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# Cleaner and Responsible Consumption

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## Unsustainable plastic consumption associated with online food delivery services in the new normal

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### ABSTRACT

The restaurant industry is one of the hardest hit sectors of the COVID-19 pandemic. The prolonged closures and declining patrons brought about by community lockdowns have imposed financial struggles to numerous restaurants and food establishments. As people were forced to remain indoors in order to curb the spread of the virus, demand for online food delivery service has surged. The growing demand for this type of food service is predicted to significantly alter the consumption pattern of restaurant patrons, which may accelerate the consumption of single-use plastics. In this paper, sustainability challenges relating to plastic consumption associated with online food delivery services are presented together with recommendations on how to address them. From the proposed actions to be implemented, it appears that the online food delivery service providers are in a central position to implement potentially high-impact actions within a relatively shorter time horizon compared with different stakeholders, such as the consumers, restaurants, and governments. Thus, encouraging greater accountability and initiatives from online food delivery service providers will be crucial in the drive for cleaner and responsible consumption of plastics derived from food deliveries.

### 1. Introduction

The COVID-19 pandemic caused by the SAR-CoV-2 has significantly altered the global way of life. In the absence of standardized methods and established drugs for curing the disease, community quarantines or lockdowns were imposed to restrict movement of the population with the aim of minimizing the spread of the virus. While the lockdowns played a critical role in mitigating the spread of COVID-19, it negatively impacted the global economy and supply chains wherein the ripple effects are expected to transcend national boundaries (Yu and Aviso, 2020).

One of the hardest hit industries of the pandemic is the restaurant industry (Song et al., 2021). The imposition of lockdowns has led to a significant decline in restaurant patrons, which may have played a major role in the shutting down of numerous restaurants. Apart from the economic decline, food consumption preference (Baker et al., 2020), dining behavior (Kim and Lee, 2020), and inclination towards the utilization of digital platforms were some of the other effects of the pandemic on the restaurant industry. In Taiwan for example, the demand for online food delivery service during the pandemic grew, wherein sales and customers increased by 5.7% and 4.9%, respectively, for every confirmed new case of COVID-19 (Chang and Meyerhoefer, 2020). The pandemic has also made a tremendous impact on restaurant-related plastic consumption.

Single-use plastics cutlery and food containers are preferred by restaurant patrons out of concerns about COVID-19 transmission (Hale and Song, 2020).

The online food delivery service (OFDS) has ushered in an alternative revenue stream for restaurants. In this business model, restaurants register with the digital platform wherein consumers can order food via an app. The food will be picked up by delivery riders at the restaurant and be delivered to the consumer. For every successful transaction, the digital platform charges a certain percentage of the sales from the restaurant. The advantage of this business model for restaurants is that they can continue their operations despite lockdowns and fewer foot traffic to their establishments, and they do not need to invest in additional manpower or motorcycles/automobiles in order to provide food delivery services. This concept is not new and is already operational even before the pandemic. The Statista Digital Market Outlook on online food delivery reports that in 2018 and 2019, the global revenues of OFDS were approximated at 91 million US dollars and 107 million US dollars, respectively (Blumtritt, 2020). The lockdowns, however, may have accelerated the adoption of this new mode of transaction for both the consumers and the restaurants, as reflected by the forecasted 11% OFDS revenue increase for 2020. Shifting the restaurant operations to focus more on food delivery requires greater utilization of takeout containers

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and packaging. Unfortunately, this also leads to a greater environmental footprint (Li et al., 2020). In this paper, the sustainability challenges faced by restaurants within the context of OFDS in this new scenario is presented, together with several proposed actions and solutions.

## 2. Challenges on sustainable consumption

The COVID-19 pandemic has led to increased consumption and disposal of plastic-based products such as face masks, face shields, and personal protective equipment (PPE), wherein the increased consumption can translate to an additional 280 tons of medical plastic waste per day (ADB, 2020). It is therefore not surprising that discussion of pandemic-related plastic wastes has mostly focused on these medical items (Patrício Silva et al., 2021). While the surge in the utility of these medically related plastic items is a cause for concern, paying attention to the contribution of the restaurant industry to plastic pollution is likewise warranted. Even prior to the onset of the pandemic, the restaurant industry has been a major source of single-use plastics in the form of food containers, cutlery, drinking cups, straws, among others (Pirani and Arafat, 2014). The pandemic has exacerbated the consumption of single-use plastics of the restaurant industry due to the growing preference for food delivery service and concerns about safety and hygiene. The number of OFDS users is expected to dramatically increase in the coming years. In China for example, it is estimated the platform-to-consumer users will reach 427 million in 2024 from 263 million users in 2019. OFDS consumption also increased during the lockdowns as evidenced in the case of Mexico, wherein as much as a 60% increase in OFDS activity was recorded (Statista, 2020a). It is therefore evident that the growing number of OFDS users will also translate to a greater plastic consumption. Another driver of OFDS utilization is the fear of contracting COVID-19, which has led to preference for using disposable utensils and food containers. While experiments have revealed that the SARS-CoV-2 can survive on different surfaces such as plastics for days (van Doremalen et al., 2020), the risk of getting COVID-19 through this route is low (Goldman, 2020; Mondelli et al., 2020). All of these suggest that the OFDS will catalyze the increased consumption of plastics derived from packaging, which already make up 46% of global plastic wastes (Statista, 2020b).

Thus, there has been growing interest on studying the environmental impacts brought by OFDS. In South Korea, it was found from material flow analysis that plastic consumption associated with food delivery which are in the form of bottles, cups and plastic bags translate to 600,000 tons of disposed plastics annually (Jang et al., 2020). In Australia, it was estimated that the greenhouse gas emission cost associated with takeout containers of a single order from OFDS ranges from 0.15 to 0.29 CO<sub>2</sub>e (Arunan and Crawford, 2020). The same study estimates that the looming expansion of this business model is expected to increase greenhouse gas emissions by 132% by 2024 for food containers associated with OFDS. While these studies have successfully provided a glimpse of the environmental impacts of OFDS through increased plastic consumption, these studies were undertaken in highly developed nations. It would be interesting to know and compare the environmental impacts of OFDS on developing nations. Another study calls for the hospitality sector to invest in “green innovations” that are supported by sound policies in order to mitigate plastic wastes derived from food containers (Filimonau, 2020). It is therefore evident that online food delivery services can have a significant impact on the plastic consumption pattern of restaurant patrons, thereby necessitating the need for greater discussion on this pressing matter. Thus, it is clear that more studies are needed that aim to quantify and measure how increasing preference to OFDS, together with the accompanying increase in plastic consumption will affect the environment, especially for highly urbanized areas. This concern will continue to grow and will require immediate attention since OFDS thrive in cities, and the trend of urbanization continues to rise (Sun et al., 2020).

Currently, the commonly available materials that can be used for takeaway and packaging are paper plastic laminates (PPL) and plastic

containers. Alternative to these container types that market themselves as green alternatives are bioplastics and bagasse-based containers. PPLs are the common material used for paper cups and paper bowls. The exterior of the material is made of cellulose and the interior is coated with a thin plastic film that endows the material the ability to retain liquids. PPL-based containers are cheap and are commonly used as takeout containers, but they are very difficult to effectively recycle and pose several environmental problems. For example, these PPL-based containers have been shown to leach microplastics upon exposure to hot water (Ranjan et al., 2021). Even more alarming is that this type of container has a carbon footprint of 75 kt of carbon dioxide equivalents, which is comparable to car manufacturing (Foteinis, 2020). Plastic-based microwaveable containers are also popular for food takeout. They are sturdier and more presentable compared with PPL-based containers. These containers can be reused, but it is not clear how many are actually reused and are discarded right after a meal. Consider the scenario wherein a regular patron of food delivery service will accumulate plastic food containers. Thus, it is reasonable to expect that a point will come in which plastic containers can no longer be kept and reused and will be therefore immediately discarded. This type of container, together with PPL are commonly found in marine litter (Konecny et al., 2018), which highlights its widespread consumption, limited reusability and poor disposal management. Moreover, such containers also pose possible health hazards to the consuming public (González-Castro et al., 2011). In addition, ingestion of plastic debris by wildlife, such as those found in marine environments can be fatal (Abreo et al., 2016). Similarly, plastic debris accumulation on beaches also pose real hazards to the environment and organisms living in the area, such as hermit crabs (Lavers et al., 2020). The use of bioplastics-based food containers has been slowly gaining traction among restaurants. Bioplastics can be made from diverse materials; the common type is made from polylactic acid (PLA) which are derived from renewable sources such as crops. It was previously reported that cups made from sugarcane-based bioplastics exhibit lower global warming and fossil depletion impacts compared with petroleum-based plastics (Changwichan and Gheewala, 2020). For recycling and material recovery however, bioplastics require special temperature-controlled facilities in order to facilitate biodegrading (Massardier-Nageotte et al., 2006). In the absence of these facilities, bioplastics can take a long time before they biodegrade, especially in a landfill (Bátori et al., 2018). Another barrier to their wider adoption is the price. Bioplastics can cost 2–5 times greater than conventional packaging materials, which can be attributed to the early developmental stage of the bioplastics innovation landscape and the absence of dominant market players (White et al., 2020). Finally, bagasse-based containers have recently gained popularity as an eco-friendly packaging material. These materials are made from the pulp and fibers of crops such as sugarcane and molded into a specific shape. Bagasse-based materials are compostable within days and under natural conditions (Liu et al., 2020), which is in contrast to PLA bioplastics. Due to the relatively small scale in which bagasse-based materials are produced, their price is not competitive compared with PPL and plastic takeout containers. In addition, bagasse-based containers may have limited food applications since these materials may not be appropriate for serving hot liquids such as soup. Thus, innovative materials are needed to be developed that can decrease our dependence on plastic.

From the outlined commonly used takeout containers, the pandemic may prevent restaurants from adopting sustainable interventions to their takeout service and packaging due to economic considerations. Restaurants that survived the prolonged closures due to the lockdowns may prioritize revenue maximization over the use of sustainable packaging materials. In addition, passing the cost of sustainable packaging to consumers may not be the best strategy since it was found that price is a strong driver for persuasion and browsing of consumers on the OFDS platform (Gunden et al., 2020). Thus, improving the sustainability of restaurants may require concerted efforts coming from different stakeholders. The following section outlines promising steps to be taken by various societal sectors.

### 3. Proposed solutions

Different levels of society can contribute potential solutions in minimizing the influx of plastic wastes derived from the restaurant industry (Table 1). At the personal level, consumers may prefer to select restaurants that are in their immediate proximity and avoid food delivery altogether. They may bring their own food containers and take home their food. However, this may still be a challenge considering the inaccurate information that is circulating about COVID-19 transmission and surfaces. Extensive information campaign is therefore needed in order to correct this information which will be critical in promoting a cleaner and more responsible plastic consumption. Consumers may also selectively patronize environmentally conscious establishments. This may be manifested in the choice of packaging materials used by the restaurants, discounts for reusing containers, among others. Such actions at the consumer level can be implemented immediately but may have minimal impact if not collectively undertaken. It has recently been reported that green consumerism and health consciousness are significant factors that influence the willingness to pay of millennials for a particular restaurant (Nicolau et al., 2020). Thus, if the awareness of more consumers can be raised regarding the impact of their decisions on the environment, consumers can leverage the power of their collective choices to bring about change. Raising environmental awareness for digital transactions is of critical importance especially after considering that this factor is often overlooked in studies that analyze consumer preference in OFDS. Previously published studies have determined that consumer preference in OFDS is influenced by app design (Gunawan et al., 2020), the consumer's past experience, subjective expectations and influence of third parties (Chen et al., 2020). Thus, future studies that examine how environmental awareness influences consumer behavior within the context of OFDS are needed in order to devise promising strategies that can lead to responsible consumption of plastic.

**Table 1**  
Summary of potential actions to be taken by different stakeholders in promoting the cleaner and responsible consumption of plastic derived from online food delivery services.

Level	Action	Timeline	Potential Impact
Personal	Choose restaurants within the vicinity and bring own containers for takeout	Immediate	Low
	Taking into consideration the type of packaging material the restaurants in selecting in which food establishment to order from	Immediate	Low
Restaurant	Increase the options for takeout containers and packaging to include sustainable materials.	Short term	Low
Online food delivery system	Provide incentives for restaurants that utilize sustainable packaging materials.	Short term	High
	Negotiate with manufacturers of sustainable packaging materials on behalf of restaurants within their network, which may drastically decrease the procurement cost of sustainable packaging materials.	Short term	High
	Devise innovative operational framework that will lead to the circular use of food containers within their restaurant network.	Long term	High
Government	Infrastructure investment for recycling facilities	Long term	High
	Review the relevance and ability of existing laws to respond to the dynamic nature of plastic waste management	Long term	High
	Education and information campaigns on proper plastic use and disposal	Long term	High

Restaurants may find it difficult to prioritize sustainability practices since the immediate and most urgent goal is to survive and minimize losses brought by the pandemic and community quarantines. One way restaurants can contribute in tempering the surge in plastic consumption derived from packaging is to provide consumers with more choices with respect to how their food will be packed and delivered. For example, restaurants can list on their app page different takeout containers like those outlined in the previous section, and let consumers decide if they are willing to pay a premium price for sustainable packaging. This strategy reconciles the observation that price is a significant factor in online food delivery options (Gunden et al., 2020) and that millennials are willing to pay a premium for green consumerism (Nicolau et al., 2020). This action can be immediately implemented but may also have marginal impact since it depends on the environmental values and preference of the consumers. Nonetheless, this action is still better compared with restaurants settling for PPLs and plastic-based containers which misses the opportunity to cater to environmentally conscious consumers.

OFDS should lead and take on a greater role in devising innovative solutions to curb plastic consumption derived from food delivery packaging, similar to extended producer responsibility. While OFDS are neither plastic manufacturers nor selling plastic-based products, OFDS should be accountable to the increase in plastic consumption due to food delivery since their business model has catalyzed the surge of single-use plastics especially during the pandemic. Currently, the only visible effort exerted by these platforms is the option not to request for cutlery. However, OFDS are in a central position to implement high-impact actions within a relatively short time frame. Since price is one of the barriers that prevents restaurants from utilizing sustainable packaging materials, providing incentives for restaurants that do so may lead to a promising outcome. Incentives may be based on the overall sustainability impact of the utilized takeout container. Moreover, the OFDS can collectively negotiate to manufacturers of sustainable packaging materials for the restaurants within their network. This can dramatically decrease the unit price of sustainable takeout containers as opposed to when individual restaurants make the purchase. A top-down approach in promoting sustainable packaging also levels the playing field for restaurants that want to use this type of takeout containers. Since the best way to minimize plastic waste is to limit its consumption in the first place, OFDS should also consider devising a way to promote reusing food containers. In Japan or South Korea for example, restaurants that directly deliver to customers use ceramic bowls or plates even as takeout containers. The delivery rider will return afterwards to collect the used ceramic bowls or plates. OFDS should invest in devising innovative operational frameworks that will lead to the circular use of food containers similar to the previously mentioned scenario. OFDS may standardize the reusable food containers used by the restaurants within their network and capitalize on consumer loyalty on their platform so that the reusable food containers can be returned to the delivery rider upon another transaction of the loyal consumer. Since the food containers are standardized, the food delivery rider may return the container to any restaurant within the OFDS network. What is of key importance in promoting container reuse is consumer loyalty and ensuring that container reuse provides economic incentives for the consumer, rather than disposing the container (Grimes-Casey et al., 2007). Thus, targeted consumer-centered incentives may simultaneously promote brand loyalty and container reuse. It is therefore evidently clear that the current operational framework of OFDS is not enough to address the environmental impacts associated with the increase in plastic consumption associated with their service. If alternative environment-friendly materials cannot be found that can decrease dependence on plastics, then different operational frameworks or policies must be devised.

The full attention of governments is expected to be on managing this pandemic. In addition, funds may be allocated for vaccine procurement and further capacitating the health sector. Thus, the environment and sustainability initiatives may take a backseat relative to the

forementioned issues. Nonetheless, governmental actions related to plastic waste management are anticipated to be of high impact despite having a long-term time horizon. Some of these include investing in infrastructure that promote and observe the hierarchy of recycling such as the depolymerization of plastics to be reused for the creation of new materials, conversion of plastics to lower type of materials, waste-to-energy systems, among others (Sikdar, 2020). Governments are also called to review existing laws regarding their ability to respond to modern challenges posed by increasing plastic consumption. In the Philippines for example, the passage of Republic Act 8749 or the Philippine Clean Air Act led to the prohibition of incineration. As a consequence, sanitary landfills are the common route for material wastes. Considering that pandemic-driven surge in plastic consumption is expected to further increase (Klemeš et al., 2020) as well as the low plastic recycling rate of the Philippines (Jain, 2017), this may be an opportune time to review the ban on incineration in order to address increasing plastic consumption. Faithful implementation of these laws is likewise required in order to fully address these environmental issues. Finally, government-sponsored intensive educational and information campaign can bring social change with respect to responsible plastic consumption. Waste management has long been the center of policy discussions. In the Philippines for example, the Department of Interior and Local Government has released Memorandum Circular 2020-147 that relates to the guidelines on the management of COVID-19 related health care wastes. The document discusses how COVID-19 related wastes should be disposed and managed. While this is a good initiative from the government to address the environmental issues related to the pandemic, similar policies or guidelines aimed at promoting responsible consumption are likewise warranted and would have strengthened these government-sponsored environmental initiatives. It has been previously shown that information campaigns are effective in reducing environmental wastes (Willis et al., 2018). Thus, the pandemic-driven surge in plastic consumption underscores the need for informational campaigns on proper plastic disposal in order to address this problem effectively.

There is an urgent need to implement interventions that seek to promote the cleaner and responsible consumption of plastics associated with OFDS even beyond the pandemic since this type of food service is anticipated to further bloom due to enhanced urbanization. This is already manifested by the results of a recent survey where 89% and 78% of respondents from South Korea (Statista, 2020c) and Hong Kong (Statista, 2020d), respectively, stated that they will continue to use OFDS even when social distancing restrictions have been eased. Moreover, it has been observed that ordering food online can take place as quickly as every other day (Chandrasekhar et al., 2019). These highlight the growing demand and market for this type of service. If left unchecked, this may become another strong driver of plastic consumption. The proposed solutions presented in this paper offer a novel set of interventions compared with previous proposals. In the paper of Filimonau (2020) for example, the proposed solutions on plastic wastes derived from the restaurant industry focused on the consumer, development of environment-friendly technologies such as plant-based alternatives, coupled with policy support. In another paper (Li et al., 2020), OFDS users are urged to properly observe segregation of packaging wastes. Thus, the present paper provides promising additional recommendations that vary in impact, scale, ease of implementation, as well as the implementation time frame. By and large, these recommendations are expected to help restaurants and OFDS become more sustainable in their operations.

#### 4. Conclusion

Online food delivery has provided struggling restaurants due to the pandemic an additional or alternative source of revenue. While this platform has helped restaurants to survive, it has also led to a surge in unsustainable plastic consumption brought by takeout containers and packaging materials. This paper has systematically presented the

sustainability challenges restaurants face and promising actions that can be implemented that can promote responsible plastic consumption. From the different stakeholders involved in this environmental problem, online food delivery service providers are in a central position to implement potentially high impact solutions within a relatively short time frame. Thus, encouraging greater accountability from online food delivery service providers for the increased plastic consumption derived from their services will be crucial in the success of promoting cleaner and responsible consumption of plastic. The paper has also identified research gaps ranging from studying consumer behavior to materials science, which may be undertaken in the future in order to lessen the environmental impacts of OFDS. The OFDS industry is expected to further increase as urbanization grows and migration to cities continue to occur. Proactive research is therefore highly needed to prepare societies and the environment that will result from the increased consumption catalyzed by OFDS.

#### 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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