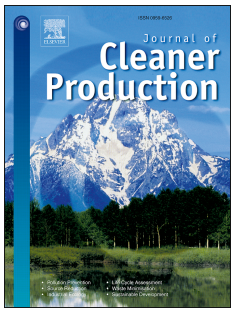

The sleeping giant? Food waste in the foodservice sector of Russia

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Viachaslau Filimonau Conceptualization, Data analysis, Data curation, Writing – initial draft

Vladimir A. Ermolaev Conceptualization, Data collection, Dana analysis, Writing – final draft

Declaration of conflict

The authors hereby declare no conflict of interest

The sleeping giant? Food waste in the foodservice sector of Russia

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Abstract

Despite being a major global economy, the challenge of food waste in Russia remains unexplored. In particular, nothing is known about the dynamics of food waste generated within its foodservice sector. The lack of empirical knowledge hampers the design of policy and management interventions for food waste reduction in Russian foodservices. The study adopts a qualitative and descriptive case study approach to provide the first benchmark of food wastage in commercial foodservices of Russia. The study shows that an average restaurant produces circa 14 t of food waste per year and the annual sectoral wastage amounts to at least 1.23 Mt, or 7% of the country's total. Most food waste occurs due to the over-production of meals and customer plate leftovers. Albeit the patterns of food waste management in Russian foodservices resemble those adopted by foodservice operators in other markets of food consumption, the study identifies a few approaches that can be classed as 'best practices' in Russia and beyond. These 'best practices' include incentives given to customers for clean plates and partnerships for food waste reduction formed with local farmers. A framework for more effective management of food waste in Russian foodservices is proposed underpinned by the principles of multi-stakeholder collaboration. This framework advocates the need to build 'collaborative bubbles' of foodservice providers, farmers and charities supported by targeted policies. Such bubbles will not only reduce food waste, but can also enhance the social and network capital of all stakeholders involved.

Keywords

Food waste

Catering

Prevention

Mitigation

Sustainability

Highlights

- First benchmark of food waste in different categories of Russian commercial foodservices
- An average restaurant in Russia wastes up to 14 t of food per year
- Fine dining and quick service waste the most and least food per business, respectively
- Over-production of food and plate leftovers are the key drivers
- Innovations in food waste management include on-site composting, clean plate incentives and collaboration with local farmers

1. Introduction

Food waste (FW) is a major societal challenge and the need to prevent and mitigate its occurrence has been recognised at the top level of global governance (UNSDG 2020). Prevention and mitigation of FW is necessary from the viewpoint of more rational use of natural resources and pollution abatement (Scherhaufer *et al.* 2018). It is also required from the perspective of business longevity as FW undermines profitability of food manufacturers, processors, retailers and foodservice providers (Martin-Rios *et al.* 2018). Prevention and mitigation of FW is critical from the moral standpoint given that a large share of global population suffers from food poverty and malnutrition (Thompson and Haigh 2017).

Effective management of FW requires knowledge of its occurrence across different sectors of the global food supply chain (Eriksson *et al.* 2019). Effective management also necessitates an understanding of the FW prevention and mitigation measures already adopted within these sectors (Papargyropoulou *et al.* 2016). This is to establish examples of 'best practices' and evaluate the scope for their cross-sectoral adoption (Hennchen 2019). Important is that these sector-specific 'best practices' should be assessed through the prism of the socio-economic, cultural and political conditions of the food production and consumption markets (Filimonau and de Coteau 2019). The drivers of FW occurrence and the determinants of their elimination are often market-dependent and connected to the local context (Aschemann-Witzel *et al.* 2018). For example, national culture plays a role in how and why FW occurs and is managed in China (Filimonau *et al.* 2020c) and the regional political agenda restricts FW management options in the EU-28 countries (Teigiserova *et al.* 2020).

Despite the importance of obtaining sector- and market-specific FW figures and then linking these figures to the prevention and mitigation practices, the related research agenda remains under-developed (Amicarelli and Bux 2020). Some sectors of the global food supply chain have been under-studied (Xue and Liu 2019). This is the case for foodservices whereby

the challenge of FW and its management has only recently drawn scholarly attention. A systematic literature review undertaken by Dhir *et al.* (2020) identifies only 63 peer-reviewed papers on FW in the foodservice sector. The majority (42 or 67% of the total) are published after 2018, thus showcasing FW in foodservices as an emerging object of scholarly scrutiny.

The geographical focus of research on FW in the foodservice sector has been skewed towards a handful of markets. The review by Dhir *et al.* (2020) finds that six countries (USA, China, Finland, UK, Germany and Italy) account for over 50% of all research outputs or 33 studies in total. Alarming is that the challenge of FW in foodservices of some major global economies has not been examined. This is the case for the BRICS (Brazil, Russia, India, China and South Africa) countries where food production and consumption evolves rapidly (Nassani *et al.* 2017). The FW phenomenon in the national foodservice sectors of Brazil, India and China has been increasingly scrutinised, see, for instance, Bharucha (2018), Matzembacher *et al*. (2020) and Filimonau *et al.* (2020c). No academic research has however attempted to explore the FW challenge in foodservices of Russia and South Africa. This is a critical knowledge gap as the steady growth of these major global economies accelerates food consumption out of home which, in turn, generates FW (Li *et al.* 2020). The call to enhance knowledge on FW occurring in various sectors of the national food supply chains in the BRICS countries was first made in the seminal work by Parfitt *et al.* (2010). After almost a decade this call remains valid.

This paper responds to the call to investigate the FW challenge in various sectors of the food supply chains in the BRICS countries by reporting on a case study of FW and its management in foodservices of Russia. For the first time, the paper (1) provides a benchmark of FW in this large market of global foodservices; (2) examines the key drivers of FW occurrence; and (3) reveals approaches to FW prevention and mitigation. By comparing the findings of this study against those reported for other markets of out-of-home food

consumption, the paper, for the first time, positions the phenomenon of FW in Russian foodservices in the context of the global sector of foodservice provision.

The paper also aims at developing a framework for more effective management of FW in the foodservice sector of Russia. This framework will be derived from the results of the empirical investigation undertaken in this study and supplemented with past evidence reported in the literature. The framework will strive to outline the scope for multi-stakeholder collaboration between the key actors of the food supply chain as a means of FW prevention and mitigation.

The rest of the paper is organised as follows. Section 2 takes stock of research on the phenomenon of FW in global foodservices, discussing its magnitude, main drivers and prime approaches to prevention and mitigation. It also introduces the study context, showcasing the lack of research on FW in Russia and categorizing its foodservice sector. Section 3 explains the research design. Section 4 presents the results of empirical investigation and reports on the key findings. Section 5 concludes by elaborating on the contribution of this study to knowledge and practice, highlighting its limitation and outlining directions for future research.

2. Literature review

2.1. FW in global foodservices

2.1.1. Magnitude

Although the challenge of FW in global foodservices is acknowledged as substantial, there are no accurate figures to quantify its occurrence. The literature reports no aggregate, global estimates but employs regional assessments to showcase the large magnitude of FW at the worldwide scale (Filimonau 2021). For example, the figures from WRAP (2020) and FUSIONS (2016) are often cited when elaborating on the proportion of food wasted in the

global foodservice sector. These figures suggest that foodservices in the UK and EU-28 countries produce circa 1.1 and 11 Mt of FW per year, respectively. This equates to 12% of the country/region's total FW generated across its food supply chain. If this figure is extrapolated on the basis of global FW of 1.3 billion tonnes (FAO 2019), then the global foodservice sector may annually waste over 150 Mt of food.

This extrapolated figure is likely to be an under-estimate (Filimonau and de Coteau 2019). Growing evidence from developed but, particularly, developing countries pinpoints much larger amounts of food wasted in their national foodservices. For example, ReFED (2018) cites a figure of 16 million as representative of FW in the US foodservice sector, which equates to over 40% of the nation's total wastage. In China, FW in foodservices can be as high as 40 Mt per year, or 50% of the nation's total FW (Wen *et al.* 2015). There is a need to generate more accurate assessments of FW in the national foodservice sectors of different countries in order to derive a (more) reliable global estimate and establish a benchmark for prevention and mitigation (Filimonau *et al.* 2019a).

There are manifold reasons for why the figures on FW generated in foodservices lack accuracy. The sector is too diverse which hampers cross-sectoral generalisations and hinders estimates that can be categorised as sector-representative (Filimonau *et al.* 2020b). Most foodservice businesses are small-to-medium sized enterprises (SMEs) possessing limited resources to monitor and measure FW in-situ (Michalec *et al.* 2018). Employees of such businesses resist the task of FW measurement as it is time-consuming and aesthetically-unpleasing (Goh and Jie 2019).

There are no established methods for FW measurement in foodservices. WRAP (2015) has developed a dedicated tracking sheet for measuring FW in foodservice enterprises but the industry uptake of this sheet is limited and does not extend beyond the UK. The measurement methods proposed by Eriksson *et al.* (2018) and Filimonau *et al.* (2021) are promising but

require empirical validation. Although technological solutions have been designed to aid foodservices in monitoring and measuring their wastage (Cane and Parra 2020), these solutions can be expensive for foodservice SMEs to adopt. For example, the Prognolite solution enabling foodservice managers to better forecast demand for food, thus reducing wastage, costs at least EURO 249 per month on a 12-month contract (Prognolite 2020).

The FW data can be considered confidential as its disclosure can damage business reputation (Filimonau *et al.* 2019a). This impedes collaboration of foodservice businesses with academics on FW quantification and management. FW is not considered an operational priority by foodservice managers/owners (Filimonau and Sulyok 2021). The challenge of FW is viewed as inevitable implying it can be sacrificed in pursuit of other business goals, most notably customer satisfaction build-up (Vizzoto *et al.* 2020).

The situation is however changing and foodservice providers are gradually recognizing the criticality of FW and the need for its management (Lang *et al.* 2020). This recognition is attributed to growing public concern of FW as a major societal challenge with customers and shareholders expecting foodservice businesses to measure and consequently reduce its occurrence (Filimonau *et al.* 2020a). The industry also recognises the need to tackle FW due to policy (dis)incentives. For instance, in China, the issue of FW in foodservices has been acknowledged at the highest level of national decision-making and businesses are expected to prioritise FW measurement and management (Gao *et al.* 2021).

The problem is that the positive change in business attitudes towards FW and the need for its management is primarily observed among the chain-affiliates (Filimonau *et al.* 2020b). For example, an overview of successful case studies on FW prevention and mitigation in foodservices made by a FW management start-up Winnow (2020) predominantly features large, chain-affiliated enterprises. Smaller, independent businesses that occupy a dominant share of many national markets of out-of-home food consumption still demonstrate

insufficient appreciation of FW as an important operational issue and a major societal challenge (Filimonau *et al.* 2021). This has to change should the global sector of foodservices progress towards its sustainability goal.

In summary, although the challenge of FW in the foodservice sector has been repeatedly recognised as significant, its exact magnitude remains unknown. There are no accurate estimates of FW generated in the foodservice sectors of many developed, but particularly developing, economies. Urgent research is required to benchmark FW in foodservices of different countries and examine the main reasons for cross-sectoral and cross-country differences.

2.1.2. Drivers

The drivers of FW in foodservices can be categorised in line with the operational areas within which wastage occurs. Food is wasted in the pre-kitchen, kitchen and post-kitchen stages of foodservice provision (Papargyropoulou *et al.* 2019). The pre-kitchen stage accounts for circa 21% of FW (WRAP 2017). This wastage is attributed to such issues as food damage in delivery as well as food spoilage on-site. Spoilage is a major contributor to FW in this stage and it is driven by human and non-human factors (Christ and Burritt 2017). The human factor is exemplified by a limited employee understanding of how food should be stored. For example, this includes poor staff familiarisation with the First-In-First-Out (FIFO) approach to food utilisation (Charlebois *et al.* 2015). The non-human factor is attributed to equipment failures, such as the breakdown of a chilling unit (Filimonau and Sulyok 2021).

The kitchen stage generates 45% of FW and the human factor plays an explicit role in its occurrence (WRAP 2017). Large amounts of food are wasted because of inadequate demand forecasting driven by seasonality (Hennchen 2019). Although certain patterns of demand can be established across a business circle, their prediction remains difficult

(Filimonau *et al.* 2020b). Mistakes in demand forecasting lead to the over-production of food or under-utilised ingredients. The human factor is also associated with the capabilities of the kitchen staff. Poor cooking and plating skills result in food orders rejected by customers while insufficient trimming skills damage food and prompt its wastage (Heikkilä *et al.* 2016).

The post-kitchen stage accounts for 34% of FW whereby wastage is driven by the human factor (WRAP 2017). Customers do not finish meals because of personal taste or when the portions are deemed excessive (Li *et al.* 2020). The social nature of consuming food out-of-home can also drive FW in this stage. For example, the need to socialise with guests and look after their well-being can lead to unfinished plates (Filimonau *et al.* 2020c).

The drivers of FW in foodservices can further be divided into societal/cultural, institutional and organisational. National culture dictates the habits of eating out. For example, in many Asian countries it is considered a norm to order more food than required as a means of demonstrating hospitability and generosity (Li and Wang 2020). The national institutions of power can drive FW in the kitchen and in the post-kitchen stages of foodservices. For instance, stringent food hygiene and safety standards in the EU-28 countries require food to be considered unsafe for consumption after spending a pro-longed period of time outside the cold chain (Filimonau and Sulyok 2021). The organisational factor is exemplified by the corporate decisions made on how to prepare and cook food, but also on how to deliver this food to customers. For instance, fine dining restaurants waste substantial amounts of food in the kitchen as they apply strict quality standards to assess the suitability of foodstuffs for service (McAdams *et al.* 2019). A corporate decision to provide food in the form of open-buffets rather than a la carte service drives FW in the post-kitchen stage (Okumus *et al.* 2020). Although open-buffet customers waste a lot of food on their plates, they hold joint responsibility for this wastage with foodservice managers/owners who provided this service to them in the first place.

In summary, the drivers of FW in foodservices are diverse and attributed to various operational and non-operational factors. The drivers are characterised by substantial cross-sectoral and cross-market differences and there is a clear association between FW and political and socio-economic factors. The drivers of FW in foodservices need to be better understood and appropriate measures should be adopted to prevent and mitigate their occurrence.

2.1.3. Management

Approaches to FW prevention and mitigation in foodservices are underpinned by the FW management hierarchies (see, for instance, Papargyropoulou *et al.* 2014). These target the drivers of FW occurring in different stages of foodservice provision. For the kitchen stage, staff training and preventative equipment maintenance can minimize wastage of food due to spoilage (Goh and Jie 2019). By establishing trusting relationships with suppliers, foodservice providers can reduce the amounts of food damaged in transit (Filimonau 2021).

For the kitchen stage, FW management should be concerned with more accurate prediction of consumer demand. Models can be developed to facilitate this (see, for instance, Prognolite 2020). Investing in sophisticated modelling may however prove unfeasible for foodservice SMEs due to its high cost. Therefore, simplistic, intuitive models can be applied instead (Filimonau and de Coteau 2019). Any model should however be based on reliable historical records of consumer demand held by a specific foodservice business. The 'richness' of this historical data will determine the quality of predictions. This highlights the importance of collecting and analysing the 'big data' for FW prevention and mitigation in foodservices (Sakoda *et al.* 2019).

In the absence of accurate forecasts, FW management in foodservices should focus on the redistribution of surplus food. This food can be given to staff or donated to charitable

organisations (Filimonau *et al.* 2019b). The raw ingredients should be re-used and re-purposed in other meals (Filimonau *et al.* 2020b). Dynamic discount pricing can be applied to redistribute surplus food and specialist digital services of food delivery, such as UberEats, or surplus food redistribution, such as Too Good To Go, can be employed for this purpose (Sakaguchi *et al.* 2018). To avoid FW occurrence in cooking, kitchen staff should be (re-)trained. This can be challenging, especially in the case of experienced chefs who often do not appreciate the need to reduce wastage (Batat 2020). These chefs should be re-programmed to ensure they understand the business, but also wider societal, implications of FW and the need for its reduction.

In the post-kitchen stage, consumer engagement is paramount to secure for effective FW management (Kallbekken and Saelen 2013). Customers should be made aware of the detrimental effect of wasted food on the business which they patronise, but particularly on the wider society (Stockli *et al.* 2018). However, raising awareness is insufficient and more pro-active means of customer engagement should be considered. These can take the form of, for example, behavioural interventions whereby clean plates are incentivised through the re-design of the dining environment or its particular elements, such as plates (Reisch *et al.* 2021). Wasteless behaviour can be rewarded with loyalty points or free gifts (Filimonau and de Coteau 2019). The principles of gamification can be adopted to make the process of not wasting food fun, especially for families (Mu *et al.* 2019). If behavioural interventions do not work, then plate leftovers can be offered to customers for take-away (Sirieix *et al.* 2017). Disincentives, such as charges for plate waste, can be applied but caution is required in their application given the potentially negative effect of financial penalties on customer satisfaction (Filimonau *et al.* 2020c).

In summary, foodservice providers have developed a range of approaches to FW management. These have tackled the challenges of demand forecasting, surplus food

redistribution, staff training and customer behaviour, among others. Research is required to test the effectiveness of various approaches to FW management in the foodservice sector when applied in various political and socio-economic contexts. Such research can aid in identifying good business practices in FW prevention and mitigation and examine the potential for their broader cross-sectoral and cross-market intake.

2.2. The Russian context

The size of the Russian foodservice sector has evolved significantly in the last few years. In 2017, there were approximately 70000 foodservice providers and in the fall of 2019 this number was circa 88000 (Federal State Statistic Service 2020). This figure is however an under-estimate as it excludes contract catering and state-subsidised foodservice providers operating in schools, hospitals and work canteens. It also disregards for-profit foodservices operating in some regional markets of Russia. Lastly, it excludes micro enterprises or so-called *индивидуальный предприниматель* (*individual entrepreneur* in English) preparing and serving food for out-of-home consumption. Interestingly, the size of Russian foodservices is comparable to the size of the commercial foodservice market in the UK which, in 2019, was represented by about 110000 enterprises (Statista 2020). Large size of Russian foodservices underlines the need to understand the patterns of FW generated within.

The foodservice sector of Russia incorporates four major categories of businesses (Rosinter Restaurants 2010; USDA Foreign Agricultural Service 2014). Fast casual restaurants (including coffee shops) are affordable catering outlets specializing in multiple/fusion cuisines. This category accounts for about 50% of the national foodservice market. Casual dining restaurants with a market share of circa 40% are the second largest segment providing affordable, often narrowly specialised, foodservice options. Quick service restaurants (QSRs) and fine dining catering outlets represent the remaining two segments.

Although their cumulative market share is low, i.e. about 10%, the number of these foodservice businesses is growing. Increasing popularity of fine dining is attributed to steadily increasing incomes of local residents in Russia, but also to tourism. The number of QSRs grows due to their appeal to younger consumers.

There are no estimates of FW generated in Russian foodservices. The assessment of FW produced across all sectors of the national food supply chain was first undertaken in 2019 (RBC 2019). In line with this assessment, 17 Mt of food is wasted in Russia per year. It is unclear how this figure was obtained as no detail on the assessment methodology was provided. The lack of reliable figures on FW in Russia in general, but also within various sectors of its national food supply chain, underlines the importance of future, targeted research which should tackle this critical knowledge gap.

94% of food wasted in Russia ends up in landfill, thus contributing to carbon footprint build-up and environmental pollution (RBC 2019). This is significantly larger than the amount of FW landfilled in Europe, i.e. 37% (Scherhaufer *et al.* 2018), which outlines the scope for intervention. Saving this food from landfilling can feed up to 30 million people, which is more than the population of those living in food poverty in Russia (RBC 2019).

Alarming is that, despite the significant amounts of wasted food, Russia has no national strategy on FW prevention and mitigation (Galaktionova 2017). No measures have been developed to date to manage FW occurrence across different sectors of its national food supply chain as a result (TIARCenter 2019). Unlike other countries whereby the challenge of FW has been tackled by voluntary industry agreements (see, for example, WRAP 2020 for details on the Courtauld commitment), the representatives of Russian enterprises in food manufacturing, processing, distribution and service have set no targets or guidelines on how to minimize FW in their operations.

There are no measures to minimize FW in Russian foodservices. A number of online food sharing platforms are operated by volunteers and business start-ups but these predominantly target surplus food in households (TIARCenter 2019). A smartphone app was developed in 2018 to aid foodservice providers in redistributing surplus meals (EatMe 2020). Although it has been downloaded by over 10000 times, the app only covers nine metropolitan areas of Russia, thus excluding a large chunk of the national foodservice market. Criticism has been raised about the business ethics of such surplus food distribution apps as some foodservice providers use them as an opportunity to boost profits, rather than reduce FW (De Almeida Oroski 2020). The impact of such apps on FW prevention and mitigation in foodservices remains unexplored. This showcases the urgent need to develop (more effective) measures for FW management in Russian foodservices.

In summary, the challenge of FW in Russia is under-examined and the contribution of different sectors to FW generation within this rapidly developing economy remains unknown. The sector of foodservices has never been studied from the perspective of FW prevention and mitigation. This outlines an important knowledge gap which this study has set to, at least partially, address.

2.3. Summary

Although the research agenda on FW and its management in the global sector of foodservices is rapidly progressing, there remain important knowledge gaps. One of such gaps is attributed to the limited geographical coverage of extant studies. Although many developed and increasingly large number of developing economies has been examined from the viewpoint of FW generated in their national foodservice sectors, such rapidly emerging, global market of food production and consumption as Russia has been excluded from analysis. This paper aims to, for the first time, provide a benchmark of the FW challenge in Russian foodservices,

identify the main drivers and establish approaches to management. By comparing the results of empirical investigation with other empirical studies conducted in other markets of food production and consumption, the paper strives to outline the similarities and differences. The paper also attempts to reveal examples of good business practices in FW management and discuss how these could be up-taken for more effective FW prevention and mitigation in Russian foodservices. The next section explains this study's research design.

3. Materials and methods

3.1. Method

The under-studied nature of the FW phenomenon in Russian foodservices justifies the adoption of exploratory research in this project. In contrast to confirmatory research which re-establishes or provides additional evidence in support of existing knowledge, exploratory research offers an initial insight into the previously unexamined topic (Jaeger and Halliday 1998). Exploratory research does not therefore have a goal of being representative; instead, it seeks to generate some preliminary findings for validation in subsequent confirmatory projects (Stebbins 2001). Exploratory research has been effectively used in past studies on the FW challenge in foodservices (see, for example, Filimonau *et al.* 2019b).

The methods of qualitative research and case studies (sometimes combined and referred to as qualitative case studies) are popular in exploratory investigations, especially in the context of SMEs (Ponelis 2015). Qualitative research enables an in-depth understanding of the phenomenon under review by offering scope for better participant engagement (Ghauri and Gronhaug 2005). As a method of qualitative research, interviews facilitate interaction by providing study participants with the freedom of expression (Silverman 2013). Interviews give researchers an option to follow up and examine expressed opinions in more detail (Veal

2011). Qualitative research is a popular method of primary data collection and analysis in studies on FW and its management in foodservices (see, for example, Vizzoto *et al.* 2020).

Case studies are often supplementary to, or an integral element of, qualitative research as they represent an in-depth investigation of a particular phenomenon within a single entity, such as a foodservice enterprise (Hyett *et al.* 2014). The investigation is facilitated by applying qualitative research methods, such as interviews and in-situ observations (Baškarada 2014). Case studies have been used in FW research on foodservices (see, for instance, Charlebois *et al.* 2015), which demonstrates their analytical merit and proves their suitability for this current project.

An interview protocol was derived from preliminary themes extracted from the literature. The protocol included questions on: (1) the operational and societal criticality of FW in comparison to other environmental externalities of foodservice business operations; (2) the main drivers of FW generation; and (3) approaches to FW management. The protocol was developed in English but back translated in Russian. It was pre-tested with five managers of Russian foodservices prior to deployment. A copy can be found in Appendix 1.

3.2. Study administration

Primary data were collected from foodservice providers in Kemerovo, a middle-sized city in the southwest of Russia. Kemerovo was preferred to the two 'capital' areas, i.e. Moscow and St Petersburg, because it is more representative of the national foodservice market. Being popular tourist destinations, the foodservice sectors of Moscow and St Petersburg are made up by a bigger number of fine dining restaurants catering for large(r) numbers of international tourists (Rosinter Restaurants 2010). The FW dynamics in these markets may therefore not accurately represent the FW dynamics in foodservices of other Russian cities and towns. When choosing Kemerovo for primary data collection, the study considered similarity of its

386 foodservice market to other, non-capital regions of Russia. Foodservices in regional cities and
387 towns cater primarily for local residents and the segmentation/categorisation of the main
388 foodservice providers better resembles that of the Russian market as a whole (Rosinter
389 Restaurants 2010; USDA Foreign Agricultural Service 2014).

390 Study participants were recruited from among commercial foodservice providers
391 registered on Tripadvisor. Non-for-profit foodservices (i.e. school/work/University canteens)
392 were excluded due to the substantially different business models adopted in their operations.
393 As of August 2020, there were 371 for-profit foodservice operators in Kemerovo and these
394 were contacted with a request to partake in this study. An introductory email was first sent to
395 all businesses explaining the nature of this research. The email was followed up with a
396 personalised phone call seeking to provide extra information about the project, offer
397 additional reassurance in its anonymous nature, answer any study related queries and,
398 ultimately, secure participation consent. When recruiting study participants, consideration
399 was given to the segmentation of the Russian foodservice market in terms of the share held
400 within by the representatives of different restaurant categories (see section 2.2).

401 In total, 21 foodservice operators agreed to participate in this study. Although sample
402 size is of less relevance to qualitative research (Silverman 2013), 10-30 participants are
403 usually required to make meaningful conclusions and record saturation (Thomson 2010 cited
404 Marshall *et al.* 2013), and this study conforms to this requirement. The participants were
405 represented by fast casual dining (9 or 43% of the sample), casual dining (6 or 29%), fine
406 dining (3 or 14%) and quick service (3 or 14%) restaurants (Table 1). This sample
407 distribution is in line with the segmentation of the Russian foodservice sector (Rosinter
408 Restaurants 2010; USDA Foreign Agricultural Service 2014).

409 [Insert Table 1 here]

Semi-structured interviews were conducted with top administrations of these restaurants. Executives at the level of General Manager/Owner and/or Head Chef were interviewed to ensure they could provide first-hand, detailed information about the challenge of FW in their enterprises. Interviews were conducted in-situ across various dates in September-October 2020. They were held in Russian and lasted, on average, between 33 and 56 minutes. Interviews were recorded for subsequent transcribing. No incentives were offered.

In addition to interviews, to set a benchmark for FW generated in different categories of Russian foodservices, a quantitative assessment of the FW challenge was undertaken. In Russia, commercial FW is disposed of by the method of collection, either by municipal (public) or private solid waste management companies. The collection charge is calculated by weighing FW provided for disposal. For example, a fixed charge is applied for each 250 kg of FW collected. The study participants were requested to provide the research team with access to their financial records on FW collection. These records enabled estimates of FW to be made. Although such a method of FW assessment is less accurate than the method of direct, on-site FW measurement, it has been effectively applied in previous studies on FW and its management in foodservices (see, for example, Li *et al.* 2020). The method of direct FW measurement is too laborious, time-consuming and expensive to implement (Wang *et al.* 2018); hence, it was considered but not applied in this project.

In addition to benchmark assessments of FW, in-situ observations were made in line with the guidelines outlined in Papargyropoulou *et al.* (2019). Observations involved the research team being present on business premises of this study's participants during the time of foodservice preparation and provision. Observations enabled witnessing how FW was generated in various operational stages of foodservice (pre-kitchen, kitchen and post-kitchen) and evaluating the measures adopted in-house for FW prevention and mitigation.

Observations were carried out prior to interviewing study participants at least three times during a 'typical' foodservice week, i.e. on Tuesday, Friday and Saturday. This was to account for the weekly variations in the FW dynamics (Filimonau and de Coteau 2019). Notes were taken during these in-situ observations; these were used in interviews to seek clarity on what has been observed (Papargyropoulou *et al.* 2019).

3.3. Data analysis

Interviews were transcribed verbatim, translated in English by a professional interpreter, and the data was analysed thematically. In line with the guidelines provided by Braun and Clarke (2006), the interviews transcripts were first carefully read by the research team's members. The data were interpreted and then coded to draft a list of themes and sub-themes. An intra-team discussion was subsequently held to ensure the (sub-)themes were meaningful and to reach an agreement on any discrepancies in interpretation (Schutz 1973). Table 2 reports on the final coding structure. Representative quotes were extracted from the interview transcripts to demonstrate the validity of data interpretation. Figure 1 presents the research design adopted in this project.

[Insert Table 2 here]

[Insert Figure 1 here]

4. Results and discussion

4.1.FW magnitude

The study provided the first benchmark of food wasted in various categories of commercial Russian foodservices (Table 1). On average, the sample of studied restaurants produced 14 t of FW per year. Fine dining restaurants wasted, on average, the largest amounts of food (17.5 t per year) while the smallest annual wastage was recorded for QSRs (9 t). This is in line with

findings of McAdams *et al.* (2019) who have established similar patterns of FW generation across various foodservice sub-sectors in Canada. There was clear correlation between FW and restaurant size with larger foodservice operators wasting twice as much food as smaller foodservice providers (Table 1). This is in agreement with Papargyropoulou *et al.* (2019) who have revealed the relationship between the size of for-profit foodservice operators and the amounts of food wasted on their premises in the context of Malaysia.

When compared against the figures of FW generated by commercial foodservice providers in other countries, wastage in Russian foodservices is excessive. WRAP (2020) posits that a 'typical' for-profit foodservice operator in the UK wastes circa 4.8 t of food per year, or three times less than the benchmark established in the current study. Concurrently, the amounts of FW in Russian foodservices are closer to those recorded in the USA. A 'typical' US restaurant generates between 11.3 and 34 t of FW per year (FWRA 2014). This showcases the need for urgent interventions to prevent and mitigate FW in the foodservice sector of Russia.

The benchmark of food wasted by restaurants established in this study can be used to obtain a cross-sectoral estimate of FW in Russian foodservices. Given that an 'average' restaurant in the studied sample produced 14 t of FW per year, when multiplied by 88000 (the number of for-profit foodservice operators in Russia), this provides the figure of 1.23 Mt. This suggests that the foodservice sector of Russia contributes with circa 7% to the country's total FW of 17 Mt. Although this relative contribution is lower than in the UK and EU-28 countries, i.e. 12% (FUSIONS 2016), the absolute value of this wastage is excessive. The UK foodservice sector generates about 1.1 Mt of FW per year but this includes for-profit and non-for-profit enterprises (WRAP 2020). The figure obtained in this study is only representative of the commercial segment of Russian foodservices. If non-for-profit operators are considered, the resultant FW figure is likely to become significantly higher.

As for the composition of FW generated in the for-profit foodservice sector of Russia, it is dominated by meat, fruits and vegetables, and bakery items (Table 1). The unique feature of Russian foodservices is the excessive wastage of meat across all restaurant categories. Research conducted in other markets of out-of-home food consumption generally confirms this finding albeit fruits and vegetables alongside bakery items represent the most wasted types of foodstuffs in other study contexts (see, for example, Filimonau and Sulyok 2021).

The kitchen and post-kitchen stages of foodservice operations generate the largest amounts of FW in Russia (Table 1) which is in line with the literature (Okumus *et al.* 2020). Kitchen is a primary contributor of FW in fine dining restaurants and the role of post-kitchen in FW is particularly pronounced in QSRs. This finds confirmation in the studies by Charlebois *et al.* (2015) and Heikkilä *et al.* (2016) conducted in the Canadian and Finnish contexts, respectively.

4.2.Criticality of FW as an operational and societal challenge

The study participants demonstrated solid awareness of the detrimental environmental effects of foodservice operations (Table 2). Energy consumption, food waste and water use were frequently cited, especially from the viewpoint of their financial implications for business profitability. This is in agreement with previous studies whereby foodservice operators have acknowledged various environmental externalities of their enterprises but linked them to the financial performance (Martin-Rios *et al.* 2018). Similarly, despite solid awareness, the study participants saw the environmental impacts of their operations as the ‘necessary evil’ required to fulfil the main purpose of foodservice provision, i.e. to satisfy customers and build consumer loyalty:

> *'Look, what do you think is the most important thing in my [foodservice] business? People! Customers, I mean. Food waste, yes, I have it, but who does not? OK, I have a piece of meat which doesn't look appetising and I give it to my client. They'll eat it and they won't like it. What will they do? Next time they'll go to my neighbour [restaurant]. I'll lose my customer, I'll lose my money. I need to ensure my customer is happy, food waste is secondary…'* (R15, fast casual restaurant)

This is in line with Vizzoto *et al.* (2020) who recorded similar attitudes being prevalent in Italian foodservices. Interestingly, plastic waste as an environmental externality of foodservice operations was mentioned by a quarter of the study participants (Table 2). This pinpoints growing industry awareness of plastic pollution and the role the foodservice sector plays within. It is important to support this growth in awareness with targeted policy interventions aimed at plastic waste reduction. Such targeted interventions can be seen positively by the industry, especially if market-based incentives are provided to eliminate plastic waste occurrence in foodservice operations (Filimonau 2021).

4.3.FW drivers

Two main drivers of FW were repeatedly cited, i.e. the over-production of meals (kitchen stage) and plate leftovers (post-kitchen stage), see Table 2. Surplus meals occurred due to poor demand forecasting attributed to the factor of seasonality. This is a major driver of FW in for-profit foodservices of Bulgaria (Filimonau *et al.* 2019a), India (Bharucha 2018) and USA (Sakaguchi *et al.* 2018). Plate leftovers were assigned to irresponsible consumer behaviour whereby restaurant guests were blamed for over-ordering or rejecting meals due to taste incompatibility. The important role of plate waste as a driver of FW has long been

established in the context of for-profit foodservices in Canada (von Massow and McAdams 2015), Slovenia (Juvan *et al.* 2018) and Switzerland (Betz *et al.* 2015). This study shows that Russia is no exception, thus underlining the need to design effective interventions to reduce surplus meals and eliminate plate leftovers.

In the pre-kitchen stage of foodservice operations, long menus were recognised as a FW driver by a quarter of the study participants (Table 2). Long menus were seen favourably as a marketing tool and a means of attracting customers by broader food choice. This required large varieties of foodstuffs to be stocked and regularly replenished on restaurant premises. In the absence of consistent demand, the ingredients for less popular menu items would be spoiled unless timely re-purposed. The role of bulky menus in wastage has long been highlighted (Fang *et al.* 2013) and finds further confirmation in the Russian context:

> *'Our menus are long and we're actually very proud of this. We see long menus as a market differentiator. It's part of the Russian culture, if you wish, the Russians are known for their generosity and hospitability, there's even a saying 'широкая русская душа' [the broad Russian soul]. Our customers come to us to have a good time. So, we don't want to tell them 'oh, we don't have this, we don't have that'. Or, we cannot give them a miniscule portion, all our portions are proper big'* (R7, fine dining restaurant)

Although this was not explicitly mentioned by the study participants, the above quote underlined the role of national culture as a FW driver. The need to provide the 'true Russian hospitality' would supress business concerns over wastage. Interesting is that national culture has been acknowledged as a FW driver in other studies (see, for example, Liao *et al.* 2018) but mostly from the customer perspective. Restaurant guests in China during social functions,

559 for instance, over-order food to demonstrate hospitability (Filimonau *et al.* 2020c). This
560 current study adds to this evidence but pinpoints how national culture can drive FW on the
561 foodservice provider side.

562 The need to serve perfect dishes in terms of their look, size and taste was outlined by a
563 quarter of the study participants as a FW driver in the kitchen stage (Table 2). To produce a
564 good-looking cut of meat and present it to customers in a visually appealing manner
565 necessitated excessive trimming and garnishing. The aesthetics of meals was therefore
566 prioritised over reducing wastage, which is in agreement with the literature (Calvo-Porral *et*
567 *al.* 2017).

568 An interesting finding was in that imperfect cooking skills of chefs and other kitchen
569 staff were cited as a FW driver in the kitchen stage by only a small number of the study
570 participants (Table 2). This contradicts the literature as seen, for instance, in Goh and Jie
571 (2019). The lack of skills may be hidden in excessive trimming required to make food
572 visually appealing. It can also be justified by the corporate pursuit of high aesthetics
573 standards, as discussed above.

574

575 ***4.4.Approaches to FW prevention and mitigation***

576 The study participants managed FW in line with the instances of its occurrence (Table 2). To
577 avoid surplus meals, it was attempted to optimise demand forecasting. To this end,
578 predictions were made using historical data and these data were collected and routinely
579 stored, especially by larger foodservice operators. Smaller businesses relied on intuitive
580 forecasting which lacked precision as argued by Hennchen (2019).

581 Portion control was applied to reduce FW on customer plates. This approach to FW
582 management should be used with caution as it may deter some consumers and even direct
583 them to competitors as consumers tend to assign poor value to smaller portions (Filimonau

584 and De Coteau 2019). In the case of the studied sample, restaurant guests were given
585 flexibility in choosing portion size and the price was adjusted accordingly. This was seen
586 favourably by many customers especially those with limited budgets and diet followers:
587
588 *'I have no problem if my customer wants to order a smaller portion. For example,*
589 *our standard steak weighs 250g, but we give the client an opportunity to order*
590 *half of it if they want to. Important is that they pay only half the price too. It's*
591 *good for the client as they may not have got enough money. It's also good for us*
592 *as the main meal has been ordered and this is what we aim for. In addition, we*
593 *reduce plate leftovers, which is great…'* (R3, casual dining restaurant)
594
595 Portion control has been found unpopular in foodservices of East-Central Europe
596 (Filimonau and Sulyok 2021) partially because customers are not communicated the option of
597 ordering less food for a lower price. As this current study shows, portion control may
598 represent a meaningful approach to reduce plate waste. This is subject to properly explaining
599 why it is applied and showcasing its (financial) benefits for consumers.
600 Some approaches to FW management that had proven to be effective in foodservices of
601 other countries were unpopular in the Russian context. For instance, selling meals at a
602 discounted price is widely used around the world (Cane and Parra 2020), but not in Russia.
603 This was attributed to the lack of digital foodservice delivery platforms that would enable
604 surplus food redistribution. This was also associated with the timings of applying discounts:
605 due to unpredicted demand and unwillingness to lose profits, foodservices tended to wait
606 until the very last minute prior to discounting surplus food. As a result, only particular
607 categories of customers could take advantage of this offer:
608

609 *'We sell surplus food at a discounted price but only when the restaurant is*
610 *closing. As we close at 23.00, there aren't so many potential customers around.*
611 *Mostly, they're taxi drivers because they're mobile and work night shifts. I think,*
612 *for them, it's a great deal as we offer high quality meals discounted by 30-50%'*
613 (R5, casual dining restaurant)
614
615 Menu redesign represents a popular approach to FW management as it provides scope
616 for identifying the most wasteful menu items (Filimonau *et al.* 2020c). In Russia, its
617 application is hampered by the fear of lost customer loyalty, as discussed earlier. Those few
618 foodservice providers who took advantage of this approach (Table 2) claimed to have done so
619 in pursuit of establishing the least popular dishes and replacing them with other meals. The
620 rationale behind menu redesign was purely profit, rather than FW reduction, driven.
621 Donation of surplus meals to charitable organisations is broadly used as a FW
622 management approach in foodservices (Sakaguchi *et al.* 2018). None of the study participants
623 however mentioned food donation in the context of Russia. When prompted, the lack of local
624 charities willing to collect surplus food for subsequent redistribution to people in need was
625 referred to as a key barrier. This outlines the scope for policy-making intervention which
626 should aim at supporting the food rescue work of non-governmental organisations in Russia.
627 The study revealed a few notable approaches to FW management that could be classed
628 as 'best practices'. To reduce plate waste, two restaurateurs provided incentives for clean
629 plates (Table 2). This is a powerful, but rather unconventional, measure to engage consumers
630 in FW prevention and mitigation (Dolnicar *et al.* 2020). Foodservice operators are often
631 apprehensive of its adoption as incentivisation implies an additional business expense. The
632 example of studied foodservices in Russia demonstrates that incentives, if properly designed,
633 do not only reduce wastage, but can also increase customer loyalty:

'We try to stimulate clean plates. In fact, we provide either a free bar of chocolate or a soft drink if customers consume all food. Children love that! They even encourage their parents to eat it all! Every day we give away about 50-80 chocolate bars. Yes, it's an extra cost, but it's worth it as children pull their parents to our restaurant next time when the family goes out…' (R2, casual dining restaurant)

One restaurant contracted a local farmer for FW collection and its subsequent disposal as the animal feed. In return, the farmer provided the restaurant with agricultural produce. Filimonau (2021) has highlighted the scope for industry collaboration with the purpose of FW reduction and this current study offers empirical evidence that such collaboration already exists. This collaborative experience should be promoted not only across the foodservice sector of Russia, but also beyond. When taking it outside Russian foodservices, appropriate legislative changes are however necessary. For example, Eriksson *et al.* (2020) argue that overly stringent food health and safety regulations in the EU-28 countries prevent foodservice operators from using FW as the animal feed. This hampers collaborative work of farmers and restaurants:

'We work with a local farmer. We've made a deal with him: he collects our food waste and gives us some of his produce. For 20kg of food waste we receive 1kg of potato or 0.5kg of carrots. This is very convenient for us because, first, we don't need to pay for municipal waste collection. Second, we receive fresh products from the farmer. We can thereby promote organic vegetables to our customers, and they like it' (R10, fast casual restaurant)

659

660 The amount of FW generated by a single restaurant can make it financially unviable for
661 the farmer to collect it due to high transportation costs. Therefore, 'collaborative bubbles' can
662 be formed by foodservice operators whereby a number of restaurants form a network and the
663 farmer collects FW from all members of this network. Such collaboration is also valuable for
664 the farmer as, by exchanging agricultural produce for FW, they can establish new supply
665 markets. This will eliminate the need for the 'middle man', thus reducing supply costs and
666 saving delivery time (Filimonau 2021). This should enable foodservice operators to offer
667 more competitive prices, thus attracting customers. This 'best practice' provides all actors
668 involved with multiple benefits and should therefore be promoted.

669 One restaurant composted FW on-site (Table 2) which is promising but hampered by
670 space constraints. Although this approach to FW management can be facilitated by the design
671 of portable composters and anaerobic digesters, it is yet unpopular with foodservice operators
672 due to high initial investment costs (Papargyropoulou *et al.* 2016). Targeted policy support is
673 necessary to incentivise on-site composting. This support can take the form of interest-free
674 loans or 'green' subsidies (Filimonau 2021). Composting can be organised as part of the
675 'collaborative bubbles' discussed earlier. A composter or anaerobic digester can be installed
676 on premises of the most spacious member of the bubble. The profits made can subsequently
677 be shared by all members.

678

679 ***4.5.Managerial insights***

680 The study outlined a number of approaches to FW management adopted in Russian
681 foodservices. Most of these approaches are conventional but some stand out as 'best
682 practices'. The promotion of 'best practices' in FW management requires business innovation
683 and multi-stakeholder engagement. Foodservice operators should aim to collaborate with one

684 another, rather than compete. Their collaboration should be extended towards farmers and
685 other relevant parties, such as commercial operators of composters and anaerobic digesters.
686 The collaboration should further be supported by policy-makers. Besides providing targeted
687 financial support to foodservice operators and charitable organisations working in the field of
688 food donations/rescue, policy-makers should strive to build capacity for multi-stakeholder
689 collaboration by linking all actors and agents together. Figure 2 outlines a collaborative
690 framework which can aid in more effective FW management in the Russian foodservice
691 sector.

692 [Insert Figure 2 here]

693

694 **5. Conclusions**

695 The study provided the first benchmark of FW in Russian commercial foodservices, thus
696 showcasing the important role played by this sector in the challenge of FW in Russia, as well
697 as globally. The annual wastage of 14 t per foodservice operator is significant and urgent
698 measures are required to reduce its occurrence. These measures should prioritise such
699 categories of commercial foodservices as fine-dining and (fast) casual dining restaurants as
700 their FW patterns are higher. By examining approaches to FW prevention and mitigation
701 adopted in Russian foodservices, as well as globally, the study designed a management
702 framework which can aid in reducing the challenge of FW, thus enabling progress of the
703 sector towards the goal of environmental sustainability.

704 This study made a three-fold contribution. First, it contributed to knowledge with
705 empirical evidence showcasing the magnitude of the FW challenge in Russian foodservices.
706 For the first time, the study benchmarked the patterns of FW generation in various categories
707 of commercial foodservice operators in Russia, outlined the main drivers and established the
708 key approaches to FW prevention and mitigation. Second, the study informed the design of

industry interventions for more effective management of FW in Russian foodservices. This was the result of highlighting some 'best practices' in FW management that the sector should strive to adopt more broadly. Lastly, the study outlined the scope for the design of policy-making interventions that are necessary to prevent and mitigate FW occurrence in Russian foodservices. These interventions should aim to (1) facilitate the work of charitable organisations on surplus food redistribution; (2) enable the network capital of foodservice providers and farmers; and (3) encourage the adoption of more pro-active approaches to FW management by foodservice operators, such as consumer incentives and on-site composting.

The study had limitations that, concurrently, represented promising research opportunities. First, it explored a small sample of Russian foodservices, thus providing an initial perspective on FW generated within. Future research should strive to generalise this study's findings by extending the sample of examined businesses in order to enhance the robustness of results. Second, the study focused on commercial Russian foodservices. Future research should look at another significant chunk of the market represented by contract caterers and non-for-profit/subsidised foodservice operators. Third, the study was conducted in a major, yet single, metropolitan area of Russia, Kemerovo. Future research should extend the geographical scope of analysis by covering other regional markets of out-of-home consumption, especially those in the capital areas of Moscow and St Petersburg. The latter two markets are particularly interesting from the viewpoint of future investigation given they cater equally for local residents and international tourists. Lastly, this study involved interviewing restaurateurs. The perspective of other actors and agents of effective FW management in Russian foodservices should also be examined. This particularly concerns such stakeholders as consumers, local farmers, food rescue charities and regional/local authorities. Consumers should be studied to better understand why they leave food uneaten and how plate waste can be discouraged. Farmers should be investigated from the perspective

734 of their collaboration with foodservices on FW collection and provision of agricultural
735 produce. Food rescue charities should be explored from the viewpoint of the institutional and
736 organisational support required to facilitate their work. Lastly, policy-makers should be
737 engaged in future research to outline potential support mechanisms they could put in place to
738 promote FW prevention and mitigation in foodservices via multi-stakeholder involvement.
739

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Section 1: Knowledge of the magnitude and key drivers of food waste.

- Tell me about the main environmental challenges (if any) in the sector of foodservice provision in Russia
    - *Energy use*
    - *Water consumption*
    - *Solid (food) waste generation*

- Tell me about the main environmental challenges (if any) that exist specifically for your business

- Now tell me about how big the problem of food waste is for your hospitality business
    - If exact figures on the magnitude of food waste are available, then ask for them. If no exact figures are available, then ask for a qualitative estimate of the magnitude i.e. Small / Medium / Large

- How do you measure the quantities of food waste produced (if at all)?
    - *If no accurate measurements are made – what stops you from taking accurate measures of food waste in your business?*

- What food is wasted the most in your business?
    - *Fruit & Vegetables*
    - *Bread and bakery products*
    - *Fresh meat and fish*
    - *Other items*

- What are the main causes of food waste in your business?
    - *Difficult to forecast consumer demand for food / Significant demand fluctuations across time*
    - *Problems with on-site storage / Faulty electric equipment*
    - *Suppliers deliver too much food / deliver large quantities of damaged / imperfect foodstuffs*
    - *Business model in place (e.g. all-you-can-eat or buffet instead of a la carte)*
    - *Specific nature of the cooking process on our business (e.g. large quantities of food waste are generated when cutting / trimming or preparing meals)*
    - *Complex / Extensive menus that result in the over-production of meals*
    - *Imperfect cooking and plating skills of kitchen staff / chefs*
    - *Customer plate waste / Irresponsible consumer behaviour*
    - *Anything else?*

- Tell me what you think the key benefits of reducing food waste in your hospitality business are (if any)
    - *Financial savings*
    - *Improved image / Enhanced corporate reputation / Corporate Social Responsibility commitments*
    - *Pressure from shareholders*
    - *Pressure from consumers*
    - *Pressure from the government*

- *Better for the environment*
- *'It is just the right thing to do' / Personal values and beliefs*

Section 2: Approaches to food waste management

- Tell me about what you currently do to reduce food waste in your operations
  - *Try to forecast demand right*
  - *Work with suppliers to ensure frequent deliveries of the 'right' food quantities*
  - *Adoption of less wasteful business models (e.g. a la carte rather than buffet)*
  - *Avoid using extensive menus*
  - *Portion control*
  - *Repurpose of excess ingredients (e.g. cooking new meals from excess ingredients at short notice --> Chef's special or Dish of the day)*
  - *Sell surplus meals at discounted prices*
  - *Take surplus food home*
  - *Give surplus food to staff*
  - *Donate surplus food (to charities or directly to the poor in local communities)*
    - *Then check in more detail if this is taking place and how this is organised*
    - *If they are not doing this --> check why*
  - *TO REDUCE CUSTOMER PLATE WASTE*
    - *Charge per weight of food*
    - *Charge back for any waste generated*
    - *Encourage smaller portions / Allow ordering restricted food quantities at once*
    - *Reduce size of plates*
    - *Incentives for 'clean' plates (e.g. a bar of chocolate OR a free drink OR loyalty points OR charitable donation)*
  - *On-site recycling / Composting / Anaerobic digestion*
  - *Dumping into the garbage bin*
  - *Anything else?*

Table 1. Study participants (n=21).

Legend: white colour indicates fine dining restaurants; light grey colour – casual dining restaurants; medium grey – fast casual restaurants; dark grey – quick service restaurants

Participant ID	**Foodservice category**	**Business size** *Small (<100 seats) Medium (100-300 seats) Large (>300 seats)*	**Annual food waste, tonnes (rounded to the nearest tonne)**	**Main foodstuffs wasted and their proportion in total food waste**	**Operational area where most food is wasted**		
					Pre-kitchen	**Kitchen**	**Post-kitchen**
R1	Casual dining	Large	Circa 30	40% fruits and vegetables; 30% meat; 10% bakery items	-	X	X
R2	Casual dining	Medium	Circa 10	40% fruits and vegetables; 30% meat; 30% bakery items	-	X	-
R3	Casual dining	Large	Circa 20	30% fruits and vegetables; 30% meat; 20% bakery items	-	X	-
R4	Casual dining (hotel)	Medium	Circa 5	40% meat; 20% fruits and vegetables; 20% bakery items	-	X	X
R5	Casual dining (hotel)	Large	Circa 12	30% meat; 30% fruits and vegetables; 20% bakery items	-	X	X
R6	Casual dining (hotel)	Medium	Circa 10	40% meat; 20% fruits and vegetables; 20% bakery items	-	X	X
RESTAURANT CATEGORY AVERAGE			**Circa 14.5**	**30% meat; 30% fruits and vegetables; 20% bakery items**	**Equally kitchen and post-kitchen**		
R7	Fine dining	Large	Circa 20	40% meat; 20% fruits and vegetables; 20% bakery items	-	X	-
R8	Fine dining	Medium	Circa 12	30% fruits and vegetables; 30% bakery items; 20% meat	-	X	X
R9	Fine dining	Medium	Circa 20	40% meat; 30% fruits and vegetables; 20% bakery items	-	X	-
RESTAURANT CATEGORY AVERAGE			**Circa 17.5**	**30% meat; 30% fruits and vegetables; 20% bakery items**	**Mostly kitchen**		
R10	Fast casual	Large	Circa 15	40% meat; 30% fruits and vegetables; 20% bakery items	-	X	-
R11	Fast casual	Large	Circa 15	50% meat; 40% fruits and vegetables; 10% bakery items	-	X	-
R12	Fast casual	Medium	Circa 12	60% meat; 30% fruits and vegetables; 10% bakery items	-	X	-
R13	Fast casual	Large	Circa 30	40% meat; 30% bakery items; 10% fruits and vegetables	-	-	X
R14	Fast casual	Medium	Circa 10	40% meat; 40% bakery items; 20% fruits and vegetables	-	X	-
R15	Fast casual	Large	Circa 15	40% meat; 20% bakery items; 20% fruits and vegetables	-	X	-
R16	Fast casual	Small	Circa 15	30% bakery items; 30% meat; 20% fruits and vegetables	-	X	X
R17	Fast casual	Medium	Circa 12	40% meat; 30% fruits and vegetables; 20% bakery items	-	-	X
R18	Fast casual	Medium	Circa 10	40% bakery items; 30% fruits and vegetables; 30% meat	-	X	-
RESTAURANT CATEGORY AVERAGE			**Circa 15**	**40% meat; 30% fruits and vegetables; 20% bakery items**	**Mostly kitchen**		
R19	Quick service	Small	Circa 7	40% meat; 30% bakery items; 20% fruits and vegetables	-	-	X
R20	Quick service	Small	Circa 10	30% bakery items; 30% meat; 20% fruits and vegetables	-	X	X

R21	Quick service	Medium	Circa 10	40% meat; 30% bakery items; 20% fruits and vegetables	-	-	X
RESTAURANT CATEGORY AVERAGE			**Circa 9**	**40% meat; 30% bakery items; 20% fruits and vegetables**	**Mostly post-kitchen**		
FW SAMPLE AVERAGE			**Circa 14**				
FW range, per foodservice size		**Small**	**7-15**				
		Medium	**5-20**				
		Large	**12-30**				

Table 2. Thematic analysis of interviews. Figures highlight the frequency of each sub-theme mentioned by study participants. Percentage outlines the proportion of study participants mentioning a particular sub-theme. Red colour indicates the most popular sub-themes.

Theme	Sub-theme	Number of mentions	% of mentions
Key environmental externalities of foodservice operations	Energy consumption with related carbon footprint	11	52
	Food waste	11	52
	Water consumption	9	42
	Plastic waste	5	24
Key drivers of food waste	Post-kitchen – Plate waste	12	57
	Kitchen – Over-production of meals	11	52
	Kitchen – cooking needs (for example, wastage in trimming)	5	24
	Pre-kitchen - Long menus leading to spoilage in storage	5	24
	Kitchen – imperfect cooking skills of chefs/kitchen staff	2	10
	Pre-kitchen - Spoilage due to technical failures	1	5
Approaches to food waste management	Kitchen - Investing in demand forecasting	12	57
	Post-kitchen - portion control (to reduce plate leftovers)	9	42
	Kitchen - discounted pricing for surplus meals	5	24
	Pre-kitchen - Menu redesign (to avoid spoilage in storage)	3	14
	Pre-kitchen – collaboration with suppliers to optimise food delivery frequency, thus avoiding wastage in storage	2	10
	Kitchen – surplus meals given to staff	2	10
	Post-kitchen - incentives for clean plates	2	10
	Kitchen – repurposing of surplus cooking ingredients	2	10
	Kitchen – use of technology to avoid wastage in cooking (for example, electric peelers)	2	10
	Post-kitchen – proactive offer of takeaway boxes	1	5
	ALL operational stages – on-site composting	1	5
	ALL operational stages – collaboration with a local farmer to provide food waste for collection and subsequent use as the animal feed + organic produce in return	1	5

Figure 1. Research design.

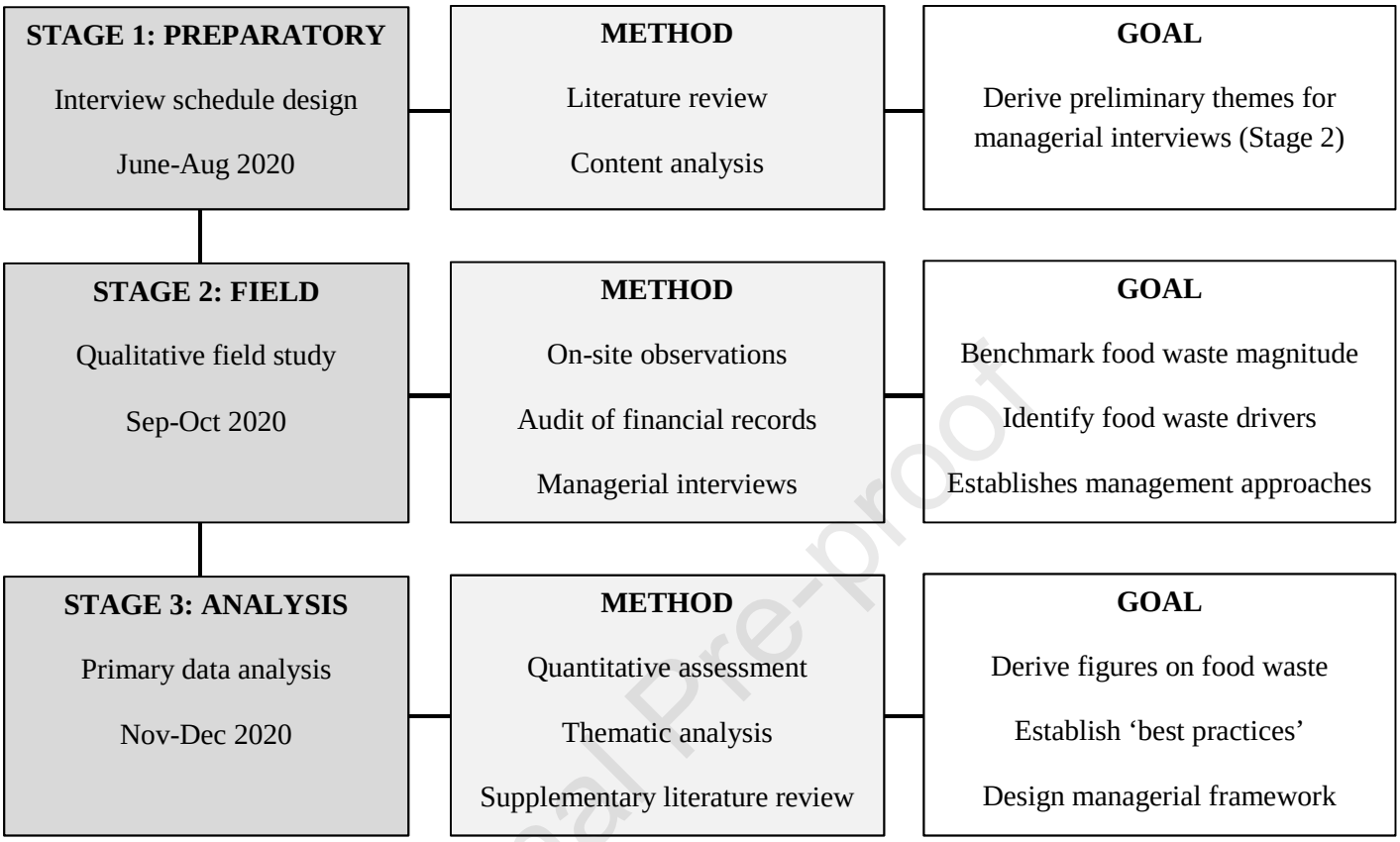
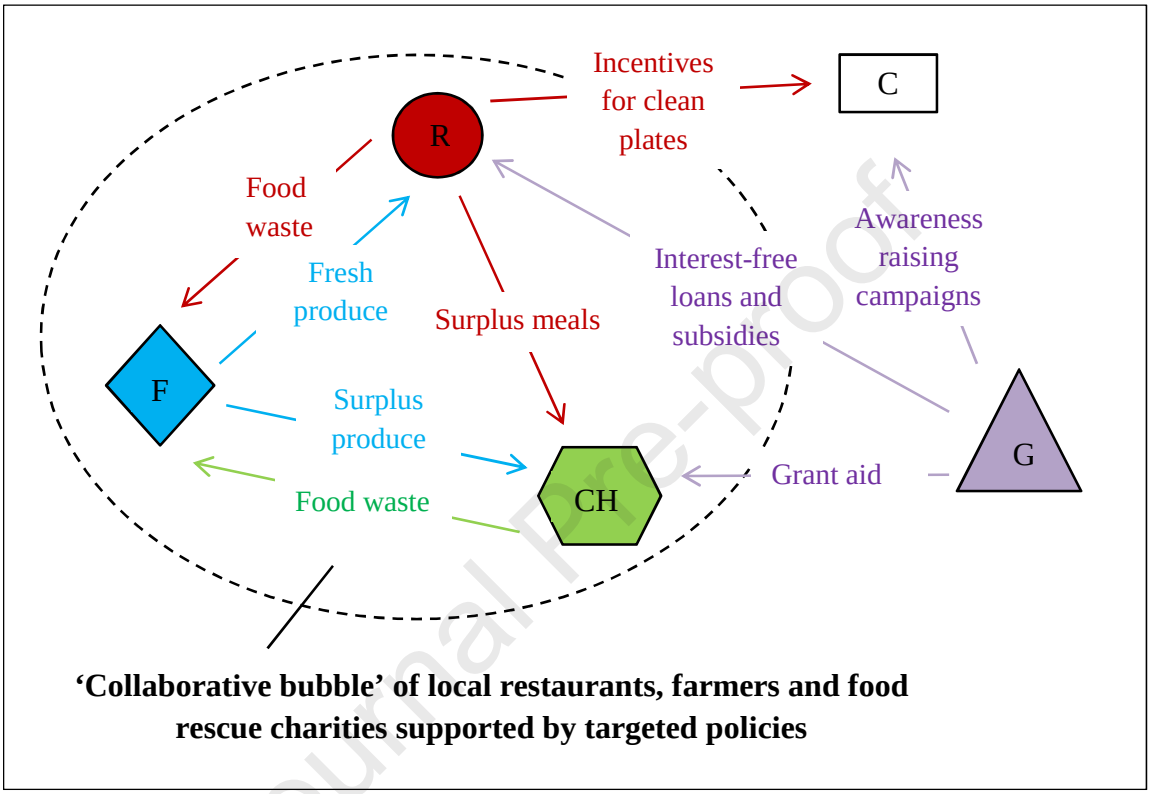


Figure 2. Multi-stakeholder collaborative framework to aid in more effective management of FW in the foodservice sector of Russia. Schematic and not to scale.

Legend: R stands for Restaurants; F stands for Farmers; CH stands for Charities; C stands for Customers; G stands for Government (local/regional/national authorities).



The authors hereby declare no conflict of interest