Article

Research on Environmental Issue and Sustainable Consumption of Online Takeout Food—Practice and Enlightenment Based on China’s Meituan

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Abstract: In today’s society, consumers’ food needs can be satisfied by catering e-commerce platforms. However, the plastic pollution of tableware and packaging caused by a large number of catering orders every day has always been an unsolved environmental problem. (1) Background: At present, China’s three largest catering platforms, Meituan, Eleme and Baidu, receive 20 million takeout orders daily and consume about 60 million plastic products. Plastic pollution will have a sustained impact on the environment. (2) Methods: In this study, we use literature research and case analysis. We use Meituan’s takeout food as an example. We studied the takeout business growth, status of online takeout in the treatment of plastic packaging, harm to environment, humans and animals, as well as specific solutions. (3) Results: There are four main reasons which contribute to the plastic packaging pollution (i.e., high recycling cost, difficulty to deal with mixed plastic packaging, low effectiveness of collecting plastic packing, and immature technology and treatment to incinerate and landfill catering plastic waste). (4) Conclusion: Our findings suggest that regulators, takeout platforms and consumers, which have corresponding responsibilities in the environmental protection consumption of online food, are supposed to work together to get rid of the online takeout pollution for achieving sustainable consumption. Not only is government legislation needed to improve the waste management system and encourage the exploration of new intelligent waste classification tools, but platforms, businesses and users should enhance the environmental awareness of online takeout packaging pollution as well. Theoretical contributions and managerial implications are also discussed.

Keywords: online takeout; plastic packaging; environment pollution; catering e-commerce platform; sustainable consumption

1. Introduction

As global residents begin to get used to life during a pandemic, more people choose to order food online and have it delivered to their homes. A British survey shows that 36% of British people feel they were forced to use more plastics. The situation in Asian countries is very similar. In Bangkok, 3432 tons of plastic waste were thrown away every day in April 2020, higher than the average of 2115 tons thrown away every day in 2019. Among these plastics, 80% were daily plastic waste such as takeout packaging. In January 2020, India began to ban major stores to provide disposable plastic bags. However, under the impact of the epidemic, the use of plastic bags is expected to rise by 30%. According to the Federal Environmental Research Institute, plastic consumption in India increased by 62% in April compared with the same period last year. Most plastics are food packaging, which is not easy to recycle. In Singapore, which has 5.7 million residents, the survey showed that takeaway packaging generated an additional 1470 tons of plastic waste.
By the end of 2020, the total number of orders for online takeout platforms in China was as high as 17.12 billion. The growth rate is 7.5% compared to the previous year. The total amount of online takeout food transactions in China reached 835.2 billion Chinese Yuan, the growth rate is 14.8% compared with previous years. It can be seen that with the rapid development of food delivery, there may be greater potential environmental pollution hazards [1]. While enjoying the convenience of interconnection, electronic communication and food delivery, a large amount of kitchen waste has been produced. Meituan, Eleme and Baidu, the top three food e-commerce platforms in China, currently have more than 20 million orders a day and consume about 60 million plastic products. Meituan APP is at the top of the list. Such huge demand for food delivery has brought great pressure to the sustainable development of the ecological environment [2].

Therefore, with the growth of the e-commerce takeout platform, research about its related problems is particularly urgent. In view of the pollution issue of online takeout, this paper analyzes the specific status quo and the existing harm. Then, using Meituan of China as a case, this paper analyzes the causes of takeout pollution, and provides pollution control strategies combined with the relevant stakeholders. Our findings have significant contributions to the extant literature of catering pollution control and consumption sustainability. First of all, through the analysis of the development of online takeout and its hazards, the literature on urban waste management is enriched. Second, this study enriches the literature of understanding the externalities of the network economy by elucidating the hazards and causes of online catering. Last but not the least, this study straightens out the countermeasures against online takeout pollution from the perspective of stakeholders. This study also affords worthy insights for practitioners.

2. Literature Review

The fast development of the Chinese online takeout mode has created prosperity in the takeout industry. As a representative of fast-food dining, takeout has become the first choice for many people, especially young people, with its convenience and fast characteristics. The takeout industry brings convenience to people’s lives, but it also brings practical problems that cannot be ignored: the waste and pollution of takeout packaging, and the disposal of garbage derived from takeout.

Research on waste management in China started in the 1990s, and there is no significant research focus in each period. Food waste management, waste source control, waste classification collection, and policy change are popular topics [3]. Wu and Yang (2017) pointed out that the single external governance subject and the unclear power and responsibility of the internal governance harm the municipal waste supervision system. The immaturity and lack of external supervision make weak the municipal waste supervision system in democratic consultation and information disclosure [4]. Xu et al. (2012) analyzed the experience of domestic waste management in some foreign cities, compared the shortcomings of municipal waste management in China, and put forward the optimization scheme of municipal waste management in China [5]. Lou (2016) analyzed from the perspective of garbage collection, and pointed out that compared with Germany and Brazil, the construction of urban domestic waste collection network in China should clarify the responsibilities of each subject and effectively play the role of each subject [6]. D. Li (2017) took universities and college students as the research object and concluded that universities and governments can formulate environmental supervision policies by establishing a variety of reward and punishment mechanisms for garbage classification, strengthening reputation mechanisms, and increasing subsidies for garbage classification supervision [7]. Shanghai, Guangzhou, Hebei, Chongqing, and other provinces and cities have issued policies to formulate relevant standards for waste classification and recycling. The promulgation of these local laws and regulations has effectively promoted the management of local kitchen waste and achieved good results. Since takeout garbage belongs to domestic garbage, those regulations and laws also lay a good foundation for the treatment of takeout garbage.
Chinese scholars have carried out in-depth studies on the pollution caused by takeout garbage, the takeout demand and environmental pollution from college students, and the environmental protection policy of takeout. In 2008, the Chinese government issued a “plastic restriction order” banning the use of disposable plastic bags thinner than 0.025 mm and other plastic products that cannot be recycled or decomposed. It has been 13 years since the “plastic restriction order” was implemented, and a survey by the National Development and Reform Commission of China shows that the use of plastic bags in supermarkets, shopping malls, and fairs has decreased by 66%, and the cumulative reduction of plastic bags has reached 87 billion. However, with the development of the online ordering business, the use of disposable plastic products has rebounded, seriously affecting the current environmental carrying capacity. In the process of rapid development of the online ordering industry, the safety problem of takeout packaging has been solved, and the development of the food packaging industry has matured, but the environmental protection problem of takeout garbage is still difficult to solve [8]. Zhao (2019) built an index system of takeout solid waste, including six factors: utilization rate, non-degradation rate, material manufacturing cost, portability, pollution level, and recoverability [9]. Xie and Song (2018) use GM (1, 1) model and Tobit model to describe the environmental impact of online food delivery waste [10]. The results show that when the market size and the number of online orders increase by 1 percentage point, the urban garbage clearance volume can be increased by 0.27187 and 0.17189 percentage points respectively. For every 1% increase in the market scale of food delivery, the number of people ordering online, and the volume of urban garbage clearance, the fixed investment in urban garbage treatment increased by 0.28258, 0.16765, and 0.19871 percentage points respectively. Online catering takeout does significantly increase the amount of urban garbage clearance and garbage disposal investment and does cause a certain degree of negative externalities to the urban environment indirectly, therefore, we need to take necessary measures to regulate the garbage problem of online takeout. Y. Lin et al. (2019) conducted a 21-day intervention experiment on the behavior of food waste and garbage sorting among college students in a Chinese university [11]. The results showed that the behavior of the subjects (food waste and food waste sorting) had a significant change after receiving the information prompt of food waste and food waste sorting, and the intervention effect was significant. Additionally, after the comparative analysis between the control group and the experimental group and the test results of different genders, it is concluded that girls have a higher degree of differentiation in all aspects before and after the experiment, and their behavior is easier to intervene and guide. The management of online takeout garbage is a complex system involving multi-subjects, multi-level and multi-factors, and requires multi-party participation and co-governance. Y. Zhang et al. (2019) used the theories, methods, and techniques of system ecology and sustainable system engineering to put forward the environmental protection behavior influence indexes [12]. They weigh the seven main bodies participating in the takeout garbage treatment through the analytic hierarchy process, including the government (treatment effect 0.103), consumers (environmental protection action 0.083), environmental protection non-governmental organizations (social influence 0.082), Garbage recycling and disposal party (environmental efficiency 0.058), catering business (practical action 0.055), takeout platform (effectiveness evaluation 0.049), and takeout packaging manufacturers (environmental efficiency 0.021). Wen et al. (2019) construct the whole industry chain as “production-transportation-use-waste disposal” [13]. He implements large sample enterprise research and takeout platform data analysis, calculates the market use proportion of takeout lunch boxes, tableware, and packaging bags of different materials and specifications in eight sample cities, excavates the mass data of rider distribution, collects urban garbage disposal, and systematically evaluate the environmental impact of the whole process of takeout. The results show that the main sources of environmental impact in the takeout packaging industry chain are production (45%) and disposal of waste (50%). Additionally, the order of severity is the solid waste discharge, water pollution, resource and energy consumption, and air pollution.
Although the takeout industry in western countries started earlier than in China, the scale of the takeout industry is far from that in China due to the influence of consumption, diet, and labor cost. Waste pollution caused by the takeout industry has not been fully realized, but there are abundant academic achievements in the study of municipal solid waste management. The main contents include the impact of urban garbage on the environment, garbage recovery and disposal, garbage supervision valuation, and efficiency. Barnes (2019) uses structural equation modeling to explain why consumers in high-income countries have a higher growth rate of per capita plastic consumption than those in low-income countries [14]. The reason is that these high-income countries export plastic waste to other low-income countries for disposal, so plastic pollution is diverted and shows little impact on the environment. Therefore, the government should put forward corresponding policies to reduce consumer consumption of plastics to reduce pollution, which has positive significance to the improvement of the global environment. Colon et al. (2012) evaluated the environmental impact of municipal solid waste treatment equipment of different scales by two new indicators, Respiration Index Efficiency (RIE) and Quality and Respiration Index Efficiency (QRIE). These new indicators are more accurate than the traditional life cycle assessment method [15].

Aschemann-Witzel et al. (2018) pointed out that food waste will have a negative impact on resource utilization, food security, and the environment. The main driving force of food waste behavior is how convenient can consumer get food [16]. Therefore, in food consumption, various interest parties should pay attention to the importance of food. Morone et al. (2016) pointed out that the environmental problems caused by urban garbage are becoming increasingly prominent [17]. This will also prompt managers to think about putting forward more scientific environmental governance programs. Dyson and Chang (2005) proposed a strategy for accurate prediction of municipal solid waste (MSW), and took San Antonio, Texas as a case study [18]. Using the system dynamics simulation tool Stella(R), they analyzed five different solid waste generation models and proposed various trends in solid waste generation. The prediction model is developed to cover a wide range of possible causal models and is able to the inevitable uncertainties. C. Lin et al. (2013) believed that food waste has great resource potential to produce raw materials for fuels and chemicals. Rather than treating it simply as waste to incinerate for energy, feed or composting, it helps the industry to improve existing processes or find new uses for waste to improve operational efficiency [19]. Windsor et al. (2019) summarized the distribution and change trend of plastics in land and water environment, which provided management direction for plastic pollution control to find the source of pollution and find treatment [20]. Pardo et al. (2015) through systematic analysis of 50 instances of literature on solid waste treatment results, compare different solid waste management strategies. Their study provided a development direction for the establishment of a more comprehensive solid waste management system [21]. Razzaq et al. (2012) did regression model analysis based on the 27 years’ data of municipal solid waste, economic development, carbon emissions and energy efficiency in the United States since 1990 [22]. Results show the causal relationship between these variables: the effective recycling of municipal solid waste can promote economic growth, reduce carbon emissions and promote energy efficiency. This provides a basis for policymakers to pay attention to the effective recycling of municipal solid waste and provides a reference measure for promoting economic development. Giordano et al. (2021) provided a comprehensive analysis of municipal solid waste management measures during the outbreak of COVID-19, illustrating the importance of waste management during the outbreak to reduce the risk of viral transmission [23]. Therefore, regarding the environmental impact of municipal solid waste, it is necessary to look at the longer-term impact on human health and survival. Managers and the public should remain sensitive to the environmental impact of waste, reduce waste generation, and promote efficient waste treatment.
Although a large amount of literature focuses on the quantity of urban garbage and
the life cycle management of garbage, they are less focused on the environmental protection
and health problems of online takeout catering. Most of the research on online takeout
catering focuses on its contribution to the economy, while ignoring its negative impact
on the environment. Few studies focus on the impact and harm of online takeout on the
human living environment. The main reason is with the rapid development of the global
Internet economy, the online takeout mode has gradually been favored by consumers, and
in the past two years, it has become an explosive growth catering mode. The ensuing envi-
ronmental and health hazards have become prominent, which in turn has aroused social
attention. However, there are still few research studies on environmental and health issues
related to this catering model. In this research context, coupled with the characteristics
of the Internet environment different from the offline operation, the environmental protection
rules and regulations of online takeout catering have been standardized on a global scale,
which needs more in-depth and comprehensive discussion and research. At present, there
are few research studies and practical experiences that can be used for reference.

Throughout the above literature reviews, many instances of literature engaged in
in-depth study on the traditional development of municipal waste, treatment, supervision,
but there is a blank that specifically discusses the negative externalities of online takeouts,
such as waste and governance issues. However, with the rapid development of China’s
online takeout industry, urban garbage has increased dramatically, which makes it an
unavoidable new problem in urban garbage management. Thus, it is urgent to carry out
corresponding in-depth research.

Based on the above problems and research status, this paper will use the environmental
problems caused by the development of the online takeout business as the research per-
spective to analyze the environmental pollution status, hazards, and governance strategies
of takeout. Meanwhile, this paper will provide a theoretical basis for better collaborative
governance among the main interest parties of online takeout business.

3. Materials and Methods

3.1. Materials

The data sources of this study are mainly data released by Internet information
platforms such as CNNIC (China Internet Network Information Center, Beijing, China),
Baidu, and DCCI (Data Center of China Internet, Beijing, China). For example, the market
conditions during the epidemic, the shift of consumption patterns from offline to online,
and the current status of network supervision. In addition, the online catering cases used
in this study are real, and the data used in the research and analysis are all data provided
by authoritative sites. In the process of analysis, it analyzes the environmental hazards
and principles caused by the growth data of online meal ordering business and consumer
behavior phenomena, and discusses related solutions.

This study uses three criteria for the selection of cases: First of all, the case must
at least meet the business type standard of online takeout catering. Meituan’s takeout
catering is an online food ordering platform under Meituan. It was officially launched in
November 2013. Takeout catering is the key business of Meituan. Second, the selection
of cases must reflect the typical characteristics of the takeout catering industry and be a
representative of this industry. According to the “Research Report on The Development of
Online Takeout Service Market (2019Q1)” released by the Internet third-party data agency
DCCI, Meituan has more than 250 million online takeout customers, more than 2 million
cooperative merchants, and more than 500,000 active delivery riders. Its business covers
more than 1300 cities, and the number of daily orders exceeds 25 million. In terms of its
number of users and market size, Meituan has become a representative online catering
brand in the online takeout catering industry. Taking Meituan as the target case of research,
our research conclusions can radiate to similar enterprises or industries, which can provide
a wide range of theoretical references. Third, the case studied should preferably have
practical measures and effects to solve the environmental problems of online takeout
catering and other aspects. After experiencing the social demands related to environmental protection, the Meituan platform widely adopts the strategy of integrating the consumption process with the theme of environmental protection. For example, the catering enterprises in the platform will advise consumers not to use disposable tableware for the purpose of environmental protection while placing orders. Therefore, Meituan has made certain efforts to solve environmental protection and related issues. According to these three criteria, Meituan’s takeout catering business meets the case selection criteria of our study.

3.2. Methods

There are three reasons for this study to adopt literature research and case study. First of all, this study combed the literature on online takeout catering, the governance of urban garbage, and waste life cycle management. Understanding the current research progress and shortcomings in environmental protection-related aspects of online takeout catering through the combing of the literature is conducive to better research and reference and makes up for the shortcomings, and promotes theoretical research on the environmental protection of online takeout catering. Second, there are few research studies on environmental protection-related issues of online takeout catering, but typical examples can be found in reality, and exploratory research methods are necessary. Third, the research on environmental protection-related issues of online takeout catering is a complex multi-disciplinary research process, which involves interdisciplinary research on e-commerce, catering, environmental protection, health management, etc. Therefore, the use of case study methods is conducive to the advancement of theoretical research.

This study first through literature review analyzes comprehensive research status and the development of the online takeout catering industry. This paper analyzes the threats and causes of the abuse of non-degradable packaging to the environment and health behind the growth of online takeout catering. Secondly, introduce an example to analyze the development of Meituan’s online takeout catering business. Through the description of the facts and the analysis of the data, the environmental risks and causes of the abuse of non-degradable packaging in Meituan takeout catering are discussed in depth. Finally, this study discusses the environmental responsibilities of the main participants in the online takeout supply chain: regulators, platforms, enterprises and consumers, and puts forward relevant suggestions and policy basis for the environmental protection, health and sustainable development of online takeout from the perspective of supervision, strengthening the concept of environmental protection and scientific innovation of environmental protection.

4. Current Situation of Online Takeout Business and Plastic Pollution

The massive use of plastic packaging in online food e-commerce has dramatically increased the consumption of disposable plastic. According to the industry statistics, orders of the top three online takeout platforms in China and their corresponding disposable chopsticks, plastic bags and other tableware produce nearly 15 billion pieces of kitchen waste. However, due to a series of reasons, a large amount of waste from online takeout business has not been properly recycled and treated, resulting in the environmental pollution caused by the abusive use of non-degradable plastic waste.

China’s online takeout business has maintained a rapid growth rate since 2011. By 2016, the total annual turnover of domestic online takeout reached 176.15 billion Chinese Yuan, and the total number of online ordering users reached 256 million. Online orders have tripled in 2017 when compared to 2016. In 2017, the total number of users of online orders in China reached 301 million; In 2018, the total number of users in China reached 345 million. After 2018, China’s online food ordering development once again showed significant growth. According to relevant surveys, in 2018, China’s total online ordering increased to 10.96 billion orders, increased by 96.8% compared with data in 2017. In 2019, the scale of China’s online takeout market increased again to 653.57 billion Chinese Yuan, which increased by 39.3% from 2018. By 2020, with the impact of the COVID-19 and the formation of people’s habit of staying at home, the number of active users of the three
major takeout delivery platforms in China has further increased at a high speed. By the end of 2020, the total number of orders in China reached 17.12 billion, and the total online ordering transactions reached 835.2 billion Chinese Yuan.

China’s online takeout industry has maintained a rapid growth trend since 2011. Food and beverage consumption of takeout platforms occupies a large proportion of the market share in China’s food and beverage consumption. With the rapid development of Internet technology, it is expected that by 2023, the consumption of takeout catering platforms will continue to grow (Figure 1). According to the expected growth trend, the online takeout business is likely to change from the former auxiliary catering mode to a major catering mode. In order to complete the sustainable development of the ecological environment, this growth trend will bring researchers to implement in-depth thinking and exploration of effective measures in the field of environmental protection.

![Figure 1. The relationship between the growth of total food consumption and food consumption in China’s online catering platform. Data sources: www.baidu.com (accessed on 15 March 2021); CNNIC Internet Data Report.](image)

According to the 46th Statistical Report on the Development of Internet in China, as of June 2020, the number of online takeout business users in China is 409 million, accounting for 43.5% of the total number of netizens. There are 11.24 million more users compared with March 2020. The number of online takeout Business users who use mobile phones to order reached 407 million, an increase of 10.67 million compared with March 2020. It accounts for 43.7% of mobile netizens (Figure 2). From 2017 to 2020, with the continuous development of mobile interconnection technology, the number of online mobile phone users in China is almost the same as the number of online takeout business users. This shows that most mobile phone users have installed online takeout catering platforms from 2017 to 2020, and most of them have experience in placing orders. With the rapid development of information intelligence technology such as the Internet and artificial intelligence and the releasing limitations of dining together during the epidemic, the online takeout catering mode, which used to be auxiliary, is likely to become the mainstream catering mode in the future.

With the rapid growth of online takeout platforms, the percentage of online takeout business has reached about 14% in the overall catering industry in China and still continues to grow. Compared with the traditional catering mode, the online catering takeout mode has certain operational advantages, as shown in Figure 3. Although 35% of the cost comes from food materials, the cost of rent and labor cost account for a larger proportion of the cost structure of traditional catering. The cost of these two parts is basically the same as the cost of food, which reduced the profit margin to 5–10%. The online catering takeout mode, due to the greater reduction of in-person customers, its rent cost is only 3% of the total cost and the human cost is also reduced even to neglectable level, therefore the profit margin can reach up to 35%. For catering businesses, this change is enough to attract them to move from the traditional model to online sales or mainly online sales. However, the
cost of packaging is increased in the online takeout catering mode. However, because the relevant regulations and guidelines do not clearly stipulate the use of packaging materials, most online platform businesses choose cheap non-degradable plastic packaging to reduce cost. Generally speaking, a takeout package of delivery contains plastic bowls, plastic bags, plastic spoons, plastic gloves, plastic soup cups and some paper packaging bags. These contents are actually the standard equipment of every takeout order. In other words, every takeout order will produce this kind of “white pollution” [24]. If we conservatively assume that the total number of orders for the three major takeout platforms is about 7 million per day, and each takeout has one plastic bag, which has a size of 0.06 square meters. Then, total daily plastic garbage from the three platforms could cover as much as 420,000 square meters, which is equivalent to the size of 60 standard football fields. Such garbage volume could cover the area of West Lake in Hangzhou in only 15 days. Therefore, it can be seen that there are serious problems of takeout garbage and white pollution in all cities of the country. The rapid growth of takeout has greatly aggravated the deterioration of related problems [25].

Figure 2. Scale of Users of Online Takeout Business and Mobile Online Users in China from 2017 to 2020. Data sources: www.baidu.com (accessed on 15 March 2021); CNNIC Internet Data Report.

Figure 3. The proportion of various costs of traditional catering and online takeout catering. Data sources: www.baidu.com (accessed on 15 March 2021); CNNIC Internet Data Report; National information center, Annual report on the development of China’s sharing economy, 2019, etc.

At present, China’s annual consumption of plastic tableware reaches 400 to 700 million. Local governments in different regions are advocating less or even zero use of non-degradable plastic packaging products. Some catering industry has also made corresponding rectification, choosing to use recyclable tableware or encouraging the way of eating to reduce the production of white waste. However, in the field of online catering, takeout inevitably depends mainly on plastic tableware. It can be predicted that the order will need at least one set of tableware. The current growth rate of online catering in China is still rising, and the white garbage of plastic tableware will generate infinitely. Additionally,
consumers do not have enough awareness of environmental protection under the concept of convenient dining, so people are unwilling to classify these white pollutions, even thrown away at will [26]. Therefore, a large number of white garbage with the growth of takeout stays latently in our city. After this pollution enters the ecological chain, it is very difficult to degrade completely. According to the survey, only about 14% of global plastic waste can be effectively disposed and recycled. Taking into account the energy use during the process of recycling these plastics, in fact, only one-tenth of the plastic is effectively recycled. Other examples of plastic packaging are often treated inefficiently by simple incineration, landfill or energy recovery systems. In fact, a large number of residual white garbage and plastic packaging caused by takeout gradually accumulated into a long-term, deep-seated, ecological and environmental problem that we can no longer ignore.

5. Hazards of Plastic Pollution of Online Takeout Business

White pollution includes agricultural waste, industrial waste and domestic home waste. The white pollution discussed in the online catering business refers to the pollution of domestic garbage. It includes disposable lunch boxes, disposable plastic bags, disposable spoons and other plastic products. These plastic products need effective recycling and supervision, otherwise, they will cause a series of hazards to human health, society and the environment [27].

5.1. Relevant Hazards to the Ecological Environment

First, the white domestic waste treated by incineration may cause secondary pollution to the ecological environment. Food waste in domestic waste belongs to the scope of combustibles, which may interact with each other and release flammable and explosive gases such as methane in the ordinary hoarding process. Just like the wildfire in the forest, flammable and explosive gases may also cause property losses of surrounding items due to accidental deflagration. In addition, when plastic waste is incinerated, toxic dioxin is also filled in black smoke. When dioxins are absorbed by animals, plants, and crops, they may damage the main organs of the relevant subjects and seriously damage the corresponding functions. Moreover, after dioxin seeps into the surrounding soil, it usually takes at least 15 months to be decomposed, which will further devastate the ecologically sustainable development.

Secondly, the white domestic waste treated by landfill operation may occupy a larger space for waste treatment and pollute the surrounding environment [28]. Plastic products have the characteristics of large volume and small density; therefore, millions of takeout orders can fill up the garbage disposal sites more quickly. After occupying a large area of the sites, it will indirectly restrict the operational capacity of the landfill in disposing of other garbage. Moreover, the site after landfilling generally has the characteristics of a soft foundation, which may provide a chance for toxic and harmful substances such as bacteria and viruses in the garbage to infiltrate into the ground and even pollute the source of groundwater. Even the plastic products are compressed, the added ingredients in the production process may also produce some toxic gases after a long time of placement and pollute the air [29].

Thirdly, the plastic waste thrown into the water may result in a large area of white garbage floating on the surface, affecting the health of benthic organisms and shipping safety. Nowadays, many marine environmental protection organizations in the world called for reducing white waste. In the North Pacific Ocean, 3,500,000 tons of discarded plastic waste products disposed of by human beings are covering an area of 3,430,000 square kilometers, known as “the death place of marine organisms”. Additionally, a large number of white garbage floating on the water surface flowing arbitrarily may affect the navigation of boats and lead to accidents.
5.2. Relevant Hazards to Human Health

Food waste will have harmful effects on human health. White pollution mainly refers to plastic waste and is likely to volatilize toxic and harmful substances under high temperatures. White waste is often treated by incineration, but in the process of incineration, the toxic gases and harmful particles are often volatilized with the high temperature of plastic products. Once the human body inhales toxic and harmful substances, it may cause disease, and may even lead to cancerous consequences [30]. Additionally, research shows that disposable foamed plastics, as takeout catering tableware, can produce more than ten kinds of toxic and harmful substances under certain high temperatures [31]. Now, most of the takeout food is put into the takeout box when it is still hot, therefore the toxic and harmful substances in this tableware may directly affect the absorption of consumers. Keep using disposable foamed tableware for a long time may affect the physical condition of the human body.

Moreover, white pollution is all over the city and suburbs. In recent years, the city appearance renovation of major cities is effective, but in slightly faraway roads, railways, and water bodies, we can still find white garbage containing catering waste discarded at will. This kind of “scenery” will destroy the overall appearance of a city and may also cause the collapse of the ecological balance due to the long-term accumulation of waste and garbage, decay, and related mosquitoes [32].

5.3. Relevant Hazards to Animal

Plastic waste is hard to be degraded, and the plastic waste scattered on land or underwater may be eaten by animals accidentally. Plastic products are difficult to digest, which may lead to the death of animals [33]. From many recent reports, we can see that precious turtles and fishes in the sea are dying because the plastic garbage. It is also common for livestock on land and fish in waters to be killed after eating plastic waste products by mistake. Moreover, the accumulation of waste catering items may become a cave for some harmful animals, providing breeding places for flies, mosquitoes, mice, and other harmful animals, indirectly leading to the occurrence of related infectious diseases.

6. Case Study

While catering e-commerce platform brings convenience, it also brings the continuous growth of white pollution. White pollutants like plastic packaging are also increasing dramatically. Below is a case study on the food delivery giant Meituan. This case will support future analysis of environmental pollutions caused by online takeout companies and strategies to deal with it.

6.1. Case Description of Meituan

At present, three main food delivery providers in China are Meituan takeout, Baidu takeout and Eleme takeout, which account for more than 90% of the total takeout share in China’s domestic market according to the iMedia Consulting Database. These three major takeout platforms are developing from different marketing strategies to expand their user groups under the background of the gradually expanded user numbers. In recent years, these platforms form a tripartite situation in which the three major takeout companies jointly dominate the national takeout market will continue for a long time. Among them, the performance of the Meituan Platform is outstanding, ranking first in the global GMW (Gross Merchandise Volume) ranking in 2018–2019, as shown in Figure 4.
among them, according to the data of 2018–2019, the number of Meituan takeout merchants exceeded 2 million in the whole country, and the takeout online market reached 1/13 of the whole domestic catering market, with an average of one out of four takeout customers being takeout users of Meituan. In recent years, the market share of Meituan users in online catering is dominating, which is greater than the sum of Eleme and Baidu takeout. At the same time, according to the data of the third quarter of 2019, the average transaction price of Meituan takeout has increased to 6.5 USD. From the perspective of the urban distribution of the Meituan takeout users, it is mainly concentrated in the first-tier cities along the coast of China, which occupy 50% of the Meituan takeout catering sales. For example, Shanghai, Beijing, Hangzhou, Guangzhou, and other coastal first-tier cities, as shown in Figure 5.

So, as a typical representative of China’s online food delivery, how to enhance market share and become the first choice of customers and businesses?

On the one hand, Meituan takeout has a flexible strategy to fit specific actual situations. Meituan Platform, working with many other businesses, launched some measures to help the major businesses to resume work under the epidemic. For example, during the epi-
Meituan launched the “spring breeze” activities to provide different user subsidies, internet data red pockets for customers, and commission return plans for partners. This flexible and rapid response to the social environment has greatly increased the market share of Meituan after the epidemic and helps small or medium-sized businesses to resume work. To a certain extent, Meituan alleviated the economic impact of the epidemic on society. From 2017 to 2020, the proportion of delivery business revenue of the Meituan platform was 62%, 58%, 56.2%, and 57% respectively. The relatively stable revenue made this business become a pivotal business of the Meituan enterprise, and also became an important online catering platform for people who are studying and working at home during the epidemic period (as shown in Figure 6).

![Figure 6. Proportion of the Meituan Platform Takeout Business Revenue from 2017 to 2020. Data sources: www.baidu.com (accessed on 15 March 2021); CNNIC Internet Data Report; www.DCCI.com.cn (accessed on 15 March 2021); etc.](image)

On the other hand, Meituan is good at cooperating with third-party catering brands to achieve win–win situation. Meituan takeout can provide efficient and consistent delivery service during and after the epidemic. Customers are satisfied with high standard services and accurate delivery time. For example, third-party cooperation that Meituan took during the epidemic let the platform, third-party company, and customers win together. For example, during the epidemic, the well-known catering brand “Grandma’s Home” only retained the takeout business called Laoyaji and shut down onsite stores in some cities. This is because Meituan takeout and Laoyaji formed a brand cooperation contract. Even during the epidemic, Laoyaji makes good use of their own brand impacts to work with Meituan takeout big data. This effective cooperation brings high-quality services to customers. Various actions soon let the number of online orders surpassed that of onsite dining, and the trend is still growing.

On the other hand, takeout delivery requires timeliness. Meituan guarantees on-time delivery with its efficient delivery systems. If we are looking at the data of Meituan takeout in the first two months of 2020, these data show Meituan’s strong capability of “contactless distribution” and “city-wide delivery”. During this period, the average daily takeout sales of Laoyaji are more than 200, and the total cumulative takeout sales are more than 13,000 orders. For takeout riders, the total income during the epidemic is higher than pre-epidemic. Therefore, Meituan not only achieves the interest of the platform, catering business, and consumers, but also solves social problems like the employment rate.

In conclusion, the Meituan takeout business fully overcomes the drawbacks of many traditional catering brands in China. Traditional catering businesses only provide a single business form, i.e., on-site dining, and so do not have the flexibility to resist risk in the market. By cooperation with third-party catering brands, the Meituan takeout business breaks the traditional mode of catering operation and achieves the “win–win situation”
among platform, merchants, riders and customers. Therefore, the platform expands; restaurants increase their profits; riders get higher income; Customers get more convenient services. Thus, the main accomplishment of Meituan is maximization of the interests of all parties involved in the online catering business.

6.2. Social Arguments about Meituan

When Meituan provides convenience for fast food, it takes into account the interests of the platform, catering business, riders and customers, but ignores the harm to the social and ecological environment. It can be predicted that Meituan cars that travel through the streets and alleys are not only transporting food, but also plastic waste, which is difficult to degrade and dispose of. While Meituan takeout provides convenience for the people, the corresponding plastic waste pollution of takeout is also increasing. This plastic pollution brings a threat to the ecological environment.

The growing white takeout garbage has become one of the urgent problems in the field of environmental protection. In 2017, some institutions accepted the public interest litigation cases of “environmental liability pollution disputes” brought by a green voluntary association against the three major takeout platforms according to law [34]. In this lawsuit, the plaintiff’s cause of action is that the defendant’s platform does not guide and provide customers with the option of “whether to use disposable tableware” when ordering takeout. This indirectly leads to the default use of disposable plastic tableware for each order. Large use of disposable plastic tableware will not only waste a lot of resources, but also seriously damage the existing ecological environment and cause health problems. It can be said that this is the first public interest litigation case in China caused by environmental pollution related to online catering waste.

This public interest litigation case makes all society aware of the environmental problems and challenges of takeout business. People have never thought that this basic livelihood demand will produce a butterfly effect, and then threaten the ecological environment and human health. To a certain extent, it has aroused widespread concern and thought upon society.

For the concern of the whole society and some critical voices, some catering takeout businesses or platforms think that the tableware service provided by the takeout platform is appropriate and ignore the social responsibility.

However, in 2008, China began to announce the implementation of a series of regulations of “plastic restriction”. Even so, it has little impact on people’s daily life. According to related laws and regulations, China lifted the ban on foamed lunch boxes in 2013, while there is no restriction on the rules of plastic tableware boxes, so it is not illegal to use plastic tableware boxes in takeout. At present, China has not issued a unified environmental protection standard for the takeout catering industry. Therefore, as long as takeout businesses do not use tableware that does not meet food safety standards, top three food takeout platform will not have the power to force restaurants to use.

In addition, China has not got the mature technology of environment-friendly disposable tableware, so the cost of environment-friendly disposable tableware is high. Meanwhile, China does not have a relatively perfect regulation or supervision standards of classification and recycling system. Therefore, it is unrealistic and inapplicable to require takeout platforms or businesses to take corresponding responsibility for recycling plastic lunch boxes.

Although the above reasons can be excuses for restaurants and platforms to avoid their responsibility, the deterioration of the ecological environment will give people warnings. Alleviating and solving the problem of plastic pollution is the responsibility of everyone on the earth. For the first time, the green environmental protection organization sued the takeout platform in the public interest’s court. No matter what the results are, this is a public advocacy campaign for the whole society. At present, the e-commerce food delivery platform is a burgeoning Internet industry during the rapid development of “Internet” and “Fast-food Catering”. This new type of business involves the interests of e-commerce
platforms, online stores, traditional catering brands, on-site restaurants, consumers, and food delivery riders. External costs generated from the food delivery business should be applied to all the interest parties. Therefore, the restaurant and takeout platform, as the main producer and source of white pollution, should bear the corresponding responsibility for environmental problems, and balance the economic benefits and environmental protection.

For the platform, it should undertake corresponding obligations. For other parties involved in online catering, this lawsuit is also a comprehensive environmental protection law education.

Because of this public interest litigation case, consumers realize that they can actively choose “not to use disposable tableware” when ordering and can use their own tableware to reduce the cost of ordering, which can effectively improve the problem of white pollution.

If we do not choose “not to use disposable tableware” and choose to use degradable environment-friendly tableware with higher cost, the extra money consumers pay would be regarded as the cost and compensation for polluting the environment. It restricts the white pollution by the price and alleviates the contradiction between demand satisfaction and environmental protection.

Therefore, only people with environmental awareness are willing to bear the corresponding responsibility, be morally constrained by the idea of environmental protection, and pay the cost of environmental protection. Traditional catering enterprises and regulatory authorities also have the responsibility to participate in this initiative.

6.3. Reasons for Environment Pollution Caused by Meituan

This study analyzes the causes and results of environmental pollution caused by Meituan takeout from the following four perspectives.

6.3.1. The Recycling Cost Is Too High, While the Recycling Rate Is Low

With the rapid increase in the number of takeouts, current waste classification in China has not yet classified plastic products into separate categories. Although some transparent polypropylene lunch boxes used in Meituan takeout can be recycled to a certain extent, the composition of disposable plastic tableware is too complex. Chinese food in packaging boxes is cooked at high temperatures, so there are many oily and acid stains. It is difficult to clean up, so the cost is correspondingly higher, while the recycling value is relatively small.

In addition, due to the lack of uniform standards and effective supervision of the government and the state in the field of takeout plastic tableware, excessive printing or color printed on many disposable plastic catering boxes will lead to higher calcium carbonate content in plastic products, which may lead to the migration of harmful substances and heavy metal poisoning. This increases the difficulty of recycling plastic tableware products.

6.3.2. Plastic Packaging Mixed with Municipal Waste Is Not Easy to Deal with

In practice, according to many recycling companies, takeout catering waste recycling volume is actually very low. A number of recycling companies agreed that takeout plastic lunch boxes, disposable chopsticks, disposable spoons and foamed lunch boxes such waste products do not have a lot of recycling value, so they do not recycle catering plastics.

Since there are no companies that want to recycle plastic packaging waste, this white pollution will be mixed into the general municipal garbage dump, resulting in a large number of plastic products mixed into the municipal waste.

Plasticization of plastic products in long-term stacking may also lead to secondary environmental pollution, which requires a balance among costs of waste, waste residue, wastewater, and other issues [35]. Unfortunately, once the catering plastic waste is mixed with municipal waste for stacking, it is even more difficult to sort and classify them [36]. The difficulty and cost will far exceed that of making new plastic products. From the perspective of rational economics, most enterprises are rational to pursue profits. If enterprises obtain relevant state or government subsidies and have to comply with environmental protection
requirements, the possibility of online businesses taking the initiative to undertake recycling work will increase.

Some staff working in renewable materials recycling enterprises said that under normal circumstances, they will not recycle plastic. In addition to the low recycling value and high cost to recycle, doing a recycling business often requires a series of special documents such as certification to prove you have the ability to ecologically recycle waste. However, it is difficult to get these legal documents. Furthermore, even if some of the plastic waste is recycled, it is often recycled in small workshops for reprocessing at a lower price. For the plastic packaging mixed with municipal waste that has not been successfully recycled, the municipal waste mixed with plastics will have a very low success rate in composting. A small number of plastic products sorted out are often difficult to recycle because of their low quality.

6.3.3. Low Effectiveness of Collecting Plastic Packing

For now, China has not established a complete recycling system for takeout plastic products recycling. Most of the jobs rely on decentralized recycling enterprises and scavenging groups, so the rest of plastic waste is stacked in the municipal waste dump. At present, the living space of individual plastic waste recycling groups in China is extremely limited. This will reduce the capacity of takeout catering recycling and white waste disposal in China, resulting in a large number of renewable resources being wasted. From the point of view of recycling and disposal efficiency of recycling groups, renewable resources have the characteristics of insufficient diversion and low efficiency of plastic waste collection. Even most of them will hardly pick up disposable plastic lunch boxes, because these lunch boxes are full of stains, no value to recycle, and hard to make money. In addition, some clean transparent plastic lunch boxes will be selected for recycling, but most of the Chinese lunch boxes are heavy oil and acid, which is difficult to become the object of selection.

However, the selling price of waste plastic bottles is relatively low, so it is also considered a non-essential recycling object. Recycling groups often will not pursue the quantity of waste plastic bottles. In addition, the effectiveness of plastic packaging collection is low, and the recycling field has not formed complete transportation. A large amount of low value-added plastic recycling cannot enter the recycling resources channel, so there is a greater possibility of being mixed into municipal solid waste again. In the long run, it will form a positive cycle that continues to worsen the environment.

6.3.4. Immature Technology and Treatment to Incinerate and Landfill Catering Plastic Waste

Generally speaking, plastic catering waste can be re-processed and utilized after many times of high temperature melting if it is not being polluted. However, the current reality is that due to high oil and acid content in takeout boxes and excessive external packaging, the use-value of takeout plastic is greatly reduced by multiple recycling. Even some recycling companies abandoned recycling them. Therefore, in most cases, after recycling once, these plastic catering waste can only become low-grade products, and then further affect the recycling value [37]. Based on this, a larger proportion of catering plastic waste can only be treated by direct landfill or incineration when it is not recycled and collected. Incineration is a method to reduce the occupancy of plastic bottles in the indoor space of garbage disposal sites. However, plastic food and beverage products are difficult to be sorted when mixed with municipal garbage. Toxic and harmful substances from plastic products will enter the human body in the process of incineration and cause adverse effects on the natural environment and people’s physical and mental health.

Hence, Meituan takeout has brought tremendous pressure to environmental protection. Since plastic tableware waste cannot be effectively treated, it may also cause a series of hazards, such as damage to human health, damage to the living space of animals and plants, and damage to the ecological balance of water and land. These realistic hidden dangers require us to pay attention to explore effective countermeasures to control the
environmental pollution caused by online food delivery platforms. As shown in Figure 7, in the traditional takeout packaging waste cycle [38], the plastic waste of takeout catering is treated by composting, landfill and incineration, and according to common sense, these methods can solve the problem of plastic pollution. However, it is because that garbage is not strictly classified and most online merchants use low-cost non-degradable plastic packaging, the expected effect of composting is difficult to achieve. Additionally, the landfill and incineration of non-degradable plastics will pose a threat to the environment and health. If the traditional way continues, the impact of online takeout food packaging will be incalculable. Therefore, the collaborative innovation and research, and development of packaging materials, and promotion and use of innovative clean and environmentally friendly packaging can make this situation controlled to move in a better direction.

![Figure 7. Disadvantages and Enlightenment of Traditional Takeout Food Packaging Waste Cycle.](image)

7. Discussion of Countermeasures against Takeout Pollution

7.1. Regulators Should Improve the Management System from the Legislative Level

From the macro point of view of the state and government, state and local governments should consider establishing and improving a series of laws and regulations related to food packaging [39]. At present, through the 13th Five-Year Plan and the corresponding construction opinions, China emphasizes that waste recycling and utilization should be adopted. Additionally, the government should rationally plan the classification and disposal of municipal waste. These measures will gradually achieve the comprehensive management goal of harmless municipal waste and improve the utilization rate of municipal waste. However, the above content is only a kind of oath language, and there are no actual laws and regulations to refer to. This leads to the existence of the concept of “no violation is legal” in public interest litigation mentioned above. Therefore, the legislative level should emphasize the packaging design standardization and classification standards of plastic tableware. At the same time, the production enterprises of plastic products should be supervised to a certain extent in terms of technology and product composition. The use of non-toxic, green, environmentally friendly and pollution-free plastic tableware raw materials should be advocated for production to eliminate pollution sources to the greatest extent [40]. As the law enforcers of local management, the government and relevant departments should introduce some policies and regulations to bring the pollution of takeout tableware into the track of legalization. At the same time, a series of positive incentives can also be taken to effectively reduce the pollution of the takeout platform. Moreover, it is necessary to have certain favorable policies and compensation to these companies who want to reduce pollution. All these actions can help to stop the further aggravation of environmental pollution from food delivery platforms. This will help to curb the further aggravation of environmental pollution of the takeout catering platform.
Moreover, at the legislative level, we can consider introducing a new version of the plastic ban, which is mainly aimed at the environmental pollution from catering businesses. For packaging of takeout, in principle, the use of non-degradable and toxic and harmful plastic products is not allowed. For disposable plastic tableware, the government should gradually ban the use of non-degradable spoons and straws city by city. At the same time, large cities can also be encouraged to take the lead in environmental pollution control and protection. For example, restaurants in these cities can provide on-site dining services. When dining no-site, it is not allowed to use non-degradable, toxic and harmful plastic products.

7.2. Industry, Platform and Users Should Enhance Their Environmental Awareness

The takeout industry, platform and customers are the main participants in the environmental pollution of online catering. It is reasonable to assume that they should take responsibility to deal with white pollutions and it is their duty to protect a sustainable ecological environment [41].

First of all, takeout businesses and industry leaders should have environmental consciousness and take the responsibility to guide the industry and customers to be environment friendly. They should respond actively to the pollution problem existing in the online catering business. Takeout catering industry associations can work with environmental protection departments to organize platforms to establish organizations like the “Takeout Green Alliance”. The alliance can formulate takeout environmental protection protocols, which give effective ways to deal with the pollution problem in online catering, so as to promote the self-conscious mechanism of the takeout catering industry. In addition, catering enterprises in the platform can cooperate with scientific research institutions to develop innovative environment-friendly materials for takeout tableware.

Secondly, the takeout platform should promote cooperation with online catering businesses, establish awareness of protection, and achieve win-win developments of the takeout economy and ecological environmental protection. For example, the “Castle Peak Plan” launched in the early stage of the Meituan takeout, that is, when customers place orders in Meituan takeout, customers can choose the option of “no disposable tableware”, then, customers will get the corresponding meal vouchers or network concessions. These are the energy-saving and emission reduction efforts made by the Meituan platform to encourage customers to participate in “self-provided tableware”. Similarly, the Eleme platform also launched resource guarantee measures in the name of “Blue Planet Business Evaluation Guidelines”. The requirements for the back-end processing of takeout tableware of blue planet customers are more stringent, and the platform also provides “takeout zero waste” effective guidance and publicity for merchants. Different platforms need to work together to integrate the unified use of environmental protection packaging, improve the recovery rate of takeout packaging, reduce the number of disposable tableware, and explore the balance between the interests of takeout platform merchants and social responsibility.

Finally, as takeout customers, people should aware of the great harm that takeout catering garbage may cause to the environment, therefore positively reacted to energy-saving and emission reduction measures of the countries and governments, and actively cooperate with the corresponding green takeout activities of major takeout platforms. Customers should use disposable tableware less and use more self-brought tableware, both environmental protection and hygiene in takeout meals. The disposal of kitchen waste should also be classified to reduce the difficulty of domestic waste classification in the later period.

7.3. Explore New Intelligent Waste Sorting Tools and Innovative Environmental Protection Packaging

The classification of plastic waste in the catering industry should also be included in the “garbage classification” project promoted by the state to effectively dispose of the front end of garbage disposal.
First, we should vigorously promote the use of garbage cans with specific classifications in companies and public places and consider setting the catering plastic waste as an independent classification treatment part. Second, we can design and develop garbage classification apps on WeChat. Through the prompts of different Apps and small programs on WeChat, as well as the prompts of the platform when ordering meals, customers can be guided to consciously and purposefully classify kitchen plastic waste. Additionally, the garbage classification Apps should be used to further promote the environmental awareness and social responsibility awareness of cooperative merchants in the selection of kitchen utensils. For example, the notification function of garbage classification Apps can play a warning role by promoting the status quo of catering pollution for the platform and businesses of the vast network catering industry, as well as relevant data. This method will help promote environmental protection. It will gradually affect the traditional business in the choice of takeout plastic tableware, make them give priority to the environmental protection materials, and do not put the lowest cost of tableware in the first place. Some of the tableware is not a necessity, nor does it need fancy packaging. If the apps or small programs such as intelligent garbage classification and evaluation tools are adopted, the merchants will be prompted to choose environmentally friendly plastic tableware that meets the industry norms when choosing takeout tableware.

Furthermore, with respect to the process of environmental pollution mitigation in online catering, focus on one goal at each stage, therefore the environmental protection objectives of online catering can be achieved step by step. Combined with the innovative consciousness of effective environmental protection materials, we practice environmental protection research and development. It needs the joint efforts of all subjects in the takeout catering industry of e-commerce platform, and only by guiding the establishment of a standardized industry environmental awareness can we make substantial progress in the coordination of takeout economy and environmental protection development. As shown in Figure 8, if the online takeout will become the mainstream catering mode, then only from the source, that is the innovative research and development of catering packaging materials and promotion and application, can make the later recycling treatment produce practical results. In this process, food packaging manufacturers, takeout platforms, and takeout businesses can form Research and Development (R&D) organizations through collaborative innovation mode. With the support of government agencies, the consumer’s usage habits are changed through environmental awareness education and the promotion and use of innovative environmental protection materials. Therefore, we should establish the awareness of environmental protection of the consumer, and formulate corresponding plans from the three directions, i.e., economic development, demand satisfaction and environmental protection.

Figure 8. Recycling of environmental protection packaging under collaborative innovation mode.
In short, the joint efforts of various subjects can make substantial progress in the coordinated development of the takeout economy and environmental protection.

8. Conclusions
8.1. Research Results

In the emerging economic model driven by technology engines, online takeout catering in the pandemic period has become an important catering mode. From the perspective of economic benefits and consumer demand, platforms, enterprises and consumers benefit from this. A series of emerging industries such as the food distribution industry and plastic lunch box industry is also booming. However, the environmental and health threats brought about by this have also attracted widespread attention. Based on this, through the literature research, as well as the discussion of the threat of online takeout to the environment and health, case analysis, and the discussion of solving strategies, it provides theoretical and practical research reference for the environmental problems and sustainable consumption of online takeout catering.

First, through the literature review and analysis of online takeout catering, urban waste quantity and waste life cycle management, we found that there are few research studies on environmental and health problems caused by online takeout. We analyze the reasons for the lack of research and practical experience. Based on literature research, we found that the environmental protection rules and regulations of online takeout catering need to be more in-depth and comprehensive discussion and research to be standardized on a global scale.

Second, considering the reality of environmental pollution caused by the growing online takeout catering services, this study describes three hidden dangers of online takeout packaging: environmental pollution, harm to human health, threat to animal survival. In this process, we also analyzed the harm of plastics in online takeout catering. According to the relevant data, the analysis revealed the growing demand for takeout catering services, the irreversible adverse impact of large-scale use of non-degradable plastic lunch boxes on the ecological environment and health, and the harm to the ecological environment and the survival and development of people and animals. This study identified and discussed the environmental and health problems behind this business model, and then found that it is necessary to study the solutions to this problem.

Third, in the research process, we take Meituan as an example. This study introduces the background, business situation, number of users and sales of Meituan. It can be seen from various indicators that Meituan’s takeout food business is on the rise, and it has become one of Meituan’s key businesses. Behind the continuous development of the takeout business, the abuse of non-degradable packaging for takeout food has not been properly resolved and controlled. The continued development of this situation will bring about considerable environmental pressure and health threats. In addition, this research also discusses the measures taken by Meituan to solve this problem, such as calling on online catering shops to guide consumers not to use disposable tableware, but to use family tableware and other environmental protection measures. However, in the face of the huge daily consumption demand for online catering, such measures are far from sufficient to alleviate or solve the environmental pressure and health threats. Based on this, the case study further concluded that there are many online catering platforms and stores similar to Meituan, and the online catering ordering model will soon become one of the main catering models for people. The effective use of this model needs to be regulated by supporting rules and regulations that support sustainable development.

Fourth, through the analysis of Meituan’s environmental pollution cases, this study analyzes four aspects: high recovery cost while low recovery rate, plastic packaging mixed with domestic waste is not easy to deal with, the effect of plastic packaging clearance is reduced, and the incineration and landfill treatment technology and ability of plastic catering waste are weak. This paper discusses the reasons and results of environmental pollution caused by Meituan’s takeout business. Combined with the traditional takeout
packaging waste recycling treatment system, this paper reveals the disadvantages of its application in the treatment of online takeout waste, and draws a conclusion: only through collaborative innovation and R&D on the source packaging materials, and promoting the use of innovative, clean and environmentally friendly packaging, can the environmental damage of online takeout catering be controlled.

Finally, according to the above analysis and discussion process, combined with case analysis, we form the following innovations:

From the perspective of supervision, it is proposed that the regulatory department has the mission and responsibility to implement the coordination of online and offline catering rules and regulations, and improve the management system from the legislative level. The innovation and practice of environmental protection, healthy legislation and rules and regulations closely following the changes of the times is the inevitable requirement of the harmonious coexistence of human society and nature. The purpose of making recommendations from the regulatory level is to provide policy guarantees for the environmental protection, health and sustainable development of online takeout.

From the perspective of enhancing the concept of environmental protection, it is proposed to enhance the environmental protection awareness of the online catering industry, platform and users. Begin with the publicity and education of the subjects participating in online takeout catering, and strengthen the ideological education of environmental and health hazards. Improve the concept of environmental protection and health. Change the status quo that industries, platforms, and users only care about economic benefits and the satisfaction of consumer demand. Establish the most basic online catering environmental protection and health awareness. This will help guide the correct social and environmental protection practice from generation to generation, and provide action guidance for the environmental protection and healthy sustainable development of online takeout catering.

From the perspective of scientific innovation of environmental protection, this paper puts forward some suggestions on scientific environmental protection and innovation. Integrate the participants of the online takeout catering supply chain, and build a collaborative innovation model. Carry out in-depth technological innovations in the environmentally friendly packaging and garbage classification of online food. Explore and develop new intelligent garbage classification tools. Subvert the disadvantages and vicious circle of the combination of online catering waste and traditional recycling system. Fundamentally remove the cancer of environmental protection and health problems of online takeout catering. This scientific innovation needs the long-term efforts of all participants, and provides a realistic guarantee for the environmental protection and sustainable development of online takeout catering.

8.2. Theoretical Contributions

First, the treatment of urban garbage has always been the focus of research on environmental protection and sustainable consumption. In particular, with the development of the Internet and the acceleration of urbanization, many new problems and challenges have emerged. From the perspective of online takeout garbage, this study deeply analyzes its hazards and causes, enriches the research content of urban garbage treatment, and provides a new perspective for the content of urban garbage treatment.

Second, the research on Internet e-commerce platform focuses more on its positive economic effects, such as the driving effect on traditional industries and emerging industries, as well as the consumption changes, such as consumption personalization, socialization, entertainment, etc., while paying less attention to its negative network externalities. With the development of takeout catering platforms, more transactions between businesses and consumers are achieved through online takeout, which means more plastic packaging waste for takeout will be generated. Therefore, based on the case study of China’s largest takeout catering platform, this study deepens the understanding of the network externality of online takeout catering, and provides guidance for improving the development mode of network e-commerce platform.
Third, sustainable consumption meets the needs of the development of the ecological environment, is beneficial to human health, and is a concrete manifestation of the scientific concept of consumption. However, in the era of network economy, sustainable consumption deserves more attention. Consumption in the online environment is like a double-edged sword. Consumers use various demands to push businesses to meet consumer needs through various product innovations, which will inevitably bring many negative effects. Plastic packaging waste for takeout is an important aspect. Therefore, this study enriches the research content of sustainable consumption under the development of the Internet, and provides direction for improving sustainable consumption.

8.3. Managerial Implications

First, the government should improve the garbage collection system. Plastic lunch boxes, as low value-added recyclables, are difficult to enter the recycling channels of renewable resources. Even if consumers take the initiative to classify plastic waste, due to the imperfect recycling system, environmental sanitation vehicles may carry all kinds of waste together and be sent to landfills or incinerators. The improvement of the waste recovery system can effectively prevent the serious pollution of soil, water source and air near the municipal refuse disposal area caused by landfills and incineration without professional treatment.

Second, government management departments should increase the promotion and popularization of reusable and degradable materials, and introduce relevant regulations and laws. Prevent the takeout platform from using disposable, non-recyclable takeout materials due to cost considerations to prevent pollution from the source.

Third, government management departments should encourage relevant scientific research institutions and enterprises to develop and promote the use of disposable environmentally friendly tableware that is lower in cost, more degradable, and less environmentally polluting during the production process. Regulate the access of disposable lunch box manufacturers, prohibit the production of disposable foam tableware, and encourage enterprises to develop and produce biodegradable environmentally friendly tableware; in addition, while strengthening food hygiene and safety supervision, it is necessary to include takeout tableware into the scope of supervision.

Fourth, catering takeout platforms need to actively innovate environmental protection measures. Takeout platforms can carry out special environmental labeling and provide priority display services for catering companies that promise to use environmentally friendly lunch box packaging. For example, when consumers order food on an online platform, the platform can add filter items, and consumers can select environmentally friendly companies with one click. This approach can strengthen the company’s environmental awareness, encourage consumers to choose environmentally friendly packaging, and enhance their attention to environmental protection. On the other hand, the online catering platform can make use of the scale advantage of its business agglomeration to provide a unified long-term plan for the businesses with large consumption of tableware to connect with high-quality environmental protection tableware suppliers, so as to improve the bargaining power of small and micro businesses, and promote the upstream industry to carry out environmental protection tableware production reform with the progress of the demand side.

Fifth, catering businesses should deeply understand the needs of consumers and use biodegradable and environmentally friendly packaging to enhance consumers’ catering experience. Catering companies should pay more attention to the catering experience of consumers in the process of using takeout packaging. For example: paying attention to whether takeout products can maintain their original appearance after they reach consumers after going through the distribution process; whether catering companies can meet the specific needs of consumers in various dining scenarios, such as the size and shape of the lunch box, etc.; and whether catering companies can strengthen the use of environmental protection packaging on sustainable consumption, strengthen the role of
consumers' contribution to environmental protection, allow consumers to have a higher sense of achievement when using environmental protection catering packaging, and use environmental protection packaging to enhance the brand image, which consequently is conducive to enhancing brand competitiveness.

8.4. Limitations and Future Research Avenues

First, this study conducted a case analysis through the largest catering platform in China, Meituan, which is representative to a certain degree. However, the research could also benefit from interviews and surveys, through qualitative research, to explore the factors influencing the ways to reduce the pollution of online catering takeout packaging, and find ways to reduce the pollution of takeout packaging.

Second, the Meituan case of this study reflects the common characteristics of online catering takeout packaging pollution. Nevertheless, follow-up research could select more research objects, select more online catering platforms for research, and analyze their differences in takeout packaging pollution, in order to provide more targeted reference experience and countermeasures to reduce takeout packaging pollution.

Third, this study mainly uses the method of case analysis to explain the causes and countermeasures of online takeout pollution from a qualitative perspective. In the future, we can try to use quantitative research methods to collect first-hand data to conduct quantitative research on the antecedents, results and intermediate mechanisms of online takeout pollution, so as to more clearly and accurately depict the relationship between various factors.

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Abbreviations
The following abbreviations are used in this manuscript:

B2C Business to Consumer
RIE Respiration Index Efficiency
QRIE Quality and Respiration Index Efficiency
MSW Municipal Solid Waste
GMW Gross Merchandise Volume
R&D Research and Development
References


