

IMPACT OF THE SARS-COV-2 PANDEMIC ON WASTE MANAGEMENT AT A RESTAURANT IN TAUBATÉ, STATE OF SÃO PAULO, BRAZIL

Wissam Rifki Akl

Environmental Engineer, Instituto de Ciência e Tecnologia – Sorocaba Campus, Universidade Estadual de São Paulo, Sorocaba, Sao Paulo, Brazil
<https://orcid.org/0000-0002-9122-3909>

Gerson Araujo de Medeiros

Professor of the Graduate Program in Environmental Science, Instituto de Ciência e Tecnologia – Sorocaba Campus, Universidade Estadual de São Paulo, Sorocaba, Sao Paulo, Brazil
<https://orcid.org/0000-0002-5646-7991>

All content in this magazine is licensed under a Creative Commons Attribution License. Attribution-Non-Commercial-Non-Derivatives 4.0 International (CC BY-NC-ND 4.0).



Abstract: The SARS-CoV-2 pandemic brought social, economic, environmental and cultural impacts to contemporary society. One of the impacted sectors was solid waste, requiring public and private managers to adapt to emerging realities. The objective of the present work was to evaluate the impact of the SARS-CoV-2 pandemic on the solid waste management of a restaurant in the municipality of Taubaté, state of São Paulo, Brazil. For about two years (October 2020 to October 2022), the following waste generated in an Arab food restaurant was collected and classified, including: organic waste (food leftovers), and dry waste (aluminum, plastic, PET, long-life packaging). Two periods were analyzed: a) during the period of social isolation (October 2020 to July 2021), when sales were made through the delivery system; b) during the reopening period for face-to-face service (August 2021 to October 2022), when sales resumed in person, but maintaining the delivery system. The results showed a significant growth of 238% in the monthly generation of waste, after the reopening of the restaurant for face-to-face service. However, a downward trend was observed in the period from June to October 2022, due to the growth in delivery sales. The results allow us to conclude that the change in customer behavior due to the pandemic increased delivery sales and transferred waste disposal to the final customer, affecting the management of solid waste in the evaluated restaurant.

Keywords: Organic waste, recyclable waste, environmental management.

INTRODUCTION

The SARS-CoV-2 pandemic affected the solid waste management system in several countries. According to the report “*Global analysis of health care waste in the context of covid-19: status, impacts and recommendations*

”, it is estimated that more than 85 thousand tons of personal protective equipment (PPE) were sold between the years 2020 and 2021. In addition, the document points out that more than 140 million test kits have been used worldwide, with the potential to generate 2,600 tons of waste. Such waste consisted mostly of plastics, but contained 731,000 liters of chemical waste (WHO, 2022). Vaccine distribution also generated a significant amount of waste, including 140 thousand tons of hospital materials (syringes, needles and safety boxes), from more than 8 billion doses distributed globally (WHO, 2022).

In Brazil, research has evaluated the impact of the SARS-CoV-2 pandemic on municipal solid waste (MSW) management, with emphasis on Penteadó & Castro (2021) (management recommendations and their applicability), Urban & Nakada (2021) (environmental impacts on MSW management systems), Oliveira et al. (2022) (impacts on MSW management in the Amazon). In addition to a few studies on the subject, there is a concentration of studies related to municipal management. However, specific sectors were affected differently and lack specific research, such as food service.

The pandemic interfered with the dynamics of commercial establishments, such as restaurants, due to *lockdown periods* and health restrictions that prohibited face-to-face service (HUETE-ALCOCER & HERNANDEZ-ROJAS, 2022, HACIOGLU-HOKE et al., 2021). Thus, restaurants and snack bars had to adapt to a new business model and use of technology, such as the *delivery system*, during the *lockdown period* (SOUZA et al., 2022). According to the company *IFood*, the number of establishments registered on the company’s platform, considered small or medium, grew by 27% in 2021, corresponding to 84% of the entire base registered in the *IFood* app (IFOOD, 2022).

After the long period of *lockdown*, ended by the advance of vaccines, restaurants resumed their face-to-face services, impacting waste generation and management. However, there is a scarcity of studies in the literature on the impact of the SARS-CoV-2 pandemic on the management of waste generated in the restaurant sector, especially in small and medium-sized enterprises. Solid waste generated in snack bars, bars and restaurants can be divided into two categories: organic and inorganic. Organic waste is mostly made up of food scraps and needs adequate storage, due to its perishable nature. Inorganic waste is generated from industrialized products, such as packaging. Thus, the correct management of this waste can generate financial return to the establishment, through the reuse and recycling of materials (PAES et al, 2021).

The objective of the present work was to evaluate the impact of the SARS-CoV-2 pandemic on the solid waste management of a restaurant. A characterization of the main waste generated in an Arab food restaurant in Taubaté, state of São Paulo, Brazil, was carried out during a two-year time interval, encompassing the period of social isolation and that of reopening for face-to-face service.

METHODOLOGY

CHARACTERIZATION OF THE RESTAURANT

The study was carried out at the Tenda Arabic restaurant, with typical Arab cuisine, located in the municipality of Taubaté, state of São Paulo, Brazil (23° 01' 51" S, 45° 32' 54" W). According to IBGE (2021), the city has an estimated population of 320,820 inhabitants, an IDHM (Municipal Human Development Index) of 0,800, and per capita GDP reaches around US\$ 8,500.

The family-run restaurant opened in March 2017. The place can receive up to 80 people simultaneously, and has five extra employees

for service. It is only open at night, from 7:00 pm to 11:00 pm from Tuesday to Sunday. Following Arabic cuisine, the restaurant has a menu of traditional foods, which are usually consumed with the hands.

The establishment only offers Arab snacks, portions and typical pastes, accompanied by traditional breads. The snacks most consumed by the public accompany a garlic mayonnaise that is made in the restaurant. The basis of recipes is milk, including curd and other dishes. For this reason, the restaurant generates a considerable amount of long-life packaging. Snacks and spreads are wrapped in paper and served on disposable plates. Snack fillings are basically composed of salads and a protein of the customer's choice, except for vegetarian and vegan snacks. The restaurant also serves non-alcoholic drinks such as soft drinks, iced teas, juices and water. Currently, the restaurant works both in person and with the *delivery service*. A computerized system is used to manage the establishment (*Consumer software*), which makes it possible to monitor and manage both stock and the number of orders, best-selling dishes and type of consumption (*delivery* or *face-to-face*).

CATEGORIES OF WASTE GENERATED

The characterization of waste generated in the restaurant prioritized those that were more expressive in quantitative terms. Other types of materials and waste are used and generated at very specific times, thus making their generation negligible, such as glass and styrofoam. The waste categories selected were:

- a) Plastic (except PET): from disposable packaging, juice bottles and frozen food storage containers;
- b) Aluminum (Al): corresponds to cans of soft drinks and carbonated drinks, and disposable thermal packaging;

- c) Polyethylene terephthalate (PET): generated by the consumption of soft drinks, iced teas and water;
- d) Long life packaging (LL): from all the milk used in the preparation of dishes and recipes;
- e) Organic waste: generated in the preparation and production of food, and by the remains left on dishes consumed by customers on site.

SEPARATION AND QUANTIFICATION OF WASTE GENERATED

At the end of each shift, at night, all waste generated was separated and stored according to its category. Dry waste (plastic, PET, Al, LL) was stored in bags provided by a cooperative of collectors in Taubat . The organic residue, manually separated, was placed in plastic bags and stored in a refrigerator.

The weighing of each category of waste was carried out using a mechanical scale, from October 2020 to October 2022. The organic material, due to its perishable nature, was weighed over a two-day interval, while the dry waste was weighed weekly.

The period from October 2020 to July 2021 corresponded to that of social isolation due to the SARS-CoV-2 pandemic, when the restaurant did not provide face-to-face service to the public. From August 2021 to October 2022, the restaurant's in-person food services resumed. Only in October 2021 did the restaurant remain closed and it was not possible to collect data, leading to its exclusion from the analyzes carried out.

RESULTS AND DISCUSSION

Table 1 presents the results of the monthly generation of wet and dry solid waste from the Tenda Arab restaurant, during the period of social isolation. During this period, the total

generation reached 48.5 kg of solid waste, or 4.9 kg/month. Organic solid waste had the highest generation (52.9% of the total), followed by plastic (26.1%) and long-life packaging (20.9%).

Table 2 shows the monthly generation of the Tenda Arabic restaurant after the return of face-to-face service. During this period, the total generation of solid waste rose to 195.4 kg (14.0 kg/month), representing an increase of 188%, when comparing the monthly generation rates of waste in the two evaluated periods. Such growth is explained by the generation of dry waste, particularly Al and PET, due to the consumption of beverages by customers in the restaurant itself. Despite the increase in the generation of dry waste, organic waste stood out and reached 52.1% of the total generated, followed by Al (18.2%), PET (11.1%), plastic (10.2%) and long-life packaging (8.4%).

ORGANIC WASTE

The generation of organic waste showed a growth of 183%, when comparing the average values of the two evaluated periods. During the period of social isolation, when food was sold only via delivery, the generation rate reached 2.55 kg/month. Upon resuming service to the public at the restaurant, this fee rose to 7.25 kg/month. Considering the period of one year, after the face-to-face return, the total generation of organic waste totaled 83 kg. According to Martins et al. (2022), Brazil wastes around 39,000 tons of food per day, making it one of the 10 countries with the highest food losses in the world. Globally, it is estimated that around 15% to 20% of the food produced is lost in the collective meals and restaurants sector (KAKITANI et al., 2014). Waste of organic food in restaurants is related to amounts left on plates by customers, as observed in countries such as Uzbekistan (FILIMONAU et al., 2022), Turkey (CERRAH

Month year	Organic	Aluminum	Plastic	PET	Long life
----- g -----					
oct/20	3065	0	1600	0	1190
nov/20	2911	0	1500	0	1120
dec/20	1673	0	820	0	700
jan/21	1817	0	699	0	630
feb/21	3071	0	1553	0	1225
march/21	2667	0	1536	0	1120
apr/21	2738	0	1291	0	1085
may/21	2633	0	1225	0	1015
Jun/21	3024	0	1279	0	1190
Jul/21	2071	0	1162	0	875
Average	2567.0	0	1266.5	0	1015.0
DP	525.0	0	308.3	0	210.6
CV	20.5	----	24.3	----	20.8

Mean: Arithmetic mean; SD: standard deviation; CV: Coefficient of variation

Table 1. Gravimetry of waste generated at the Tenda Arabe restaurant, in Taubaté – SP, during the period of social isolation of the SARS-CoV-2 pandemic.

Month year	Organic	Aluminum	Plastic	PET	Long life
----- g -----					
aug/21	8389	3155	1817	2306	1330
sept/21	9102	3010	1812	1924	1260
nov/21	8845	3005	1843	2173	1330
dec/21	5778	1950	1029	1353	770
jan/22	5099	1690	893	1060	700
feb/22	9708	3130	1627	1760	1330
march/22	8707	3205	1521	1751	1365
apr/22	8041	2960	1349	1431	1260
may/22	7741	3046	1259	1411	1155
Jun/22	8165	2665	1287	1383	1225
Jul/22	5862	2131	1056	1166	980
aug/22	6307	2010	1919	2070	1400
sept/22	5955	2000	1494	1009	1260
oct/22	4176	1553	1122	808	1050
Average	2567.0	0	1266.5	0	1015.0
DP	525.0	0	308.3	0	210.6
CV	20.5	----	24.3	----	20.8

Mean: Arithmetic mean; SD: standard deviation; CV: Coefficient of variation

Table 2. Gravimetry of waste generated at the Tenda Arabe restaurant, in Taubaté, state of São Paulo, Brazil, during the return period of face-to-face service.

& YIGITOGLU, 2022) among others.

The significant increase in the average generation of organic waste at the Tenda Arab restaurant is due to the consumption of food by customers on site, since in the period of social isolation of the SARS-CoV-2 pandemic, the generation of this category of waste was only due to the preparation of food on the property.

The trend observed in the generation of organic waste presented two distinct moments. The first period can be seen in Figure 1, encompassing the last three months of the period of social isolation, and the months of the beginning of the face-to-face return. In the first months of the face-to-face return, the average generation of organic waste grew by 238%. This significant increase is probably due to psychosocial issues, at the end of the population's confinement period, motivating face-to-face social interaction (BLAND et al., 2022).

The second period analyzed corresponded to the last eight months of the research period, from March to October 2022. In Figure 2, a significant downward trend in the generation of organic waste can be seen. The average rate of decrease of this generation reached 0.58 kg/month and a correlation coefficient of 0.85. This phenomenon is related to the growth of the delivery service, which prevailed during the period of social isolation. Thus, the pandemic brought about a change in behavior in the population, which began to use the delivery service more, affecting the management of solid waste at the analyzed restaurant.

An alternative for managing organic waste found by the Tenda Arabe restaurant was its donation for composting. The restaurant partnered with an organic producer in the city of Taubaté. In exchange for this donation, the restaurant receives vegetables from the aforementioned farmer. Such food

is used in the establishment allowing an economic return, since it receives products free of charge or with differentiated market prices, in addition to guaranteeing the best destination for this waste. However, not all the organic residue generated is consumed by the producer, due to the rapid putrefaction of this residue due to the climatic condition of Taubaté, especially in the summer, when the average reaches 26 ° C. Thus, it would be necessary to remove this residue from the restaurant on a regular basis daily, or its refrigeration, an economically unfeasible alternative. Consequently, part of the organic waste generated in the restaurant is sent to the municipal landfill, through the municipal collection service. This is a trend in restaurants in Taubaté, which send dry and recyclable waste mixed with organic waste to the landfill. In the literature, organic restaurant waste has also been recommended as feed for animals such as chicken, after recycling, due to its fat, calcium, phosphorus and other nutrients, as highlighted by Garnida et al. (2022). However, in the municipality of Taubaté there is no structure for this destination.

ALUMINUM

The aluminum packaging was only collected after the face-to-face return, as during the period of social isolation, disposable thermal packaging, soda cans and other carbonated drinks were discarded by customers in their homes. During this period, 35.5 kg of aluminum was collected (August 2021 to October 2022) or 2.5 kg/month.

The downward trend observed in the generation of aluminum packaging followed that of organic waste, as can be seen in Figure 3. The average rate of decrease in the generation of this category of waste reached 0.24 kg/month, with a significant linear trend, expressed as a correlation coefficient of 0.94. This phenomenon corroborates that observed

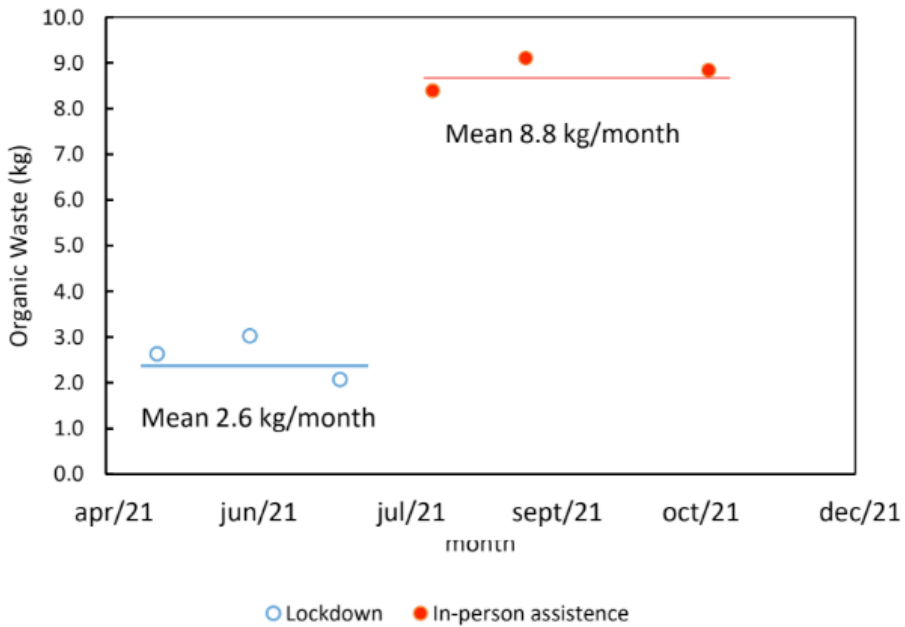


Figure 1. Generation of organic waste at the Tenda Arabic restaurant in the last months of the social isolation period (May to July 2021) and at the beginning of the face-to-face return at this establishment (August to November 2021).

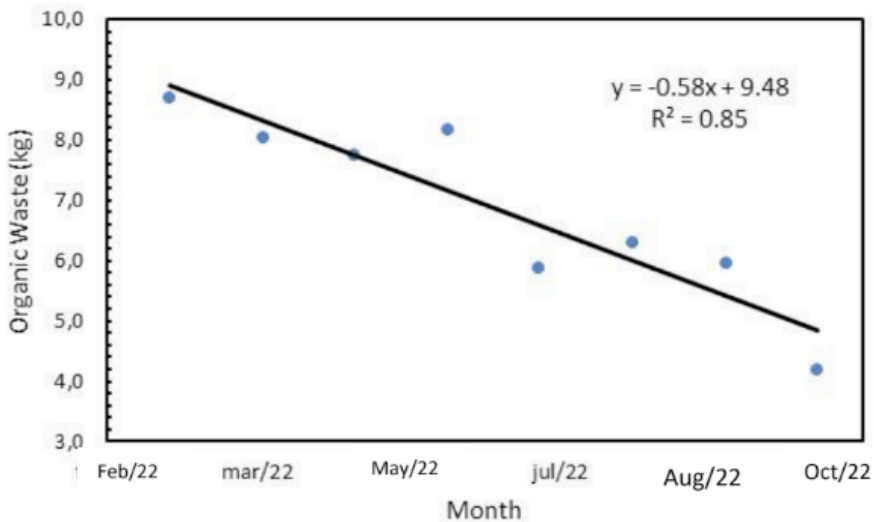


Figure 2. Variation in the generation of organic waste at the Tenda Arabe restaurant from March to October 2022.

for organic waste, due to the growth of the delivery service, as sales of products that generate Al did not decrease in this period.

The aluminum generated in the restaurant is easy to store and handle, and makes it possible to sell it in the municipality of Taubaté. The average price of aluminum reaches US\$ 1.00/kg, representing an economic value of US\$ 36.00, in the face-to-face return period. This waste has been donated to collectors, promoting the circular economy and with a social character.

PLASTIC

At the Tenda Arabic restaurant, the average generation of plastic waste increased by 13%, after the return of face-to-face service. This growth was much lower than that observed in organic and aluminum waste, as plastic waste consumed by customers, in the face-to-face format, corresponded only to juices. However, in the restaurant, plastic waste generated from disposable packaging and frozen food, used in food preparation, predominated. For this reason, a significant linear trend of reduction in the generation of this waste was also not observed ($R^2 = 0.0011$) in the most recent months of this research (Figure 4), representing a waste generation rate of approximately 0.004 kg/month.

Plastic, in the food sector, is a residue that is easy to handle and store. In addition, in the municipality of Taubaté there are several collection and purchase locations for this type of waste. However, estimating the economic value becomes difficult due to the diversity of types, composition and classification of plastics. As with aluminum, the Tenda Arab restaurant donates plastic waste to recycling cooperatives in the municipality.

POLYETHYLENE TEREPHTHALATE (PET)

Like aluminum, PET was only generated in

the restaurant during the face-to-face period, since it comes from packaging of soft drinks, water and iced teas, which were consumed by customers in the establishment itself. During the period of social isolation, these drinks were marketed by *delivery*, being discarded by the final consumer. The accumulated total of this residue reached 21.6 kg from August 2021 to October 2022.

Although not significant, a linear downward trend was observed in the PET generation rate (Figure 5), which reached 0.082 kg/month, from March to October 2022. This downward trend can be explained by the commercialization of drinks by delivery, since the average monthly sale of these products remained the same in the evaluated period. In Taubaté, several establishments and cooperatives sell PET, either by selling the material for recycling or transforming the waste into handicrafts. The direct sale of PET reaches an average price of US\$ 0.50. The Tenda Arabic restaurant donates this waste to cooperatives and collectors in the municipality.

LONG LIFE PACKAGING

The increase in the average generation of long-life packaging waste reached 15.5%, after the return of face-to-face service. Months with higher sales and more open days produced more waste. Figure 6 shows the variability in the generation of this type of waste, leading to a linear trend of little significance. This phenomenon does not allow visualizing an effect of delivery on the generation of this waste in the restaurant. However, the average reduction rate reached 0.12 kg/month after the face-to-face return. One of the alternatives for managing this waste is selling or donating recyclable materials to cooperatives. Another option is to allocate this waste to the Taubaté Selective Collection service, implemented in June 2017, the alternative most chosen by

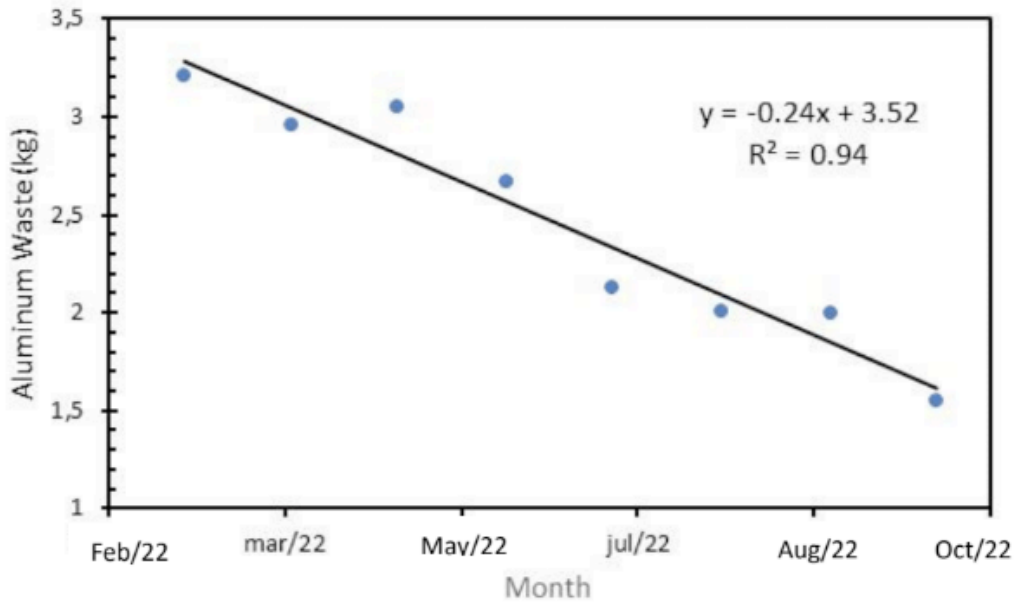


Figure 3. Variation in the generation of aluminum waste at the Tenda Arabe restaurant from March to October 2022.

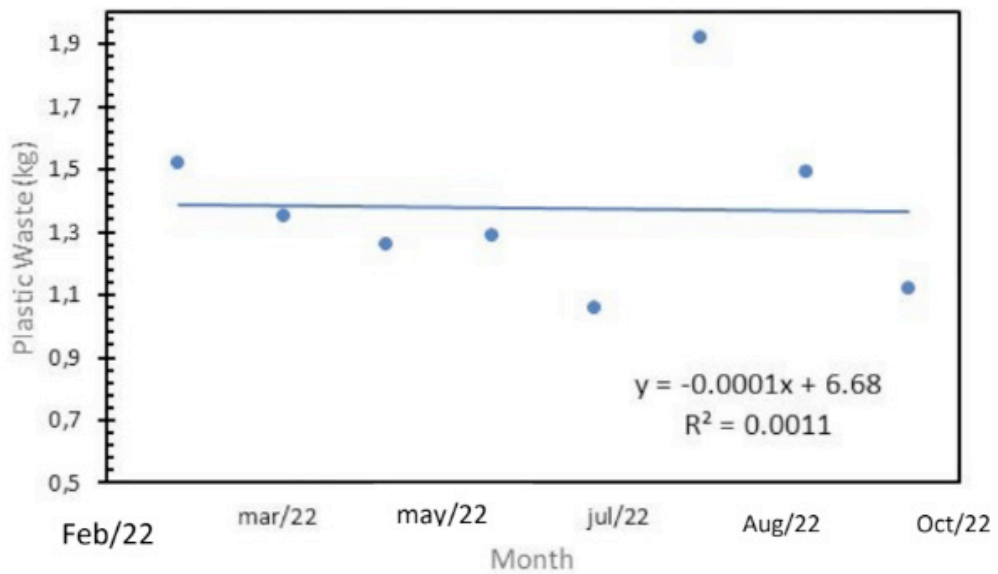


Figure 4. Variation in the generation of plastic waste at the Tenda Arabe restaurant from March to October 2022.

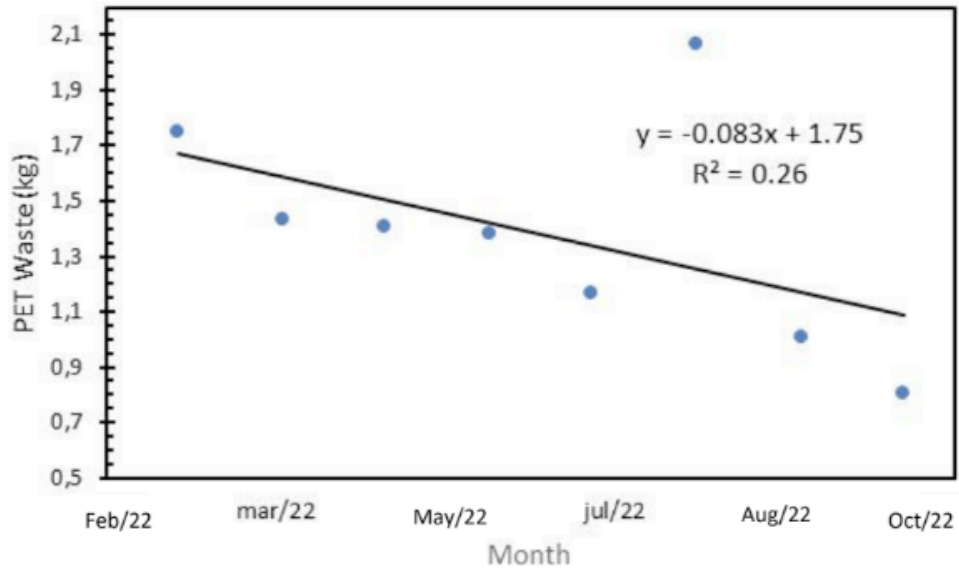


Figure 5. Variation in the generation of PET waste at the Tenda Arabe restaurant from March to October 2022.

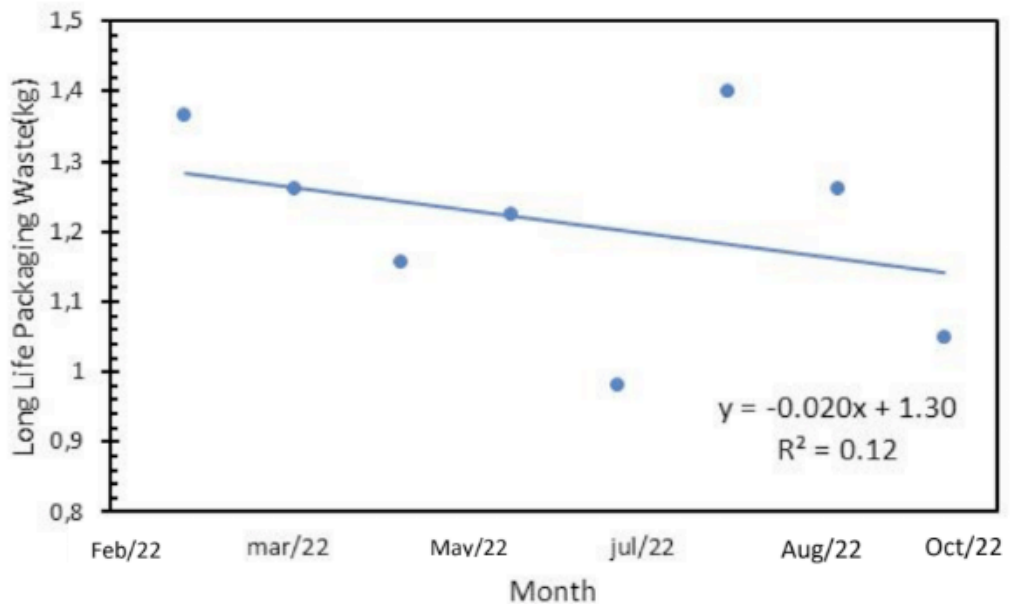


Figure 6. Variation in the generation of long-life packaging waste at the Tenda Arabe restaurant from March to October 2022.

the population. Since the implementation of this service, more than a thousand tons of recyclable material have been collected per semester.

CHANGE IN CUSTOMER BEHAVIOR AND ITS INFLUENCE ON WASTE GENERATION

Most of the restaurant's solid waste showed a decreasing generation trend in the last months of this survey, especially for organic waste, aluminum and PET; despite the increase in waste generation with the return of face-to-face service, from June to October 2022. To analyze this phenomenon, all requests for orders received from June to October 2022 were surveyed (Table 3). Such information was collected through the *Consumer software*, used by the Tenda Arab restaurant for financial, inventory and order control.

The restaurant's sales, in the evaluated period, remained approximately constant, as can be deduced by the coefficient of variation of 5.2% and by Figure 7, which allows visualizing a linear trend of relative growth of delivery in total orders. During this period, most of the restaurant's orders corresponded to the delivery system, which ranged from 72% to 88%. Therefore, the results demonstrate that the change in customer behavior, due to the social isolation caused by the SARS-CoV-2 pandemic, led to a trend towards an increase in delivery orders. This trend has also been observed in the United Kingdom (HACIOGLU-HOKE et al., 2021), China (WANG et al., 2022) and Italy (ALAIMO et al., 2022), after the reopening of social isolation. Globally, the delivery system grew by 9.5% in the period from 2019 to 2020, due to the SARS-CoV-2 pandemic (SOUZA et al., 2022). Thus, the digital habit has been influencing consumer behavior, which has gained more confidence in the service after a

test period imposed by the *lockdown*.

An offshoot of the delivery growth trend is related to solid waste management at restaurants, forcing the sector to readapt to such changes. In this context, the final consumer assumes responsibility for disposing of part of the waste generated by the sector of restaurants, snack bars and other food establishments.

CONCLUSION

The results of this research made it possible to assess the effects of the Sars-Covid pandemic on the waste management of a restaurant. The in-person reopening of the restaurant increased waste generation in the first few months. This increase was driven by higher generation of organic waste, due to food leftovers left by customers, and dry waste, mainly aluminum and PET, due to beverage consumption. However, a downward trend in generation has been observed, due to the increase in delivery sales, when there is a transfer of waste disposal to the final customer.

The dynamics in the customer-restaurant relationship affected the solid waste management of the evaluated establishment. The city of Taubaté provides good destination options for the dry waste generated in the restaurant (aluminum, PET, plastic, long-life packaging), however, there was a greater difficulty in the destination of organic waste, as an alternative to disposal in landfills.

Month year	Total orders	delivery	Delivery/Total (%)
Jun/22	467	337	72
Jul/22	451	385	85
aug/22	514	449	87
sep/22	458	391	85
oct/22	472	416	88
Average	472.4	395.6	83.4
DP	24.6	41.3	0.1
CV	5.2	10.4	0.1

Table 3. Variation in the number of total orders and deliveries at the Tenda Arabic restaurant, from June to October 2022

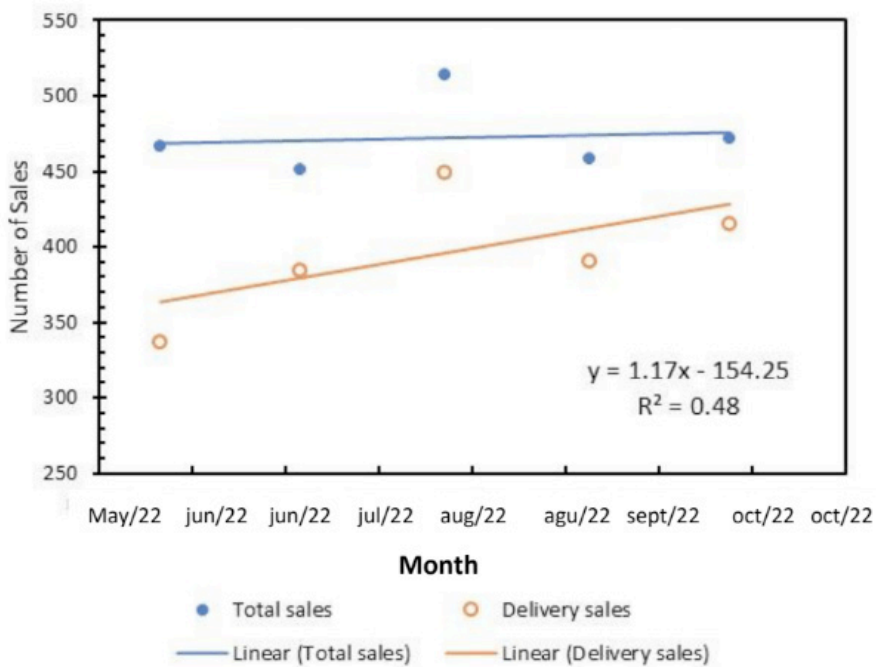


Figure 7. Ratio between the total number of orders and those for delivery at the Tenda Arabic restaurant, from June to October 2022.

REFERENCES

- ALAIMO, L.S.; FIORE, M.; GALATI, A. Measuring consumers' level of satisfaction for online food shopping during COVID-19 in Italy using POSETs. **Socio-Economic Planning Sciences**, v.82, 101064, 2022. <https://doi.org/10.1016/j.seps.2021.101064>
- BLAND, A.R.; ROISER, J.P.; MEHTA, M.A.; SAHAKIAN, B.J.; ROBBINS, T.W.; ELLIOTT, R. The impact of COVID-19 social isolation on aspects of emotional and social cognition. **Cognition and Emotion**, v.36, n.1, p.49-58, 2022. <https://doi.org/10.1080/02699931.2021.1892593>
- CERRAH, S.; YIGITOGLU, V. Determining the effective factors on restaurant customers' plate waste. **International Journal of Gastronomy and Food Science**, v. 27, 100469, 2022. <https://doi.org/10.1016/j.ijgfs.2022.100469>
- FILIMONAU, V.; MATYAKUBOV, U.; ALLONAZAROV, O.; ERMOLAEV, V.A. Food waste and its management in restaurants of a transition economy: An exploratory study of Uzbekistan. **Sustainable Production and Consumption**, v.29, p. 25-35, 2022. <https://doi.org/10.1016/j.spc.2021.09.018>
- GARNIDA, Y.; RUDIANSYAH, M.; YASIN, G.; MAHMUDIONO, T.; KADHIM, A.J.; SHARMA, S.; HUSSEIN, H.A.; SHICHIYAKH, R.A.; ABDELBASSET, W.K.; Acim Heri ISWANTO, A.H. Investigation of parameters in restaurant food waste for use as poultry rations. **Food Science and Technology**, v. 42, e118621, 2022. <https://doi.org/10.1590/fst.118621>
- HACIOGLU-HOKE, S.; KÄNZIG, D.R.; SURI, P. The distributional impact of the pandemic. *European Economic Review*, v.134, p.103680, 2021. <https://doi.org/10.1016/j.euroecorev.2021.103680>
- HUETE-ALCOCER, N.; HERNANDEZ-ROJAS; R.D. Do SARS-CoV-2 safety measures affect visitors experience of traditional gastronomy, destination image and loyalty to a World Heritage City? *Journal of Retailing and Consumer Services*, v.69, 103095, 2022 <https://doi.org/10.1016/j.jretconser.2022.103095>
- IBGE. Instituto Brasi @Cidades: Taubaté, São Paulo, 2021. Disponível em: <https://cidades.ibge.gov.br/brasil/sp/taubate/panorama>. Acesso em 24 Janeiro 2023.
- I FOOD A força do delivery: pequenos e médios crescem no Ifood. Disponível em: <https://news.ifood.com.br/a-forca-do-delivery-pequenos-e-medios-crescem-no-ifood/> Acesso em 24 Janeiro 2023
- KAKITANI, R.; SILVA, T.I.F.F.; SHIINO, E.T. Desperdício de alimento no pré-preparo e pós-preparo em um refeitório industrial. **Revista Ciências do Ambiente**, v.10, n.1, p.30-35, 2014.
- MARTINS, M.R.S.F.; VIANA, L.F.; CAPPATO, L.P. Food waste profile in Brazilian Food and Nutrition Units and the implemented corrective actions. **Food Science and Technology**, v. 42, e100421, 2022. <https://doi.org/10.1590/fst.10042>
- OLIVEIRA, B.O.S.; MEDEIROS, G.A.; ALVES, R.C. Gestão de resíduos sólidos durante a pandemia do COVID-19 na região da Amazônia Ocidental, Brasil. *Research, Society and Development*, v. 11, n. 4, e26811427434, 2022. <http://dx.doi.org/10.33448/rsd-v11i4.27434>
- PAES, M.X.; MEDEIROS, G.A.; MANCINI, S.D.; RIBEIRO, F.M.; OLIVEIRA, J.A.P. Transition to circular economy in Brazil: A look at the municipal solid waste management in the state of São Paulo. *Management Decision*, v. 59, n. 8, p. 1827-1840, 2021.
- PENTEADO, C.S.G.; CASTRO, M.A.S. Covid-19 effects on municipal solid waste management: What can effectively be done in the Brazilian scenario? *Resources, Conservation and Recycling*, v.164, p.105152. <https://doi.org/10.1016/j.resconrec.2020.105152>
- SOUZA, T.S.P.; MIYAHIRA, R.F.; MATHEUS, J.R.V.; NOGUEIRA, T.B.B.; MARAGONI-SANTOS, C.; BARROS, F.F.C.; ANTUNES, A.E.C.; FAI, A.E.C. Food services in times of uncertainty: Remodeling operations, changing trends, and looking into perspectives after the COVID-19 pandemic. *Trends in Food Science & Technology*, v.120, p.301-307, 2022. <https://doi.org/10.1016/j.tifs.2022.01.005>
- URBAN, R.C.; NAKADA, L.Y.K. COVID-19 pandemic: Solid waste and environmental impacts in Brazil. *Science of the Total Environment*, v. 755, p. 142471, 2021.

WANG, X.; ZHAO, F.; TIAN, X.; MIN, S.; CRAMON-TAUBADEL, S.; HUANG, J.; FAN, S. How online food delivery platforms contributed to the resilience of the urban food system in China during the COVID-19 pandemic. **Global Food Security**, v.35, 100658, 2022. <https://doi.org/10.1016/j.gfs.2022.100658>

WHO. World Health Organization - Global analysis of healthcare waste in the context of COVID-19: status, impacts and recommendations. Geneva: World Health Organization; 2022.