The prospects of waste management in the hospitality sector post COVID-19

Viachaslau Filimonau[1]

[1]Faculty of Management, Bournemouth University, Talbot Campus, Fern Barrow, Poole, Dorset, BH12 5BB, UK

Email: vfilimonau@bournemouth.ac.uk

Phone: +44(0)1202965980

The authors declare no conflict of interest

Abstract

COVID-19 has imposed significant detrimental effects on the global hospitality sector. These effects have primarily been considered from the socio-economic perspective, ignoring the implications of the pandemic for the environmental performance of hospitality services. By drawing upon emerging evidence from various academic and non-academic sources, this conceptual paper critically evaluates the implications of the preventative and protective measures adopted against COVID-19 for the generation of the hospitality sector's food and plastic waste. The implications are divided into direct and indirect and considered through the prism of temporality of their anticipated occurrence (immediate, short-term and medium-term perspective). The paper proposes potential strategies to aid in the management of these wastes in the hospitality sector in a post-pandemic world. To address the issue of food waste, the hospitality sector should be integrated into alternative food networks (AFNs) and short food supply chains (SFSCs). Business coopetition between hospitality enterprises and other

actors of the food supply chain is necessary for the success of such integration. To address the issue of plastic waste, the hospitality sector should invest in 'green' innovation. This investment needs to be encouraged and supported by targeted policy interventions. The paper argues that these strategies are critical not only in the context of the COVID-19 pandemic, but will also remain valid for the sustained development of the hospitality sector in light of future disastrous events, especially climate change. The paper discusses the institutional and organisational prerequisites for the effective implementation of these strategies and highlights the related research opportunities.

Keywords

Solid waste

Food waste

Plastic waste

Business coopetition

'Green' innovation

COVID-19 pandemic

1. Introduction

The COVID-19 pandemic has demonstrated fragility of the hospitality sector and showcased its vulnerability to external disruptions. To prevent the virus, closure of international borders eliminated inbound tourism (Gössling *et al.* 2020) which used to be a significant source market for hospitality providers. National lockdowns were subsequently introduced (Hall *et al.* 2020) putting hospitality operations on a complete standstill. Except for hospitality businesses specializing in food takeaway and delivery, the hospitality sector ceased to temporarily exist as such.

The implications of the forced lockdown for the hospitality sector were manifold and, largely, detrimental. Forced business closures prompted hospitality providers to furlough their staff or make them redundant (Larue 2020). The preventative and protective measures against COVID-19 had eradicated the determinants of effective hospitality operations, i.e. instant flows of cash and hardworking employees, highlighting a bleak post-pandemic future for the sector (Filimonau *et al.* 2020a).

The lockdown measures will eventually be lifted across the world, but the pandemic will have a long-lasting impact on the hospitality sector (Nunn 2020). This impact will be socio-economic given the immediate negative effect of forced temporary business closures on the sector's revenues and staff retention/recruitment (Filimonau *et al.* 2020a). There will also be a delayed detrimental socio-economic effect due to a large number of protective measures that hospitality operators will have to adopt in a post-COVID-19 world (Dube *et al.* 2020). These measures will include social distancing rules and enhanced hygiene restrictions (Food Standards Agency 2020). The application of these measures will reduce the operational capacity of hospitality providers and decrease the (already thin prior to the pandemic) profit margins of hospitality operators. It is expected that anti-COVID-19 protective measures will remain in place for some time (BBC 2020b) which does not facilitate business confidence in rapid financial recovery. Consumer demand for hospitality services will not reinstate immediately in a post-pandemic future due to health and safety precautions among customers (Gursoy *et al.* 2020). Although the rebound effect in consumption of hospitality services is possible (Jingjing 2020), there has been limited evidence of its occurrence to date. A new wave, or even several waves, of the virus are anticipated (Xu 2020). Until an approved vaccine becomes widely available, hospitality providers, when they fully reopen, will be bound to strictly adhere to the governmental guidance on social distancing and preventative hygiene (BBC 2020b).

Academic discourse on the implications of the pandemic for the hospitality sector has duly revolved around the socio-economic well-being of hospitality operators and their employees (Dube *et al.* 2020). COVID-19 will worsen the sector's environmental performance (Galanakis 2020), but this perspective has not been discussed scholarly yet. The worsened environmental performance of hospitality operations is attributed to the loss of food stock inventories by hospitality businesses during national lockdowns (immediate direct effect). The environmental performance of hospitality operators will also worsen because of the (current and future) business needs to adopt a number of preventative and protective measures against the virus, such as social distancing and deep cleaning (short-to-medium term direct effect). The worsened environmental performance will also relate to the future reduced operational capacity of the hospitality sector. The implications of this reduced capacity may stretch beyond direct hospitality operations and, potentially, across borders of traditional hospitality markets (medium term indirect effect).

This conceptual paper will outline the direct and indirect implications of COVID-19 for the environmental performance of the global hospitality sector, looking in particular at the issue of solid, food and plastic, waste generation. The paper will review the evidence of environmental impacts from hospitality operations as showcased by the trade press, popular media reports and emerging academic publications. The paper will highlight specific hospitality practices that can generate excessive wastage of resources in a post-pandemic world. The paper will discuss strategies that should be adopted by the sector in order to enhance its environmental sustainability in light of the on-going COVID-19 outbreak, but also future disasters. Some of the strategies proposed herewith will remain valid after the pandemic is over. The adoption of these strategies can be critical for improving the environmental performance and building the business resilience of hospitality operators in view of such future disasters as climate change, for example.

2. Food waste

Food waste has been recognised as a major environmental challenge for the global hospitality sector (Papargyropoulou *et al.* 2016). For example, only in EU-28, circa 11 Mt of food are wasted by hospitality operators per year, which is equivalent to 12% of total food waste produced across the food supply chain of this region (FUSIONS 2016). Due to various operational and non-operational reasons, substantial amounts of food are wasted in kitchens of hospitality providers (Silvennoinen *et al.* 2015) and equally significant wastage occurs on customer plates (Dolnicar and Juvan 2019). The excessive magnitude of food wasted in the hospitality sector has accelerated its scholarly research which has covered a number of consumption markets, such as the USA (Sakaguchi *et al.* 2018), China (Wang *et al.* 2018) and Sweden (Eriksson *et al.* 2018). Research has also targeted various hospitality sub-sectors, such as fine-dining restaurants (Charlebois *et al.* 2015), casual dining restaurants (Filimonau *et al.* 2020c) and coffee shops (Filimonau *et al.* 2019). Research has highlighted the importance of consumer behaviour (Filimonau *et al.* 2020b), managerial attitudes (Filimonau *et al.* 2020d), political support (Papargyropoulou *et al.* 2019), and employee actions (Goh and Jie 2019) in food waste prevention and mitigation.

The COVID-19 pandemic has exacerbated the challenge of food waste in the hospitality sector by imposing the immediate direct, short term direct and medium term indirect effects (Figure 1). The immediate direct effect was observed in significant quantities of food wasted after the lockdown measures were announced (Aldaco *et al.* 2020). In most countries these announcements came at a short notice, with most hospitality businesses being unprepared to almost instantly shut their operations down. For example, in the UK the lockdown measures were imposed on Monday, the 23rd of March 2020, i.e. right after a weekend when many people dined out. By the time of the lockdown announcement,

foodstuffs remained in stock in UK hospitality businesses with limited time for their effective utilization. While some hospitality operators froze this surplus food, gave it to staff, provided it to local retail outlets, donated it to food rescue charities or cooked meals for public health professionals, a lot of food excess went to waste (Eley and Hancock 2020). One of the reasons was the lack of freezing facilities as most hospitality operators were located in city/town centers with their restricted space and, subsequently, limited storage capacity. Limited surplus food redistribution opportunities were another issue. While food banks and charities rescue surplus food around the world (Nair *et al.* 2018), these remain small in number and largely unsupported by other stakeholders in their charitable work (Hecht and Neff 2019). Due to the lack of human (volunteers), financial (money) and physical (transport) capital among charitable organisations, the opportunities to rescue surplus food from the hospitality sector at the time of the lockdown were reduced (Civil Society 2020).

[Insert Figure 1 here]

The short term direct effect of the pandemic on food wastage in the hospitality sector was attributed to the reported growth in the quantities of food wasted by takeaways and restaurants. These, during the lockdown, turned to food takeout and delivery (Zambrano-Monserrate *et al.* 2020). Food was wasted in these businesses due to unpredictable consumer orders. Some takeaways, in pursuit of customer loyalty, offered discounts and flexibility in ordering food (Smithers 2020b). For example, customers were given an option to cancel orders at a short notice. The discounts resulted in over-ordering which led to food waste generation in households (Zambrano-Monserrate *et al.* 2020). The flexibility in placing orders resulted in last-minute cancellations with leftover meals produced in the kitchens of takeaways (Li *et al.* 2020). Although many takeaway businesses redistributed this surplus, the redistribution was not always feasible due to its operational limitations, as discussed above.

The medium term indirect effect of the COVID-19 pandemic is reflected in the impact of the lockdown measures on the upstream of the (inter)national food supply chains (Sharma *et al.* 2020). Temporary closure of the hospitality sector disrupted the sophisticated, often long-established, links of hospitality operators with their food suppliers (Eley and Hancock 2020). The lockdown measures prevented movement of labour migrants working in farms (FAO 2020). As a result, catering suppliers and, particularly, food producers (farmers) had large inventories of unsold foodstuffs. Media reports from around the world (see, for example, Cook 2020) shown that most of this food was wasted as farmers had no alternative ways to redistribute the surplus. In supply chain management this phenomenon is known as the 'ripple effect' (Dolgui *et al.* 2020) and its impact is likely to last. Some hospitality businesses may not re-open after the pandemic while many will return to operate at a reduced capacity which is due to predicted low consumer demand (Gursoy *et al.* 2020). Reduced operational capacity suggests that food producers and catering suppliers will continue facing the problem of surplus food for some time. This surplus food is likely to be wasted.

2.1.Potential mitigation strategies

The fragile nature of the hospitality food supply chain underlines the need for hospitality operators to reconsider their work with catering suppliers and food producers. In the future, all actors of the food supply chain, including hospitality providers, should move away from the traditional model of food supply which is bulky and unresponsive to sudden external pressures. By involving multiple actors (farmer-wholesaler/distributor-catering supplier-hospitality business) the traditional business models of food procurement lack visibility and impede sympathy. There is no flexibility and, if one actor of the chain experiences a sudden need in something, the chain is unlikely to react to this need instantly. For example, if a farmer has produced too much food, it is difficult, if not impossible, for them to sell this

surplus. Farmers set, usually finite, contracts with wholesalers and catering suppliers and these contracts offer little scope to add to or delete the food inventory (Dolgui *et al.* 2020). This surplus food may be left to rot in the field which leads to wastage in primary production. On the other side of the food supply chain, if a restaurant manager has a suddenly reduced need in a particular food stock, it may be difficult for them to cancel outstanding food orders due to contractual obligations with a 'middle man'. The food gets delivered to a restaurant and often goes to waste as it is no longer required in the kitchen.

A potential strategy to prevent food waste occurrence and build more reliable relationships across the food supply chain in a post-pandemic world would be to form alternative food networks (AFNs). These are characterised by the spatial and temporal proximity of all actors (Bernardi and Tirabeni 2018). Actors can communicate with one another directly, thus building trust and improving the agility, responsiveness and resilience of the food supply chains. Given the spatial proximity element, AFNs can contribute to the short food supply chains (SFSCs). Compared to the traditional food supply chains, SFSCs are more resilient to external impacts and more environmentally-benign (Sellitto *et al.* 2018). They also reassure food integrity and provide customers with confidence as more safety measures will be required when moving from farm to fork in a post-COVID-19 world (Rizou *et al.* 2020). AFNs and SFSCs can increase the social and network capital of all actors across a food supply chain in a specific locality (Bernardi and Tirabeni 2018). This will not only improve the preparedness of actors for future disastrous events, but can also outline the scope for business innovation. For example, AFNs can be utilised to redistribute surplus food from farm to fork under the 'business as usual' conditions. This becomes possible due to the links established between an excess food owner (farmer) and a food operator (for example, a restaurant or a retail outlet) (see Figure 2 for details). Digital technology can facilitate surplus

food redistribution (Galanakis 2020), thus minimizing food loss and waste across the food supply chain but, particularly, in primary production (Beausang *et al.* 2017).

[Insert Figure 2 here]

Building AFNs and SFSCs is especially important in light of climate change which can expose vulnerability of global food systems to external disruptions (Zambrano-Monserrate *et al.* 2020). Increased probability of extreme weather events with their multiplying, cascading, impacts on the critical infrastructure (Pescarolli and Alexander 2016), such as the well-established food supply chains, can disrupt food deliveries. As demonstrated by the COVID-19 pandemic, unpredictable consumer behaviour, such as panic buying and stockpiling in the time of crises, may exacerbate this disruption (Hobbs 2020). By forming the local 'bubbles' of food production, distribution and consumption, all actors of AFNs and SFSCs can build the capacity to, at least partially and temporarily, withstand the disruptions. This improved capacity will make actors more robust and enhance their resilience to external pressures. AFNs and SFSCs can be built in any market but they have all pre-conditions to be formed in regions that specialise in food production but have large markets of (out-of-home) food consumption (Sellitto *et al.* 2018). Local production in such regions can fulfil a significant share of demand for food in hospitality services, thus making a good case for the development of AFNs and SFSCs.

Another strategy for reducing food waste in the hospitality sector and along its food supply chain in a post-COVID-19 world in the immediate, but also short-to-medium, perspective is in the (better) integration of food rescue charities, food processing enterprises and operators of anaerobic digesters into AFNs and SFSCs. Food rescue charities can aid in the redistribution of surplus food by taking it from hospitality providers to people in need (Filimonau and de Coteau 2019). Food processing enterprises can work closely with hospitality operators and food producers and, in the case of any surplus food on a farm or in a

hospitality business, collect this food for freezing or processing (FAO 2020). For example, jams and chutneys can be made of any surplus fruits and vegetables while fish can be vacuum-packed and deep frozen. These foodstuffs can subsequently be procured by hospitality operators at a discounted price. Any food leftovers from farms and restaurant kitchens, including those arising from customer plates, can be used by anaerobic digesters to produce energy (Kuczman *et al.* 2018). This energy can subsequently be supplied to the providers of food leftovers. Any profits made from selling this energy can be shared between all actors involved, i.e. providers of wasted food and operators of anaerobic digesters.

2.2.The prerequisites for the mitigation strategies

Institutional and organisational factors need to be addressed for the proposed mitigation strategies to work effectively in a post-COVID-19 world (Espejo *et al.* 2020). The implementation of institutional factors is largely dependent on the political will of (local/regional/national) authorities. The success of organisational factors is mainly determined by the readiness and preparedness of hospitality providers, and other actors across AFNs and SFSCs, to work towards a common goal.

The institutions of power are critical to building the pre-conditions for food waste mitigation in AFNs and SFSCs. They should provide incentives to hospitality operators to prevent food waste occurrence. Incentivisation was important for addressing the challenge of food waste prior to the pandemic (Filimonau and De Coteau 2019). It will become particularly critical in a post-COVID-19 world as national lockdowns have ceased the cash flows in the hospitality sector (Nunn 2020). Food waste prevention and mitigation is unlikely to be a priority for hospitality businesses after the pandemic. This highlights the need for the government to use ‘soft’ market-based policies and tools (Richards and Hamilton 2018) in raising the profile of this issue among the sector professionals. Examples of such policies and

tools include interest-free (emergency) loans (FAO 2020) or subsidies for those hospitality operators actively engaging in building AFNs and SFSCs in specific localities.

Institutional support is required to integrate other actors of relevance into AFNs and SFSCs. This primarily concerns food rescue charities whose work has aided significantly in food waste mitigation prior to the pandemic and proven to be critical for surplus food redistribution during the lockdown (Smithers 2020a). The number of charitable food rescuers remains small, especially in developing countries. This is a major shortcoming as the challenge of food loss and waste, particularly in primary production, persists in developing economies in the presence of hunger and malnutrition (Wang *et al.* 2018). This portrays wastage as being not only environmentally-unsustainable but also morally unacceptable. Charities have very limited resources that imped surplus food redistribution. Targeted institutional support is required not only in the form of traditional governmental grants, but also in other forms of assistance, such as provision of transportation and storage for surplus food.

The institutional will is necessary to streamline the processes and procedures of surplus food redistribution. Overly stringent food hygiene standards and food safety requirements represent a major barrier for surplus food donations by hospitality operators (Filimonau *et al.* 2019). These standards and requirements should now be revised to minimize food wastage. Another area for the revision of food hygiene standards and food safety requirements is in the use of food leftovers from the kitchen and customer plates (Galanakis 2012). Traditionally, many of these would be landfilled but, after the pandemic, food leftovers should be directed to anaerobic digesters (Kuczman *et al.* 2018). In small quantities and as a trial, these leftovers can be given to local farmers for use as animal feed (Salemdeeb *et al.* 2017). The national institutions of power should treat COVID-19 as an opportunity to reconsider their current approach to leftover food as a waste and start viewing it as a by-product, or even as a

resource instead (Lee and Tongarlak 2017). The possibility of feeding food leftovers to insects with the subsequent use of these insects as animal feed should also be examined (Salomone *et al.* 2017).

The organisational factor is important in building the social and network capital of AFNs and SFSCs as, currently, this capital may be insufficient. The social and network capital of hospitality operators is restricted by definition as most of the sector is represented by small-to-medium sized enterprises. The network of such enterprises alongside the links they have established with one another, but also other actors of the food supply chain, are often limited (Kim and Shim 2018). This is attributed to a highly competitive and diverse market of hospitality services in which each individual business strives to prioritise its short-term financial wellbeing over building the long(er)-term, industry-wide, network capacity (Binder 2020). The economic paradigm of the 'tragedy of the commons' can be used to explain the uncaring behaviour of hospitality operators. This paradigm describes why individuals, in the presence of a finite resource, such as the environment, tend to act selfishly (Patt 2017). The 'tragedy of the commons' can be extended from the realm of consumer behaviour to the realm of business decision-making in the hospitality sector. While the 'tragedy of the commons' considers the environment as a scarce resource, in the context of hospitality services this resource is represented by customers.

Hospitality operators are conservative in that they are often reluctant to accept any alternative, innovative ways of doing business. This is reflected in the limited uptake of environmental innovations in the hospitality sector (Martin-Rios *et al.* 2018). This conservatism prevents hospitality businesses from adopting novel methods of food procurement. It further averts them from engaging with other actors of the food supply chains for the sake of communal, rather than individual, benefit, as discussed earlier. Strong organisational will is required to change the mind-set of hospitality providers by turning them

from the ‘conservatives’ into the ‘innovators’ or even the ‘market disruptors’. Crises and disasters offer scope for organisational learning and enable businesses to re-think past business and organisational behaviour models (Filimonau and De Coteau 2020). The COVID-19 pandemic should be used by hospitality operators for identifying and conquering new, previously unthought-of, (business) opportunities. This novel, out-of-the-box, thinking may prompt hospitality businesses to no longer consider other hospitality operators as competitors, but as collaborators or, at least, as coopetitors.

This innovative business strategy of coopetition (Czernek and Czakon 2016) may extend beyond the goal of food waste mitigation. In the time of crises, not only surplus food can be redistributed from one hospitality business to another or from one farmer to a hospitality business. Human resources or the infrastructure of hospitality operators and other actors within the food supply chain can also be ‘shared’. For example, to avoid wastage, the surplus food can be re-allocated from a shut hospitality operator to the one which still functions by cooking takeout and delivery meals. The storage facilities of one hospitality provider can be used to freeze and then keep the expensive foodstuffs, such as fish and seafood, of other hospitality businesses. Restaurant staff that cannot be put on a furlough scheme by a shut hospitality operator can be, instead, temporarily ‘borrowed’ by those hospitality businesses that are still in operation, such as takeaways. Redundant staff can even be temporarily employed, after appropriate training, by food producers who suffered from the lack of farm workforce during national lockdowns (FAO 2020). Such coopetition can be underpinned by the principles of the ‘sharing economy’, thus up-taking it from a (more) traditional, customer-to-customer (C2C) or business-to-customer (B2C), realm to a new, business-to-business (B2B), realm. Limited evidence of effective sharing, especially with sustainability goals, has been recorded in this realm to date (Grondys 2019). Figure 3 presents

an action framework which can aid in the (more) effective management of food waste in hospitality services in a post-pandemic world.

[Insert Figure 3 here]

2.3.The positive spillover effect of the pandemic?

The COVID-19 pandemic can also contribute to food waste prevention and mitigation in the hospitality sector. The food hygiene concerns may prompt hospitality operators to abolish such wasteful catering services as self-service 'open buffets' (Daily Sabah 2020). In theory, this abolition will offer more control to hospitality businesses over managing the amounts of foodstuffs that require cooking, thus reducing food waste occurrence in the kitchen due to over-production. This assumption is, however, yet to be empirically tested.

Although the overproduction of food may decrease, the abolition of buffets may drive food wastage on customer plates. The main reason behind using open buffets is in (staff) time savings that these provide. With no open buffets, hospitality businesses will have to either increase the headcount of staff or be prepared to sacrifice the speed of service. This suggests that, to maintain competitiveness, hospitality providers will have to allow for a certain time lapse between the time when a customer places a food order and the time when it gets delivered to their table. There is a probability that the food ordered will no longer meet consumer expectations, resulting in plate leftovers. Potential changes to food waste flows in hospitality businesses operating under the effect of new preventative and protective measures in a post-COVID-19 world need to be carefully understood.

Another potentially positive impact of the pandemic on food wastage in the global hospitality sector can be attributed to the increased appeal of the 'local' (Tomassini and Cavagnaro 2020). National lockdowns have prompted consumers to better recognise the value of locally produced foodstuffs and appreciate the work of local food producers

(farmers). In the UK, for example, consumers have started purchasing more local food (Searle 2020). This may, in theory, minimise food wastage in hospitality services due to reduced spoilage in transit.

The pandemic may also spark procurement of local and seasonal foodstuffs, thus leading to the reduction of food miles with the related carbon benefits (Pratt *et al.* 2017). However, media reports from France (Snouwaert 2020) and the UK (Selby 2020) indicate that the local appeal is only applicable to cheap foodstuffs as customers tend to save money in the time of crises. This suggests that expensive foodstuffs, such as quality cuts of meat, fish and seafood, may potentially be wasted more in a post-pandemic world, both in hospitality services and in the upstream of their food supply chains. Better understanding of consumer behaviour in a post-COVID-19 future and its (positive or negative) implications for food wastage in the hospitality sector is necessary.

3. Plastic waste

Although popular media reports have highlighted the issue of plastic waste in the context of hospitality services (BBC 2019), the related research agenda is under-developed. 'Grey' literature has assessed the potential contribution of the hospitality sector to global plastic pollution (WRAP 2013), but very few academic studies have attempted to shed light on the managerial approaches to its mitigation (Koiwanit and Filimonau 2021). The challenge of plastic waste has been severely under-researched in the 'old normal' realm of hospitality service provision. The pandemic has added new insights into the so urgently needed scholarly investigation of this topic.

COVID-19 imposed immediate and short-to-medium term, direct and indirect, negative impacts on plastic pollution within the global hospitality sector (Figure 1). While the pandemic has had a positive effect on consumer and manager awareness of food safety and

hygiene, it will force hospitality businesses to take extra precautions when serving food and beverages to their guests. These precautions will be reflected in the immediately increased usage of disposable masks, gloves, cutlery and, in the case of food deliveries, plastic packaging (Silva *et al.* 2020). For example, increased demand for food takeout and delivery has already caused a surge in plastic waste pollution (Ikiz *et al.* 2021). This pollution trend is expected to continue despite the declared bans on the use of single-use plastic in hospitality services across the world (Tanakasempipat 2020).

In the longer term, the food safety and hygiene precautions will be exemplified by the grown patterns of plastic waste generation in hospitality operations arising from the disposal of the larger number of empty water bottles, hand sanitizers, disinfectors and cleaning liquids (Monella 2020). For example, the well-established practice of serving tap water in a jar, which not only reduced plastic pollution but also saved money in restaurants, may cease to exist. The service of bottled water will become mainstream across the sector. Single-use menu cards may become a new reality (Gursoy *et al.* 2020). Although such menu cards can be made of paper, exceptional affordability of plastic pinpoints it as a probable medium for printing single-use menus in the future. More plastic is likely to be used by suppliers in food deliveries, which is, again, due to enhanced hygiene requirements and plastic affordability. COVID-19 can revive the global single-use plastic industry which has been suppressed prior to the pandemic due to the mounting public and political pressures (Kalina and Tilley 2020). For example, in the UK, the calls have been made to postpone single-use plastic ban until at least 2022 (BBC 2020a). The hospitality sector will become an important player in this revival, primarily due to the increased demand for single-use cutlery (Silva *et al.* 2020).

The problem of plastic waste in the hospitality sector is attributed to its disposal. Substantial quantities of used disposable plastic masks, gloves and cutlery are being dumped in the marine ecosystems (Kalina and Tilley 2020). These plastic items have become

common street litter in both developed, but particularly, developing countries (Scaraboto *et al.* 2020). The non-recyclability of single-use plastic and the limited recycling facilities that exist for its safe disposal should represent a major point of concern for the post-pandemic hospitality sector (Jung *et al.* 2021). With plastic waste still being regularly transported from developed to developing countries (O'Neill 2019), the North-South divide is likely to intensify in a post-COVID-19 world. The hospitality sector will become one of the key contributors to this intensification, thus extending the scope of its negative impacts from the environmental realm of sustainable development to its socio-economic realm.

3.1.Potential mitigation strategies

To mitigate the mounting pressure of plastic waste in the hospitality sector post-pandemic, the scope for adopting plant-based alternatives to single-use plastics should be examined. Wooden cutlery can, for example, be used (Horton 2019). Consumer studies should aim at exploring the determinants of customer acceptance of traditional cutlery in a post-COVID-19 future. Some restaurant guests may be prepared to use conventional cutlery, subject to its thorough disinfection. This development will, however, shift the problem of environmental pollution from plastic waste towards wastewater.

The example of Kenya shows that single-use plastics can be effectively eliminated from many aspects of everyday life (Horvath *et al.* 2018). Grounding on this example, disposable face masks can be made of plant-based materials. Plant-based materials, such as jute and sisal, can be utilised for this purpose as they represent a more environmentally-friendly medium due to its recyclability and biodegradability.

Re-usable face masks should be promoted. These can, for instance, bear the trademarks of hospitality operators and be provided for free with marketing purposes. Face marks have become a fashion symbol (Abraham 2020) which outlines the scope for innovative thinking

on how this opportunity can be harnessed by hospitality operators. For instance, branded re-usable masks provided to restaurant guests can, in theory, increase customer loyalty and enhance brand recognition.

Re-usable, branded cutlery can be provided for free and customers should be encouraged to bring it back to a restaurant in subsequent visits (National Geographic 2019). Not only will this increase consumer confidence in the cleanliness of such items, but can also shift responsibility of hospitality operators for clean-up and disinfection. Monetary discounts can be given to customers for 'bringing in' the re-usable cutlery which is similar to the initiatives adopted by many coffee shops in an attempt to reduce wasted coffee cups (Murray 2018). Such initiatives build upon the evidence that financial incentives can 'nudge' more responsible consumer behaviour in hospitality operations (Filimonau and Magklaropoulou 2020).

Digital technology can be used to reduce plastic waste. Digital menus can replace traditional paper- or plastic-made menus being accessible to customers via branded apps (Yim and Yoo 2020). The Bring Your Own Device (BYOD) concept will not only eliminate the need for disposable menus, but also enable hospitality operators to make short notice menu changes. This will contribute to food waste prevention and mitigation as flexible menus facilitate the repurpose of excess ingredients and promote sales of surplus meals at a discounted price (Filimonau and De Coteau 2019). Discounts will build customer loyalty, which is important in a post-COVID-19 world given the hospitality sector needs to restore consumer confidence.

3.2.The prerequisites for the mitigation strategies

To reduce plastic pollution from the hospitality sector in a post-COVID-19 world, similar to the case of food waste and its management, institutional and organisational support will be

required. The institutions of power will be instrumental in providing effective plastic waste collection, separation and disposal services (Fan *et al.* 2021). The issue with such plastic waste as empty bottles in restaurants is often in the lack of adequate recycling facilities in a locality. This problem is particularly pronounced in the context of developing countries where organised municipal solid waste collection services are under-developed (Penteado and de Castro 2021). While in developed economies plastic waste recycling is more established, the issue with single-use plastic persists. Guided by the principle 'out of sight, out of mind', certain waste fractions are transported to developing countries for final disposal. This transfers the problem from one locality to another without effective and pro-active solution (Wang *et al.* 2020).

In a post-pandemic world, the institutions of power should adopt a more pro-active approach to managing plastic waste from the hospitality sector given that this waste is likely to increase significantly. For example, incentives should be given to hospitality businesses promoting plant-based alternatives to single-use plastic. Incentives can also be adopted to encourage plastic waste separation in-situ for subsequent recycling. For instance, the 'deposit-refund' system (Linderhof *et al.* 2019) can be introduced or discounts can be offered by municipal waste collection services for properly separated plastics. Disincentives can be applied to discourage wasteful behaviour. For example, the 'pay-as-you-throw' programmes can be considered whereby hospitality operators pay per weight of disposed plastic waste. Such programmes have proven effective in various contexts (Linderhof *et al.* 2019) and can, potentially, be rolled out towards the hospitality sector in a post-pandemic world. The current 'flat' charge for solid waste disposal discourages hospitality operators from more effective solid waste management (Silva *et al.* 2020).

Organisational commitment is necessary to invest in plastic waste reduction in hospitality services. Low cost of single-use plastic and affordability of its disposal (Trower

2018) may prevent hospitality operators from purchasing more environmentally-benign cutlery and re-usable face masks. The willingness to invest in plastic waste management will be further hindered by the need to address other operational challenges of the immediate post-COVID-19 future. These challenges include procurement of protective equipment and staff recruitment and training. Investment decisions have been traditionally difficult for hospitality operators, especially for small-to-medium-sized enterprises (Filimonau *et al.* 2020c). Investment decisions on solid waste management can be particularly hard to make, especially in the time of crises, which requires genuine organisational commitment towards sustainability.

Traditional conservatism of the hospitality sector will also play a role in solid waste management. Hospitality operators are reluctant to invest into the future 'intangibles', such as enhanced corporate image, rather than the immediate 'tangibles', such as improved cash flows (Filimonau and De Coteau 2019). This links to theories of environmental innovation and corporate social responsibility. These theories emphasise the importance of personal sustainability values of business leaders in thinking unconventionally and seeing future opportunities for maintaining market competitiveness (Martin-Rios *et al.* 2018). Such examples of disruptive innovations in the hospitality sector as digital food delivery platforms (for example, Deliveroo or UberEats) or digital surplus food redistribution apps (for instance, Too Good To Go) demonstrate the value of pro-active and novel thinking. These 'unconventional' business models represent the only segments of the global hospitality sector that did not come to a complete standstill in the time of the forced lockdown. This demonstrates how novel, pro-active, thinking can aid in better preparation for disastrous events. Figure 4 presents an action framework for the (more) effective management of plastic waste in hospitality services in a post-pandemic world.

[Insert Figure 4 here]

4. Conclusions

The COVID-19 pandemic has exposed vulnerability of the global hospitality sector to external pressures. Although the effect of the pandemic was devastating, COVID-19 should be considered by the sector professionals a learning opportunity. This is of particular relevance for waste management practices adopted by hospitality operators. Waste management in hospitality operations was mediocre prior to the pandemic, but COVID-19 has worsened it. The pandemic has also transferred some of hospitality wastes to the upstream of the sector's supply chain. With no prevention and mitigation measures applied, the hospitality sector will produce disproportionately high volumes of food and plastic waste in a post-COVID-19 world. This will undermine the environmental sustainability of global hospitality services.

This paper argued that the pandemic outlined the need for the hospitality sector professionals to prepare for future disastrous events. Climate change represents a major disaster to watch as its consequences will be damaging to hospitality operators. Measures are necessary to enhance the agility of the global hospitality sector and improve its resilience to future disasters. Hospitality operators should invest in more environmentally-friendly product alternatives, such as plant-based or re-usable cutlery, instead of single-use plastics. Hospitality operators should also build novel, more environmentally-benign and responsive to disastrous events, business models of food procurement. These novel models can revolve around the concepts of alternative food networks (AFNs) and short food supply chains (SFSCs). Long-term organisational commitment of hospitality operators and governmental support are paramount for the industry uptake of such novel business models.

Although climate change is similar to the COVID-19 pandemic in terms of the damaging power, it is also notably different. Unlike the pandemic which has evolved rapidly,

climate change is growing slowly. Unlike COVID-19 which has affected almost everyone everywhere in the world, climate change will primarily impact the most vulnerable categories of global population. Climate change may be too abstract to comprehend so that it does not prompt immediate defence reaction to combat its consequences. The global hospitality sector should improve its environmental performance now, when the effect of the COVID-19 pandemic is still in the air. If improvements are left for later, the memory of this disaster will vanish and the sector professionals will forget about the need to stay vigilant and prepare for future disastrous events, such as climate change. This suggests that the hospitality sector professionals may return to their past, largely unsustainable and irresponsible, business practices, ignoring the lessons taught by the pandemic.

Research is necessary to support the progress towards environmental sustainability of the hospitality sector in a post-COVID-19 world. This research should explore the feasibility of integrating hospitality businesses in AFNs and SFSCs, looking, in particular, at the impediments of such integration and evaluating how these impediments can be overcome. The determinants of business coopetition in the context of food and plastic waste management should be examined from the perspective of hospitality managers, catering suppliers, wholesalers, farmers, policy-makers and other actors across the food supply chain. This includes food rescue charities, operators of anaerobic digesters (for food waste) and local recycling facilities (for plastic waste). The role of consumer behaviour in the time of increased hygiene concerns, changed (food) preferences and enhanced social distancing rules should also be studied.

The key limitation of the paper is in its conceptual nature. The novelty of the COVID-19 pandemic and its uncertainty diminish the accuracy of scholarly predictions. To partially overcome this limitation, the paper elaborated on the future of hospitality waste management in the pandemic's aftermath and in light of future disastrous events, such as climate change.

Limited scientific knowledge of COVID-19 and an insufficient understanding of its short- and long-term effect on the hospitality sector pinpoints possible subjectivity of any elaborations of the exact magnitude of this effect. To partially overcome this shortcoming, the paper grounded its arguments on available, yet limited, evidence reported in popular media, trade press and emerging academic publications. While being not necessarily scientifically-robust, such reports are more reliable than any 'guestimates' made on the topic in question. Such reports enable the parallels to be drawn and extrapolations to be made on the basis of existing and past evidence as to how COVID-19 may affect the future of the hospitality sector.

Note on contributions:

Viachaslau Filimonau Conceptualization, Data curation, Writing – final draft

References

Abraham, T., 2020. Designer masks for £15: How 6 LFW designers hope to raise £1 million with face coverings collection. *The Telegraph,* 05 June 2020.

Aldaco, R., Hoehn, D., Laso, J., Margallo, M., Ruiz-Salmon, J., Cristobal, J., *et al.*, 2020. Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach. *Science of the Total Environment*, 742, 140524.

BBC, 2019. Single-use plastic: takeaways challenged to use less. Available from: https://www.bbc.co.uk/news/uk-england-bristol-47403669 [Accessed 06 June 2020].

BBC, 2020a. Coronavirus: Calls to delay single-use plastic ban until 2022. Available from: https://www.bbc.co.uk/news/uk-wales-52864403 [Accessed 06 June 2020].

BBC, 2020b. Why social distancing might last for some time. Available from: https://www.bbc.com/future/article/20200324-covid-19-how-social-distancing-can-beat-coronavirus [Accessed 05 June 2020].

Beausang, C., Hall, C., and Toma, L., 2017. Food waste and losses in primary production: Qualitative insights from horticulture. *Resources, Conservation and Recycling*, 126, 177-185.

Bernardi, D.P., and Tirabeni, L., 2018. Alternative food networks: sustainable business models for anti-consumption food cultures. *British Food Journal*, 120(8), 1776-1791.

Binder, P., 2020. Impacts of network relationships on absorptive capacity in the context of innovation. *The Services Industries Journal,* in press, https://doi.org/10.1080/02642069.2018.1533955

Charlebois, S., Creedy, A., and Massow, M.V., 2015. Back of house"–focused study on food waste in fine dining: the case of Delish restaurants. *International Journal of Culture, Tourism and Hospitality Research*, 9(3), 278-291.

Czernek, K., and Czakon, W., 2016. Trust-building processes in tourist coopetition: The case of a Polish region. *Tourism Management*, 52, 380-394.

Civil Society, 2020. *John Tizard: Charities must shape the Covid-19 rescue, recovery and reform agenda*. Available from: https://www.civilsociety.co.uk/voices/john-tizard-charities-must-shape-the-covid-19-rescue-recovery-and-reform-agenda.html [Accessed 05 June 2020].

Cook, C.D., 2020. Farmers are destroying mountains of food. Here's what to do about it. *The Guardian*, 7 May 2020.

Daily Sabah, 2020. Coronavirus to make 'open buffet' system history, tourism reps say. *Daily Sabah*, 15 April 2020. Available from: https://www.dailysabah.com/business/tourism/coronavirus-to-make-open-buffet-system-history-tourism-reps-say [Accessed 06 June 2020].

Dolgui, A., Ivanov, D., and Rozhkov, M., 2020. Does the ripple effect influence the bullwhip effect? An integrated analysis of structural and operational dynamics in the supply chain. *International Journal of Production Research*, 58(5), 1285-1301.

Dolnicar, S., and Juvan, E., 2019. Drivers of Plate Waste. A Mini Theory of Action Based on Staff Observations. *Annals of Tourism Research*, 78, 102731.

Dube, K., Nhamo, G., and Chikodzi, D., 2020. COVID-19 cripples global restaurant and hospitality industry. *Current Issues in Tourism*, in press, https://doi.org/10.1080/13683500.2020.1773416

Eley, J., and Hancock, A., 2020. UK food industry fears waste explosion as coronavirus strains supply chain. *Financial Times*, 31 March 2020.

Eriksson, M., Osowski, C.P., Bjorkman, J., Hansson, E., Malefors, C., Eriksson, E. and Ghosh, R., 2018. The Tree Structure–A General Framework for Food Waste Quantification in Food Service. *Resources, Conservation & Recycling*, 130, 140-151.

Espejo, W., Celis, J.E., Chiang, G., and Bahamonde, P., 2020. Environment and COVID-19: Pollutants, impacts, dissemination, management and recommendations for facing future epidemic threats. *Science of the Total Environment*, 747, 141314.

Fan, Y.V., Jiang, P., Hemzal, M., and Klemes, J.J., 2021. An update of COVID-19 influence on waste management. *Science of the Total Environment,* 754, 142014.

FAO-Food and Agriculture Organisation, 2020. *Mitigating risks to food systems during COVID-19: Reducing food loss and waste*. FAO, Rome, Italy. Available from: http://www.fao.org/3/ca9056en/CA9056EN.pdf [Accessed 06 June 2020].

Filimonau, V., and De Coteau, D., 2019. Food Waste Management in Hospitality Operations: A Critical Review. *Tourism Management*, 71, 234-245.

Filimonau, V., Krivcova, M. and Pettit, F., 2019. An Exploratory Study of Managerial Approaches to Food Waste Mitigation in Coffee Shops. *International Journal of Hospitality Management*, 76, 48-57.

Filimonau, V., and De Coteau, D.A., 2020. Tourism resilience in the context of integrated destination and disaster management (DM2). *International Journal of Tourism Research*, 22(2), 202-222.

Filimonau, V., and Magklaropoulou, A., 2020. Exploring the viability of a new 'pay-as-you-use' energy management model in budget hotels. *International Journal of Hospitality Management*, 89, 102538.

Filimonau, V., Derqui, B., and Matute, J., 2020a. The COVID-19 pandemic and organisational commitment of senior hotel managers. *International Journal of Hospitality Management*, 91, 102659.

Filimonau, V., Matute, J., Kubal-Czerwinska, M., Krzesiwo, K., and Mika, M., 2020b. The determinants of consumer engagement in restaurant food waste mitigation in Poland: An exploratory study. *Journal of Cleaner Production*, 247, 119105.

Filimonau, V., Todorova, E., Mzembe, A., Sauer, L., and Yankholmes, A., 2020c. A comparative study of food waste management in full service restaurants of the United Kingdom and the Netherlands. *Journal of Cleaner Production,* 258, 120775.

Filimonau, V., Zhang, H., and Wang, L., 2020d. Food waste management in Shanghai full-service restaurants: a senior managers' perspective. *Journal of Cleaner Production,* 258, 120975.

FUSIONS, 2016. *Estimates of European food waste levels*. FUSIONS, Stockholm.

Food Standards Agency, 2020. Reopening checklist for food businesses during COVID-19. Available from: https://www.food.gov.uk/business-guidance/reopening-checklist-for-food-businesses-during-covid-19 [Accessed 05 June 2020].

Galanakis, C.M., 2012. Recovery of high added-value components from food wastes: Conventional, emerging technologies and commercialized applications. *Trends in Food Science and Technology,* 26(2), 68-87.

Galanakis, C.M., 2020. The Food Systems in the Era of the Coronavirus (COVID-19) Pandemic Crisis. *Foods,* 9(4), 523.

Goh, E. and Jie, F., 2019. To Waste or not to Waste: Exploring Motivational Factors of Generation Z Hospitality Employees towards Food Wastage in the Hospitality Industry. *International Journal of Hospitality Management,* 80, 126-135.

Gössling, S., Scott, D., and Hall, C.M., 2020. Pandemics, tourism and global change: a rapid assessment of COVID-19. *Journal of Sustainable Tourism*, in press, https://doi.org/10.1080/09669582.2020.1758708

Grondys, K., 2019. Implementation of the Sharing Economy in the B2B Sector. *Sustainability,* 11(14), 3976.

Gursoy, D., Chi, C.G., and Chi, O.H., 2020. *Restaurant and hotel customers' sentiment analysis (Data collected May 24 - 30, 2020). Would they come back? If they would, WHEN?* Unpublished report, June 2, 2020, Pullan, WA, USA.

Hall, C.M., Scott, D., and Gössling, S., 2020. Pandemics, transformations and tourism: Be careful what you wish for. *Tourism Geographies*, in press, https://doi.org/10.1080/14616688.2020.1759131

Hecht, A.A., and Neff, R.A., 2019. Food Rescue Intervention Evaluations: A Systematic Review. *Sustainability*, 11, 6718.

Hobbs, J.E., 2020. Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics*, in press, https://doi.org/10.1111/cjag.12237

Horton, H., 2019. Reusable plastic cups are better for the environment than 'swaps' - even wooden cutlery, Greenpeace report says. *The Telegraph*, 04 October 2019.

Horvath, B., Mallinguh, E., and Fogarassy, C., 2018. Designing Business Solutions for Plastic Waste Management to Enhance Circular Transitions in Kenya. *Sustainability*, 10(5), 1664.

Jingjing, M., 2020. Restaurants hope for rebound after novel coronavirus dies, call for support policies. *Global Times*, 2 February 2020. Available from: https://www.globaltimes.cn/content/1178219.shtml [Accessed 05 June 2020].

Jung, S., Lee, S., Dou, X., and Kwon, E.E., 2021. Valorization of disposable COVID-19 mask through the thermo-chemical process. *Chemical Engineering Journal*, 405, 126658.

Ikiz, E., MacLaren, V.W., Alfred, E., and Sivanesan, S., 2021. Impact of COVID-19 on household waste flows, diversion and reuse: The case of multi-residential buildings in Toronto, Canada. *Resources, Conservation and Recycling*, 164, 105111.

Kalina, M., and Tilley, E., 2020. ''This is our next problem": Cleaning up from the COVID-19 response. *Waste Management*, in press, https://doi.org/10.1016/j.wasman.2020.05.006

Kim, N., and Shim, C., 2018. Social capital, knowledge sharing and innovation of small- and medium-sized enterprises in a tourism cluster. *International Journal of Contemporary Hospitality Management*, 30(6), 2417-2437.

Koiwanit, J., and Filimonau, V., 2021. Carbon footprint assessment of home-stays in Thailand. *Resources, Conservation and Recycling*, 164, 105123.

Kuczman, O., Gueri, M.V.D., de Souza, S.N.M., Schirmer, W.N., Alvez, H.J., Secco, D., Buratto, W.G., Ribeiro, C.B., and Hernandez, F.B., 2018. Food waste anaerobic digestion of a popular restaurant in Southern Brazil. *Journal of Cleaner Production*, 196, 382-389.

Larue, B., 2020. Labour issues and COVID-19. *Canadian Journal of Agricultural Economics*, in press, https://doi.org/10.1111/cjag.12233

Lee, D., and Tongarlak, M.H., 2017. Converting retail food waste into by-product. *European Journal of Operational Research*, 257(3), 944-956.

Li, C., Mirosa, M., and Bremer, P., 2020. Review of Online Food Delivery Platforms and their Impacts on Sustainability. *Sustainability*, 12(14), 5528.

Linderhof, V., Oosterhuis, F.H., van Beukering, P.J.H., and Bartelings, H., 2019. Effectiveness of deposit-refund systems for household waste in the Netherlands: Applying a partial equilibrium model. *Journal of Environmental Management*, 232, 842-850.

Martin-Rios, C., Demen-Meier, C., Gossling, S. and Cornuz, C., 2018. Food Waste Management Innovations in the Foodservice Industry. *Waste Management*, 79, 196-206.

Monella, L.M., 2020. Will plastic pollution get worse after the COVID-19 pandemic? *Euronews*, 13 May 2020. Available from: https://www.euronews.com/2020/05/12/will-plastic-pollution-get-worse-after-the-covid-19-pandemic [Accessed 06 June 2020].

Murray, A., 2018. Which coffee shops will offer you 50pc discount for reusing your cup? *The Telegraph*, 10 January 2018.

Nair, D.J., Grzybowska, H., Fu, Y., and Dixit, V.V., 2018. Scheduling and routing models for food rescue and delivery operations. *Socio-Economic Planning Sciences*, 63, 18-32.

National Geographic, 2019. Why carrying your own fork and spoon helps solve the plastic crisis. *National Geographic,* 30 June 2019. Available from: https://www.nationalgeographic.co.uk/environment-and-conservation/2019/06/why-carrying-your-own-fork-and-spoon-helps-solve-plastic [Accessed 06 June 2020].

Nunn, J., 2020. Restaurants will never be the same after coronavirus–but that may be a good thing. *The Guardian,* 14 April 2020. Available from: https://www.theguardian.com/commentisfree/2020/apr/14/coronavirus-restaurants-pandemic-workers-communities-prices Accessed 05 June 2020].

O'Neill, K., 2019. As more developing countries reject plastic waste exports, wealthy nations seek solutions at home. *The Conversation,* 05 June 2019.

Papargyropoulou, E., Wright, N., Lozano, R., Steinberger, J., Padfield, R., and Ujang, Z., 2016. Conceptual framework for the study of food waste generation and prevention in the hospitality sector. *Waste Management*, 49, 326-336.

Papargyropoulou, E., Steinberger, J., Wright, N., Lozano, R., Padfield, R., and Ujang, Z., 2019. Patterns and Causes of Food Waste in the Hospitality and Food Service Sector: Food Waste Prevention Insights from Malaysia. *Sustainability*, 11, 6016.

Patt, A., 2017. Beyond the tragedy of the commons: Reframing effective climate change governance. *Energy Research & Social Science*, 34, 1-3.

Penteado, C.S.G., and de Castro, M.A.S., 2021. Covid-19 effects on municipal solid waste management: What can effectively be done in the Brazilian scenario? *Resources, Conservation and Recycling*, 164, 105152.

Pescarolli, G., and Alexander, D., 2016. Critical infrastructure, panarchies and the vulnerability paths of cascading disasters. *Natural Hazards*, 82, 175-192.

Pratt, S., Mackenzie, M., and Sutton, J.L., 2017. Food miles and food choices: the case of an upscale urban hotel in Hong Kong. *Journal of Sustainable Tourism*, 25(6), 779-795.

Richards, T.J., and Hamilton, S.F., 2018. Food waste in the sharing economy. *Food Policy*, 75, 109-123.

Rizou, M., Galanakis, I.M., Aldawoud, T.M.S., and Galanakis, C.M., 2020. Safety of foods, food supply chain and environment within the COVID-19 pandemic. *Trends in Food Science and Technology*, 102, 293-299.

Sakaguchi, L., Pak, N., and Potts, M., 2018. Tackling the Issue of Food Waste in Restaurants: Options for Measurement Method, Reduction and Behavioral Change. *Journal of Cleaner Production*, 180, 430-436.

Salemdeeb, R., zu Ermgassen, E.K.H.J., Kim, M.H., Balmford, A., and Al-Tabaa, A., 2017. Environmental and health impacts of using food waste as animal feed: a comparative analysis of food waste management options. *Journal of Cleaner Production*, 140(Part 2), 871-880.

Sellitto, M.A., Vial, L.A.M., and Viegas, C.V., 2018. Critical success factors in Short Food Supply Chains: Case studies with milk and dairy producers from Italy and Brazil. *Journal of Cleaner Production*, 170, 1361-1368.

Salomone, R., Saija, G., Mondello, G., Giannetto, A., Fasulo, S., Savastano, D., 2017. Environmental impact of food waste bioconversion by insects: Application of Life Cycle Assessment to process using *Hermetia illucens. Journal of Cleaner Production*, 140(Part 2), 890-905.

Scaraboto, D., Joubert, A.M., and Gonzales-Arcos, C., 2020. Using lots of plastic packaging during the coronavirus crisis? You're not alone. *The Conversation*, 28 April 2020.

Searle, F., 2020. Surplus veg business predicts lasting changes after crisis. *Fresh Produce Journal*, 23 April 2020. Available from: http://www.fruitnet.com/fpj/article/181585/surplus-veg-business-predicts-lasting-changes [Accessed 06 June 2020].

Selby, J., 2020. Coronavirus latest: People urged to eat more steak, as panic buying subsides and British beef goes unsold. *iNews*, 2 May 2020. Available from: https://inews.co.uk/news/consumer/coronavirus-latest-britons-urged-eat-more-steak-british-beef-unsold-2764602 [Accessed 06 June 2020].

Sellitto, M.A., Vial, L.A.M., and Viegas, C.V., 2018. Critical success factors in Short Food Supply Chains: Case studies with milk and dairy producers from Italy and Brazil. *Journal of Cleaner Production*, 170, 1361-1368.

Sharma, H.B., Vanapalli, K.R., Cheela, V.S., Ranjan, V.P., Jaglan, A.K., Dubey, B., *et al.*, 2020. Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling*, 162, 105052.

Silva, A.L.P., Prata, J.C., Walker, T.R., Campos, D., Duarte, A.C., Soares, A.M.V.M., *et al.*, 2020. Rethinking and optimising plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Science of the Total Environment*, 742, 140565.

Silvennoinen, K., Heikkila, L., Katajajuuri, J-M., and Reinikainen, A., 2015. Food waste volume and origin: Case studies in the Finnish food service sector. *Waste Management*, 46, 140-145.

Smithers, R., 2020a. UK food waste charity given 360 tonnes more than usual as businesses close. *The Guardian*, 10 April 2020.

Smithers, R., 2020b. UK takeaway food waste rises during coronavirus lockdown. *The Guardian*, 13 May 2020.

Snouwaert, J., 2020. 5,000 tons of French cheese are at risk of going to waste amid the coronavirus pandemic as demand sinks. *Business Insider*, 6 May 2020. Available from: https://www.businessinsider.com/5000-tons-french-cheese-at-risk-wasted-demand-sinks-report-2020-5?r=US&IR=T [Accessed 06 June 2020].

Tanakasempipat, P., 2020. Plastic piles up in Thailand as pandemic efforts sideline pollution fight. *Reuters*, 11 May 2020.

Tomassini, L., and Cavagnaro, E., 2020. The novel spaces and power-geometries in tourism and hospitality after 2020 will belong to the 'local'. *Tourism Geographies*, in press, https://doi.org/10.1080/14616688.2020.1757747

Trower, F., 2018. *The plastics debate: How will it affect food waste in your kitchen?* Winnow. Available from: https://blog.winnowsolutions.com/the-plastics-debate-how-will-it-affect-food-waste-in-your-kitchen [Accessed 06 June 2020].

Wang, L., Xue, L., Li, Y., Liu, X., Cheng, S., and Liu, G., 2018. Horeca Food Waste and Its Ecological Footprint in Lhasa, Tibet, China. *Resources, Conservation and Recycling*, 136, 1-8.

Wang, C., Zhao, L., Lim, M.K., Chen, W-Q., and Sutherland, J.W., 2020. Structure of the global plastic waste trade network and the impact of China's import Ban. *Resources, Conservation and Recycling*, 153, 104591.

WRAP-Waste and Resources Action Programme, 2013. *Overview of Waste in the UK Hospitality and Food Service Sector*. WARP, Banbury, UK.

Xu, S., and Li, Y., 2020. Beware of the second wave of COVID-19. *The Lancet*, 395(10233), 1321-1322.

Yim, M.Y-C., and Yoo, C.Y., 2020. Are Digital Menus Really Better than Traditional Menus? The Mediating Role of Consumption Visions and Menu Enjoyment. *Journal of Interactive Marketing*, 50, 65-80.

Zambrano-Monserrate, M.A., Ruano, M.A., and Sachez-Alcalde, L., 2020. Indirect effects of COVID-19 on the environment. *Science of the Total Environment*, 728, 138813.

Figure 1. The impact of the COVID-19 pandemic on generation of wastes in the hospitality sector. Source: Authors' own elaboration.

Waste **Impact** Potential time scale	**Immediate** 6 months		**Short-term** 12 months	**Medium-term** 24 months	**Medium-term** 36 months
	Direct		**Direct**	**Direct**	**Indirect**
Food	Unfinished food inventories due to sudden implementation of national lockdowns and temporary business closures	Increased food wastage in food take-away businesses due to the surge in popularity of home food deliveries			Wastage of food in the upstream of the food supply chain due to reduced orders from catering businesses and permanent business closures
Plastic	Increased use of single-use plastics and single-use gloves and face masks in food preparation and service due to enhanced hygiene requirements		In addition to increased use of single-use plastics and single-use gloves and face masks - Increased use of other plastic types, such as water bottles, cleaning liquid containers and hand sanitizers		Increased use of plastic packaging in food deliveries

Figure 2. Traditional (a) and novel (b) models of food supply chains for hospitality services in a post-COVID-19 world (illustrative and not to scale). Source: Authors' own elaboration.

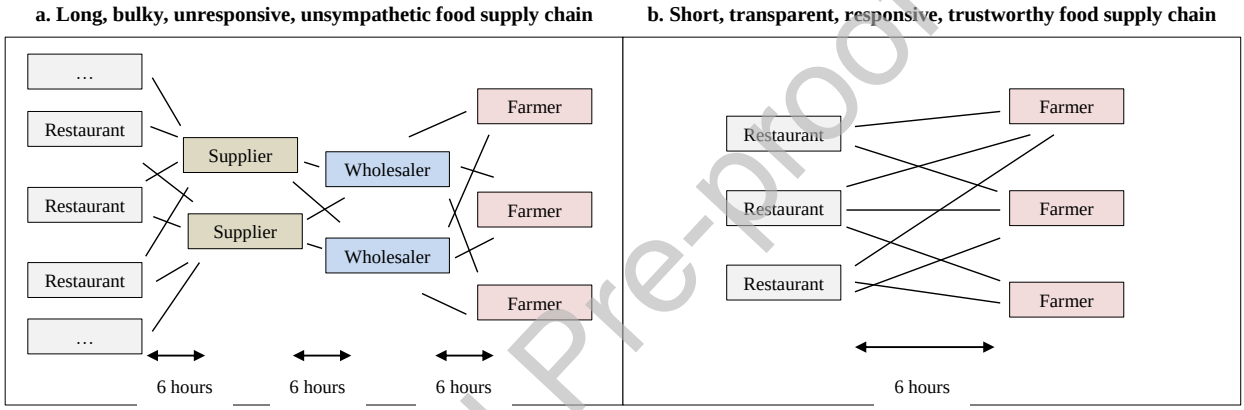

Figure 3. An action framework for the more effective management of food waste in the hospitality sector in a post-pandemic world. Source: Authors' own elaboration.

Legend:

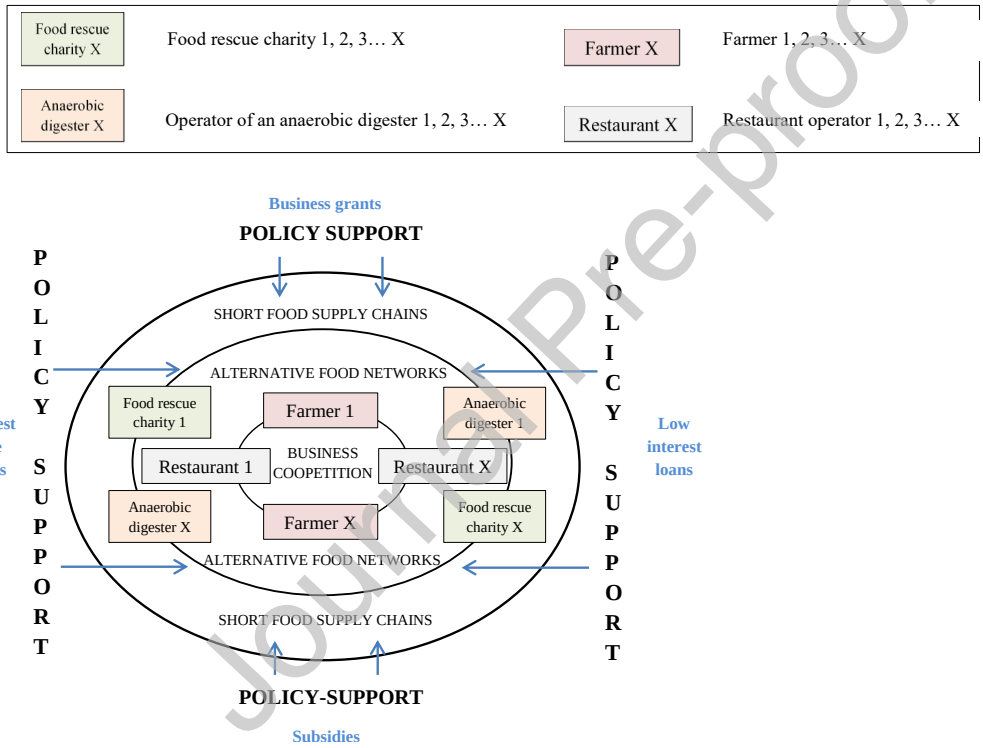

Figure 4. An action framework for the more effective management of plastic waste in the hospitality sector in a post-pandemic world. Source: Authors' own elaboration.