



The Current Use and Management of Single-Use Items (SUIs) in the Fast Food Industry in Ho Chi Minh City, Vietnam

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ABSTRACT

This study aims to determine the composition and the weight of individual single-use items (SUIs) generated in the selected fast-food restaurants (FFRs) in Ho Chi Minh City (HCMC), Vietnam. A semi-structured questionnaire was used to collect data of SUIs consumed per day from 126 FFRs covering six popular fast food companies (FFCs). At the same time, waste from 30 FFRs was collected, and its composition and weight were determined. Consequently, the amount and composition of the waste varied among the studied FFCs and is dependent on the food menu, the number of franchises for each FFC, customer number, size, and the type of SUIs used at these restaurants. Total waste collected across the six FFCs was 6 t.d^{-1} and was equivalent to 1560 t.yr^{-1} in HCMC. Of which, single-use plastic items (SUPIs) waste and single-use paper items (SUPAls) waste accounted for 39% and 28%, respectively. The total weight of unnecessary SUPIs (condiment containers, straws, and forks) generated was about 44 t.yr^{-1} . The results suggest that the necessity of standardizing the type and size of the SUIs used at the FFRs, phasing out the use of unnecessary SUPIs, improving the local waste management practices through material recovery and recycling.

INTRODUCTION

The fast-food industry (FFI) has rapidly developed for decades due to the economic development and an increase in the “on the go” consumption culture. The global fast-food market is growing at a compound annual growth rate of 4.2% and is estimated to be worth more than \$690 billion in 2022 (Zion Market 2017). Single-use plastic items (SUPIs) are commonly used in fast-food restaurants (FFRs), small packaging industries, and retail shop owners and grocery stores for product delivery, and they treat plastics as waste rather than a valuable resource. Thus, the FFI generates a considerable amount of packaging waste or single-use items (SUIs) that include cups, containers, cutlery, straws, lids, and bags. Most packaging waste comes from dining areas (39%), followed by kitchen areas (36%) and outside restaurants (25%) (Aarnio & Hämäläinen 2008). Plastic packaging accounted for 47% of the globally generated plastic waste, with more than 50% originating from Asia (UNEP 2018b). It is estimated that food delivery packaging waste account for 1% of the annual municipal solid waste generated in China (Song et al. 2018). Most packaging waste in the FFI is landfilled, although its theoretical recovery potential was 93%, and only 29% of the packaging waste is recovered (Aarnio & Hämäläinen 2008).

The disposal of packaging waste, especially plastic waste, is considered as wasting resources, polluting the environment, especially, the marine environment where there is prolong biophysical breakdown of plastics (Leal Filho et al. 2019, Moharir & Kumar 2019). Therefore, addressing SUPIs and plastic packaging in the FFI should be considered as one of the priorities to deal with ocean pollution.

The consumption of SUIs, including single-use plastic items (SUPIs) and single-use paper items (SUPAls), has been increasing due to the development of the FFI in urban areas (Gautam & Caetano 2017). With the introduction of online food ordering and home delivery, especially through the use of mobile devices, a sharp increase in SUIs consumption in the FFI has been reported (Gautam & Caetano 2017). It is estimated that more than 69% of customers have ordered food by using mobile devices (Gupta 2019). Notably, plastic packaging waste accounts for one-third of total plastic production, much of which is used for the production of SUPIs (UNEP 2016). Globally, 360 million tons of plastic were produced in 2018 with 51% of total plastic production originating from Asia (Plastics 2019) and nearly 40% of plastic was discarded after a single use (Ocean Conservancy 2019). It has been estimated that 12,000 Mt of plastic waste

will be disposed to landfills or in the natural environment by 2050 (Geyer et al. 2017). For example, in 2015, 146 Mt of primary non-fiber plastics was used in the packaging industry, which is mainly composed of polypropylene (PP), polystyrene (PE), and polyethylene terephthalate (PET), that contributed significantly to plastic packaging waste (Geyer et al. 2017). In particular, in the FFI, it is estimated that plastic packaging waste accounted for 11% of the waste generated in McDonald's restaurants in Finland (Aarnio & Hämäläinen 2008). Additionally, plastic containers made of PP and polystyrene (PS) accounted for approximately 75% of the total packing waste in high-populated megacities in China (Song et al. 2018), one of the major countries contributing to global marine plastic pollution (Ocean Conservancy 2019).

With a growing concern of ocean pollution caused by SUPIs, many countries have introduced policies to phase out SUPIs (Ocean Conservancy 2019). To date, 27 countries have introduced a ban on the manufacture, distribution, use, sale, and/or import of SUPIs (UNEP 2018a). However, only 22 countries have banned specific products, such as plastic plates, cups, and utensils while, 16 countries have prohibited materials of polymers, most commonly polystyrene and expanded polystyrene (UNEP 2018a). In ASEAN countries, 18 cities in Indonesia have planned to ban bags, straws, and foam containers for food by 2025 (Akenji et al. 2019). Similarly, Malaysia will also ban drinking straws by 2030, whilst Thailand is planning to phase out SUPIs in 2022 (Akenji et al. 2019).

Vietnam is one of the five major countries that is importing plastic waste through the transboundary agreement (UNEP 2018a). With the increased awareness about ocean plastic pollution, Vietnam has enacted limited policies on SUPIs, except a levy on plastic bags (UNEP 2018b). Vietnam is ranked as the eighth-most valuable market for global food chains (Vietnam: Vietnam ranks eighth for global franchise expansion - ProQuest, n.d.). In particular, the food and beverage sector accounts for the major share of consumers' monthly expenditure, which grew by 18% in 2018 (Vietnam: Vietnam's food processing, packaging sector thriving - ProQuest, n.d.). In Vietnam, Kentucky Fried Chicken (KFC), Lotteria, Jollibee, Pizza Hut, and The Pizza Company recorded revenues of VND5 trillion (\$213.5 million) in 2018, an increase of 13% from 2017 (Vietnam: Fast food chains in the slow lane amid focus on health - ProQuest, n.d.). Interestingly, the waste generated by the FFI in Vietnam is considered commercial waste and is collected and landfilled along with the waste generated from hotels and restaurants (Verma et al. 2016). Ho Chi Min City (HCMC) is the largest city in Vietnam. In 2018, the amount of municipal solid waste generated in HCMC was about 8,900 t.yr⁻¹, of

which, food waste accounted for 60%, followed by plastic waste (14%). A survey of 752,000 Vietnamese people, with 50% of respondents in HCMC, indicated that they would prefer either to eat out in quick services (36%) or to choose a restaurant (50%) because of its convenience (DecisionLab 2016). Data collected from websites of the above-mentioned six popular FFCs indicated that there are approximately 520 FFCs in Vietnam. Of which, Lotteria owns 210 franchise restaurants, followed by 140 KFC restaurants, 100 Jollibee restaurants, 26 Popeyes Stores, 20 Texas Chicken, and 23 McDonald's restaurants across the country. Nevertheless, research in solid waste management of the FFI is still limited (Aarnio & Hämäläinen 2008), especially of the FFI in Vietnam. To our knowledge, the composition and management of SUIs in the FFI in HCMC has not been investigated. The study aims to determine the weight and the composition of SUIs consumed and disposed of per day as well as to examine the waste generation and management in FFCs in HCMC.

MATERIALS AND METHODS

Research Design

The study aims to determine the type, composition, and total weight of individual SUIs consumed and disposed of per day as well as to examine waste generation and management in the selected FFCs in HCMC. Accordingly, this research was carried out by collecting both qualitative and quantitative data (see Fig. 1).

The qualitative data were collected by using a semi-structured questionnaire to quantify the daily and annual waste generation, and management practices at the selected FFRs in HCMC. The qualitative research collected data of SUIs from 126 respondents of 163 surveyed restaurants belonging to six popular FFCs (Lotteria, KFC, Jollibee's, Popeyes Stores, Texas Chicken, and McDonald's) in HCMC. The data was then calculated for 183 FFRs of six FFCs in total in HCMC during the period of the survey in 2017 (see Table 1).

The survey included four sections with 40 questions (from Q.1 to Q.40), and qualitative data were collected. The semi-structured questionnaire focused on the following main sections. Section 1: General information about fast food restaurant profile with seven questions (from Q.1 to Q.7) focused on the restaurant's location, and the number of customers visiting restaurants every day. Section 2: SUIs use and management with 18 questions (from Q.8 to Q.25). These questions were about the composition and the number of SUIs consumed per day. The data collected from the survey were also used in quantitative research. Section 3: Waste generation and management with 13 questions (from Q.26 to Q.38). These questions concentrated on current

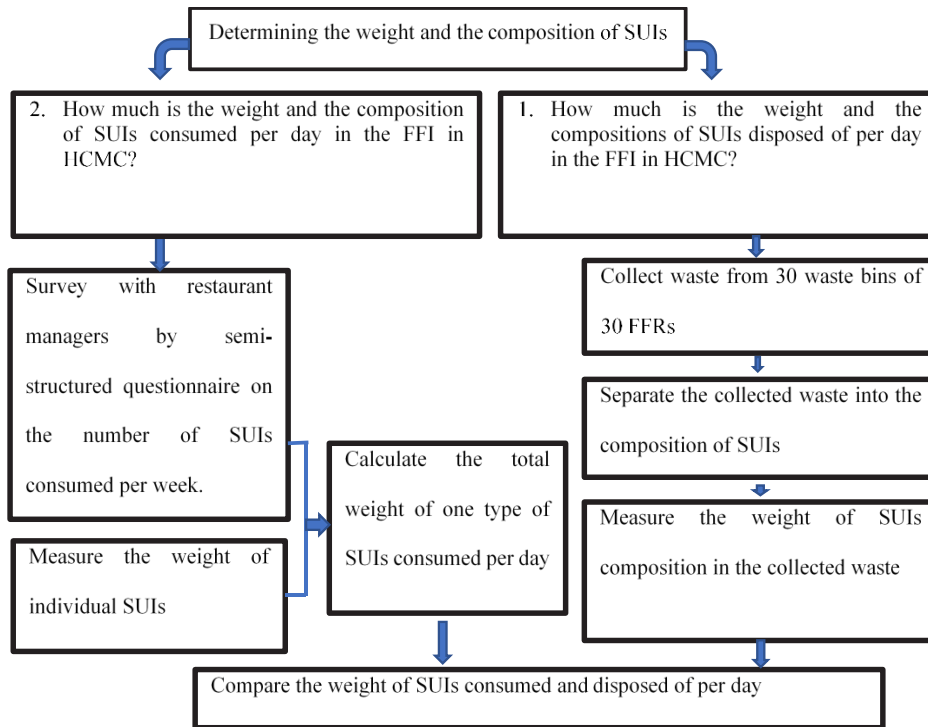


Fig. 1: The process of determining the weight and the composition of SUIs in FFRs in HCMC.

waste management in the surveyed restaurant. Section 4: Manager's experience in restaurant management with two questions (from Q.39 to Q.40). Most of the questions were multiple-choice questions. In this questionnaire, section 2 was used for quantitative research. Section 2 of the questionnaire focused on asking restaurant managers about the number of SUIs consumed per week. The respondents were restaurant managers who are responsible for waste management and general supervision. From the websites of FFCs, the information about restaurants' addresses was used for the survey process.

Primary data was collected from 30 waste bins randomly

selected from the 30 restaurants (see Table 1). The collected waste was then separated and weighed into the following components: (1) SUPIs (condiment containers and lids; cutlery; bottles; cups; straws; condiment bags; other plastics); (2) food waste; (3) SUPaIs (cups, bags, other papers); (4) other waste. The weight of the individual components was also measured, and their percentage in the total sample was determined.

Fast Food Industry Survey

Fast food restaurant profile: Six popular FFCs in HCMC were selected for the study as presented in Table 1. In 2017,

Table 1: The total number of FFRs used for survey and waste collection through dedicated waste collection bins in HCMC in 2017.

FFC	Total restaurants		Number of FFRs surveyed (n_1)	Number of FFR used for waste collection from waste bins (n_2)
	r^1	%		
Lotteria	90	49.18	62	11
KFC	49	26.78	34	6
Jollibee's	14	7.65	10	4
Popeyes Stores	11	6.01	8	3
Texas Chicken	10	5.46	7	3
McDonald's	9	4.92	5	3
Total	183	100	126	30

¹ Source: Websites of fast food companies in Vietnam in 2017

there were 183 FFRs for the six selected companies in HCMC. Data collected from websites of FFCs in Vietnam during the period of the survey shows that the biggest chain of FFCs in HCMC is Lotteria with 90 restaurants, followed by KFC, Jollibee, and Popeyes Stores with 49, 14, and 11 restaurants, respectively. Later, two more FFCs came into existence, Texas Chicken and McDonald's, with 10 and 9 restaurants, respectively. One hundred sixty-three restaurants belonging to the six selected FFCs were surveyed. Of which, 37 FFRs declined to respond. Thus, 126 FFRs participated in the survey and were randomized as per Solvin's formula (Perdana 2018). For each FFC, 50% of the sample size was surveyed in suburban districts, and the remaining rest were surveyed in central districts of HCMC.

Profile of the respondents: Of the total 163 FFRs, managers from only 126 FFRs agreed to participate in the survey. Some managers did not agree to participate or were too busy at the time of the survey. Sometimes, only one of the two shift managers agreed to participate in the survey. Most of the managers who participated in the survey had worked previously as a crew at the same restaurant before becoming a manager.

Sampling: Managers' participation in the research was voluntary and they signed a consent form with confidentiality of responses. The survey was carried out for four months (January 2017 through April 2017). The population size (N) was the total number of FFRs belonging to the selected six FFCs in HCMC (N =183 retrieved from websites of FFCs) during the period of the survey (2017). With confidence level $e = 0.05\%$, using Solvin's formula (Perdana 2018), the total number of restaurants that participated in the survey ($n = 126$) was estimated as shown in the equation (1):

$$n = \sum_1^6 n_1 = \frac{N}{1+N(e)^2} = \frac{183}{1+183*(0.05)^2} = 126 \dots(1)$$

The number of FFR surveyed for each FFC (n_1) was calculated based on the percentage of the number of restaurants that each FFC owned in HCMC, which was multiplied by the sample size ($n = 126$). Value n_1 of one FFC was calculated by using the equation (2):

$$n_1 = r/N*100\%*n \dots(2)$$

Collection and Compositional Analysis of Fast Food Restaurant Waste

Grab samples of waste were collected from 30 FFRs belonging to the six selected FFCs (value n_2 , column 5, Table 1). The collected waste was separated into five main compositions: (1) SUPIs (cutlery, cups or containers, condiment bags, condiment containers and lids, straws, other plastic); (2) food waste; (3) SUPaIs (cups, bags, other paper); and (4)

other waste. The separated components were then weighed by using a weighing balance (Kingship, Model: KD-TBED). In each waste bin, a large plastic bag was placed to collect the waste. Upon filling up, the bag was brought and placed in the dedicated area of the restaurant yard. Thus, the bags in the study were collected from dedicated areas.

Calculations

The number and the weight of SUIs consumed per day: The total weight of individual SUI is denoted as w_1 (gram). Data on the number of SUIs consumed per week (Monday through Friday) is denoted as m (items/week) and this data was provided by the restaurant managers. The total number of SUIs consumed per day by an FFR is denoted by m_1 (items).

$$m_1 \sum_1^{n_1} m \dots(3)$$

The total average weight of SUIs consumed per day by all surveyed restaurants is denoted as q_1 (kg/day) in the equation [4].

$$q_1 = m_1 * w_1 \dots(4)$$

The average number of SUIs consumed per day by an FFR belonging to any FFC is denoted by m_2 (items/day).

$$m_2 = m_1/n_1 = (\sum_1^{n_1} m) / n_1 \dots(5)$$

The total weight of SUIs consumed per day by one FFC is denoted by q_2 (kg/day). The value r (the number of FFRs of one FFC in HCMC during the period of the survey) is presented in Table 1.

$$q_2 = m_2 * r * w_1 \dots(6)$$

The total weight of SUIs consumed per day by six selected FFCs is denoted by q_3 (kg.week⁻¹). The total number of SUIs consumed per day by an FFC is m_3 (items/day).

$$m_3 = m_2 * r \dots(7)$$

$$q_3 = \sum_1^6 q_2 \dots(8)$$

The study also compares the q_2 value among the studied FFCs. The difference in q_2 value will provide the total weight of each SUIs consumed per day at each FFC. This q_2 value is variable and is dependent on the number of FFRs established in HCMC. Similarly, the q_3 value indicates the difference in the total weight of each type of SUIs consumed per day by six FFCs in HCMC. The q_3 and m_3 values vary depending on the weight, and the number of individual SUIs consumed per day.

Amount of SUIs waste collected from the waste bins and estimating the total amount of waste generated by six fast food companies: The total amount and the composition of waste generated per day by FFC were calculated by weighing each separated SUI collected from the waste bin

and expressed as a_1 (kg/day/bin). The number of waste bins generated per day at one FFR is denoted by u (bins/day/restaurant). The average weight of each SUI generated per bin at any FFR is denoted by a_2 (kg/day/bin/restaurant) in the equation (9).

$$a_2 = \frac{\sum_1^u a_1}{u} \quad \dots(9)$$

The average number of waste bins generated per day by one FFR is u_1 (bins/restaurant) (10), while n_2 is the number of restaurants whose waste was collected (column 5, Table 1).

$$u_1 = \frac{\sum_1^{n_2} u}{n_2} \quad \dots(10)$$

The estimated total weight of each SUI generated per day by FFC is denoted as a_3 (kg/day) and the number of FFRs for each FFC in HCMC is denoted as k (restaurants/company). From the above three values a_2 , u_1 , and k , the weight of SUIs generated per day by each FFC (a_3) was calculated by using the equation (11) shown below:

$$a_3 = a_2 * u_1 * k \quad \dots(11)$$

The weight of SUIs generated per day by each FFC (a_3) is compared with the q_3 value.

RESULTS AND DISCUSSION

Waste Management in FFRs

Waste management at each FFR is started by collecting waste in the dining area and the kitchen area of the FFR. Therefore, each FFR has two types of waste bins, one in the dining area and the other in the kitchen area. A black plastic bag of 200 L capacity is generally placed in the waste bins. When the bag is full, it will be transferred to a dedicated area of the restaurant. Thereafter, a restaurant crew collects these bins and move them outside of the restaurant to be picked up by the waste collection truck and transported to landfills. The District Public Services Company Limited (DPSC) or HCMC Urban Environment Company Limited (CITENCO) of each district is responsible for transporting them to landfills. During the time before these bins are collected by DPSC or CITENCO, there are sometimes waste pickers coming to look for salable SUPIs such as plastic bottles in these bins. However, all cutlery, straws, and cups with lids as well as bags made of plastic are not picked up by these informal pickers due to their low values.

With respect to SUI management, each FFR places an order with the headquarter for the delivery of a certain number of SUIs. These SUIs are delivered directly to the concerned FFRs on a regular basis. SUIs used at each studied FFR are qualified and met the standard of QCVN 12-4:2015/BYT

on national technical regulation on the safety and hygiene of glass, ceramic, porcelain, and enameled implements, containers, and packaging in direct contact with food. In turn, each FFCs orders their supply chain to manufacture SUIs meeting their requirements. Regarding the use of SUPIs at the FFRs, there are no policies to limit the use of SUIs per customer. These findings suggest that restaurant managers can improve the use of SUPIs by encouraging their staff to ask customers if they want to use SUPIs or limit the number of SUPIs delivered to their customers based on the order, which leads to a reduction in the number of SUPIs released into the environment.

Waste Generation and Waste Composition

Waste generation: The estimated daily waste (Monday through Friday) generated at the studied FFCs is presented in Fig. 2B and Fig.3. Results showed that approximately 6 t/d of waste was generated at the studied FFCs and is dependent on the location of the FFR and the number of customers visited. Of the total waste, SUPIs accounted for 39.4%, followed by food waste (32.7%) and SUPaIs waste (27.5%) (see Fig. 2B).

The survey result also indicated that the studied FFCs had only one day off due to the Tet holiday in HCMC. Thus, the total waste generated for one year (260 days) was estimated to be 1,560 t.yr⁻¹, excluding the weekends. Of which, plastic waste originating from SUPIs (SUPIs waste) would account for 590 t.yr⁻¹. These findings were in accordance with previous research, which reported that the percentage of food waste and inorganic waste accounted for 30% and 70%, respectively, of the waste generated in KFC outlets in Semarang, Indonesia in 2015 (Alfagi et al. 2015). These findings were also in line with previous research in Italy, which reported that food waste accounted for approximately 28% of the waste generated in Fano seafood restaurants in 2019 (Tatàno et al. 2017).

Among the six FFCs, Lotteria produced more than 2 t/d, followed by KFC with 1.4 t/d (Fig.3). The highest daily waste generation noticed for Lotteria than other FFCs in the study was because Lotteria had the highest number of restaurants (90) operating in HCMC. McDonald's with the lowest number of restaurants (9), produced 1 t.d⁻¹ of waste more than the other three FFCs (Fig.3).

Notably, the survey indicated that on average, more than 500 customers were registered at McDonald's every day - the highest average number of customers visited in comparison with other FFRs. Evidence shows that the food menu, material consumption, and waste management policies of FFC played a critical role in the amount of waste generated. The waste management policies of FFCs also influenced the composition and recovery of SUPIs (Hilaro 2014). In particular, McDonald's generated a large amount

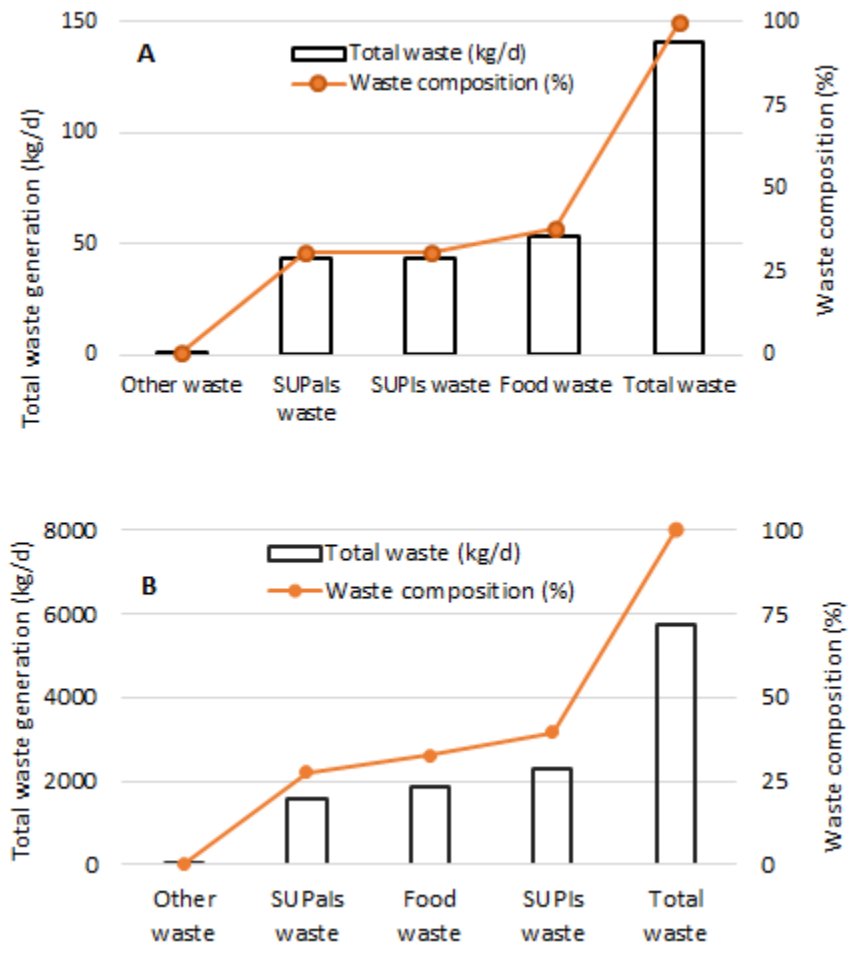


Fig. 2: Total waste amount (kg/d) and its composition (%) from the waste (A) collected from 30 waste bins across the selected six FFCs (B) Estimated for 183 FFRs in HCMC.

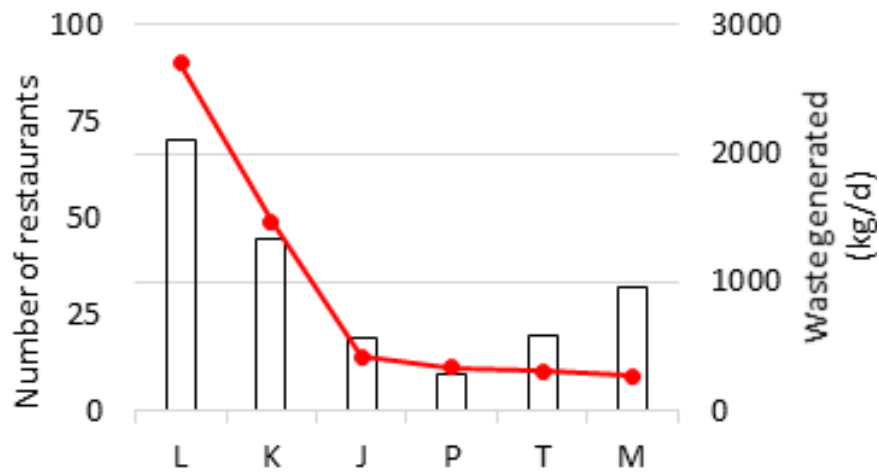


Fig. 3: Total number of FFRs and the amount of waste generated across the studied six FFCs in HCMC. Note: L: Lotteria; K: KFC; J: Jollibee's; P: Popeye Stores; T: Texas Chicken and M: McDonald's.

of paper waste and was planning to use packaging material that was 100% derived from renewable resources, recycled or certified by 2025 (Packaging and Recycling - McDonald's, n.d.). Accordingly, McDonald's policy currently indicated that 50% of the company's guest packaging originates from renewable or certified sources. These policies affected considerably the composition of waste the company-owned restaurants generate.

Organic waste and non-organic waste: The composition of waste generated in FFRs and the consumption of SUIs are presented in Fig 4. Overall, a significant variation in the composition of waste generated across the studied FFCs, especially with SUIs, was noticed for both 30 waste bin data and the calculated waste data for the 183 restaurants. Of the total waste, organic waste, i.e., food waste generated by the customers (post-consumption), accounted for 37.8% of the total waste in the 30 waste bins (Fig. 4A). This finding was in line with the previous research, which reported that organic waste accounted for 30% of waste reported in KFC outlets in Semarang, Indonesia (Alfagi et al. 2015).

The corresponding value for the 183 restaurant waste was 33% (Fig. 4B). The total SUIs waste, i.e. SUPIs and SUPaIs together accounted for 61.7% of the total waste in 30 waste bins (Fig. 4A) and 67% of total waste calculated for 183 FFRs (Fig. 4B). This difference in the composition of food waste and SUIs was obviously due to the difference in the number of restaurants, food menu, packaging material consumed, and policies adopted by each FFC on the use of SUIs. For instance, FFCs Lotteria and KFC consumed a large amount of diversified SUPIs in comparison with the other FFCs. Further, the number of restaurants for both Lotteria (90) and KFC (49) was higher than the other four FFCs in HCMC, thereby resulting in generating vast amounts of SUPIs wastes. Nevertheless, the proportion of SUIs waste

(67%) noticed in the present study was 1.5 lower than the value of 93% reported for packaging waste at McDonald's in Finland in 2006 (Aarnio & Hämäläinen 2008) due to the improvement in material consumption and waste management policies of these FFCs over last ten years. In particular, for McDonald's, 50% of the company's guest packaging originated from renewable or certified sources (Packaging and Recycling - McDonald's, n.d.). This company has eliminated packaging through innovating material and design (Packaging and Recycling - McDonald's, n.d.). Similarly, KFC has applied and performed corporate social responsibility (CSR) successfully since 2012, which considered the environment as one of four factors in their CSR reports (Bediako 2018). On the other hand, the menu of both companies' restaurants in HCMC focused on Vietnamese traditional dishes (more rice) that were significantly different from the normal fast foods. All these solutions led to a reduction in the amount of packaging waste generated in comparison with the research in Finland in 2006. However, this result was also in accordance with 70% of inorganic waste reported at KFC outlets in Semarang, Indonesia in 2015 (Alfagi et al. 2015). It can be explained that the same component of waste was generated in both regions, which consist of plastic and beverages packaging and drinks leftover (Alfagi et al. 2015). In addition, in both countries, it was not obligatory for FFRs to separate the waste into different components for recycling. This led to the similarity in the component of the inorganic waste of KFC outlets in Semarang and HCMC.

Within SUIs, SUPIs and SUPaIs accounted for 30.8% and 30.9% respectively for the total SUIs generated in 30 waste bin data (Fig. 4A). The corresponding values for 183 FFR were 39.4% and 27.5%, respectively. Interestingly, SUPIs waste noticed in the present study was 2.3-3.5 times higher than the value reported in the literature. In particular,

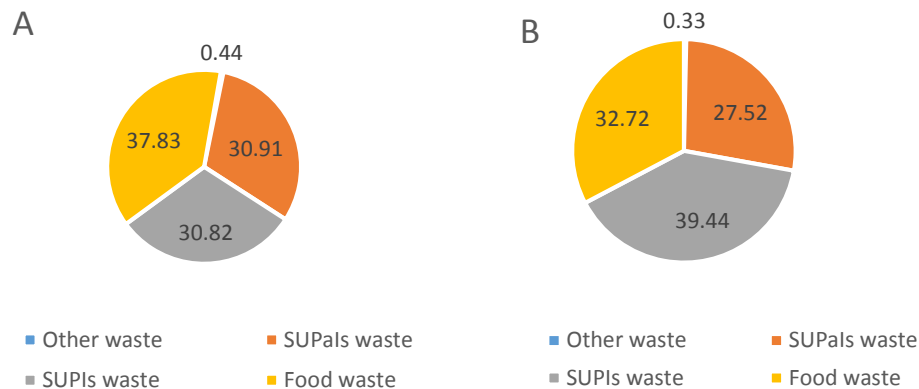


Fig. 4: The percentage of waste composition and SUIs disposed at the studied restaurants in HCMC: (A) Data of waste composition collected from 30 waste bins, (B) Data of waste composition estimated for 183 FFRs.

plastic waste accounted for 11% of total waste generated at McDonald's restaurants in Finland in 2006 (Aarnio & Hämäläinen 2008), which was 2.8 to 3.5 times lower than this study's findings. This can be explained as the consequence of the difference in McDonald's policies in several developed countries and Vietnam. In particular, although McDonald's has set its policy on the type of packaging materials to be used for its operations since the 2000s, the packaging material consumed was 22% of the global plastic packaging for function and safety of food worldwide (Packaging and Recycling - McDonald's, n.d.). However, the survey process in HCMC indicated that the McDonald's-owned restaurants still used a variety of SUPIs, such as spoons, forks, knives, straws, condiment containers, and cups as presented in Table 2. Thus, the percentage of plastic packaging waste at

McDonald's in Finland in 2006 was lower than these findings. Similarly, SUPIs accounted for only 17% of the waste generated in seafood restaurants in Fano, Italy (Tatàno et al. 2017), which was 1.8 to 2.3 times lower than the percentage of SUPIs in the waste generated by the studied FFRs. It can be explained that restaurants in Fano, Italy served seafood that was preferred in the dining area instead of taking them away as fast food. Additionally, Finland and Italy were two of the European countries that issued policies on the limitation in the use of SUPIs (UNEP, 2018a). In contrast, the large percentage of SUPIs (30,8% of the waste in 30 bins and 39.4% of the waste calculated for 183 restaurants) in the waste generated the studied FFRs was 2.8 times higher than the value of 14% of plastic waste reported in the municipal solid waste in HCMC. The difference could be explained

Table 2: The type and the weight of individual SUPIs used by six FFCs (g).

Type of SUPIs	Lotteria	KFC	Jollibee's	Popeyes Stores	Texas Chicken	McDonald's
Plastic spoon 1	-	1.38	-	-	-	2.67
Plastic spoon 2	3.80	2.88	3.37	3.50	2.84	3.65
Plastic fork	2.83	3.08	3.02	2.85	2.99	3.57
Plastic knife	-	-	-	-	2.8	3.81
Plastic straw	0.64	0.47	0.44	0.52	0.56	0.52
Plastic condiment container	0.58	0.86	0.47	0.81	1.02	0.58
Small plastic lid	1.55	1.39	1.68	1.98	-	1.80
Big plastic lid	2.7	4.62	-	-	2.30	-
Plastic cup	14.4	13.6	-	-	13.21	20.39
Plastic ice cream cup	5.47	9.01	-	-	-	-
Plastic container	37.85	5.61	-	-	-	-
Plastic bag	4.22	6.07	6.36	-	-	3.13
Styrofoam container	-	-	4.03	-	-	-
Big paper cup	12.06	10.66	9.26	9.02	10.71	9.03
Small paper cup	7.08	9.00	7.16	-	-	-
Paper ice cream cup	6.68	-	7.93	-	-	9.78
Paper tea cup 1	-	-	10.14	-	-	-
Paper tea cup 2	-	-	13.98	-	-	-
Medium paper bag	8.00	6.96	5.68	6.21	5.84	5.92
Large paper bag	-	-	6.19	-	-	9.18
Small paper bag	3.05	7.05	5.77	4.42	1.2	9.41
Wrapping paper	2.85	1.64	3.24	2.85	2.68	2.24
Paper container 1	-	8.32	-	-	-	7.57
Paper container 2	-	17.48	-	-	5.87	11.2
Paper container 3	-	27.09	25.29	28.40	34.98	13.09

Note: (-) Not used.

by the significant contribution of domestic waste (60-70%) to the municipal solid waste generated in HCMC (Thang et al. 2018).

Composition of SUPIs and SUPAls

Data on the number and weight of SUIs consumed per day collected from the FFRs is presented in Table 2 and Fig. 5.

In particular, the estimated amount of SUIs consumed per day across the 183 FFR was 2.49 t (Fig. 5A and Fig. 5C). Of which, the amount of SUPAls (57% - 1.41 t - Fig. 5C) was 1.3 times higher than the SUPIs (43% - 1.08 t - Fig. 5A). In contrast, the amount of SUIs waste generated was 3.87

t (Fig. 5B) with SUPIs share (2.27 t) was 1.42 times more than that of SUPAls waste (1.6 t). The reason for this difference was that many customers brought takeaway drinks or food from other food services when they visited the studied FFRs. This increased the number of SUPIs disposed of in the studied FFRs.

Fig. 5B shows that the number, type, and weight of individual SUPIs consumed varied across the six FFCs in HCMC. Plastic cups accounted for the highest weight (400 kg), followed by plastic lids (193 kg). This result was in accordance with the previous results, which indicated that 75% of food delivery packaging waste in Chinese megacities

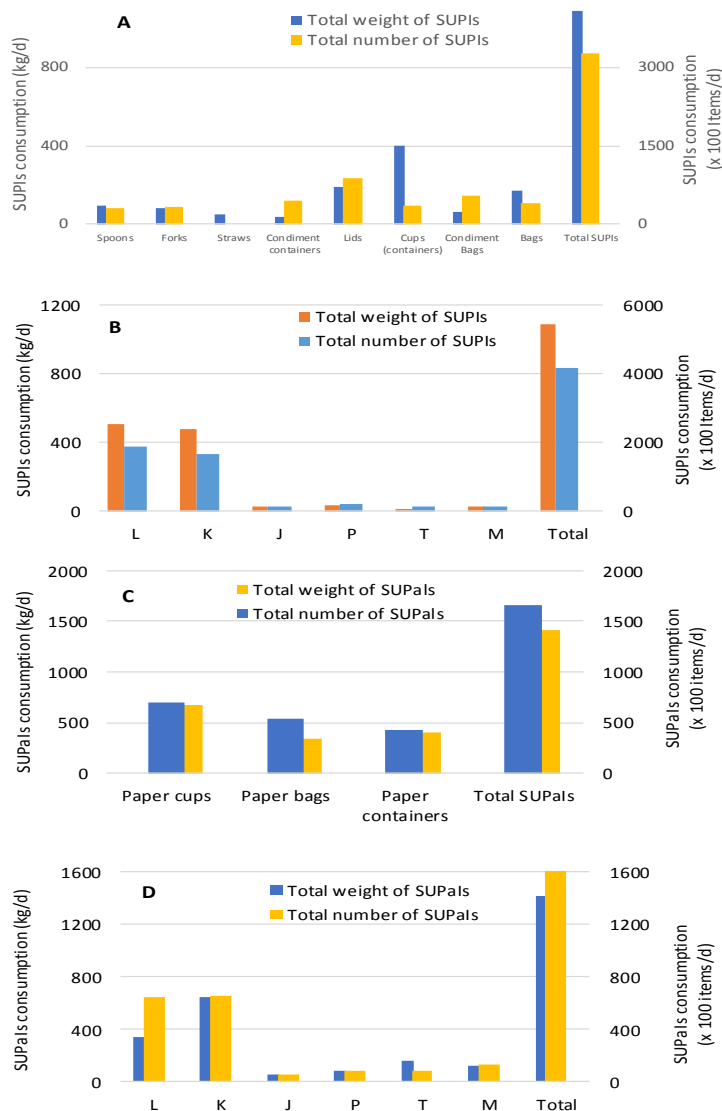


Fig. 5: The total weight and the number of SUIs consumed per day by six FFCs: (A) by each type of SUPIs, (B) by SUPIs across FFCs, (C) by each type of SUPAls, and (D) by SUPAls across FFCs. Note: L: Lotteria; K: KFC; J: Jollibee's; P: Popeye Stores; T: Texas Chicken and M: McDonald's.

was plastic containers (Song et al. 2018) and 32 million of SUPIs annually consumed were plastic bottles, cups, bags, and disposal plastics by food delivery (Jang et al. 2020).

In addition, the considerable number of SUPIs, including condiment containers, straws, and forks, appears to around 168 kg/day and was estimated to be about 43.7 t/yr (260 weekdays/yr). Most of these SUPIs have been identified as unnecessary SUPIs and have been enacted to be banned in many countries (UNEP 2018a).

In terms of the number of SUIs, the total number of individual SUPIs and SUPaIs consumed across the studied FFCs is presented in Fig. 5A and Fig. 5C. Results showed that the total number of SUPIs consumed across the studied FFCs was 415633 items and was 2.5 times higher than that of SUPaIs (166357 items). However, the total weight of SUPIs consumed was 1.3 times lower than that of SUPaIs. This variation in the weight distribution between SUPI and SUPaIs was obviously due to the difference in the weight of individual SUIs.

Regarding the weight of SUIs, the total weight of SUPaIs consumed per day was approximately 1.41 tons and 1.3 times higher than the weight of SUPIs (1.08 t). Results showed that the number, type, and weight of individual SUPIs consumed varied across the six FFCs in HCMC (Fig. 5B) and depended on the number of company-owned restaurants. The relatively high amount of SUPIs consumed by Lotteria (508 kg) and KFC (474 kg) was due to the fact that these two FFCs had the highest number of franchises in HCMC, 90 and 49 respectively. Accordingly, the weight of paper cups consumed was 670 kg/day and was the highest among the SUPaIs. This amount of consumption of SUPaIs in HCMC was half the consumption rate by the under 65 Portuguese population (Gautam & Caetano 2017). Among SUPaIs, paper bags were the least consumed item (338 kg) (see Fig. 5C). Among the FFCs, the highest SUPaIs consumption (646 kg/d) was noticed for KFC followed by Lotteria, Texas Chicken, and McDonald's (Fig. 5D). Conversely, Jollibee's and Popeyes Stores had the lowest consumption rate of SUPaIs.

In respect of the material for SUPIs, the SUPIs used in the studied restaurants were made of polypropylene (PP- the resin identification codification-6), such as forks, spoons, and knives or condiment containers or Polystyrene (PS – the resin identification codification-5). Among these SUPIs, only PP and PS have a high potential for recycling (Van der Harst & Potting 2014). SUPIs made of PS are expected to have a less environmental impact than those made of PP. Previous studies indicated that the effects of these SUPIs on the environment would be reduced by 20% through effective recycling (Gallego-Schmid et al. 2019). Therefore, PS instead of PP should be used for the manufacturing of SUPIs.

Furthermore, Lotteria, Jollibee's, and KFC in HCMC used plastic utensils without resin identification codifications. The resin identification codifications enable consumers to identify the post-consumer plastic products that can be recycled (UNEP 2018a). Therefore, it is essential to regulate all plastic manufacturers to mark the resin identification codifications on their plastic products.

Regarding the diversity of SUIs, Table 2 presents the type and the weight of individual SUIs across six FFCs. Among FFCs, Lotteria, KFC, Jollibee's, and Popeyes Stores did not provide plastic knives to their customers. As a standout, Jollibee's provided Styrofoam containers as packaging material for a particular rice dish. The lighter weights of SUPIs used in these restaurants were plastic straws and condiment containers and their weight ranged from 0.44 g (company Jollibee's straw) to 0.86 g (KFC's condiment container). Interestingly, Jollibee consumed the lowest amount of these two items. In contrast, the plastic cup from McDonald's (20.39 g) and a single plastic container of Lotteria (37.85 g) were the heaviest SUPIs used in these FFCs. However, the weight of other individual SUPIs ranged between 2 and 6 g across the six studied FFCs. Interestingly, Lotteria and KFC were the only FFCs with more diversified usage of SUPIs. From Table 2, it can be seen that SUPIs such as spoon, fork, straw, and condiment container have the same function for all fast-food restaurants. If we regulate that, the same amount of plastic for one individual spoon, one individual fork, one individual straw, and condiment container is 2.84 g (Texas Chicken), 2.83 g (Lotteria), 0.44 g (Jollibee's), and 0.47 g (Jollibee's), respectively (Table 2); therefore, the amount of plastic that would be prevented from being released into the environment by six FFCs in HCMC will be 42.3 kg/day, equal to 11 tons/year. These results suggested that the standardization of the size and the weight of each SUPI would prevent a considerable amount of plastic waste coming from SUPIs releasing into the environment.

The evidence from this study shows that there are several recommendations to improve the use and management of SUIs in FFRs, which aim to reduce the amount of plastic waste released into the ocean. First, the role of restaurant managers in encouraging their staff to provide the accurate number of required SUPIs to their customers. Second, the government should regulate separating waste at the source to collect and recycle plastic waste and other waste. Third, the FFCs need to identify unnecessary SUPIs to be phased out in a short time, which has been done in several developed countries (Accorsi et al. 2014). In addition, the Vietnamese government should issue the Packaging and Plastic Act as a intervention policy to standardize the size and the weight of each type of SUPIs, which would prevent a considerable

amount of plastic waste from SUPIs released into the environment. Finally, it is necessary to use reusable items in dining areas of FFRs, which leads to a significant reduction of plastic cups and cutlery used once. Further research should focus on the role of managers in sustainable alternatives to SUPIs.

CONCLUSION

The study showed that amount and type of SUIs consumed and disposed of varied among the studied FFCs and was dependent on the local waste management technologies and the national policies in HCMC. Results showed that the total waste collected across the six FFCs was 6 t.d⁻¹ and was equivalent to 1560 t.yr⁻¹ in HCMC. Of the total waste generated, SUPIs and SUPaIs accounted for 39% and 28%, respectively. Among the six FFCs, Lotteria consumed and generated the highest amount of waste while Popeyes Stores generated the least amount of waste. The total weight of unnecessary SUPIs (condiment containers, straws, and forks) was about 44 t.yr⁻¹. For sustainable waste management and to reduce the amount of plastic waste generated by the FFI, policies on separating waste at source, standardization in the size, weight, and material used for SUPI are highly recommended. Further, the vital role of FFCs in the improvement of SUPI management is to identify unnecessary SUPIs to be phased out at all FFCs in the near future and improve the local waste management practices through material recovery and recycling.

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