NSW EPA 2017; Sustainability Victoria 2021) and 1 journal article (Jayasekara et al. 2024). Given that relevant publications from Australia dominate, this discrepancy in publication types within the Australian context underscores the prevalence of industry-oriented publications as a broader trend observed across the relevant publications that quantifies food waste in QSRs.

Table 5: Publications that record how much food is wasted in QSRs. Information from 10 relevant research publications and 1 industry publication, out of a total of 69 research and industry publications in this review.

Reported amount of food waste	Country	Citation	Publication type
Approx. 25 kg average daily pre-consumer food waste produced from all food waste categories across 2 QSR outlets, with about 60% from inedible waste. This equated to approx. 5.5–6.1 kg per full-time-equivalent employee (FTE) per day. Used coffee grounds was the largest single contributor of total pre-consumer waste for both food outlets.	Australia	Jayasekara et al. (2024)	Journal article
1.22MT food wasted at the consumer level in foodservices, across the sector.	Australia	FIAL (2021b)	Research report
153,000 tonnes hospitality waste. Sample size not specified.	Australia	Sustainability Victoria (2021)	Research report
The National Food Waste Baseline estimates the takeaway food sector generated 130,600 tonnes of food waste in AU in 2016/17. By state: 2,300T in ACT; 44,700T in NSW; 16,00T in NT; 25,400T in QLD; 7,900T in SA; 2,500T in TAS; 33,700T in VIC; 12,500T in WA. Approx 95% ends up in landfill and 5% is composted. At the time of reporting, there were 80,000 QSR businesses in Australia, but it is unspecified how many businesses provided data.	Australia	ARCADIS (2019)	Research report
"Businesses in NSW could recover an additional 140,529 tonnes of food waste or prevent 281 million meals from going to landfill each year. Food waste fills over 60% of the bin of an average café or restaurant." (QUOTED)	Australia	NSW EPA (2017)	Research report
According to the USDA, households and foodservice operations (restaurants, cafeterias, fast food, and caterers) together lost 86 billion pounds of food in 2008, or 19 percent of the total U.S. retail-level food supply. 10% of wastage at fast food restaurants due to misprediction of service. This includes a policy by McDonalds to dispose of fries within 7 min after preparation.	USA	Gunders (2012b)	White paper
40% meat, 30% bakery, 20% fruit and vegetables, mostly post kitchen. Sample size: 21 employees from 3 QSRs,	Russia	Filimonau and Ermolaev (2021)	Journal article
QSR (grams per customer per day) total is 59.28g spoilage: 1.46g (2.4%), preparation: 27.35g (46.1%), production: 28.98g (48.9%), Plate (not collected), unidentifiable: 1.5g (2.5%). Sample size of 4 restaurants, including 1 QSR.	Canada	McAdams et al. (2019)	Journal article
Europe QSR A: 157kg waste per day (102kg customer and 55kg staff), B: 102kg waste per day (customer 71kg, staff 31kg) China QSR A: total 1,500kg, B: 400kg (page 35). 30% of plates wasted in China post service - cultural aspects. Sample size of 4 QSRs	Sweden and China	Drewitt (2013)	Thesis
The waste audit showed 52.35% of recyclables, 32.76% compostable and 14.89% residuals. The compostables included 1,705 lbs of (pre-consumer) food scraps (18% of all waste). Cooking oil from the grease trap was classified as part of the recyclables category at 2,234 lbs (24% of all waste). Sample size of 4 QSRs	USA	Austin Resource Recovery (2012)	Research report
0.48kg per customer. Most of the food waste comes from preparation (peelings, off cuts and anything ruined while cooking), 30% of food waste comes back from customers' plates, 5% of food waste is classified as 'spoilage' (out-of-date or unusable items). Sample size of 10 restaurants	United Kingdom	SRA (2010)	Research report

Small sample sizes and patchy information limit the usefulness of extant quantifications

Further examining the relevant publications within the Australian context reveals a lack of information specific to the amount of food wasted generated BOH in QSRs (see Table 5), making it difficult to establish a baseline. Three of the 5 relevant Australian publications quantified food waste in QSRs as part of the wider foodservices or hospitality sector, with no specific breakdown for QSRs (FIAL 2021b; NSW EPA 2017; Sustainability Victoria 2021). This includes the most recent National Food Waste Baseline report by (FIAL 2021b), reporting 1.22MT food wasted at the consumer level in foodservices, across the sector. Of the two remaining publications, the previously published version of National Food Waste Baseline report provides the only nation-wide estimate of food waste generated in QSRs (ARCADIS 2019). The report estimates the QSR sector (reported as takeaway food sector — see section 3.3) generated 130,600 tonnes of food waste in 2016/17 as a whole (ARCADIS 2019) but does not provide specific figures for BOH food waste. The remaining publication is the only known journal article to date that specifically measured BOH food waste in QSRs in Australia, reported as an average of 25 kg daily (Jayasekara et al. 2024). This waste was measured at two QSR outlets, giving little indication of the BOH waste levels across the wider QSR sector in Australia.

Examining the 6 relevant studies for the six other countries (USA, Canada, United Kingdom, Sweden, Russia and China) reveals a similar trend of patchy information that makes it difficult to quantify national waste levels across QSRs in those countries, let alone globally. See Table 5 for further information. The sample sizes were small or otherwise vague, with 4 publications reporting studies that engaged four QSRs at most (Austin Resource Recovery 2012; Drewitt 2013; Filimonau and Ermolaev 2021; McAdams et al. 2019), 1 publication not mentioning the number of QSRs (Gunders 2012b), and 1 publication mentioning the wider restaurant sector (SRA 2010). Different units of measure were also used to quantify the waste, ranging from grams or kilos per customer per day (Drewitt 2013; McAdams et al. 2019) to percentage-only reports (Filimonau and Ermolaev 2021; Gunders 2012b), rendering the reported quantifications more difficult to compare.

The observations described in this section are not meant to diminish the value of the individual publications mentioned. Rather, collective examination of these publications reveal a relative lack of relevant quantification data for BOH food waste in QSRs that is useful to compare and to establish a baseline. This underscores an opportunity for additional quantification studies in Australia and globally that are larger in scale and use easily comparable units of measurements.

3.5.2 Publications that quantify what foods are wasted and at what stage

Table 6 and Figure 8 show the types of foods wasted BOH in QSRs and at what stage of operation. These stages are initial delivery and storage, food preparation, and service ready. A total of 38 publications in this review (55%) provided relevant information. The relevant publications comprise of 9 journal articles, 2 theses, 1 white paper, and 20 industry press releases, providing information for multiple food type and stage categories. In Table 6, this information is presented by number of publications. In Figure 8 this information is presented by percentage of the total number of publications in this review.

There are nearly double the number of relevant industry publications (21 publications) than research publications (11 publications) that provide information on types of foods wasted BOH in QSRs and at what stage. All but one of these industry publications were industry press release articles. This means that not only do publications written for an industry audience dominate, most of these publications (the industry press releases) have been written by industry for industry

Stage wasted	Publications	Breakdown of food type wasted (publications)
Delivery / storage	10	Other / not specified (8), fresh produce (1), meat (1), bakery (1),
Preparation	23	Other / not specified (19), fresh produce (4), meat (2), bakery (2), seafood (1)
Service ready	22	Other / not specified (20), carbohydrates (4) Fresh produce (3), meat (3), bakery (2),

Table 6: Types of foods wasted back-of-house in QSRs and at what stage, by number of publications. From 38 relevant publications of a total 69 publications in this review.

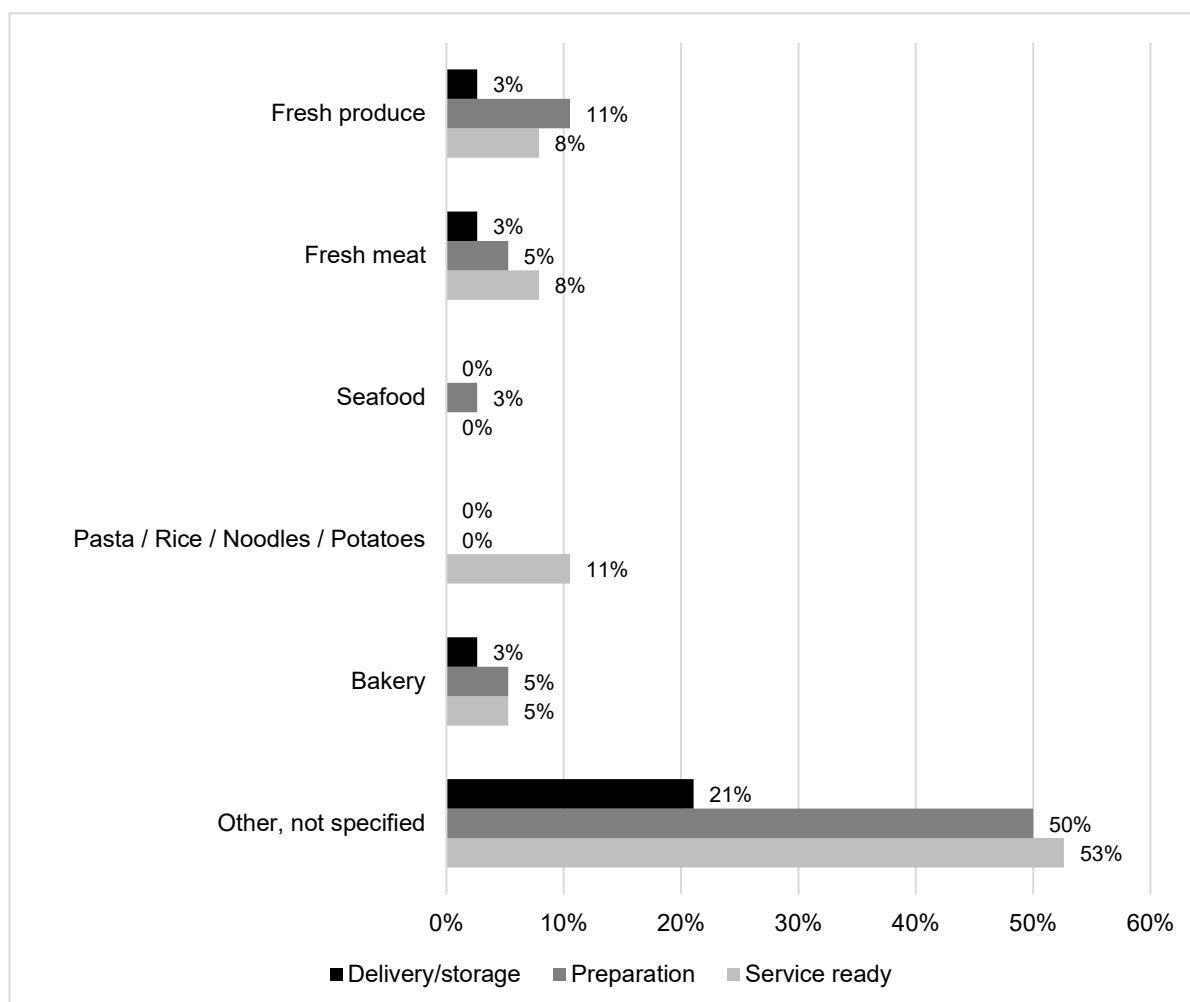


Figure 8: Types of foods wasted back-of-house in QSRs. Information categorised by stage and presented by percentage of publications. Percentages calculated from 38 relevant publications of a total 69 publications in this review.

Limited information on what specific categories of food are wasted back-of-house in QSRs

Just under a third of the relevant publications (11 of 38 relevant publications) mentioned specific categories of food which were wasted BOH in QSRs. Fresh produce, fresh meat, seafood, carbohydrates (pasta/ rice/ noodles/ potatoes) and bakery were the specific food categories the publications in this review provided QSR BOH food waste information on. The relatively small number of food categories which the publications did provide information on could be due to the overall paucity of publications on BOH food waste in QSRs (see section 3.1). The food categories which were mentioned could also reflect the cuisine types of QSRs on which these publications focussed.

While industry press release articles dominate most mentioned publication type for information on foods wasted BOH in QSRs and at what stage, only 4 of the 20 articles mentioned what specific food categories were wasted. These food categories include fresh produce (Daus et al. 2023) and carbohydrates (Oches 2018; Whitehead 2020) and bread (QSR Web 2022).

Over two thirds (27 of 38 relevant publications or 71%) did not specify what type of foods were wasted BOH in QSRs. This is shown in Table 6 and Figure 8 by the dominance of the category “other, not specified” across all waste stages. Surveyed food categories which the reviewed publications did not provide relevant information on were omitted from Table 6 and Figure 8 including processed meats, dairy, eggs, preserves / pickles, sauces and spreads, desserts, canned food, and beverages. The lack of specific food category information may extend beyond a paucity of publications on BOH food waste in QSRs. It may also reflect on what the publication authors are choosing to report on — discussed in section 4.5.2. Over half of these publications (16 publications) were industry press release articles, the other publications were 8 journal articles and 3 industry reports.

Food preparation and services ready stages most represented in back-of-house QSRs food waste, each reporting different categories of foods most wasted

All 38 of the relevant publications mentioned what stage food was wasted. The food preparation stage (23 publications) and service ready stage (22 publications) were the most mentioned stages where BOH food waste occurred in QSRs. The initial food delivery and storage stage (10 publications) was mentioned half as many times in comparison.

For both food delivery/storage and food preparation stages BOH in QSRs, the most mentioned foods wasted were fresh produce, followed by meat, and bakery. In the preparation stage, these specific foods were reportedly wasted at least twice as many times. This corresponds to there being twice as many publications reporting on foods wasted in the preparation stage than the delivery and storage stage. In the preparation stage there is mention of seafood by one publication (Dzumbunu 2018). This is a food category not mentioned in the delivery and storage stage, despite all the food other categories aligning in type. It is possible that the greater number of relevant studies per preparation stage, the greater the number of food categories for which there is relevant information. Four specific food categories were reported on in both the preparation and service stages, which were represented by 23 and 22 publications respectively. The specific reason is less important, rather a reason is suggested to highlight that there may be a connection between why food is wasted in the food delivery/storage and food preparation stages — discussed in section 4.5.2.

Carbohydrates (pasta/rice/noodles/potatoes) were reportedly the most wasted food category in the service ready stage, followed by fresh produce, meat and bakery. It means that the food categories reported as wasted in the service ready stage and the number of times these food categories are mentioned is different to the delivery/storage and preparation stages. Carbohydrates were mentioned only in the service ready stage.

3.6. Reasons for back-of-house food waste in QSRs

3.6.1. Publications that mention food waste in QSRs by stage and temperature

Understanding the reasons for BOH waste and the areas where it is generated is important to help identify hotspots or particular areas so that solutions can be curated to address them. With the goal of this project being to understand what actions QSRs can take within their own kitchens and stores to reduce food waste, focusing on the BOH areas is key. In the BOH area we categorised the stages of operation of where food waste can arise into delivery/storage, preparation and service ready stages (Figure 9). For each stage, the temperature-type of the wasted food was recorded, categorised as ‘frozen’, ‘fridge’, ‘ambient’, ‘hot’, and ‘not specified’. ‘Fridge’ refers to ingredients or prepared food items (e.g. salad) that are kept chilled for service. ‘Ambient’ refers to ingredients ordinarily stored at room temperature. ‘Hot’ refers to cooked foods (e.g. fries), and items kept warm for service.

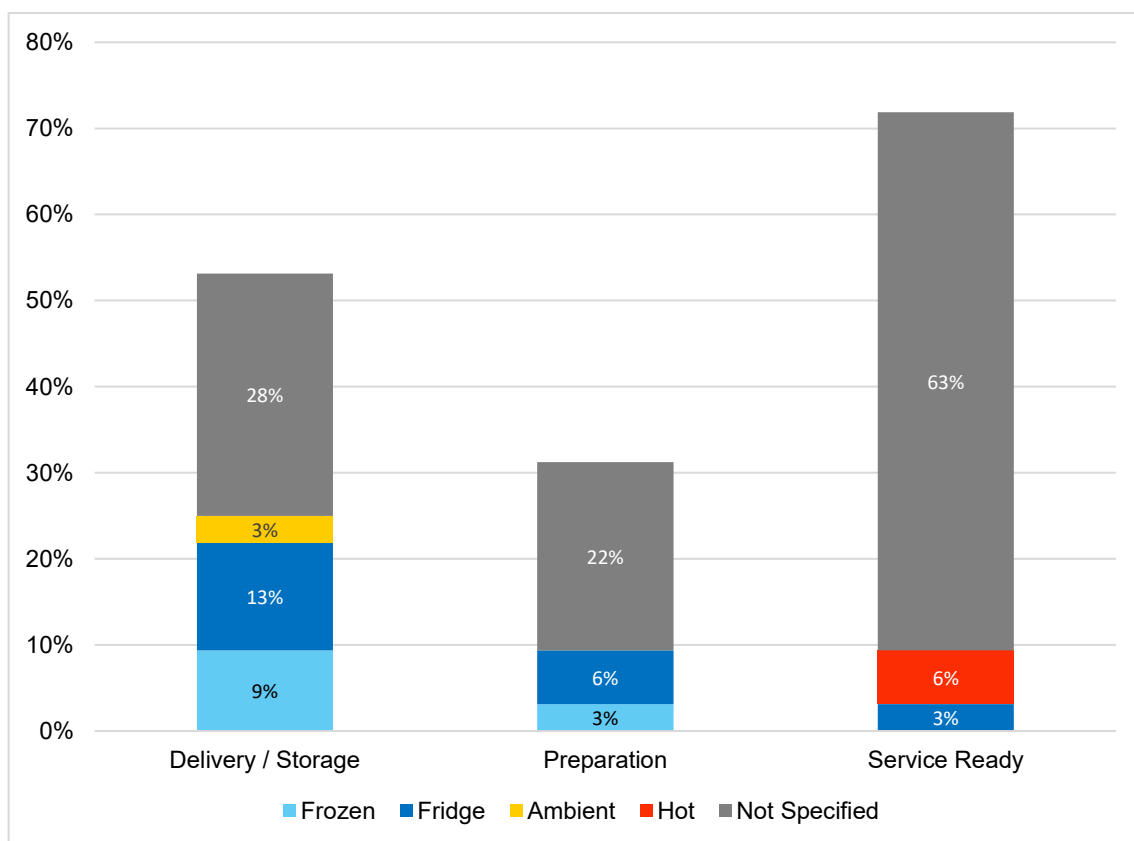


Figure 9: Back-of-house food waste in QSRs, by supply chain stage & temperature.
 Percentages calculated from 32 relevant publications, out of a total of 69 publications.
 Percentages rounded to the nearest whole number.

Less than half of the analysed publications mentioned reasons for BOH food waste in relation to stage of operation. Of these, the most referenced stage of where this food waste was generated was in the service ready stage, followed by the delivery/storage stage. Reasons given for why food is wasted at the service stage were concerns around food safety and hygiene (Hirth et al. 2021), of which are embedded in company policy, such as McDonalds ordering staff to dispose of fries within 7 mins of preparation (Gunders 2012a). Human error in this stage, particularly for hot food, was also mentioned

(Whitehead 2020). Human error was also mentioned at the delivery and storage stage (Dzumbunu 2018), with businesses such as Roll'd having waste generated by team members inaccurately predicting shelf-life of products (Kisok Marketplace 2021). Mechanical breakdowns of freezers were also mentioned as challenges that occur at this stage (Dzumbunu 2018).

Figure 9 compares the stage of generation to the temperature of the food when the waste is generated. In the majority of publications, this detail was not specified but where it was insights showed that at the storage/delivery stage, food waste is generated in the frozen and refrigerated states (Dzumbunu 2018; Emerson 2020). Lack of data made it difficult to draw conclusion from the other stages but in the service ready stage, hot food made up more of a proportion of other temperature types stated (Gunders 2012a; Hirth et al. 2021; Whitehead 2020). This makes logical sense as these are typically the states the food is in as it flows through the QSR, entering as frozen or refrigerated item and leaving as a hot/cooked item.

3.6.2: Publications that mention reasons for back-of-house food waste in QSRs

Figure 10 (overleaf) documents the reasons for BOH food waste in QSRs. From the total of 69 publications analysed 28 publications mentioned reasons for BOH food waste. These publications suggested reasoning that covers 5 main areas: forecasting, hygiene, process, staff, and packaging.

The most commonly cited reasoning for food waste generation was 'preparation of too much food' (Dhir et al. 2020; Jayasekara et al. 2024), mentioned in 54% of relevant publications. Forecasting issues were a commonly cited theme, with 36% also mentioning that 'ordering too much stock' was a source of food waste generation (Filimonau et al. 2019; QSR Media AU 2022b). Hygiene concerns were also highly referenced as reasons for food waste, with factors concerning storage period (Hirth et al. 2021), storage temperature (Emerson 2020) and spoilage (Dzumbunu 2018).

In the process side of the kitchen, the main cited reasons for food waste were preparation/offcuts waste (Jayasekara et al. 2024) and imperfect cooking (Filimonau and Ermolaev 2021), mentioned in 32% and 21% of the relevant publications respectively. The amount of preparation waste generated at a particular restaurant is dependent on what is considered edible and inedible, which has a number of cultural connotations (Jayasekara et al. 2024). Other process actions such as poor storage and machine maintenance were mentioned as well as incorrect ordering. An inability to donate food was also mentioned as a reason for food waste in QSRs (Dhir et al. 2020).

The action or inaction of staff also play a role in BOH food waste in QSRs. 21% of relevant publications mentioned that staff training or lack thereof was a driver (Dzumbunu 2018; Kisok Marketplace 2021; McAdams et al. 2019). Investment in further staff training (McAdams et al. 2019) or training staff on equipment that saves them time (Kisok Marketplace 2021), can result in less food waste (Dzumbunu 2018). However there are challenges in providing further training to staff in the hospitality sector due to high turnover rates and increasing costs of training (McAdams et al. 2019). Lesser-mentioned staff-related reasons for food waste was management or staff direction issues (Filimonau and Ermolaev 2021; Noone and Coulter 2012), mentioned by 7% of the publications in this review.

Packaging was least mentioned of the identified categories for BOH food waste in QSRs. The most commonly mentioned packaging reason was date labelling, accounting for 14%. This includes outdated date labelling practices, such as relying on staff to memorise the exact shelf life of particular products (Kisok Marketplace 2021). Although this literature review has not identified packaging as a frequently mentioned reason for BOH food waste in QSRs, the impact of packaging on reducing food waste is known (Wohner et al. 2019). Packaging's role in reducing household food waste has also been explored in recent years (Chan 2022a, 2022b). This present review posits that packaging's role in generating/reducing food waste in the foodservice sector and specifically the QSR sector is an under researched area.

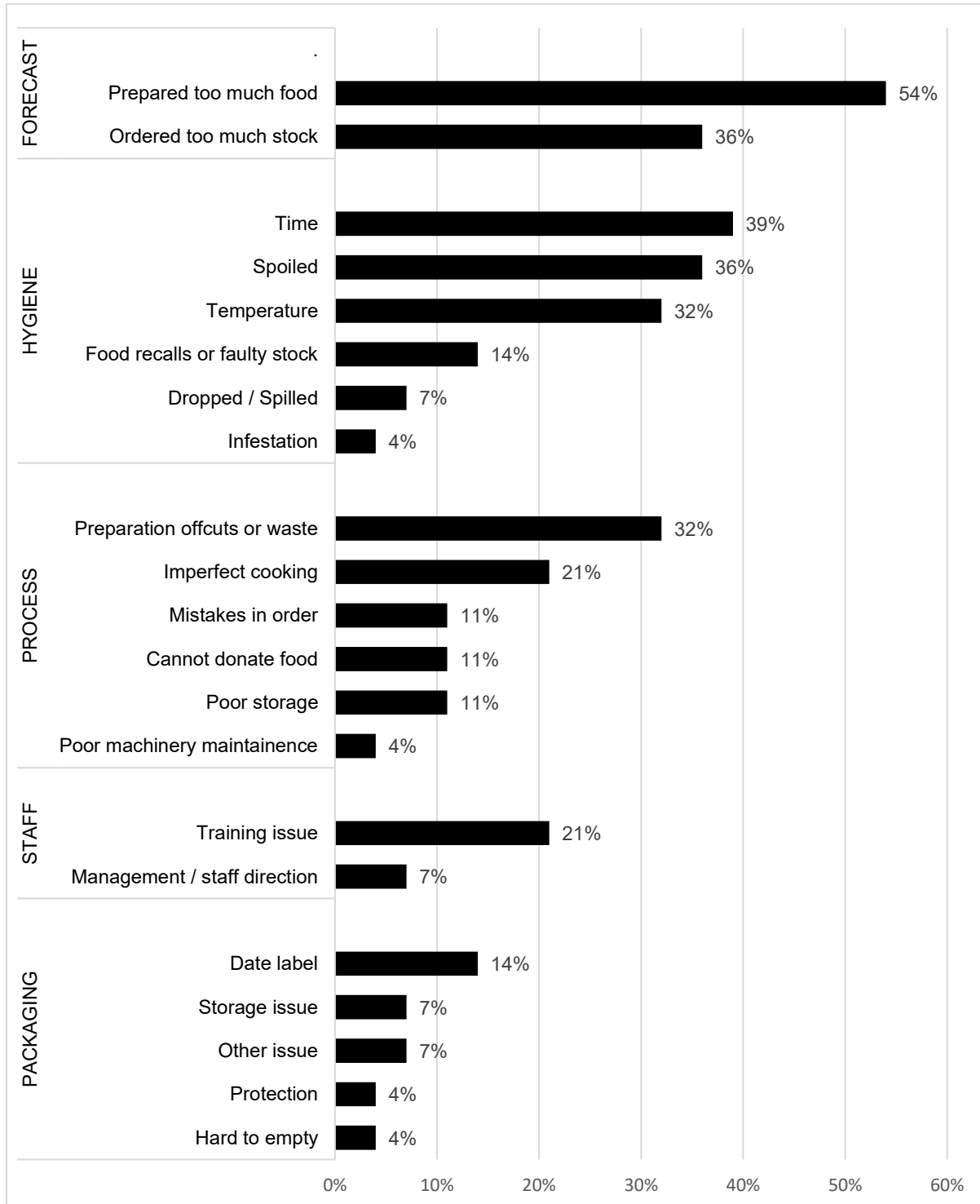


Figure 10: Reasons for back-of-house food waste in QSRs.
 Percentages calculated from 28 relevant publications, out of a total of 69 publications in this review

3.7. Key actors associated with back-of-house food waste in QSR

Figure 11 records the key actors associated with BOH food waste at QSRs. Out of the analysed 69 publications of this review, 39 (57%) mentioned key actors associated with BOH food waste at QSRs. Publications that related to plate waste was excluded as it was outside the scope.

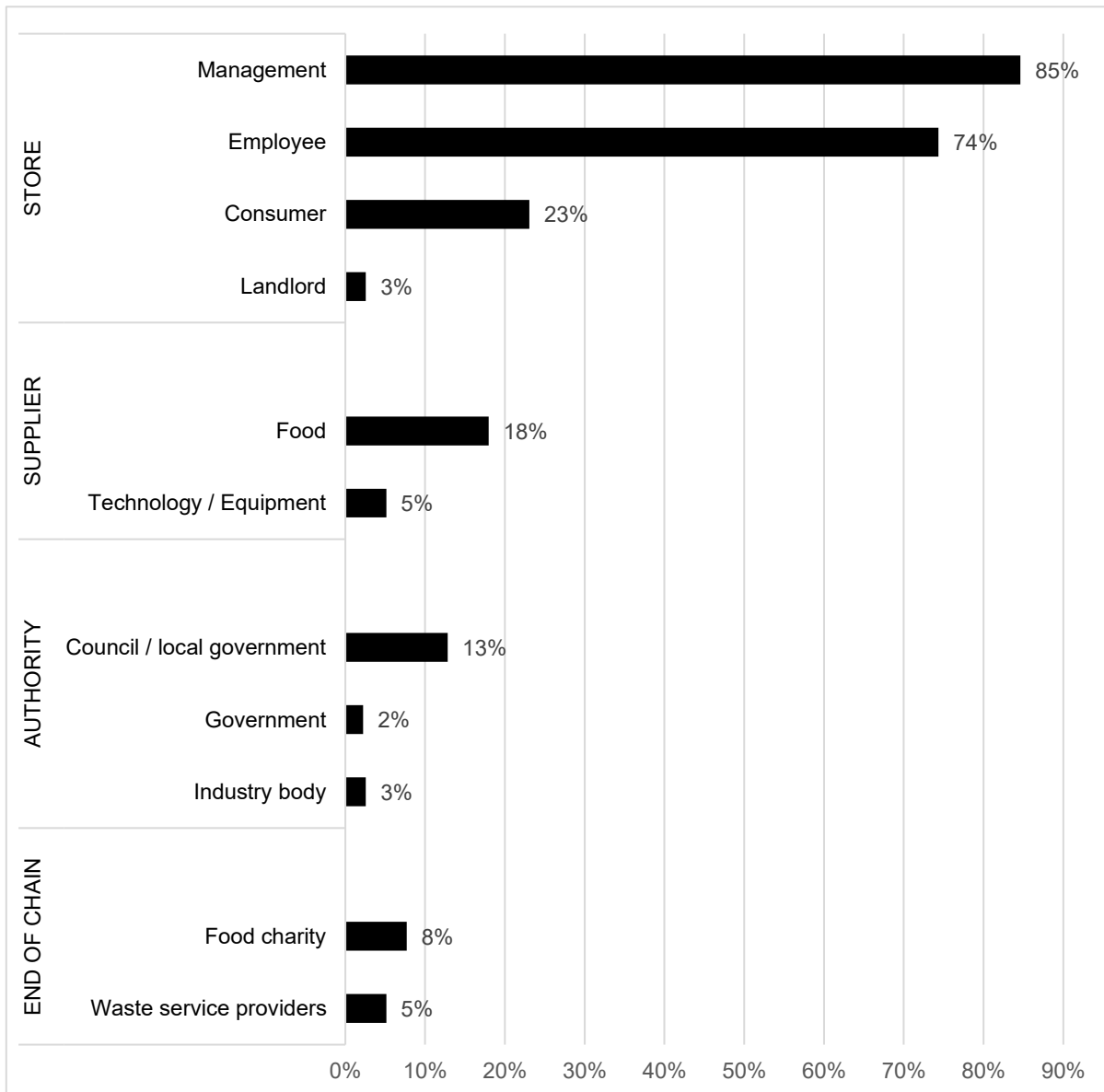


Figure 11: Key actors associated with back-of-house food waste in QSRs.
 Percentages calculated from 39 relevant publications, out of a total of 69 publications in this review.

Overwhelmingly, these relevant publications referenced 'management' and 'employees' of the store as the key actors (Filimonau et al. 2019; Filimonau and Uddin 2021; Jayasekara et al. 2024; Martin-Rios et al. 2018). This is to be expected as in the BOH context these are the most present and influential stakeholders. These two stakeholders are inextricably linked to each-other, with management to staff relationships being noted as a significant point of food waste generation (Dhir et al. 2020; Filimonau et al. 2019). Managers in QSRs and in hospitality venues more broadly set the agenda for waste management (Dhir et al. 2020). Managers can either set an environment that is conducive to wasting food or one that minimises it. Managers tend to order more stock than a store needs to meet customers' expectations of always having everything (Filimonau et al. 2019), conducive to generating food waste. Budgetary constraints and staff disengagement are also mentioned as a limiting factor for reducing food waste (Filimonau et al. 2019). On the other hand, the larger financial resources available to chain-affiliated businesses affords access to better management tools to more accurately forecast expected customer numbers and order an appropriate amount of stock (Dhir et al. 2020), conducive to minimising food waste.

Lack of employee skill is a factor that contributes to food waste (Clowes et al. 2019; Filimonau and Ermolaev 2021; McAdams et al. 2019). In a study that compared employee skill level across different foodservice types, the skill level of employees was consistently mentioned as having a relationship with food waste across the board (McAdams et al. 2019). Notably, the QSR restaurant in the study had the simplest food to prepared but that was also correlated to the lowest employee skill level (McAdams et al. 2019). This was attributed to the nature of the job being minimum wage and the fact that for a majority of the workforce, this was their first job. Managers in the study reiterated this point by mentioning that despite the 'highly automated environment', a significant portion of their waste was due to 'employee error' (McAdams et al. 2019).

Consumers were mentioned in 23% of publications assessed to be key actors in generating BOH food waste. There are various ways these consumers can influence BOH food waste, including food discarded due to being past holding time (hygiene/time/temperature reasons) as the customer did not show up on time (Davityan 2023b; QSR Magazine 2022). A sudden surge of customers can lead to increased food waste due to management cooking/preparing more food than is served (Dzumbunu 2018). Management directs staff to cook more but this direction does not cease after the surge passes or customers leave as they have been waiting too long (Noone and Coulter 2012). Customers are tangentially involved in creating food waste in this scenario but ultimately, this waste is generated due to management. In many cases management controls menu design, another large contributor or inhibitor of food waste (QSR Media AU 2022a; QSR Web 2016).

Food suppliers are another key actor that can contribute to BOH food waste in QSRs (Dzumbunu 2018; Emerson 2020; Hospitality Technology 2014). Issues included suppliers delivering the product to the wrong specification (Dzumbunu 2018), poor systems of ordering (Hospitality Technology 2014), or sub optimal products delivered due to poor cold chain practices (Emerson 2020).

Other actors were council local governments and waste service providers. Council local governments were mentioned in the context of providing more support to enable businesses to deal with generated food waste (Filimonau et al. 2019). Waste service providers were also mentioned in a similar context of helping provide equipment to encourage the recycling of food waste (Michalec et al. 2018).

3.8. Strategies for reducing back-of-house food waste in QSRs

Solutions to BOH food waste in QSRs were suggested by 90% of the publications reviewed, with the majority of that arising from the 38 industry publications in comparison to the 24 research publications. Interestingly, a higher proportion of the industry publications were strategy focused, with 95% of these publications focusing on BOH strategies to reduce food waste.

Figure 12 charts the frequency with which individual strategies are mentioned in the literature, presented as a percentage of all the 62 publications in this review. For further detail, Figure 13 compares these strategies by whether they were mentioned in industry publications or research publications. To better examine these strategies, they were categorised into the themes of 'adoption', 'increase' and 'improvement', as seen in Figure 12 and Figure 13.

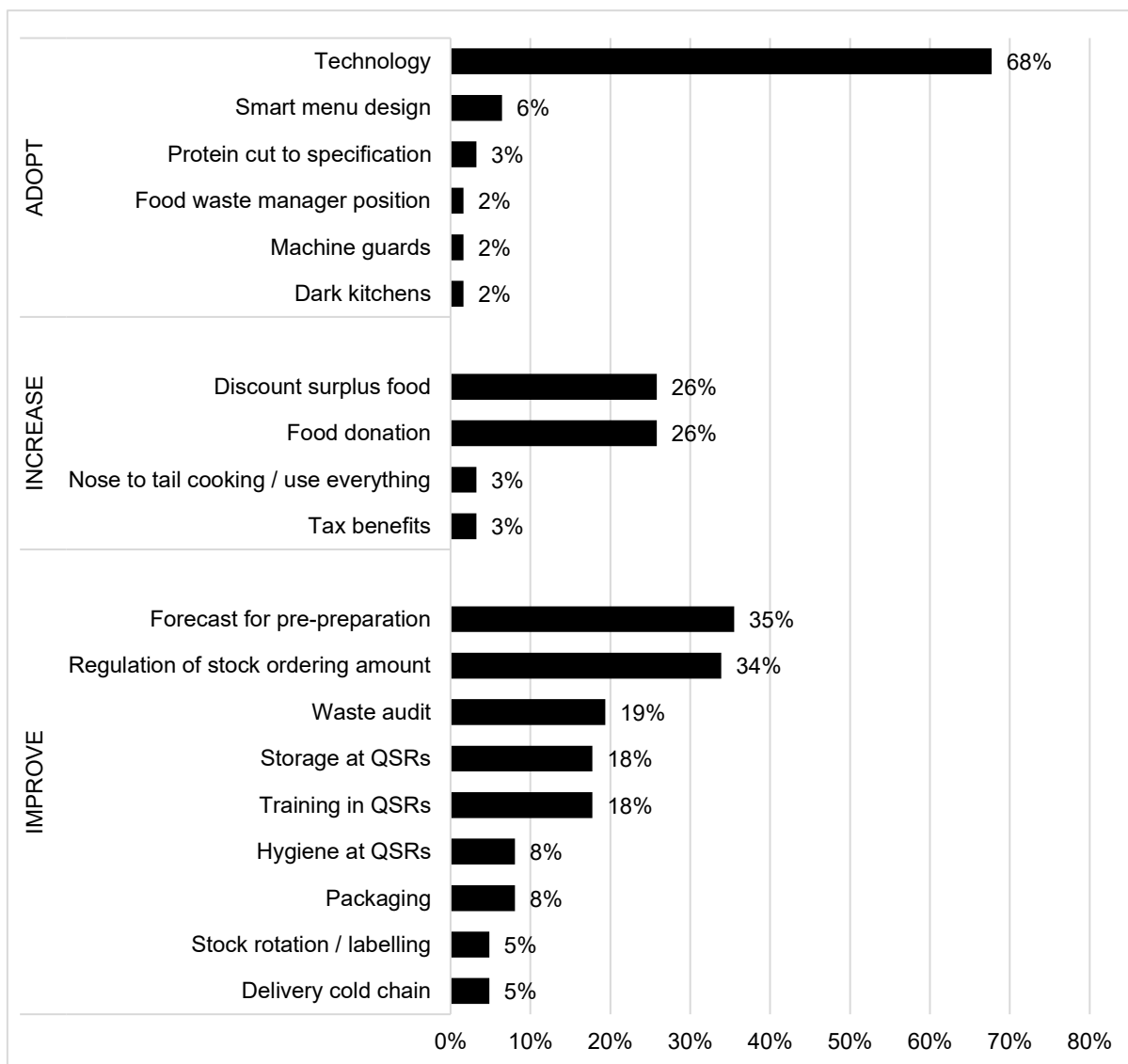


Figure 12: Strategies to reduce back-of-house food waste in QSRs.
 Percentages calculated from 62 relevant publications, out of a total of 69 publications in this review.
 The relevant publications included 38 industry publications and 24 industry publications.

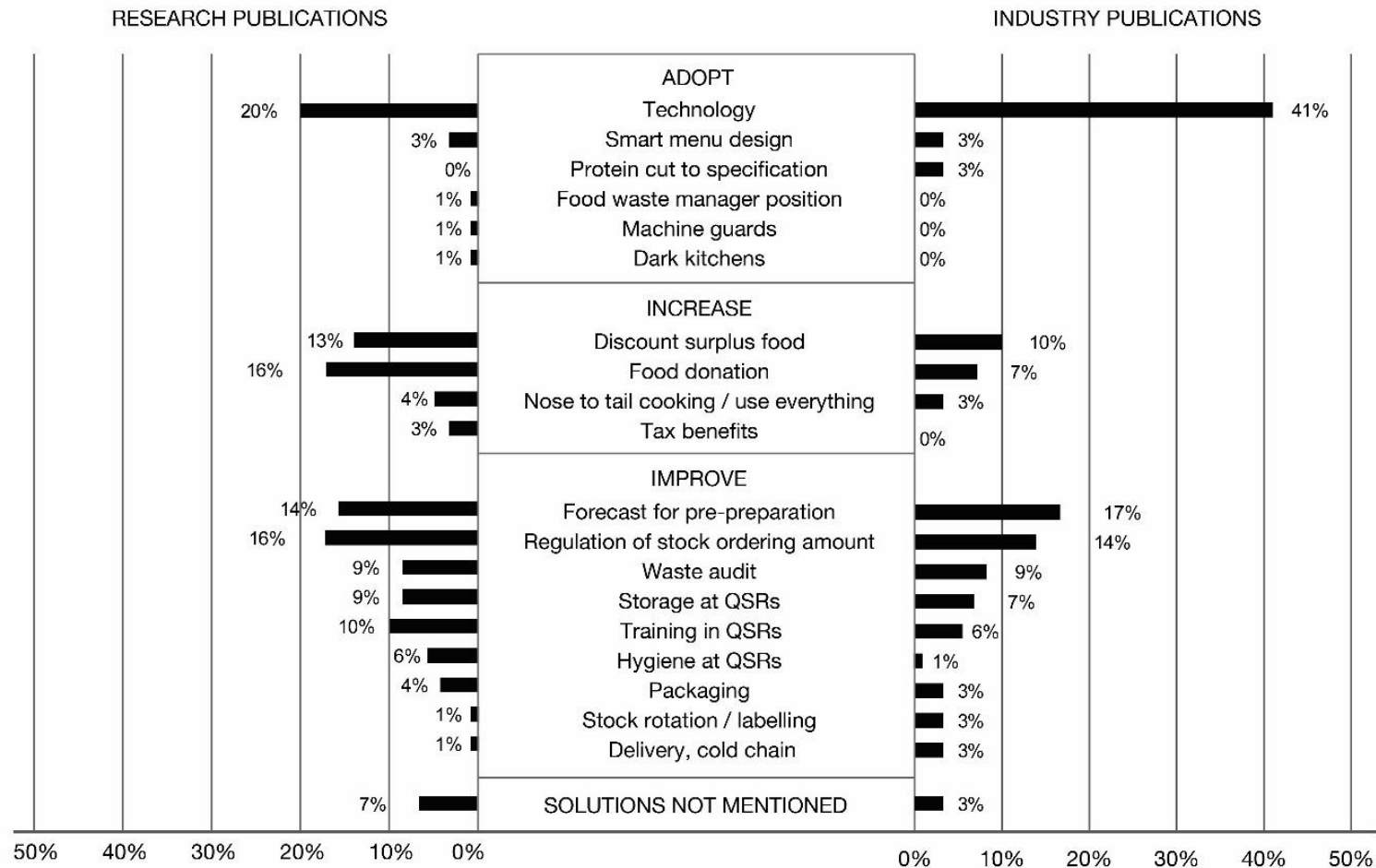


Figure 13: Comparing solutions to reduce back-of-house food waste in QSRs.
 Percentages calculated from 62 relevant publications out of a total of 69 publications in this review. The relevant publications included 38 industry publications and 24 industry publications.

Figure 12 and Figure 13 show that technology is considered to be an effective solution. Representing 68% of relevant publications it is most commonly mentioned, with higher representation in the industry publications. Other solutions focused on increasing food waste diversion away from landfill or lower waste hierarchy solutions in favour of food donation and discounting surplus food. The most commonly suggested solutions to prevent food waste in the first place included forecasting for pre-preparation and regulation of stock ordering.

Technology was a highly represented solution. The types of technological solutions suggested in the literature was wide ranging. AI-based solutions were widely recommended, with suggestions to use predictive AI combining previous sales data and real-time weather forecasts to predict food preparation amounts and timings (Groene and Zakharov 2024), to training Internet of Things AI systems to prevent food preparation and spoilage waste by up to 10% (Aytaç and Korçak 2021). Examples such as AI kitchen management platform, PreciTaste, which helped QSR UrbanBelly reduce food costs by 5% by using the platform to inform staff on what, when and how to prepare and cook food, which reduced waste by ensuring correct quantities (QSR Magazine 2023b), were outlined by the industry publications.

Cloud-based solutions were also mentioned in the industry publications. These solutions ranged from auditing capabilities (QSR Media AU 2023a) to menu and recipe reviews to reduce waste (QSR Media AU 2023b) to allowing QSRs to sell surplus food through a cloud-based mobile app (Whitehead 2018). Mobile apps were a prominent solution suggested to help enable discounted sales or donation of surplus food. Mobile apps such as Y-waste in Australia (Thong and Anich 2022) and Too Good to Go globally (QSR Magazine 2023a; Vo-Thanh et al. 2021) are referenced both in the research and industry publications as solutions for QSRs to redistribute surplus food to food insecure people or to customers at a discounted price. These mobile apps helped QSRs reduce food waste generation (Whitehead 2018). While Y-waste shut down in 2023 after 6 years of operation, the app acted as a proof of concept for food waste apps in Australia. Too Good to Go entered the Australian market in 2024 and partnered with over 1300 businesses in the first year (Retail World 2025; Too Good To Go 2024), suggesting both retailer confidence and consumer readiness for app-based food waste solutions.

Technology can help businesses self-audit their food waste. Smart scales, such as Winnow and Leanpath, can give real-time feedback on what items are being wasted and in what quantities so businesses can adjust accordingly (Clowes et al. 2019; Daninhirsch 2022). Other technology-based solutions include surveillance or remote video audits of staff performance (QSR Web 2018), tech-based menu designs (QSR Media AU 2022a) and using modern robotics technology to augment workers' cognitive capacity (Noone and Coulter 2012).

Solutions that were not techno-centric were suggested by both publication types, with a greater proportion from the research publications. The research publications suggested further training for staff (Hollis 2019; Marx-Pienaar et al. 2020), improvements in hygiene practices (Lal et al. 2021; Whitehead 2016), increased/improved storage (Dzumbunu 2018; WRAP and Guardians of Grub 2020) and Nose to tail cooking (NSW EPA 2017; Principato et al. 2021) as effective ways to reduce food waste in the QSR sector.

3.9. Barriers to reducing back-of-house food waste in QSRs

Key barriers to reducing food waste were highlighted only in a small number of the analysed publications. A total of 14 out of 69 publications mentioned barriers to reducing BOH food waste in QSRs. Two industry publications mentioned these barriers compared to the 12 research publications. Despite this small sample size some key barriers were identified. Figure 14 charts the frequency with which different barriers to reduce BOH food waste are mentioned in the literature, presented as a percentage of the total publications in this review. For further detail, Figure 13 and Figure 15 compares these barriers by whether they were mentioned in industry publications or research publications. To better examine these strategies, they were categorised into the themes of 'people', 'perception' and 'costs', as seen in Figure 14 and Figure 15.

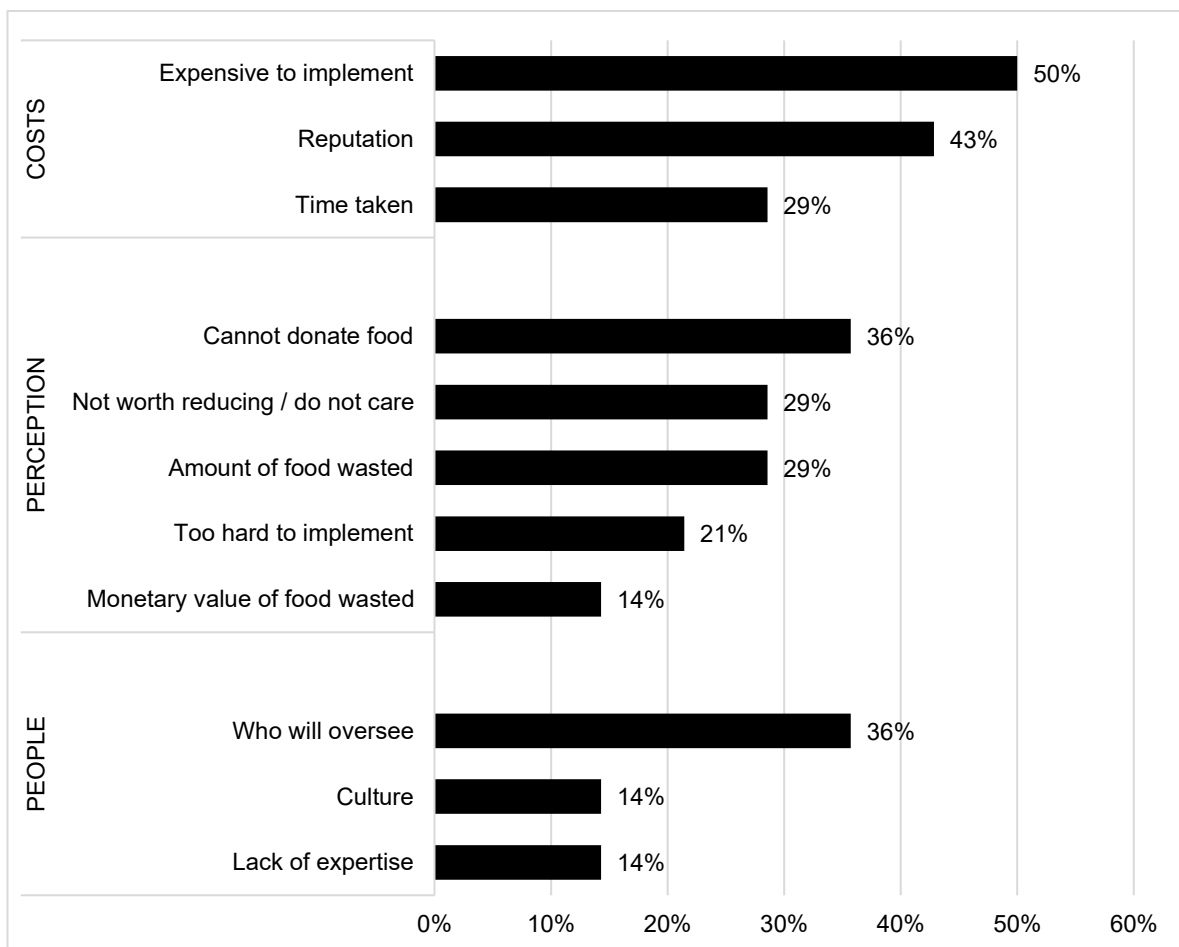


Figure 14: Barriers to reducing back-of-house food waste in QSRs.
 Percentages calculated from 14 relevant publications, out of a total of 69 publications in this review.
 These relevant publications included 2 industry publications and 12 research publications.

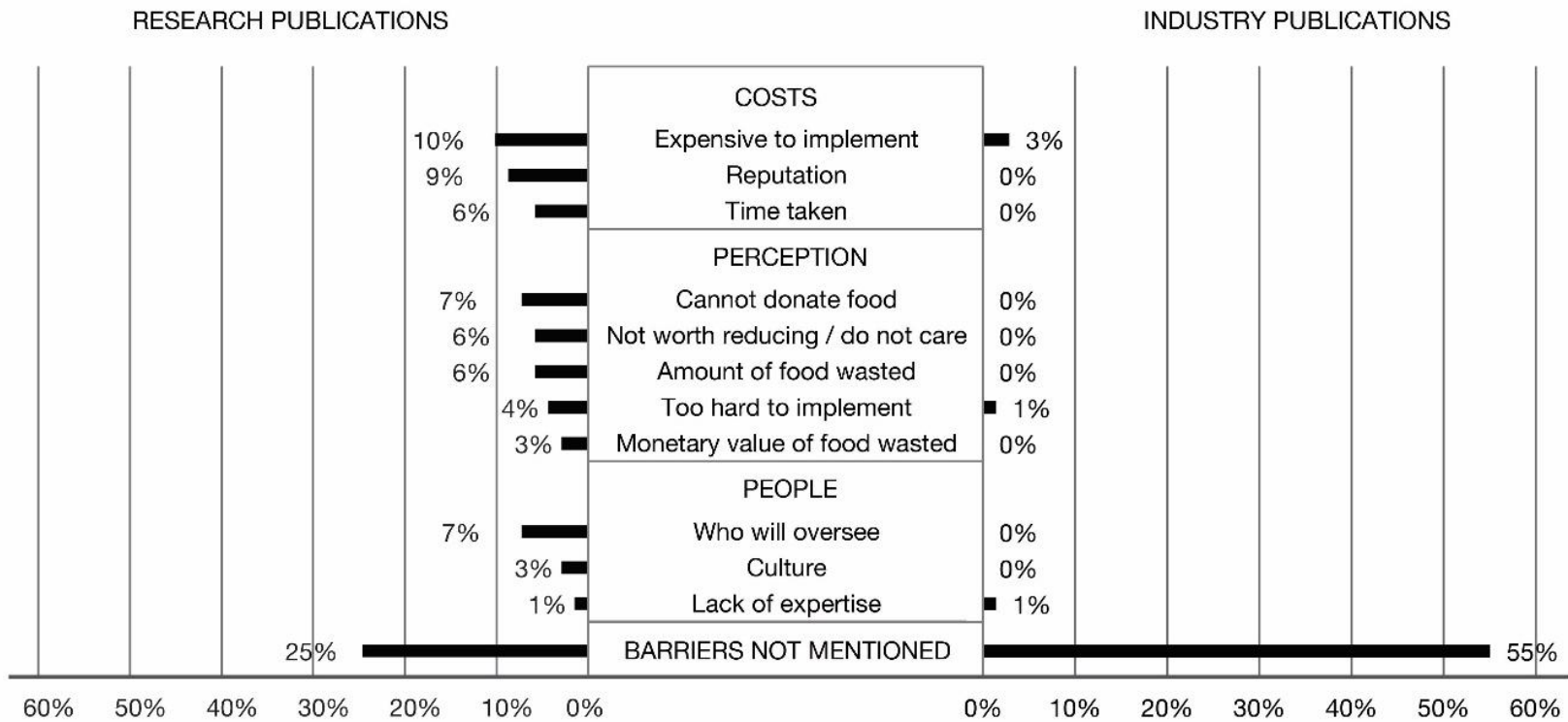


Figure 15: Comparing of barriers to reducing back-of-house food waste in QSRs.
 Results from 29 research publications and 40 industry publications. Percentages calculated from out of a total of 69 publications in this review

The expense of implementing a solution is the most mentioned barrier to reducing food waste (Filimonau et al. 2019; Hirth et al. 2021; Martin-Rios et al. 2018; Marx-Pienaar et al. 2020; McAdams et al. 2019; Noone and Coulter 2012; ReFED 2016). This ranges from the expense of a technology (ReFED 2016), to businesses (Jayasekara et al. 2024) being unwilling to bear the cost of training staff (McAdams et al. 2019). The second most mentioned barrier to action is reputation. It may seem reasonable to assume that acting to reduce waste would positively correlate with reputation, but the literature mentions that there are reputational risks. First is with regards to serving sizes (Filimonau and Ermolaev 2021). Reduced serving sizes and smaller menu sizes or range can reduce the amount of food waste generated, but it risks displeasing customers due to a perception of reduced value (Filimonau and Ermolaev 2021). The other reputational concern held by QSRs is the liability concern around food donation (Davityan 2014; Dhir et al. 2020; Filimonau et al. 2019; Hirth et al. 2021), leading businesses to declare that they cannot donate food. The research papers that mentioned reputational concerns of businesses around food waste also reported that businesses could not donate food. The time taken, from an expense of human capital, to address the challenge of food waste was mentioned by four articles as a barrier to action (Filimonau et al. 2019; Hirth et al. 2021; Martin-Rios et al. 2018; Thong and Anich 2022).

Perception-based barriers to reducing BOH food waste in QSRs included perceiving it is not worth reducing/not caring about food waste (Filimonau and Ermolaev 2021; Hirth et al. 2021; Martin-Rios et al. 2018; McAdams et al. 2019), that actions are too hard to implement (Aytaç and Korçak 2021; Martin-Rios et al. 2018; Thong and Anich 2022), that the business does not waste much food (Akamatsu et al. 2022; Dhir et al. 2020; Martin-Rios et al. 2018; Marx-Pienaar et al. 2020), and that the wasted food is not worth much (Akamatsu et al. 2022; Martin-Rios et al. 2018).

The challenge of 'people' as a barrier to reducing BOH food waste in QSRs included concerns over who would oversee the implementation of actions to reduce food waste (Filimonau et al. 2019; Martin-Rios et al. 2018; McAdams et al. 2019; ReFED 2016; Thong and Anich 2022), the culture of the establishment (Drewitt 2013; Filimonau and Ermolaev 2021) and the lack of expertise in the business (Filimonau et al. 2019).

4. Discussion

4.1. Research publications vs industry publications

There is a significant gap between the industry publications and research publications (see section 3.1.1). Industry publications and its contents may be anecdotal or promotional nature. This was observed through this literature review. The industry literature — especially the industry press releases — tended to highlight particular brands engaged in addressing food waste (Hospitality Technology 2014; QSR Media AU 2016) or highlight how particular technologies or solution providers could help businesses reduce waste and save money (Cherryh 2019). Although these publications lacked the rigour of peer-reviewed journal articles, they were useful to gauge industry perceptions and attitudes toward food waste in QSRs. The abundance of industry publications compared to the research publications was an intriguing finding. As stated in section 3.4, industry publications reporting on BOH food waste outnumber research publication 5 to 1. With the clear industry interest pertaining to the challenges of food waste, there is an opportunity for more academic research into the QSR sector to identify and validate solutions.

Interest in the topic of food waste in BOH context of QSR has been building over the time period analysed in this review, although the number of publications in the research and industry literature has fluctuated. As explored in section 3.1.2, there was a general trend of an increase in industry publications followed by an increase in the research articles. This trend suggests that the industry publications can speak to issues in the zeitgeist in a timelier manner than research literature. For example, this review found that industry publications mentioned the potential for mobile apps to aid food donation (Whitehead 2018) before the research literature (Thong and Anich 2022; Vo-Thanh et al. 2021). That said, there is a need for more rigorous research into the QSR sector. As the process of publishing research in journal articles can be lengthy, there is an opportunity to first publish the research results as industry reports. Industry reports, especially through End Food Waste Australia, offer an avenue to disseminate research in a manner that is timely and accessible to industry. Key results and insights from this research to produce a sector action plan for the QSR industry will be published as an industry report.

The present literature review compared if the research publications influenced industry and vice versa, but limited evidence of this trend was found. Evidence from industry publications pointed more to other factors such as costs (Oches 2018), efficiencies (Hospitality Technology 2014), celebrity chefs (QSR Magazine 2015), consumers (Daninhirsch 2022), sustainability pressures (QSR Magazine 2019) and local council (QSR Media AU 2016). Research publications mention industry publications in passing but it is difficult to determine whether industry publications have influenced the research publications in anyway.

As the world emerges from the COVID-19 pandemic impacted years, there is an opportunity to observe if the research literature will increase to match the increase in industry literature in the 2023 period (as seen in Figure 2), following the patterns observed previously. Likewise, there will also be an opportunity to map the geographical locations of research in the upcoming literature. In this present review, 44% of industry publications emerged from North America. This may be attributed to the high concentration of QSR businesses in the region, with the North American QSR market being the largest globally (Mordor Intelligence 2024). It will be of interest to track whether this trend continues, considering that the factors affecting it may shift. For example, Australia is implementing mandatory Environmental, Social and Governance (ESG) reporting for businesses over a certain size (Australian Government Treasury 2024), which will force them to report on Scope 3 emissions which will include wasted food, whilst jurisdictions such as NSW have announced that they will be implementing mandatory source separation of organic waste in the coming years (NSW EPA 2024a). These policy changes are set to flow down to QSR businesses to influence how food waste is perceived and addressed in the wider industry. It is unclear if this will catalyse an increase in industry publications in Australia. Still, the policy settings of certain countries over the coming years, as each seeks to address the of challenge food waste, may have some influence on the distribution of industry publications.

The distribution of research publications pertaining to BOH food waste in QSRs is influenced by how specific countries are enabling research into food waste. Specifically, End Food Waste Australia and WRAP in the UK have contributed to this research work. In recent years End Food Waste Australia has funded research into food waste generated in QSRs (Anich and Thong 2022; Jayasekara et al. 2024; Thong and Anich 2022) and will contribute further through this current QSR SAP research project. Despite certain countries taking the lead in certain areas of research and publication, it is important that investment in research is continued and undertaken in all parts of the world to capture the different nuances that come with differing geographical contexts. As stated in section 3.5, globally there is patchy information on BOH food waste in QSRs which makes it difficult to quantify. Further information needs to be collated to reveal the full scale of the problem.

4.2. Opportunity for future research studies on food waste generated within QSRs

4.2.1. Different puzzles pieces: the challenge of generalising across the publications in this review

The challenge of comparing the research studies and industry publications has been mentioned multiple times in this review (see section 3.2 and 3.5). A reason includes different sample sizes (see section 3.2), from engaging 1 QSR outlet (McAdams et al. 2019) to 100 branches (Noone and Coulter 2012). Another reason includes the different data collection methods used to measure food waste (see section 3.5). While this challenge highlights the diversity of approaches to used study food waste, the diversity of approaches has limited the ability to draw direct comparisons across the research publications. Each study in this literature review is akin to a piece of a puzzle, contributing to our understanding of the QSR industry. Assembling these pieces is a challenge, but when completed, will offer insights into the dynamics of reducing food waste in the QSR sector. As such, the extant food waste research studies lay the foundations for future studies, with each new study becoming another piece in the puzzle.

4.2.2. Extant food waste research studies or publications lay the foundations for future studies

The study of food waste in the QSR sector is an emerging field. In recent years, there has been a rise in publications relevant to food waste generated within QSRs (see Figure 2 in section 3.1). Many of the research publications or studies have been smaller in scale or used a less diverse sampling (see Table 4 in section 3.2), which limits the generalisability or wider applicability of these studies or publications in this review to broader contexts. Despite the limits to generalisability, extant research studies are useful in laying the foundations for future studies. Interviews were the dominant research method used in the research studies or that were smaller in scale (see Table 4 in section 3.2). As a qualitative research method, interviews can provide a benefit of depth to the results (Guest et al. 2013), capturing some of the complexities and variations of how food waste is generated within the QSR industry. For example, Dzumbunu (2018) has provided a comprehensive overview of the causes of food waste in the QSR industry in South Africa; and Drewitt (2013) examined food waste prevention in QSRs in China and Sweden. There is scope for future research to build on these findings. This includes exploring whether the themes identified by these studies on food waste generation and prevention in QSRs are relevant to other countries, such as Australia. There is also an opportunity to conduct larger scale quantitative studies, such as through surveys, which would help to address the issue of generalisability.

4.2.3. Opportunity for more food waste research studies to directly engage QSRs

While a majority (62%) of the research studies or publications in this review directly engaged QSRs (see section 3.2), the remaining 38% were less clear about whether QSRs were directly engaged, referring to restaurants, hospitality or foodservice more generally. Given that research studies or publications comprise less than half of the total publications in this review (see section 3.1), these 38% of studies significantly reduces the QSR-specific research information available. The reference to hospitality and/or restaurants as one homogenous industry is a limitation. This lack of distinction is an issue as the QSR sector

has specific practices that set it apart from full-service restaurants and other sectors in the hospitality industry (IBIS World 2023). Clear distinction between hospitality sectors in future studies can increase the usefulness and relevancy of these studies. Overall, the analysis of the research studies or publications in this review has highlighted an opportunity for researchers to conduct a greater number of studies that directly engage the QSR sector. Such studies can provide a deeper understanding of food waste in the QSR sector.

4.3. A need to better understand how the QSR industry defines the industry

4.3.1. Opportunity to better understand how the QSR industry defines the industry

There is an opportunity to identify what specific words are used by industry actors to refer to their industry. Although a greater number of industry publications than research publications in this review contain information relevant to food waste in QSRs, (see section 3.1) most of these industry publications did not mention the word “QSR” and did not define or describe what the QSR sector is (see section 3.3). While this result is surprising due to the subject focus of this review, this result could be explained by industry press releases being the predominant type of industry publications that were identified. Context matters and it is implied that the publications are about QSRs. The industry press releases were published in industry magazines directly marketed to the QSR sector and the title of these industry magazines include the word “QSR”. On the other hand, research publications are written for a wider audience, where the publications (i.e. academic journals) may cover a wide range of topics and readers may not be familiar with the QSR sector. This may explain why over half of the research publications use the term “QSR” and define the term (see Figure 5 in section 3.3). It may also explain why different words were used in research publications to refer to or define the QSR sector (see Figure 6 and Figure 5 in section 3.3). No matter what the reason, there is an opportunity for future research to better understand what words the QSR industry.

There is an opportunity to explore whether the words “fast food” and “QSR” are used synonymously by industry actors in practice. The findings of this review have suggested that “fast food” was most commonly used to define “QSR”, to the point that the word could be considered synonymous to “QSR” (see section 3.3). These words used to describe or define the QSR sector were identified in the introduction sections of the publications and may not reflect the definition used in practice or every-day speech by industry actors. Hence, there is also an opportunity to explore whether industry actors currently use other words or phrases identified in the reviewed publications to describe “QSR” or “quick service restaurant”. To recapitulate, the words are “limited-service restaurant” (identified in industry publications) and “food-on-the-go” (identified in research publications). According to information from Google Books Ngram Viewer (Google 2024; Sparavigna and Marazzato 2015), the word “quick service restaurant” has been used as early as the beginning of the 20th century, its use rising exponentially from the 1950s onwards before peaking in 2004. Similarly, “fast food” has been used since the early 20th century, its use rising exponentially from the 1960s and peaking in 2002. Moreover, “limited-service restaurant” has been used since the mid-20th century, rising exponentially from the 1990s and peaking in 2003. Finally, “food-on-the-go”, has been used since the mid-20th century, rising exponentially from the 1990s to 2019, the current endpoint for the Google Books Ngram corpus period. Given the fluctuations in frequency of usage for the words “quick service restaurant” and associated words over time, further research could provide insight into if and how these words are currently being used in industry practice. Such research can enhance researcher–industry communication (see next subsection) and can potentially be used to map different sub-sectors in the QSR industry.

4.3.2. Opportunity to align QSR language used by industry actors and researchers

The literature review suggests that there is a difference between the way the QSR sector is defined in industry and research publications. As shown in Figure 5 and Figure 6 (section 3.3), there is double the variation of words used in the research publications and where the words “takeaway” and “food on the go” only appear in the research publications. Due to a lack of relevant industry publications that defined the QSR sector, most of the words (or so-called ‘definitions’) reported in this review are from the perspective of researchers. While there are limitations to this literature review given the relatively small number of relevant studies, the results reasonably suggest that industry and researcher terminologies or language used to describe QSR do not align. When researchers communicate with industry actors, a misalignment of terminologies could mean there is a chance that researchers could use words that industry actors do not identify with, reducing the effectiveness of this communication.

There is an opportunity for future research to identify what words QSR industry actors and researchers use to define the QSR industry. This research could be used to align QSR terminologies used by industry actors and researchers, to assist researchers to communicate with the QSR industry using industry language. When researchers use industry-aligned language to communicate how industry actors can reduce food waste in QSRs — such as through a QSR SAP — this can increase the chances of effective communication and industry uptake (Charter and Clark 2007).

Tangentially, there is an opportunity for researchers to understand how QSR industry actors use language to describe food waste. Corporate sustainability literature suggests that the way industry actors talk about sustainability issues can shape industry actors' attitudes and actions toward these issues (Joutsenvirta 2009). As such, engaging the QSR sector in this type of language research can provide researchers with a deeper understanding of what attitudes QSR industry actors have towards food waste in QSRs. If researchers can tailor the type of language they use to communicate food waste reduction strategies to QSR industry actors, it could potentially increase the chance that the strategies are accepted and adopted within the QSR industry.

4.4. Differences in research and industry publication foci highlights biases

Given this literature review primarily focussed on BOH food waste in QSRs, it is unsurprising that a greater number of publications focussed on reporting only BOH food waste in QSRs, compared to publications that focussed on reporting both front of house and BOH food waste in QSRs (see Figure 7 in section 3.4). What is more interesting is the breakdown of research publication and industry publications that reported the information in these two groups. A significantly greater number of industry publications reported only BOH food waste in QSRs. This trend reversed for the publications that reported on both front and BOH food waste in QSRs, with a significantly greater number of research publications. It is unclear why this is the case, though a reason could be that research publications can report on a wider topic scope. This result suggests that research publications provide a more holistic view of food waste generation in QSRs. Moreover, industry press releases dominated the publications that focussed on BOH food waste. The nature of press releases being short and therefore limited in what is reported may explain why the reviewed industry publications mostly focussed on BOH food waste. No matter what the reasons, these results show a clear difference between the focus of research publications and industry publications — aligning with other sections of this review (e.g. sections 3.3 and 4.3; sections 3.4 and 4.4; and sections 3.9 and 4.10). These results are a segue to reflect on the potential biases of the reviewed publication groups.

4.5. There is value in quantifying back-of-house food waste in QSRs

There is currently a paucity of publications that quantify BOH food waste in QSRs, with the relevant academic and industry publications collectively representing 16% of the total number of publications in this review (see section 3.5). It is unclear why this is the case, though it is possible that it reflects the finding that there are few research studies on BOH food waste in QSRs overall (see section 3.1). There is a clear opportunity for a greater number of studies to collect information on the amount of food wasted in BOH in QSRs. Measuring food waste is a first step in understanding the scale of the problem, so that recommendations can be made to help reduce it (Champions 12.3 2020).

4.5.1. Opportunity for a greater number of studies on QSR back-of-house food waste in multiple countries

A relatively large number of countries (7) is represented in the 11 publications that quantify BOH food waste in QSRs. Currently, only two of these seven countries (Australia and USA) are represented by more than one relevant publication and the sample size of these quantification studies are small (see section 3.5). This suggests multiple things. First, the relatively large number of countries represented highlights that BOH food waste in QSRs is an international problem and importantly, there are researchers and industry actors in multiple countries who are interested to better understand how much is being wasted. Second, given that research on food waste in QSRs is still an emerging field (see section 3.1), it is unsurprising that the sample size of these quantification studies is small — they may be pilot studies. However, it does strongly suggest that at this present moment, there is insufficient information on how much food is wasted BOH in QSRs for any of the countries represented in this review. There is clear opportunity for a greater number of studies in each of these countries to collect information on the amount of food wasted in BOH in QSRs.

4.5.2. Opportunity for quantification studies to inform country specific QSR food waste baselines

There is an opportunity for a greater number of country-specific studies to collect information on the amount of food wasted BOH in QSRs. Such quantification studies can help build the knowledge needed to establish country-specific baselines of the amount of food wasted BOH in QSRs, which could feed into country specific targets to reduce food waste. While there are already national food waste baseline studies in countries such as Australia (i.e. FIAL (2021b) and ARCADIS (2019)), specific information on how much is wasted in QSRs is lacking and the subsector is sometimes not distinguished from the wider hospitality or foodservice sector (ARCADIS 2019; FIAL 2021b; Gunders 2012b). This highlights the merit of future studies that specifically focus on BOH food waste in QSRs.

Given the limited food waste data on foodservice sub-sectors in Australia (ARCADIS 2019), there is scope for future studies to quantify the food wasted BOH in the Australian QSR sector. This aligns with a recommendation in FIAL (2021b, p. 28) to track the volume and cost of waste in Australian hospitality and foodservice businesses. The insights could be used to develop recommendations to help reduce this waste, contributing to the National Food Waste Strategy to halve food loss and waste in Australia by 2030 (Commonwealth of Australia 2017).

Given different units of measurement are used in extant studies to quantify food wasted BOH in QSRs (see section 3.5), there is also an opportunity for researchers to collect food waste quantification information in a standardised way that allows for this information to be compared. A suggested quantification methodology includes the Food Loss and Waste Protocol, which is an international food loss and waste accounting standard designed to guide government and companies (Hanson et al. 2016). DIRECT is solution aligned to this standard, designed to help businesses to quantify and understand the “true cost of waste” (Empauer 2023; Hill et al. 2023; Verghese et al. 2018), Standardised quantification would increase the usefulness of this information in helping to establish a baseline of BOH food waste in QSRs.

4.5.3. Opportunity for quantification studies to be communicated to encourage greater sector engagement

A greater number of publications documenting the amount of food wasted by QSRs were written for an industry target audience than for an academic audience. As clarified in section 3.5, all 11 of these publications report on research, but the academic publications consist of 3 journal articles and 1 thesis. Within the Australian context, there is 1 relevant journal article and it was published in 2024 (Jayasekara et al. 2024). This relative paucity of academic publications suggests that research on food waste in QSRs is an emerging field — aligning with what is mentioned in other sections (see section 3.1). There is an opportunity for future research publications to be published as journal articles, to increase the academic discourse. That said, the dominance in publications written for an industry target audience is encouraging, as it suggests active engagement by researchers to communicate the scale of BOH food waste in QSRs to relevant actors in the QSR industry and wider foodservice or hospitality sectors. QSR industry sector engagement is a key first step to help reduce BOH food waste in QSRs. Research quantifying back-of-house food waste in QSRs can be useful to increase QSR industry sector engagement. Such research not only provides insight into the extent of wasted food but also facilitates the calculation of its monetary value, enabling the formulation of a business case for waste reduction initiatives (Hanson and Mitchell 2017) that can be communicated to key QSR industry actors.

4.6. A case for communicating information about what and when food is wasted

4.6.1. Opportunity for researchers to communicate to industry what foods are wasted and how much is wasted

Section 3.5 of this review focussed on reporting the amount of food wasted, what has been wasted, and when (or what stage of operation) food is wasted BOH in QSRs. This present section discusses the different foci of industry and research publication in reporting this information and from this, suggests future research and communication opportunities.

While many industry press releases offered information on when food has been wasted (20 press releases), comparatively few reported on what is wasted (4 press releases) and none reported how much is wasted (see sections 3.5.1 and 3.5.2). It is unclear why certain types of information is presented more often but it could reflect what certain industry actors see as relevant or what is being promoted or focused upon. This is a reasonable assumption given that industry press release articles are written by industry actors to communicate to other industry actors. In the context of this review, the industry press release articles were published in QSR industry magazines platforms. As many of these industry press release articles in this review focus on marketing food waste solutions (see section 3.8), it would make sense if communicating what stage (food delivery/storage, preparation, service ready) the solution can assist is prioritised. Additionally, it could be that industry do not report how much is wasted due to a lack of available data, or the data is considered confidential for reputational reasons (Filimonau and Ermolaev 2021). Given that “what is measured is managed”, it is crucial that QSR businesses track food waste and work towards a target to reduce this waste. WRAP in the UK has produced the “Guardians of Grub” resource to help professionals across the whole hospitality and foodservice sector to reduce food waste (WRAP 2023). There is an opportunity to produce a similar resource for the QSR industry in Australia through the QSR Sector Action Plan chapter research project.

Research publications are most represented for reporting on information on how much food is wasted BOH in QSRs (see section 3.5.1). While a number of these research publications are research reports (or industry reports) and therefore written for an industry audience, the key is that they are written by researchers. Given no industry press release articles or industry written publications in this review presented such information, it can be presumed that researchers and industry actors deem different information relevant to present to the QSR industry for reducing food waste. It also suggests that researchers and industry actors are reporting or promoting insights to different audiences e.g., researchers to researchers and industry to industry. This highlights an opportunity for research–industry collaboration in the QSR sector, so that insights of both parties can synergistically inform effective and implementable solutions to reduce food waste. Research–industry collaboration is therefore

vital (Charter and Clark 2007) and its benefits has been demonstrated through End Food Waste Australia's Save Food Packaging Criteria and Framework research project (Francis et al. 2024; Hughson 2024).

On the other hand, few research publications and few industry publications reported on the specific types of food wasted BOH in QSRs (see section 3.5.1). There is therefore an opportunity for future research studies to collect information on what specific foods are wasted, so hotspots can be identified and addressed. There is also an opportunity for researchers to use QSR industry magazines as a platform to communicate to QSR industry actors what foods are wasted BOH in QSRs and how much. Communicating research across multiple industry-oriented platforms could help with greater research reach, so that the findings can be used to help reduce BOH food waste in QSRs.

4.6.1. Opportunity for future research to gather more information on what foods are wasted back-of-house

In the context of future research on when (or what stage) food is wasted BOH in QSRs, there is an opportunity to gather more information on what is wasted. This is supported by a finding in section 3.5.2 that shows a paucity of studies that report what food is wasted. There is an opportunity to examine whether processed meats, dairy, eggs, preserves/pickles, sauces and spreads, desserts, canned food, and beverages are wasted, given that these categories were not reported in the reviewed literature. The absence of information on these specific food categories could reflect the different aims of research projects and available resources, including funding and time. It could be that researchers have chosen to focus on visible food waste, including unsold food, potentially missing bags of precut produce or half empty sauce bottles that are out-of-date. As such, it is important to avoid assuming that specific food categories are not wasted because these categories are not reported. Due to paucity of data, we only know that the reported food categories are wasted, but we do not know what else is wasted and how often. Researchers should take care to avoid generalising from the food waste categories reported in this review. Additional research into what foods are wasted BOH in QSRs could help to answer the question of whether the food categories reported in this review are an accurate reflection of what is really wasted. The value of this research is that it would help to identify BOH food waste hot spots in QSRs in a more holistic matter, and therefore the findings would be more useful in generating a QSR sector action plan on how to reduce this waste.

4.6.3. Opportunity to explore the connection between different food stages and foods wasted

This review has gathered information on when food is wasted BOH in QSRs, categorising this in three stages: delivery and storage, food preparation, and service ready (see section 3.5.2). This present section discusses potential connections, both between these stages and between specific stages and the food types which are reportedly wasted. From this, future research opportunities are suggested.

The food preparation stage and service ready stages were mentioned by twice as many publications than the initial food delivery and storage stages (see section 3.5.2), suggesting they could be hotspots for BOH food waste in QSRs. There is scope for future research to gather additional information to ascertain whether this is accurate, especially within a country specific or QSR company specific context. This recognises that the way food waste is generated in QSRs could differ depending on these contexts, increasing the potential usefulness of the gathered information to develop suggestions to reduce this waste.

The foods reportedly wasted in the service ready stage is different to what is reported for the food delivery/storage and preparation stages (see section 3.5.2). These differences could be due to the different food handling processes specific to each of the food stages, which lead to reasons for waste (see section 3.6 and 4.6) that render specific foods more likely to be wasted. Future research could explore whether this is the case.

There may be a connection between why food is wasted in the food delivery/storage and food preparation stages, given that both stages report the same types of food being wasted and at comparable ratios (see section 3.5.2). It is also currently unclear

why the same types of foods are reportedly wasted more often in the food preparation stages than the food delivery/storage stages. A reason could be due to the different food handling processes specific to each of the food stages. Future research to explore the potential connection between these two stages could help reveal the actual reasons why. If the two stages are connected, then BOH food waste solutions for QSRs could be more strategically targeted.

4.7. Opportunity to research the stages of food waste distinct to the QSR sector

The food waste stage categories used in section 3.6.1 differ slightly to those used in previous foodservice research publications and hospitality education publications. Previous publications have used the categories of 'spoilage', 'preparation' and 'plate waste' (some also have a 'other' category) (Papargyropoulou et al. 2019; WRAP and Guardians of Grub 2020). The current project has a specific focus on actions that the QSR businesses can take to reduce BOH food waste, so certain categories such as 'plate waste' or front-of-house (FOH) food waste was excluded. Still, It is important to acknowledge that a large portion of food waste in the sector is understood to be generated FOH, despite FOH being difficult to measure due to the takeaway nature of food served in QSRs (Charlebois et al. 2015; Filimonau and Ermolaev 2021). Even though FOH food waste is beyond the scope of this project, it is still worth future research attention and remediation efforts.

The food waste stage categories reported in previous studies are targeted towards encouraging action across the broad range of different hospitality subsectors. This generalisation may not account for the nuances or differences in these subsectors, including QSRs. Moving forward, there are opportunities to focus research on the food waste stage categories that are most relevant or distinct to the QSR sector. Specifically, this includes the 'service ready' category. Although this type of waste does occur in other hospitality subsectors, we suggest that the challenges it provides for QSR businesses are sector specific. QSRs are in a fine balancing act of predicting how many customers they will need to service, pre-preparing enough food to be ready for customers soon after they arrive but not too much in that it will become wasted. As flagged earlier, businesses such as McDonalds have company policies that limit the amount of time items such fries can stay at this service ready stage (Gunders 2012a). This sees these fries in a place of "bain-marie purgatory"; walking a tightrope where the fries either make it into the hands of a customer or fall to the depths of a QSRs bin, destined to rot in a landfill and emit methane. For that reason, further research into the stages of food waste generation distinct to the QSR sector is needed. With this further information, hotspots can be identified, and actions can be implemented.

Packaging had a limited number of mentions in the publications surveyed for this review (see section 3.6.2). Despite this, it is well established that packaging does have an impact on food loss and waste generation (Chan 2022b; Wohner et al. 2019). The nature of the QSR sector means that a lot of food is pre-prepared (McAdams et al. 2019), meaning it is entering the site in some sort of packaging. Further research is needed to determine how this affects food waste in the QSR context, such as the benefits or not of precut ingredients.

4.8. Publications that mention reasons for back-of-house food waste in QSRs

4.6.1. Opportunity for additional research into food waste hotspots back-of-house in QSRs

The factors or reasons that drive food waste in the QSR sector are important to identify so appropriate actions can be directed towards addressing them. This literature review has identified multiple reasons (see section 3.6), but another aspect to consider is if there is bias in what reasons are reported. For instance, challenges around forecasting how much food to pre-prepare were among the most mentioned throughout the analysed research publications and industry publications. Industry publications — and in particular industry press releases — strongly focused on recommending solutions to the forecasting challenges faced by QSRs. Technological solutions such as demand forecasting via AI and IoT applications were among some of the most

mentioned solutions (see section 3.8). Industry publications that showcase technology need to explain why the technology is needed, potentially leading to a bias in 'demand forecasting' being highly mentioned as a driver of BOH food waste in the QSR sector. This potential bias in the industry publications should not discount the impact of less-than-ideal forecasting on food waste, given that this reason for food waste was also mentioned in the research publications (Jayasekara et al. 2024; Marx-Pienaar et al. 2020). Even so, limited academic research has been conducted on food waste generated BOH in QSRs. This means that a focus on any single factor as the primary issue for food waste may be skewed; the research publications report on what we know and there still much more to discover. Further academic research is needed to independently display the major reasons for food waste generated BOH in QSRs. This would help to address the current lack of research and additionally, the information would be useful to help verify what is reported in the industry publications. For example, there is a specific opportunity for future research to explore whether technological solutions are as effective as addressing food waste as they are showcased to be.

The inability of QSRs to donate food is a driver of food waste mentioned in the publications (Dhir et al. 2020). There could be multiple reasons why QSRs perceive that they are unable to donate food. This includes how the model of food donation, where food is collected at the end of the day, may not neatly align with the sporadic nature in which some QSRs generate food waste. That is, edible food could become waste at various points throughout the day as items surpass the maximum time they are deemed able to safely sit at a service ready state. Large businesses can be risk adverse when it comes to food donation, although some of the industry publications suggest that this is changing (SRA 2010; Vo-Thanh et al. 2021). Certain QSR companies also have policies around how much food, if any, staff can take home. Addressing these limitations will help to reduce BOH food waste in QSRs.

4.9. Opportunity for further research into the role of staff training and management

This literature review suggests that the key actors associated with BOH food waste are those with the most touch points to it, e.g. employees and store management. This is unsurprising given that these actors have the most control of whether food becomes waste, be it from the ordering stage, managing flows of food through the kitchen, to preparing the food. It is important to highlight these areas of who is involved and at what points so solutions can be identified for their contexts.

Where the surveyed publications mention employees as key actors in generating food waste, it is from the perspective of lack of skill, employee error and a lack of training. A challenge in the QSR sector is how to overcome this issue. Increasing the investment in staff training could help to address this issue (Dzumbunu 2018; McAdams et al. 2019). However, staff training can be difficult to implement due to financial costs and high staff turnover (McAdams et al. 2019). The food being prepared in QSRs compared to other foodservice types is simple, but QSRs also have the lowest level of skill in their employees, compared to other foodservice sectors (McAdams et al. 2019). This low skill level reflects fact that the role is a minimum wage job with high turnover, often serving as a first job for many employees. For that reason, QSR businesses have not widely invested in the training of these staff. Further research could explore how QSR businesses seek to address food waste in this context of low skilled workers and whether this includes investing in staff training.

When these findings are contextualised with the suggested measures to reduce food waste (section 3.8), this literature review suggests that technology is more favoured than investing in staff training, given that technology doesn't require retraining. Given the range of technology currently available to help QSRs manage ordering and stock rotation, it may be possible to overcome some of the challenges to reducing food waste identified in this review. Managing the flow of food in the kitchen is like being an air traffic controller (Fine 1990). With troughs and peaks of demand, managers in QSRs play a critical role in keeping the kitchen functioning. Moving forward, developments in technology and particularly predictive AI, add to the tools that management could use to manage this flow more effectively. Further research should look at where the relational efficiencies attained by implementing changes to the workflow of management are realised and how this affects the rest of the staff at

QSRs. (Dzumbunu 2018; McAdams et al. 2019). Further research should investigate how QSRs view staff training in comparison to the use of technology. There is also an opportunity to explore whether QSR businesses' perceptions of technology to augment the physical activities employees undertake or completely replace employees. This will help to elucidate how QSR businesses approach food waste reduction and what the future holds for low skilled workers in the QSR sector.

4.10. Opportunity for further research into the implementation of solutions

This literature review indicates that in terms of strategies to reduce food waste, the industry publications have focussed on the role of technology. 41% of the industry publications focused on technological solutions, a much higher proportion compared to 20% of the research publications. The research publications contain a comparatively much more even distribution of solution types, suggesting that researchers look more holistically to understand the broader picture of food waste generated in the QSR sector. As for the industry publications, the distribution suggests two key things. Firstly that there are more technological solutions coming onto the market, and secondly that the businesses selling these products are advertising through the industry publications. Given the promotional nature of the industry press releases the majority of these technological solutions were identified from, there is currently limited evidence to support the effectiveness of these solutions to reduce food waste in QSRs. There is therefore an opportunity for future academic research to focus on the technological solutions identified in the industry publications, to provide an understanding of the benefits, risks and challenges of implementing these solutions.

Industry press release articles suggest that investments in technology are helping QSR businesses to navigate challenging business environments where there are staffing shortages and wage inflation countries such as Australia (QSR Media AU 2023b). There is an opportunity for future research to investigate the relationships between the introduction of technological solutions and the future of workers in the QSRs, to find out how that affects people's relationship to food. Furthermore, there is scope for future research to identify what factors drive QSR businesses to implement solutions to reduce food waste. Factors such as cost savings appear to be a common theme in the industry publications but drivers such as sustainability also appear. Understanding what factors drive QSRs to implement what solutions will help give context to the decision-making processes inside these organisations.

The more evenly distributed focus of the research publications on different solutions suggests that there are a greater range of solutions identified by the research publications than are currently being discussed by industry. Further research should focus on why it seems that certain solutions are left behind in research publications and are not being picked up by industry. There is scope to explore whether bridging that divide may lead to better outcomes for food waste reduction in the QSR sector.

4.11. Addressing barriers to reducing food waste in the QSR sector

4.11.1. Lack of industry comment on barriers to reduce food waste

Solutions to food waste are only effective when they are implemented. As such, it is important to understand what barriers QSR businesses face to reduce BOH food waste. Interestingly, only two industry publications mentioned barriers (Davityan 2014; ReFED 2016). With industry publications comprising a large proportion of the total publications presented this literature review, it was telling that there was a lack of industry comment on the barriers to action. This more than anything, shows that the industry publications are particularly industry facing and seek to showcase actions or technology that businesses can pick up to improve efficiencies. Therefore, suggesting barriers to that action would be slightly counter-intuitive. Biases in the industry publications — especially in the industry press releases — is also reported in Section 4.8.

4.11.2. Financial cost as a barrier to action

In contrast to the industry publications, the research publications have reported extensively on the barriers QSR businesses face to reduce BOH food waste. The most frequently mentioned concern was that of cost and reputation. The financial costs of acting were widely mentioned as concerns businesses had around taking action to address food waste (Filimonau and De Coteau 2019; Martin-Rios et al. 2018). These mentions of costs seem to not consider the costs of inaction, and take the assumption that businesses are already doing best practice, which is clearly not the case (FIAL 2021a). These assumptions by businesses that they are doing the best they can, show that businesses still see food waste as a cost of doing business and are not aware of the potential benefits of changing practices. Effectively educating businesses to become aware of the financial benefits of reducing food waste is the challenge. Martin-Rios et al., (2018) suggests that in countries where it is required to act on food waste — be it in France where offering a doggy bag to customers is mandatory, to places where pay-per-volume charges on waste is the law — businesses were more aware of the cost of inaction. Further outreach programs such as WRAP's hospitality staff training program Guardians of Grub (WRAP and Guardians of Grub 2020) and others like the NSW EPAs Your Business is Food (NSW EPA 2024b) and the City of Sydney's Love Food Sydney (City of Sydney 2024), are steps towards changing that narrative. There is also an opportunity for further initiatives with the food service industry as a whole, like though the End Food Waste Australia Sector Action Plans or tools such as DIRECT which show the "true cost of food waste" (Empauer 2023; Hill et al. 2023; Verghese et al. 2018).

4.11.3. Lack of care as a barrier to action

Outreach and educational programs focussing on the main issues of food waste can help to address the challenge that businesses and people (including staff and customers) generally do not care about food waste (Filimonau and Ermolaev 2021; Hirth et al. 2021; Martin-Rios et al. 2018; McAdams et al. 2019). The typical QSR staff member is on the minimum wage and usually in their first job. It is therefore argued that these staff do not feel empowered enough to take actions to reduce food waste generation, either because they are not paid enough to care (McAdams et al. 2019) or because management have not created a culture where they can care about food waste (Filimonau et al. 2019).

With regards to caring about food waste, publications in this review have suggested that QSRs seem to treat food as a commodity (McAdams et al. 2019). It has been suggested that how people treat or appreciate food has some correlation to their behaviours around generating food waste (Quested et al. 2013; Quirk et al. 2024). This begs the question of how 'food' being treated in the QSR sector as a commodity changes the relationship between cook and food. There is an opportunity for further investigation around how the QSR 'production mentality' (McAdams et al. 2019) contributes to staff engagement around reducing food waste.

4.11.4. Reputational cost as a barrier to action

The second most common barrier mentioned in the reviewed publications was the reputational costs associated with reducing food was. These mostly centred around the risk of liability of donating food (Davityan 2014; Dhir et al. 2020; Filimonau et al. 2019; Hirth et al. 2021). The EFWA CRC Café Sector Action Plan shows that this is a concern held throughout the hospitality industry. That report mentions that the number of cases that have been brought before a court or a business has actually been reprimanded is close to zero (Addison-Smith et al. 2024). Moreover, the *Civil Liability Amendment (Food Donations) Act 2005*, colloquially known as the 'Good Samaritan Act', protects food donors in Australia from civil liability when donating food in good faith for charitable or benevolent purposes (Beckmann et al. 2022). Despite this protection, businesses take a very risk adverse position to food donation. That research revealed that the threat of legal consequence, although stated commonly, was much less of a threat to the business than that of a bad review (Addison-Smith et al. 2024). A negative online review was something realised by a lot more businesses and had a more tangible impact on limiting what the business did rather than the threat of legal recourse.

The barriers identified here depict a picture of where the concerns of the industry are at, but further research could examine the reasons why businesses take action to address food waste. This further research would be able to determine whether businesses act because they must (i.e. mandated to by government) or they see the opportunities from a cost or reputational standpoint or for another reason. Understanding these pull factors will help build the clearer picture of the barriers versus the benefits of action. There are also opportunities to bring these statistics and insights to the actors that actually do have the power to make change, including the operational, upper management, executive and board levels of QSR businesses, for tangible action to reduce food waste across the QSR sector.

5. Conclusion

This literature review has provided a 14-year overview of research and industry publications pertaining to food waste generated BOH within the QSR sector. By examining this literature, this review has documented what types of research have been conducted on QSRs, how QSRs are defined, how pre-consumer/back-of-house (BOH) food waste is managed in QSRs, quantities and reasons for food waste, key actors involved, and the solutions and barriers to food waste. In doing so, this review has mapped the current landscape of knowledge surrounding BOH food waste in the QSR sector.

The landscape of knowledge is expanding, with a growing number of research and industry publications relevant to BOH food waste generated within the QSR sector (section 3.1). A large proportion of these publications were published in the Global North (developed world), with industry publications dominating (section 3.1). The research publications generally reported on qualitative studies with small sample sizes, with interviews the most used data collection method (section 3.2). For the publications that defined the word “QSR”, most were research publications where the words “fast food” and “takeaway” were used synonymously with “QSR” (section 3.3). While this review has focussed on food waste generated BOH in QSRs, just under half of these publications also examined front of house food waste (section 3.4). The preparation and service-ready stages were most mentioned across the publications as when BOH food waste occurs in QSR, with fresh produce and carbohydrates the most reported foods wasted (section 3.5). Forecasting, particularly preparation of too much food, was the most mentioned reason for this waste (section 3.6). Management and employees were most identified as the key actors who have been addressing this waste (section 3.7). Technology was the most mentioned solution for reducing BOH food waste, with costs being mentioned as the most common barrier to implementing solutions (section 3.8 and 3.9). The mapping of this landscape is a useful first step to develop a sector-wide action plan to reduce food waste in the QSR sector, rendering this review relevant to practice.

The current literature offers valuable insights, but research on BOH food waste generated within the QSR sector is still emerging and much remains unknown. The findings of this review (see section 3) therefore represent a basis on which to build future research. Avenues for future research have been proposed in section 4 of this review. A key opportunity is to conduct research that quantifies the amount of BOH food waste generated at QSR sites, with details on what specific foods are wasted and when. This additional research would help to fill knowledge gaps, given that only 16% of the publications reported the amount of BOH food wasted in QSR and just under a third mentioned specifically what was wasted. Other opportunities for future research include exploring the connection between wasted foods and when or at what stage they are wasted. The proposed research opportunities can help researchers and industry actors to better understand the contexts in which BOH food waste is generated and assist in implementing solutions to help reduce this waste.

The research and industry publications in this review have produced distinct insights, highlighting the different understandings and views between researchers and industry actors on ways to reduce BOH food waste in QSRs. Developing a QSR sector-wide action plan to reduce food waste requires collaboration between researchers and industry actors. The industry viewpoints identified in this review could help researchers to connect with industry actors more effectively, fostering dialogue conducive to co-designing practical solutions to reduce food waste across the QSR sector.

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