



Routes to sustainability in public food procurement: An investigation of different models in primary school catering

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ABSTRACT

Increasingly, policymakers are setting ambitious goals for sustainability in public procurement, integrated across different pillars. Such ambitions are apparent in public catering services, where procurement models have been shifting towards greater localisation of supply chains and purchasing of more organically grown food. To date however, few studies have examined empirically what the impacts of different procurement models are across these multiple pillars of sustainability. This research aimed to fill the gap, by measuring and comparing the environmental, economic and nutritional outcomes of different models of school meals procurement. Case studies were undertaken of ten primary school meals services in five European countries, capturing different procurement model types. Results showed carbon emissions ranged from 0.95 kgs CO₂e per meal in the lowest case to 2.41 kgs CO₂e in the highest case, with adoption of low carbon food waste disposal methods and reduction of the amount of ruminant meat in the menus being the most important actions for lowering emissions. In terms of economic impact, local economic multiplier ratios ranged from 1.59 to 2.46, and although the level of local food sourcing contributed to these ratios, the effect was eclipsed, in some cases, by investment in local catering staff. Meanwhile, implementation of a robust standards regime and improving canteen environment and supervision were the most important actions for nutritional quality and intake. The paper discusses the implications of the findings for integrated, sustainable models of food procurement.

1. Introduction

Public procurement is an economically significant activity on a

global scale, comprising 12% of GDP in OECD countries (OECD, 2019), and much higher percentages in developing countries (Smith et al., 2016). It has long been argued that public procurement can therefore

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make a positive contribution to sustainability, not only via the direct purchasing choices of public institutions (Alvarez and Rubio, 2015), but also by setting an example to private sector companies of what sustainable procurement strategies consist of and what they can achieve (Igarashi et al., 2015). In many parts of the world, governments are developing and elaborating policies for sustainable public procurement. In the EU for example, Green Public Procurement (GPP) provides a framework and guidance to public institutions on how to improve the environmental impact of their procurement supply chains (Council of the European Union, 2006), while Directive 2014/24 encourages procurement bodies to expand the scope of sustainability to include economic and population health/well-being outcomes (Council of the European Union, 2014). These policy shifts are well illustrated in public catering services, such as for schools, hospitals, universities and care homes. In this sector, many programmes have been developed by national and regional authorities to encourage procurement that not only reduces environmental impact, but also supports local economies and puts healthy, nutritious food on the plate. Examples include initiatives that encourage public caterers to procure more goods from local suppliers, and/or increase their purchase of organically grown food (Morley, 2021).

To date, a wealth of scholarship has emerged in the field of sustainable public procurement. Studies have addressed many issues, from the design of sustainable procurement policies (Smith et al., 2016) and the operationalisation of sustainability principles into procurement tenders (Testa et al., 2016; Igarashi et al., 2015), to the experiences of national, regional and local stakeholders in responding to policy signals (Sonnino, 2009; Morley, 2021; Grivins et al., 2018). However, less work to date has sought to measure, in a systematic way, what the effects of different procurement approaches are on multiple sustainability outcomes. Indeed, much remains to be revealed about which activities in a food supply chain have the greatest impacts on sustainability, particularly for outcomes other than environmental ones (Videgar et al., 2021). Which procurement approaches or models offer the best chance to meet multiple goals in a synergistic way? Which unexpected or counterproductive outcomes need to be avoided? Arguably, research into these questions not only contributes to better policy design (Smith et al., 2016; Morley, 2021), but also supports procurement professionals on the front line to identify which actions to prioritise within their own domains. This is particularly important given the resource constraints these professionals typically face (Igarashi et al., 2015).

The present study sought to address these research gaps. Specifically, the study aimed to:

- (i) measure and compare different models of public food procurement in terms of their sustainability impacts (environmental, economic and nutritional).
- (ii) analyse the relative contributions that different procurement actions make to sustainability outcomes, across the models.
- (iii) identify, overall, which procurement strategies are most likely to address multiple sustainability outcomes, in a synergistic way.

The focus of this research is particularly timely given the increasing advocacy of integrated food policies (Candel and Pereira, 2017), which seek to achieve greater coherence in goals and better synergies across programmes implemented by separate authorities or departments (Candel and Biesbroeck, 2016). Integrated policies have received much scholarly attention in recent years, an interest that has been supported by research in the parallel discipline of integrated sustainability analysis. This work aims to assess simultaneous impacts of different policy actions, often using multi-criteria decision-making (MCDM) or similar

quantitative techniques (e.g. Dos Santos et al., 2019; Santoyo-Castelazon and Azapagic, 2014). However, to undertake such analyses, a sound evidence base is first needed on which to build the modelling assumptions and metrics. As the evidence base for public food procurement is still developing, a further aim of the current study is to generate rich insights into the sustainability impacts of different procurement approaches, and the possible synergies between them, to lay the groundwork for more structured or quantitative assessments in future.

The empirical research consisted of in-depth case study analysis of ten primary school catering services located in five European countries. School catering is an appropriate sector to examine issues of sustainability in public food procurement. Not only does it represent a significant proportion of total public sector food procurement, but these services have attracted much policy attention in recent years, including the encouragement of initiatives to tackle multiple aspects of sustainability. School meals also have the power to set an example to the next generation of adults of what healthy, sustainable food provisioning and eating habits can mean in practice.

The paper begins by reviewing what existing research reveals about public food procurement and sustainability, and the debates about the sustainability impacts of localising procurement supply chains. The methods and results of the empirical study are then reported. The paper concludes with reflections on which actions public catering services can take, to maximise their outcomes across multiple sustainability pillars.

2. Public food procurement and sustainability

For many years, scholars have argued that public sector bodies are instrumental in progressing sustainability, and this has been particularly true in relation to food procurement for catering services. In Europe, agricultural production alone contributes almost 10% of GHG emissions (Eurostat, 2017), while the activities of processing and transporting foods for public catering add further environmental burdens. Modern agri-food supply chains are also much criticised for driving economic inequalities (e.g. between small farmers and large processors/distributors) and for creating food environments that are harmful to consumer health and wellbeing (e.g. by fuelling poor dietary habits). As public institutions like schools, hospitals and care homes wield large budgets, for example totalling an estimated €82 billion in Europe (Neto, 2016), the decisions they make about food procurement can have considerable influence on agri-food supply chains, not to mention public food consumption habits.

Nevertheless, public food procurement operates within a complex political and regulatory landscape, which presents challenges for professionals seeking to tackle sustainability goals. For example, many nations lack dedicated food policies. Food-based spheres of activity, including public food procurement, therefore operate at the intersection of other, sometimes competing, policy imperatives that are poorly integrated (Grivins et al., 2018). This results in many difficulties for advancing sustainability, which can be illustrated by the case of school food provisioning. First, minimum thresholds for servings of animal protein, derived from health policy imperatives, partially conflict with the environmental policy push for reductions in meat consumption for climate change reasons. Also, continued economic policy imperatives for productivity and efficiency in agri-food production and distribution, which promote farm and processor agglomeration and longer supply chains, are at odds with social policy goals to better connect producers and consumers and to develop vibrant, mixed, local economies and communities. Finally, the WTO precepts for Most Economically Advantageous Tenders (MEAT) in procurement contract awards (WTO, 1994) set a focus on low cost and efficiency which is challenging to the

provision of quality food embodying socio-economic benefits. Faced with these conflicting imperatives, considerable knowledge, skill and agility is demanded of the professionals who organise and operate procurement and catering services, as they shoulder the burden of negotiating and prioritising between them (Grivins et al., 2018; Stoffel et al., 2019). Research shows that for environmental sustainability alone, many contracting authorities struggle with the processes of transposing goals into procurement tender criteria, then evaluating bids and making contract awards based on those criteria (Igarashi et al., 2015). A greater struggle can be expected for those carrying out these processes for multiple sustainability goals.

These policy tensions, and their consequences for sustainability, are echoed in the wider policy literature. Here, calls are made for more integrative policies, where “constituent elements are brought together and made subject to a single, unifying conception” (Underdal, 1980), and where instruments to promote different sustainability outcomes are complementary and synergistic. However, there are many complexities to address in the integration process (Candel and Biesbroeck, 2016) before responsible bodies may be able to articulate coherent policy goals and connect these with instruments that reinforce those goals rather than undermine them (Candel and Pereira, 2017). In sectors such as energy, where a solid evidence base already exists on sustainability impacts, public bodies can be guided in their policymaking by the methods and outputs of integrated sustainability analysis, which offers structured or quantitative assessment of the simultaneous effects of policy instruments across different sustainability indicators (Buchmayr et al., 2021; Dos Santos et al., 2019). Such analysis can show, for example, which instruments optimise both environmental and economic outcomes, in a synergistic way (Naegler et al., 2021; Santoyo-Castelazo and Azapagic, 2014). As argued earlier, the current lack of a solid evidence base in public food procurement makes this kind of quantitative analysis more difficult, hence the value of more exploratory methods in research to inform future studies. As the field develops however, scholars may examine procurement approaches or models currently in practice which may have the potential for reconciling otherwise competing or conflicting policy goals. One such model that has come to the fore, and is much debated in food systems research, is localisation.

Aligned conceptually with the principles and orientation of alternative food systems (Le Velly, 2019), localisation has indeed been proposed as a route to ‘squaring the circle’ of competing imperatives across environmental, economic and social impacts. In terms of economic goals, by procuring goods from geographically proximate suppliers, contracting authorities offer new market opportunities to local enterprises, thereby stimulating local economic growth (Morley, 2021). The stronger local supply chains that result then contribute to improved community cohesion and vibrancy (Fitch and Santo, 2016), thereby advancing social goals. In terms of the environment, the implied lower food miles in distributing local food are associated with reduced carbon emissions, while - if local food is also organically grown - there is the possibility of reduced fossil fuel inputs and increased biodiversity. From a health perspective, food produced within a local area is also associated with freshness and seasonality, which allows catering services to deliver better quality food on the plate (Singh and Fernandes, 2018), as well as promoting improved understanding amongst consumers (e.g. school pupils and their families) of food origin and quality. This, in turn, contributes to well-being and the development of better dietary habits (Swensson and Tartanac, 2020). Hence, by these dynamics, localised public procurement may offer a virtuous circle of beneficial ecological, economic, social and health outcomes, and a possible basis for integrated public food procurement policy.

In Europe, bolstered by the provisions of EU Directive 2014/24, policies and programmes for sustainable public food procurement have emerged in which local sourcing is a key feature, often in alignment with greening measures, such as promotion of organic food (Smith et al., 2016). For example in Italy, policies and laws encourage or mandate minimum sourcing of local, organic, PDO, and/or typical/traditional

products in food procured for school meals (Maietta et al., 2016), while in the UK, the Food For Life programme sets standards for public catering providers based on measures including levels of fresh, local and organic products (Jones et al., 2017). Similar initiatives have developed in the USA (Kloppenborg et al., 2007), Latin America (Sonnino et al., 2014) and Africa (Singh and Fernandes, 2018).

However, while localisation has gained traction in policies and programmes, the concept has also been subject to critique (Born and Purcell, 2006). Scholars argue that the potential of public food procurement to grow local economies is hampered by the challenges of reconciling the demand norms of public catering services (high volume, standardised across seasons) with the typical supply capacities of local growers and processors (small-scale, irregular, premium-seeking) (Krivasonoka, 2017). In terms of environmental impacts, critiques of the concept of food miles have cast doubt on the ecological advantages of localised procurement (Edwards-Jones et al., 2008; Oglethorpe, 2010). Scholars have also questioned the social impacts of localisation in food systems, arguing for example that localised systems can be associated with exclusivity and social divisions (Tregear, 2011). In relation to school catering, ‘farm to school’ programmes in the US, in which local communities take over the governance of their own schools’ meals, have been criticised as furthering a neoliberalist political agenda, rather than an example of local community empowerment (Allen and Guthman, 2006).

It is in light of these unresolved debates about how to advance the sustainability of public food procurement across multiple pillars in a coherent way, and the extent to which localisation may be the route to achieving it, that the present research was carried out. The next section describes the methods of the empirical study.

3. Methods

3.1. The case studies

The research employed a comparative case study method. In five European countries (Croatia, Greece, Italy, Serbia, UK),¹ a pair of primary school catering services was selected, each consisting of the supply chain and catering activity providing meals to a sample of five schools in the service (four in the Serbian cases). For all countries except Italy, one case in the pair represented a local model service (LOC), in which the contract award criteria explicitly encouraged local sourcing, and/or in practice featured a larger proportion of local suppliers. The second case in these pairs was a low cost (LOW) procurement model, where contract awards emphasised either lowest price or little to no mention of local sourcing, and/or a *de facto* lower proportion of local suppliers. In Italy, according to the laws setting procurement thresholds for local, organic and related products, the two cases were LOC-ORG (a procurement model mainly based on organic and local products) and ORG (a procurement model mainly based on organic products). Fig. 1 shows the geographic location of the case studies, and this is followed by descriptions of the policy contexts and operational features of each of the services.

3.1.1. Croatia

At the time of the research, public food procurement policies in Croatia placed most emphasis on food safety and low price, with very little mention of sustainability in contract award criteria. Also, although

¹ At the time of data collection and analysis, all countries, with the exception of Serbia, were member states of the European Union. The countries were selected to include different geographic areas of Europe (western, eastern and Mediterranean), which in turn captured a diversity of school meal provision contexts (e.g. different lengths of establishment of school meals programmes, centralised vs decentralised administration). More details are given in the case descriptions.

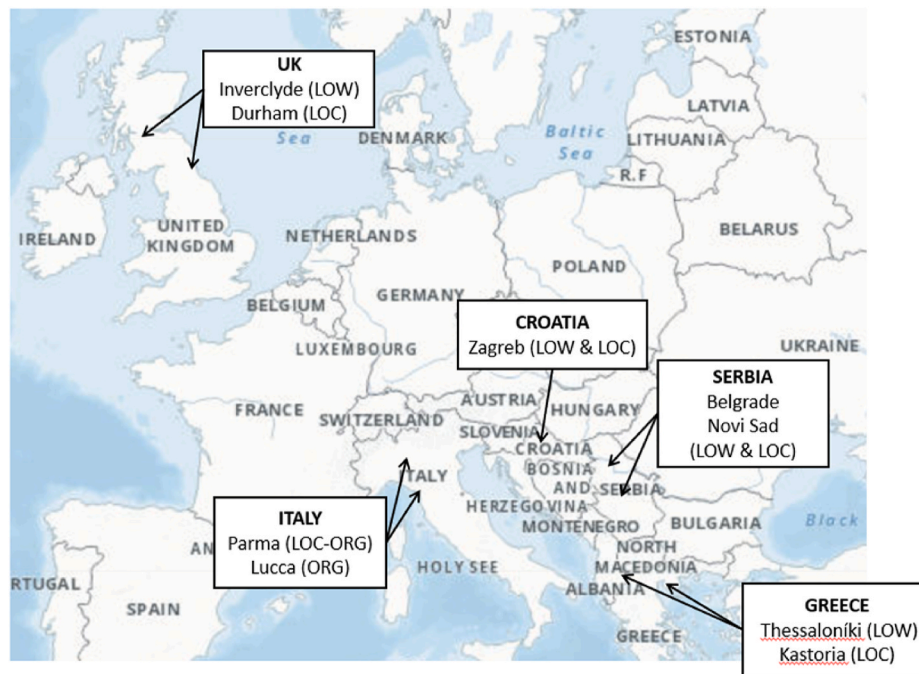


Fig. 1. Geographic location of the ten case studies.

Croatia established national nutritional standards for school meals in 2013, compliance systems were still in development. Both case studies were located in the capital city Zagreb, where the city council organised collective procurement contracts for core items such as milk and bread. For everything else, individual schools managed their own contracts. Meals were typically cooked on-site in school kitchens, at a full price of €1.20. The dataset for the first case study (LOW) consisted of five individual primary schools who each operated according to this context. The second case comprised a hub school with a large kitchen, which prepared meals for 12 other Zagreb schools, in addition to itself. Due to its larger budget, the hub school had more flexibility to contract additional, usually local, organic and/or family-owned suppliers. This case was therefore classed as a LOC model, and the dataset consisted of the hub school plus four schools in its network.

3.1.2. Greece

Public provision of school meals was introduced for the first time in 2016, in a state funded programme (c.€2.22 per meal) to address social inequities. Contracts were let at the municipal level and awarded according to the MEAT framework. Contract holders were typically private catering firms who undertook all procurement and meal provision activities, and transported meals from their central kitchens in insulated containers for service in classrooms/communal areas. No national nutritional standards for school food were specified. The first case study was the contracted meals service in a relatively deprived district of the city of Thessaloniki. Most of the catering firm's first tier suppliers were located outside the municipality or abroad, hence this was classed as a LOW model. The second case was the contracted service in the rural municipality of Kastoria. This catering firm drew from its established local supply network to procure its foods, including both first tier suppliers and also farmers/growers. Hence, this meals service represented the LOC case.

3.1.3. Italy

Public procurement policies in Italy have long embraced the sustainability agenda (Morgan and Sonnino, 2007), and combined with a well-elaborated regime to support high-quality food and nutritional standards in school meals, the context was highly conducive to localised and organic procurement. School meals were organised at the municipal

level, often operated by private catering firms using central kitchens. The first case study was the school meals service in the relatively wealthy municipality of Parma, in Emilia-Romagna region. As the contract specification followed the regional legislation regarding local, organic, typical and traditional products in school canteens (minimum 70% of food served to come from a mix of these sources), it was classed as a LOC-ORG service. Most meals were cooked in a central kitchen, and then distributed to the schools, at a full price of €6.18 per meal. The second case was conducted in the quite wealthy municipality of Lucca, in Tuscany. Here, the regional guidelines and procurement contract specified the majority of foods for meal preparation to be organic, hence it was classed an ORG service. The contract was also operated by a private catering firm, and all the meals were cooked in a central kitchen, charged at €5.00 per meal.

3.1.4. Serbia

At the time of the research, public procurement policies had placed less emphasis on sustainability, and indeed obliged contracting authorities to accept lowest cost tenders. National nutritional standards for school meals were introduced in 2018. Meals were organised at individual school level, the majority of whom outsourced to private catering firms, while the remainder managed their own in-house services and procurement contracts. The first case study (LOC) comprised four schools (two in the capital Belgrade and two in the city of Novi Sad), which had relatively high proportions of food procured from local suppliers. The LOW case comprised four schools (three in Belgrade, one in Novi Sad) with higher proportions of food sourced from geographically distant suppliers. All schools in both cases operated their own procurement and in-house meals services, and the full prices per meal averaged from €1.02 (in LOC schools) to €1.21 (LOW schools).

3.1.5. UK

Policy support for sustainable procurement had grown in recent years, notably through the Food For Life programme² in relation to school catering, and a nutritional standards framework was implemented in 2014 (2003 in Scotland). At the time of the research, almost

² <https://www.foodforlife.org.uk/>.

all school meals services in Scotland were organised at the municipal level, whereas in other parts of the UK the spatial scale varied, from municipal to individual school level. In all areas, a mix of in-house operation and use of private caterers existed. The first case study was the meals service in County Durham, north east England. In this case, all procurement and catering activities were contracted to a private caterer: almost all meals were cooked on-site in schools, at a price of £2.00 (£2.28). As the contract specified thresholds for local sourcing, this service was classed as the LOC model. The second case was the meals service in Inverclyde, west central Scotland. The local authority operated the procurement and meals service directly, and almost all meals were cooked on-site, at prices of £1.95–£2.00 (£2.21–£2.27). As the procurement documentation made no specific reference to local sourcing, this service was classed as the LOW model.

3.2. Data collection and analysis

Data collection and analysis were undertaken over 18 months, from spring 2017 to autumn 2018. First, procurement invoices and logistics information were collected for all foods supplied to the sample schools: this dataset was the basis for estimating the carbon footprints of the case meal services. Second, in-depth interviews were conducted with key stakeholders in each meals service chain, including procurement officers, suppliers, catering managers and school staff. These yielded data on how meals budgets were spent, which informed analysis of the economic impacts of the meals services. Third, records were made of the recipes from a sample of daily menus in each of the services, and samples of plate waste were collected. This information was used in the assessment of the nutritional quality of the meals, for both planned and actual intake. The next sections detail the calculation methods used to estimate these impacts.

3.2.1. Calculation of the carbon footprints of the case meals services

The core measure of environmental impact was carbon footprint, expressed as kgs of carbon dioxide equivalent (CO₂e) emitted annually from the production, processing, transportation and waste disposal of food items procured by the sample schools in each case. To calculate these emissions, a method similar to Lancaster and Durie (2008) was devised, as follows.

First, for emissions relating to agricultural production, processing and upstream transportation of procured food items, delivery invoices, sent by the suppliers to the case schools, were collected for a minimum six week period in 2017–18.³ From these invoices, the total annual quantities (in kgs) were estimated of food items procured in each case. They were then multiplied by relevant per kg emissions factors.⁴ These calculations captured all emissions up to and including transport to first tier suppliers (wholesalers).

For emissions relating to the downstream transportation of the food items from wholesalers to the case schools, information was collected on suppliers' vehicle types, loads, delivery round distances and frequencies.

³ For the Italian cases, it was not possible to obtain the invoices. Instead, food quantities were estimated from documents supplied by the municipalities and catering firms regarding menu compositions and food quantities for the school year.

⁴ In all cases except Italian, we used emissions factors proposed by Audsley et al. (2009) for fresh food items; the Rowett Institute of Nutrition and Health Database (2017) for processed items; and Williams et al. (2006) for organic items. In Italian cases, we used well-established and reliable databases which provided emissions factors more specific to the Italian context, recognising the high proportion of specific quality products procured in these cases, such as PDO and PGI products. The databases included BCFN Double Pyramid database, the Environmental Product Declaration (EPD) database, LCA-Food database, and Ecoinvent database. We inspected the values across the different datasets for a sample of food categories, in order to check comparability across the cases.

The estimation formula of Defra (2013)⁵ was then applied.

Finally, for emissions relating to the disposal of food waste, samples of daily plate waste were collected and weighed for two schools in each case, over two week-long periods (one week-long period in the Greek cases). From these data, average annual plate wastes were estimated for all the featured schools in each case. These were then multiplied by Moulton et al.'s (2018) waste handling emissions factors, which capture emissions from different categories of waste, as well as from different waste disposal methods.

3.2.2. Calculation of the economic impacts of the case meals services

To assess economic impacts, local economic multiplier analysis was conducted. This involves estimating the additional economic value generated to a local area, as a result of the spending and subsequent re-spending of a starting budget within that area. For each case service, the total annual meals budget was recorded, including the proportions spent on staff and suppliers, and whether those recipients were local or non-local to the area.⁶ Local/non-local classification of staff members was based on the location of their home residence, while for suppliers, it was the location of the headquartered address of their business, as stated on their invoices. From these data, the proportion of monies re-spent by the budget recipients within the local area was estimated. In terms of calculation outcome, the local economic multiplier is expressed as a ratio between 1, which indicates no budget is retained within the local area, and 3, which indicates the budget is entirely retained and re-spent within the local area.

3.2.3. Calculation of the nutritional impacts of the case meals services

To assess nutritional impacts, food composition analysis was undertaken on a sample of 20 daily menus in each case meal service,⁷ from across two seasons. For each menu, catering staff confirmed the standard quantities of ingredients per serving and cooking method. The nutritive values of these recipe norms were then assessed using the national food composition database in each country.⁸ From this process, the nutritional composition of a standard served portion from each daily menu was determined, focused here on total energy (kilocalories) and macronutrients (g) (protein, total fats, carbohydrates, dietary fibres and saturated fatty acids). Finally, these nutritive values were evaluated against referent national standards for nutrition in primary school meals to assess what percentage of the daily menus met those standards, or

⁵ The formula we used was as follows, including assumption of 89% weighted average allocated to the distance of the delivery round and 11% for the vehicle load (Kellner and Otto (2011)).

$$\begin{aligned} & \text{Total CO}_2 \text{ Emissions From Transportation Process per Week} = \\ & \left(\text{Total Delivery Rounds CO}_2 \times \frac{\text{School Drops}}{\text{Total Drops}} \times 89\% \right) + \\ & \left(\text{Total Delivery Rounds CO}_2 \times \frac{\text{School Load}}{\text{Vehicle Load}} \times 11\% \right) \end{aligned}$$

⁶ The local areas of the cases were country specific, defined by each research team in consultation with stakeholders, according to local context. By this process, the defined radii were: Croatia – 10 km from Zagreb city centre (applied for schools in both cases); Greece – 50 km from bases of LOC and LOW caterers, respectively; Italy – 50 km from the locations of the City Council headquarters; Serbia – 15 km radius from locations of each featured school in both cases; UK – 40 km from bases of LOC and LOW caterers, respectively.

⁷ 10 for each Greek case.

⁸ Croatia: Kaić Rak and Antonić (1990) National food composition tables. Italy: Food Composition Database for Epidemiological Studies (2015). Greece: Composition tables of foods and Greek dishes, HHF (2004). UK: McCance and Widdowson (2015) The Composition of Foods integrated dataset. Serbia: Serbian Food and Nutrition Database, IMR (2012).

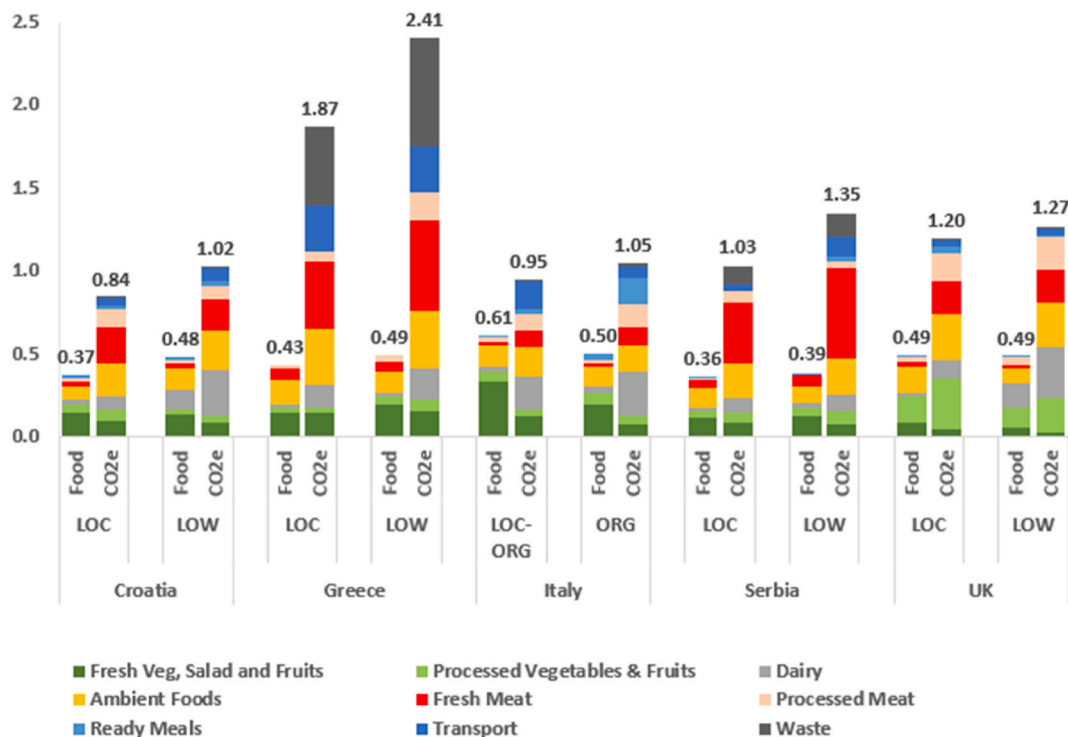


Fig. 2. Weights (kgs) of foods procured for the average meal in the case school meals services, and corresponding carbon emissions (kgs CO₂e).

were excessive/deficient.⁹ World Health Organisation guidelines were used as proxy standards for Greek and Serbian cases, in the absence of national standards at the time of data collection. Plate waste from a total of 179 lunchtime services was also collected across the cases. Through weighing and analysing the waste composition, estimates were derived of actual nutrient intake of pupils, compared with what was planned in the menus.

4. Results and discussion

4.1. Carbon emissions of the case meals services

First, the total carbon emissions are reported for the meals services, based on food production and processing activity, transportation, and waste disposal. Of the paired bars in Fig. 2, the left-hand bar shows, for each case service, the total weight in kgs of food procured for the average meal, broken down by food category (meat, dairy, fruit and vegetables, etc). The right-hand bar shows the corresponding carbon emissions (in kgs CO₂e), plus emissions from the transportation and waste disposal of the food.

The left-hand bars in Fig. 2 show that, across the cases, the total quantities of food procured for the average meal ranged from less than 400 g in the Serbian and Croatian LOC case, to at least 500 g in both Italian cases. There were also noticeable differences in the types of food comprising the meals. In particular, the Greek and Serbian meals contained relatively high proportions of fresh meat, of which beef was a substantial component, whilst the Italian meals contained high proportions of fresh fruit and vegetables. The UK case meals contained the lowest proportions of fresh fruits and vegetables, and the highest proportions of processed.

The right-hand bars reveal notable differences across the cases in

⁹ If a standard referred to a minimum or maximum threshold for a nutrient but not a range, then recipes containing less or more than the threshold were recorded as 'deficient' or 'excessive' in that nutrient, with other quantities recorded as 'adequate'.

terms of the corresponding carbon emissions. Most strikingly, emissions per meal in the Greek cases were more than four times the physical weight of the food purchased, and more than three times the food weight in the Serbian LOW case. At the opposite end, the Croatian and Italian cases exhibited the lowest carbon emissions. Given that the Italian cases procured the largest quantities of food per meal, their emissions are particularly striking, at only 1.5 and two times the weight of food procured.

The breakdowns of the emissions per average meal reveal the reasons for these variations. The single most important contribution to high emissions in the Greek cases was waste disposal method: in those cases, all food waste was directed to landfill, which has a high carbon burden. For all other services except the Serbian ones, where half of waste went to landfill, food waste was directed to anaerobic digestion, composting or animal feed, all of which are low carbon disposal methods. The next highest contributor to Greek case emissions was the amount of fresh meat in the average meals, a substantial component of which was beef, which has a high carbon burden. A similar effect was apparent in the Serbian cases. By contrast, the small amounts of meat, high proportions of fresh fruit and vegetables, and low carbon waste disposal explain the small carbon footprints of the Italian cases.

A final key point from Fig. 2 is the modest contribution of transportation to total emissions, comprising <5% of emissions for the average meal in eight cases. It was somewhat higher in Greek LOW and Italian LOC-ORG cases, at 15% and 18%, respectively. Some of the suppliers in those cases were located at considerable distance from the caterers: in Italy LOC-ORG case, one supplier transported tinned tomatoes from Campania region, 700 kms away, while the fresh beef for Greek LOW case was transported from Bavaria, Germany. Despite these long distances, the contribution of transport to total emissions in these cases was still relatively modest, and outweighed by other activities in the chain. Overall, although the LOC cases here had smaller emissions than their LOW or ORG counterparts, the carbon footprints of all cases depended more on what was on the menu (in particular, proportions of beef relative to fresh fruit and vegetables), and how waste food was disposed of, rather than where the food had come from.

How else did procurement policies and/or models influence the emissions outcomes of these meals services? The Italian cases reveal an interesting point. Although the procurement contracts for these cases placed much emphasis on provenance and production-related criteria (i. e. local, organic, typical and traditional products), ultimately those criteria were less important to the low emissions of these cases than nutritional standards, as it was the latter which determined the low-carbon balance of food types in the meals. Hence, quite unintentionally, policies towards child health and nutrition greatly influenced the positive environmental outcomes of those meals services. This implies a need for continued work on how public food procurement contracts are specified and weighted for environmental outcomes. The waste disposal of the cases is a second interesting point. The effect of waste disposal method on the cases' emissions was dramatic, yet for catering managers, change can be held back by lack of disposal alternatives. At the time of data collection, anaerobic digestors were not widespread in Greece or Serbia, and both UK case services were only in their first year of disposing this way. Arguably, meals services organised by individual schools – common in Serbia and Croatia - are particularly powerless to change, as low carbon disposal facilities require strategic planning and investment at a municipal scale, driven by environmental policies not specific to school meals provision. The findings here demonstrate the key role that state and municipal authorities play in shaping environmental outcomes for public food procurement, through the provision of vital cross-cutting infrastructure and facilities for lowering carbon footprints.

4.2. Economic impacts of the case meals services

Next, the patterns of budget expenditure and local economic impact are reported. Fig. 3 shows, for each case, the percentages of the meals budgets spent on local vs. non-local staff and suppliers, and the local economic multiplier ratio derived from this pattern (a figure between 1.00 and 3.00).

As expected, meals budgets with greater levels of local expenditure generated higher economic multiplier ratios. According to the multiplier effect, this translated into considerably more added value for the local economies. In the Serbian LOC case, which had the highest ratio of 2.46, the effect implies that for every €1.00 (or equivalent currency unit) spent

from those schools' meals budgets, an additional €1.46 was generated for the local economy. Conversely, the low ratio of 1.59 in the Greek LOW case means that every €1.00 spent from this meals budget generated only €0.59 of additional value for the local economy. These results support existing work on the beneficial economic impacts of increasing local procurement (e.g. Swensson and Tartanac, 2020).

However, Fig. 3 also reveals which parts of the budget expenditures drove the economic impacts. In some cases, it was the spend on service staff that pushed up the multiplier ratio, not the spend on suppliers. In Croatia for example, the higher ratio of the LOW case was due to a greater proportion of its budget being spent on staff (all of whom were local), compared with the LOC case. A similar effect happened in the UK case pair: although the LOC caterer spent three times more on local suppliers compared with LOW, the ratios of the two cases were almost identical due to the greater spend on staff in LOW case. The effect is due to the fact that in primary school catering, workforces typically reside close to their schools and hence respnd large proportions of their income in the local area, creating a multiplier effect. This is an important insight for policymakers and procurement professionals. Whilst debates about the economic impacts of public procurement tend to fixate on budget spend on suppliers, the results here reveal the important contribution that expenditures on staff make to local economic impact. Investment in and valorisation of catering service staff are not only worthy from a social development perspective therefore, but also represent value generated for local economies, because a well-remunerated local workforce is incentivised to remain in the local area and respnd a proportion of higher earnings there.

There is a further interesting result in Fig. 3. In the Italian case pair, a very small proportion of the LOC-ORG budget was spent on local suppliers: indeed, it was amongst the smallest of all 10 cases. This was surprising, given the intention of the LOC-ORG municipality to encourage sourcing of local products. However, closer inspection of the procurement contract revealed no minimum threshold for local sourcing, and also the boundaries of the local area were broadly defined, at up to 100 km radius. In consequence, the LOC-ORG catering firm - which was part of a large organisation with supply networks to many firms headquartered outside the region – was not obliged to adjust its established sourcing practices towards more localisation. Hence, the vast majority of suppliers in this case were not local. The result underlines

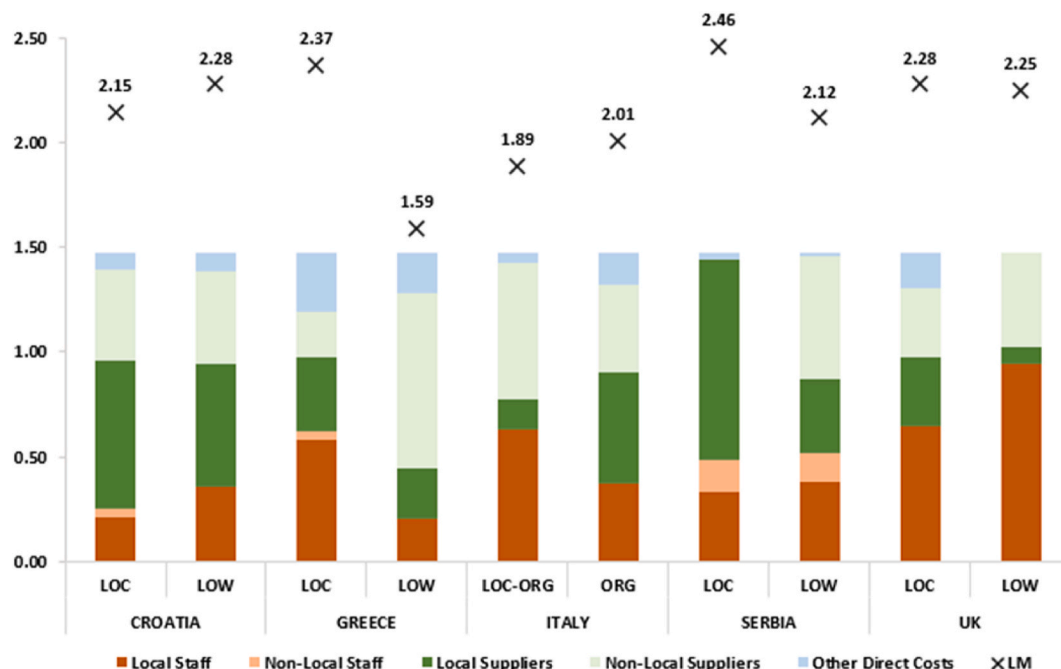


Fig. 3. Proportions (%) of total meals budgets spent on local staff and suppliers vs. non-local, and corresponding local economic multiplier ratios.

Table 1
Proportions of sampled daily menus that met official recommended standards, or were excessive/deficient, for total energy and selected macronutrients.

	Nutrients for which >50% of menus provided less than recommended amounts	Nutrients for which >50% of menus provided recommended amounts	Nutrients for which >50% of menus provided more than recommended amounts	Nutrients for which similar proportions of menus provided less, more, and adequate recommended amounts
Croatia	Energy Total Fat (LOW) Fibre	Protein (LOC) Carbohydrates Saturated Fat	Protein (LOW)	Total Fat (LOC)
Greece	Carbohydrates	Protein Saturated Fat (LOC) Fibre	Energy Total Fat Saturated Fat (LOW)	Protein
Italy	Saturated Fat	Energy Carbohydrates Total Fat Fibre	Total Fat (LOW)	Energy Total Fat (LOC)
Serbia	Carbohydrates	Protein Saturated Fat Fibre	Carbohydrates Total Fat Saturated Fat	Energy (LOC)
UK		Energy (LOW) Protein Fibre	Carbohydrates Total Fat Saturated Fat	

how much the economic impact of public food procurement can be influenced by the geographic scale and profile of contract holders' existing supply chain networks, and how clear and strict contract award criteria are needed to close the gap between the ambition and actual generation of economic impact at the local level.

4.3. Nutritional impacts of the case meal services

Finally, the results are reported of the nutritional analysis of menus. Table 1 shows, for all the case services, the percentage of the sampled daily menus that met official standards, or were excessive or deficient relative to those standards, for the provision of energy (calories), and five selected macronutrients.

As Table 1 shows, there was considerable variation in the extent to which sampled menus met national standards. Whilst the vast majority complied with standards for protein and fibre, quite large proportions of the menus were either deficient or excessive in provision of energy, carbohydrates, total fat and saturated fat. Most of the Greek and Serbian sampled menus contained excessive total fat and insufficient carbohydrates, while in the UK, large proportions were high in total fat, saturated fat and carbohydrates. Of all the cases, the Italian menus performed best, with the majority compliant on four measures, including very high rates of compliance on three (energy, carbohydrates and fibre). Although the results here are based on a small sample and so do not represent the nutritional profile of the entire menu cycles of the cases, they do suggest menu designs that were not optimising nutritional quality on the plate.

Nutritional impact is more accurately estimated when the nutritional losses from plate waste are also accounted for. Based on the samples collected, the average rate of plate waste was just under 30% of each served meal by weight. As fruits and vegetables and starchy foods were the most wasted items, it can be inferred that actual intakes of fibre, energy and carbohydrates were lower than the planned quantities in the menus. This is of general concern, but particularly relevant for Croatian and Serbian cases, where planned intakes were already lower than recommended for many daily dishes.

What do these results reveal about the role of procurement policy and/or model in nutritional impact? First, Table 1 indicates no

consistent patterns between the nutritional balance of the daily menus in the cases and the type of procurement model adopted. Instead, the strongest driver of nutritional quality was found to be robust, well-resourced regimes for implementing nutritional standards, including involvement of professional nutritionists in menu design. Such were the policies and practices behind the nutritionally balanced menus of the Italian cases, but which were lacking, for example, in the Croatian cases. This explains the weaker compliance in those menus, despite the presence of a national standards framework for school meals.

However, the plate waste findings add an important qualification to the above result. Specifically, the Italian ORG case - with its low carbon, nutritionally balanced menus sourced from organic ingredients - generated the second highest plate waste levels of all the cases, at 38%. Therefore, despite the considerable policy support and resource invested in the ORG menus, many did not fulfil the requirement of meeting pupils' tastes. Conversely, the smallest plate waste levels (12%) were generated by the Croatian LOW case, where a greater proportion of sampled menus were not compliant with nutrient standards. Analysis indicated that high quality interaction and supervision by catering staff of pupils helped to increase intake levels. Therefore, combined effort, at both national policy and local service delivery levels, is needed for positive nutritional outcomes. The plate waste results also reveal how investment in catering staff is not only valuable to local economies, but also to child nutrition and waste reduction.

5. Further discussion and conclusion

Against a backdrop of debate about how to tackle multiple pillars of sustainability in public food procurement in an integrated way, and the merits of localisation as a route to achieve this, the current research measured and compared the environmental, economic and nutrition-related impacts of different models of school meals procurement. In particular, it sought to identify which activities in procurement and catering have the greatest impacts on sustainability, and which mix of actions may synergistically tackle goals across different pillars. Ultimately, the study was also interested in assessing localised procurement models as a possible basis for integrated policy in public food procurement.

In terms of which activities have the most sustainability impact, results indicate that to reduce carbon emissions, the priorities for catering services are to adopt low carbon food waste disposal and to adjust menu compositions, in particular, by reducing proportions of ruminant meat relative to fresh fruit and vegetables. Localising the supply base is less important for reducing emissions, because transportation represents a modest proportion of total carbon footprint compared to these other activities. For nutrition-related outcomes, implementing a robust standards regime is the most important action to ensuring the nutritional quality of menus, while to improve children's nutritional intake, the priorities should be enhancing canteen environments and lunchtime supervision, as these actions lower rates of plate waste. In contrast, the findings indicate that local sourcing, in itself, has little effect on these nutritional outcomes. In terms of economic impact, using local suppliers brings much clearer positive outcomes for the local economy. However, spending decisions on catering staff can be equally, and in some cases more, impactful.

As with all case study research, these results do need to be interpreted with caution, as the sample size of cases was small and cannot be assumed to represent all school catering services. For example, services in geographically larger or more remote rural areas may show a greater contribution of transport emissions to total carbon emissions, while services featuring greater proportions of fish-based dishes, such as in Scandinavian countries, may show a different relationship between the nutritional profile of menus and carbon burden. Notwithstanding these limitations, the findings are offered to help inform future quantitative analyses of the sustainability impacts of public food procurement actions, by providing grounded evidence on which modelling assumptions

and metrics can be built.

In terms of localisation, the results of this study show that although such procurement models bring some positive impacts, for many sustainability measures it is other types of action that carry greater weight. If localisation is indeed a route to only partial achievement of multiple sustainability goals, what else can stakeholders focus on to promote greater synergies across impacts, and ultimately fuel more integrated policy-making? This research indicates two possible areas of attention, which may be pursued together. First is a sustainable menu focus. Results from the Italian case analysis indicate it is possible for public catering services to address environmental and nutritional goals synergistically, through the same menu design. Specifically, menus composed for nutritional balance – i.e. those high in (fresh) fruit and vegetables and complex carbohydrates, moderate in dairy products and low in ruminant meat – typically also carry a low carbon burden. Therefore, menus in public catering, like diets more generally (Donati et al., 2016), can be improved on two sustainability measures (nutrition and carbon emissions) with the application of a single policy instrument. However, a focus on menu composition alone neglects the effect of food waste, which is a significant environmental impact of public catering: contributing up to one third of the total emissions from a catering service, according to the current study. Therefore, to close this loop, instruments supporting sustainable menus should be connected with those promoting infrastructure development and installation of low carbon waste disposal methods, such as composting or anaerobic digestion, thereby maximising the positive environmental impacts of public catering. Connection with policies to reduce levels of food waste would also, of course, be valuable.

The second area of attention centres on the valorisation of catering service staff. The current research found that catering staff contribute to local economies through the multiplier effect of their spending, and they are also instrumental in implementing menu innovations and reducing plate waste, which have positive environmental and nutritional impacts. While the value of catering staff to enhancing food education and increasing uptake is already known (Kimberlee et al., 2013), the economic and environmental benefits of their activities have been less appreciated to date. Therefore, by developing instruments that promote greater investment in frontline service staff, raising the status of the profession, and providing more skills and training, policy-makers can boost impacts of public catering synergistically across three sustainability pillars (environmental, economic and nutritional).

To conclude, we make a final reflection on the implications of this study for policy integration in public food procurement and catering. Specifically, as scholarship on integrated food policies tells us (Candel and Biesbroeck, 2016), progress on any issue or focus of attention for sustainability purposes, such as menu designs or valorisation of catering staff, requires adjustments not only to directly targeted policy instruments, but also coordination within and across institutions. For example, continuous improvement in sustainable menu design, which builds on new scientific knowledge in food production systems, recipe innovations, storage or cooking methods, requires that stakeholders involved in nutritional policies and those in environmental policies talk to each other, which is typically not the case (Grivins et al., 2018). Waste reduction and disposal policies, meanwhile, tend to be the responsibility of yet further, separate, public departments. Therefore, better coordination is needed across these groups and departments in future. Pursuing staff valorisation strategies can also be problematic under existing institutional arrangements. Often, public institutions separate out the management and decision-making for catering service delivery from the management of procurement contracts. This means that the addressing of sustainability issues is often siloed in the realm of procurement, overlooking the very real potential of integrating the catering service delivery to address sustainability outcomes. In future, public institutions need to adopt a more boundary spanning perspective (Bratt et al., 2013), with better coordination across separate departments/functions (Testa et al., 2016). For food and meals provision, this particularly means

taking a more holistic view of procurement and service delivery functions, to fully maximise their potential for enhanced environmental, economic and nutritional outcomes.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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