

**ENVIRONMENTAL IMPACTS OF SINGLE-USE PACKAGING DURING  
THE COVID-19 PANDEMIC**

Are there any form of environment implications on possible increased used of single-use packaging during the pandemic?

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Submitted by

Ujala Gosai

500688716

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## **Abstract**

Packaging is interchangeably used to mean the physical materials that are used to protect or wrap goods; the process of wrapping foods; or the special way an item is presented to the public with the aim of gaining consumer loyalty. Pieces of evidence have shown that there was more packaging during the COVID-19 pandemic. Meanwhile, most packaging during the pandemic was single-use plastics. Prior to COVID-19, intergovernmental efforts made several attempts to curb the production of single-use plastics. In the wake of the COVID-19 pandemic, multiple pieces of evidence unveil the massive scale at which single-use plastics are produced. This report explores the wastes generated from the utilization of single-use plastics, and how they impact the environment.

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# CHAPTER 1

## 1.0 INTRODUCTION

### 1.1 Background

Single-use packaging is predominantly plastics or substances derived from petrochemicals, and which are meant to be used once before disposal (Charlebois et al., 2019). Typically, single-use goods are for the most part used for packaging other goods and services that are daily used by humans (Charlebois et al., 2019). According to Chen et al (2021), single-use plastics are specifically invented for the contemporary society also known as a throw-away society, to be used once and then discarded. These plastics and their derivatives are increasingly produced globally and used as packaging or other consumables such as single-use plastic shopping bags and disposable tableware (Chen et al., 2021). In recent years, there have been growing concerns and awareness of the indiscriminate use of single-use packages such as disposable plastic bags, disposable nylons, delivery packs, several other polyethylene derivatives (Proshad et al., 2018). Forced lockdowns across the world and restrictions on people's movement during the COVID-19 pandemic led to the proliferation in the use of single-use packages in various forms such as disposable wipes, gloves and gowns, masks, delivery packages, and a lot more (Prata et al., 2020). (Prata et al., 2020). There was spike in e-commerce as various products are branded and packaged to meet high online traffic for goods (Prata et al., 2020). Majority of these items are shipped or delivered in single-use packages (Prata et al., 2020). The packaging industry has therefore adapted to the shift in consumer purchasing patterns as the coronavirus has visibly

changed the way people shop and it is all over the media. On August 3, 2020, Associated Press reported how the COVID-19 pandemic led to excessive use of single-use packaging which was believed to have significantly led to excessive waste problem around the world (Zeidenberg, 2020). This report highlights the correlation between single use packaging and environmental pollution. This report will explore environmental impacts of increased packaging due to the pandemic.

### **1.2 Research Questions**

This research will be guided by the following research questions: “Is there any appreciable different in single-use packaging during the COVID-19 pandemic?” “Are there any form of environment implications on possible increased used of single-use packaging during the pandemic?”

### **1.3 Research Objective**

The overall objectives of this research are:

- To identify the correlation between movement restriction and shift in peoples buying behavior.
- To find out whether or not there is a connection between recent lockdown due to COVID-19 and surge in single-use packaging
- To find out whether or not there are environmental implications of increased use of single-use packaging.

## CHAPTER 2

### 2.0 LITERATURE REVIEW

The semantics of the word “packaging” enjoys varied usage as it is interchangeably used to mean the physical materials that are used to protect or wrap goods; the process of wrapping foods; or the special way an item is presented to the public with the aim of gaining consumer loyalty. Regardless of its usage, packaging has come to be identified with any physical materials (branded or unbranded) made to wrap or cover items, and the business of packaging items (Fabris, Freire & Reyes, 2006). In a study conducted by Beitzel-Heineke et al (2016), it is revealed that packaging has become vital to today’s generation considering the evolution of the society into a fast-paced and convenience-driven society. Robertson (2012) also attests to the central place of packaging in contemporary times considering how increasing numbers of people daily depend on packaged food. Plastic, a derivative of petrochemicals, is a vital materials utilized within the packaging industry due to its versatility, disposability and convenience of use (Ertz et al., 2017). Production data on the production of plastic made available on Statista (2018) reveal that manufacturing of plastic has been at an all time high since 1976. Xanthos and Walker (2017) further observe that approximately 39 percent of plastics demanded in Europe is meant for packaging purposes. Xanthos and Walker (2017) and Statista (2018) unambiguously agree that plastics are vital to packaging.

Xanthos and Walker (2017) however observe that more than half of the 335 million metric tonnes of plastic produced are rarely used twice because they are disposed after use.

Meanwhile, majority of the single-use packaging are believed to be non-biodegradable which implies that they can remain intact for more than a hundred years without disintegrating into their safer component parts (Barboza and Gimenez, 2015). The myriads of evidence examined so far reveal that production of single-use packaging was high prior to the COVID-19 pandemic. During the COVID-19 pandemic, multiple pieces of evidence have emerged to state that there is a significant surge in the use of single-use packaging (Prata et al., 2020; Silva et al., 2020). According to Prata et al (2020), the use of single-use plastics were banned in some places and minimized in other places. The fear over the role of reusable plastics as vectors for the spread of coronavirus influenced the reversal of such bans thereby leading to the explosive use of single-use packaging (Prata et al., 2020). The outcomes from the same study unveil that the use of personal protective equipments by frontline medical workers, gloves, facial masks, medication packs and protective wrappings of goods brought online significantly contributed to the copious use of single-use packaging (Prata et al., 2020). According to Silva et al (2020), the pandemic contributed to surge in single-use packaging in three ways. The first way is through the disruption of policies that limit the use of single-use packaging (Silva et al., 2020). The second way is through shift in consumer behaviour as demonstrated by significant increase in demands for foods packaged with single-use plastics (Silva et al., 2020). The third way identified by Silva et al (2020) is uncontrolled use of single-use plastics by medical frontline workers (Silva et al., 2020).

Also, Hale and Song (2020) observe that high demands for packaged foods and the use of other single-use plastics tremendously increased the quantity of single-use plastics at people's homes and the community. In another study that examines the factors that contributed to the surge experienced in Wuhan with the use of single-use plastics, the outcomes reveal that in Wuhan, the epicenter of the pandemic, astronomical demands in personal protective equipment, plastic-based medical supplies, and packaged products (Adyel, 2020). The study further stated that the demand for single-use face mask was so much that production in China soared to 116 million per day in February which is believed to be approximately 12 times more than usual production (Adyel, 2020). Adyel (2020) further observe that at the peak of the pandemic, a hospital in Wuhan utilized more than 240 tonnes of single-use plastic-based medical waste (Adyel, 2020). Typically, this is more than 6 times. Also, the author believes that if a hospital should use large quantity of single-use plastic-based packaging, hospitals in the United States are believed to use double this amount (Adyel, 2020). While computing the factors that contributed to the tremendous surge in single-use plastics, Adyel (2020) stated that home-delivered groceries and takeout meals contributed to 1400 tonnes of plastic waste in Singapore during its own version of lockdown (Adyel, 2020). Increased single-use plastics during the lockdown is believed to increase the global plastic packaging market size which is forecasted to grow from its current 909.2 billion dollars to 1012.6 billion dollars by 2021 (Adyel, 2020).

More in-depth exploration of other sources reveal deeper truth about the correlation between the COVID-19 pandemic and its impacts. In a study spearheaded by Abu-Qdais, Al

Ghazo & Alghazo (2020), the outcomes reveal that the surge in single-use packaging significantly led to increased medical wastes. Further analysis of the environmental impacts of the surge unfolds how the tenfold increase in medical waste overloads the capacity of each hospital, the nation or municipality, to manage or adequately treat the waste (Abu-Qdais, Al-Ghazo & Alghazo, 2020). According to Silva et al (2020), inability to adequately treat medical waste renders the hospitals as potential vectors; a breeding ground for disease and infections. In furtherance to the analysis of the impacts of improperly treated medical wastes on the environment, Silva et al (2020) argue that a second and possibly third waves of infection could emanate from the landfills where improperly medical wastes are dumped. Confirming the possibility of a medical landfill becoming a potential breeding ground for infections and disease, Abu-Qdais, Al-Ghazo & Alghazo (2020) added that chemicals from the single-use packaging release toxic and heavy chemicals into the surroundings thereby polluting water sources.

Confirming the works of other authors on the environmental impacts of increased single-use packaging, Zambrano-Monserrate, Ruano & Sanchez-Alcalde (2020) argue that single-use plastics possess hazardous chemicals that accumulate in landfills generated by copious amount of used single-use packages. Also, reduced capacity to recycle waste generated from single-use packaging leads to increase in petrochemical wastes that further endanger physical space such as land and water, and non-physical space such as air (Zambrano-Monserrate, Ruano & Sanchez-Alcalde, 2020). According to Hale & Song (2020), one of the major reasons that single-use plastics pose serious danger is their durability because they are mostly non-biodegradable.

Therefore, Hale & Song (2020) denounce that increased single-use packaging during the pandemic is like passing death sentence on wildlife and aquatic ecosystem. By this, Hale and Song (2020) imply that extensive utilization of single-use plastics end up in the aquatic habitat and ingested by aquatic animals thereby resulting in death. Even some aquatic animals that escape ingesting the plastics get entangled in them leading to their deaths (Hale & Song, 2020). Elaborating further on the dangers posed by the voluminous utilization of single-use plastics to marine environment, Danielli & Sousa (2020) stated that increased production and use of single-use plastics will end up with 13 million tons of the plastics inappropriately disposed will find their way into marine environment where aquatic animals are attracted to them due to their movement under water and their bright colours (Danielli & Sousa, 2020).

In a similar study, researchers explored the correlation between the COVID-19 pandemic and spike in the production of single-use plastics and other petrochemical derivatives (Sangkham, 2020). The outcomes of the study reveal that the pandemic and its associated lockdown triggered mass production of plastics which are used as primary raw material for the production of single-use packaging (Sangkham, 2020). The findings unveil that the sharp increase in the generation of face mask resulted into proportional generation of unprecedented quantity of medical wastes that end up polluting the land and waterways (Sangkham, 2020).

In an expected corollary between the environmental impacts of more packaging due to the pandemic and the human health, more findings argue that the human health is also affected along with the environment. According to Silva et al (2021), more packaging means increasing

the carbon footprint of the environment which eventually lead to poor air quality, and other adverse health conditions. Silva et al (2021) argue that increasing numbers of people develop adverse health conditions such as chronic obstructive pulmonary disease and asthma due to exposure to some substances packaged with single-use plastics. In another study that examine the close connection between more packaging due to the pandemic and adverse health conditions, it is revealed that landfill is a product of the more packaging and the explosive production and use of single use (Magalhães et al., 2020). According to Magalhães et al (2020), apart from negatively affecting the environment. more single-use plastics badly affect the human health. Magalhães et al (2020) argue further that massive waste was generated which are mostly improperly disposed off end up becoming a reservoir for a host of infectious disease capable to affecting both humans and animals (Magalhães et al., 2020).

## **CHAPTER 3**

### **3.0 METHODOLOGY**

#### **3.1 OVERVIEW**

This research adopted a non-experimental design typology. Non-experimental research is one in which the research is neither able to manipulate independent variables nor control extraneous variables via random assignment (Cash, Štorga & Stanković 2016). It is the type of research that involves copious search of primary and secondary sources for useful information relevant to predetermined research question or topic (Cash, Štorga & Stanković 2016). It is unlike experimental research where the researcher is able to manipulate the variable to suit various research conditions (Cash, Štorga & Stanković 2016). Typically, non-experimental research is appropriate if the research question precludes interaction between two variables that share statistical relationship (Cook & Cook, 2008). According to Cash, Štorga & Stanković (2016), non-experimental approach can also be adopted when the research question that underscores the entire research is about causal relationships, but in which the independent variable cannot be manipulated or if it is impossible to randomly assign research participants to other conditions except the prevailing condition (Cash, Štorga & Stanković). This research method is also applicable where the research situation makes it practically impossible to conduct such research in the presence of the research participants. Non-experimental research method is applied to this research because the physical distance restrictions imposed as a result of COVID-19 are still in place thereby making it extremely difficult to engage in experimental research.

Also, the independent variables cannot be manipulated by whatever means thereby making non-experimental research the most appropriate option. Lastly, the required variables have been measured by other researchers thereby making it highly unnecessary to engage in another experimental research to determine previously predetermined values. Although researchers cannot manipulate independent variables or randomize, one major advantage of non-experimental designs is the fact that dependent variables are already known through precedents (Thompson & Panacek 2007). This offers the research unquantifiable leverage to gather dependent variables for the purpose of analysis (Thompson & Panacek 2007). Although non-experimental research is appropriate for this research, it has some limitations. It limits the researcher's ability to manipulate different conditions to test other conditions. Also, non-experimental research is prone to bias in the sense that it is capable of generating invalid results. This is corrected through stratification of the study population and the extensive use of cause-effect information in which the study population were based on just two variables: environmental impacts of single-use packaging during COVID-19.

### **3.2 DATA ANALYSIS METHOD**

Thematic analysis approach was adopted to analyze the data collected during the extensive literature search. Thematic analysis is a method that is typically employed to analyze qualitative data generated in the course of a research. This approach is appropriate for this research because it allows for descriptive summarization of various pieces of evidence that explore the correlation between increased single-use packaging during COVID-19 and the

environment. This approach also provides the required themes necessary to the sort the secondary sources used for this research. In addition to thoroughly searching the Ryerson University's database, several other databases such as CINAHL, IBSS, PsycINFO, OpenGrey, ASSIA, and few other health and policy databases were searched. Vast amount of research and data were generated by the searches. To limit biases and create enough leverage required to establish thematic categories, the search was extended beyond Canada, to include other countries with firsthand experiences of COVID-19.

The inclusion criteria were sources that explore environmental impacts of increased utilization of single-use packaging during COVID-19. The exclusion criteria are sources that adequately cover COVID-19 issues without due reference to the environmental impacts of the disease on the sample population. Another category of sources excluded filtered from the search results are those that cover COVID-19 issues in sufficient details but fails to consider the single-use packaging variable. Relying on the inclusion and exclusion criteria to set the boundaries for the systemic review, the search criteria were “single-use packaging during COVID-19 pandemic” “single-use plastics during COVID-19 pandemic” “correlation between single-use packaging and COVID-19 pandemic” “increased use of single-use plastic packaging during COVID-19 pandemic” “environmental impacts of increased use of single-use packaging during COVID-19 pandemic.” Some keywords featured prominently in the searches. Keywords like “single-use packaging” “COVID-19 pandemic” “plastics” “single—use plastics” and “increased use of single-use packaging.”

In all, a total of 150 researches were filtered with the inclusion and exclusion criteria set. More than two-third of the studies were located by reading through the abstract while approximately one-third of the studies were located by reading through the entire research. 66 of the research studies that met the inclusion criteria were rejected from the abstract because more than two-third of the research paper's content were devoted to other related content and less space was devoted to discussing domestic violence and how the media impact it. 25 were rejected due to duplicated contents while 16 were dropped because the contents were irrelevant to the research topic. 3 research studies were later dropped for wrong participants. They were rejected because studies focused only on COVID-19, but failed to feature the environmental variable. 17 were rejected for misleading contents. 2 were further rejected because it was a draft version of research study. 7 were abandoned and never used because they were based on the wrong ethnic sample.

It is also worthy of mention that more preference was given to Ryerson University library for searching systemic researches. The main reasons for preferring Ryerson University library over other databases is because of the orderliness of the search outcomes and the quality of the search outcomes. Ryerson University library always returned quality search results without stripping the key word from the search results. It was easier to quickly locate various researches that meet my search criteria. Only one tenth of the search result returned with less quality. Other databases became necessary because some primary required primary sources were missing from most Ryerson University library's search results. Other databases equally yielded good search

results, but I had to manually remove some repetitive search items from the search results. This sometimes happened more than a couple of times for every six searches made. To track good research outcomes from among the search result, I had to manually sort them out and weed out repeated contents.

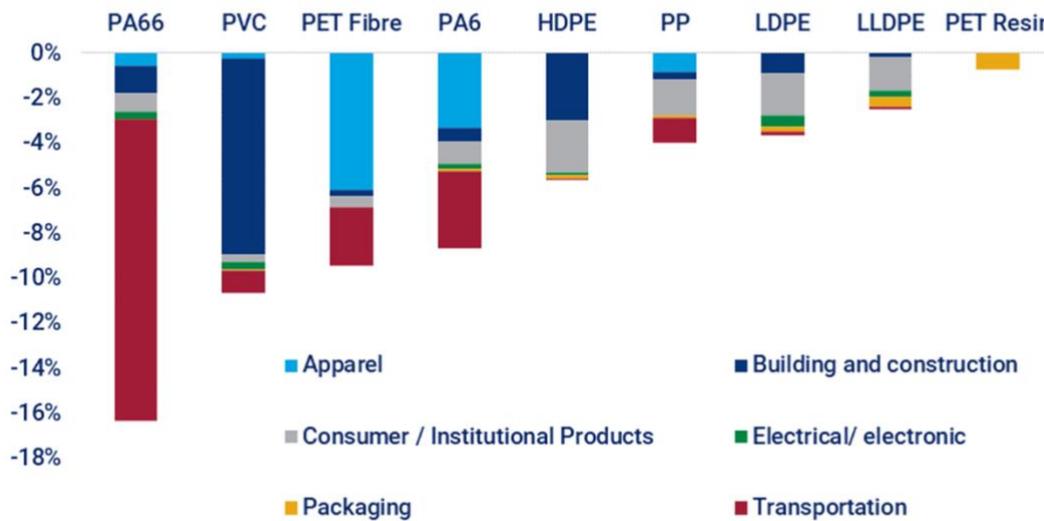
It is also important to note that when a random poll was held to no particular target audience, differentiating age, gender, or geographic location in relations to inquire whether or not the average consumer took climate change into consideration when it came to packaging surrounding the COVID-19 pandemic. The results these polls yielded provided interesting information in contributing towards the results.

### **3.3 RESULT AND DATA PRESENTATION**

Vast amount of data were filtered from the various searches. Few data were derived from primary sources while majority came from secondary sources. Of particular interest were the secondary sources because they yielded wide array of outcomes that significantly contributed to the understanding of the association between single-use plastics and the environment. Data regarding sharp increase in the consumption of single-use plastics in the wake of COVID-19 were instrumental. Some of these data were filtered from Silva et al (2021). According to Silva et al (2021), in the wake of the COVID-19 pandemic, there was sharp increase in the production and utilization of single use masks and reusable masks with disposable filters. Their contribution towards climatic change is believed to be  $\sim 1.47E + 009$  and  $1.50E + 009$  (Silva et al., 2021).

It is further revealed that the total carbon footprint emission of producing 200 pieces of rubber glove was approximately 42 kg CO<sub>2</sub>-eq (Silva et al., 2021). Considering the vast amount of disposable rubber gloves produced during the pandemic, it was estimated that carbon footprint emission of  $1.44 \times 10E + 010$  Kg CO<sub>2</sub> eq kg (14 Mt CO<sub>2</sub> eq) are expected (Silva et al., 2021). Data extracted from the same source stated further that in the UK alone, approximately – 0.179 t CO<sub>2</sub> eq./t MSW from incineration and 0.395 t CO<sub>2</sub> eq./t MSW from landfilling (Silva et al., 2021). Another set of important data were filtered from multiple sources that examined changes in the demand and production of single-use packaging. This set of data is crucial because they provide explanations to the observed changes in the production and utilization of polymers. Figure 1 demonstrates the graphical representation of these changes.

### Coronavirus: change in polymer demand forecast for 2020 under a 'setback' scenario



Source: Wood Mackenzie Chemicals

**Figure 1: Shift in demand for polymer (Wood Makenzie, 2020)**

The United Nations provides one of the most important visual cues that demonstrated the environmental impacts of increased utilization of single-use packaging. Image 1 below depicts one of the correlations between the environment and surge in single-use plastics. Similarly, image 2 was distilled and isolated from one of the major primary sources, United Nations. Figure 2 shows similar trend with improved activities with single-use plastics during COVID-19 pandemic. The data is sourced from a secondary source.

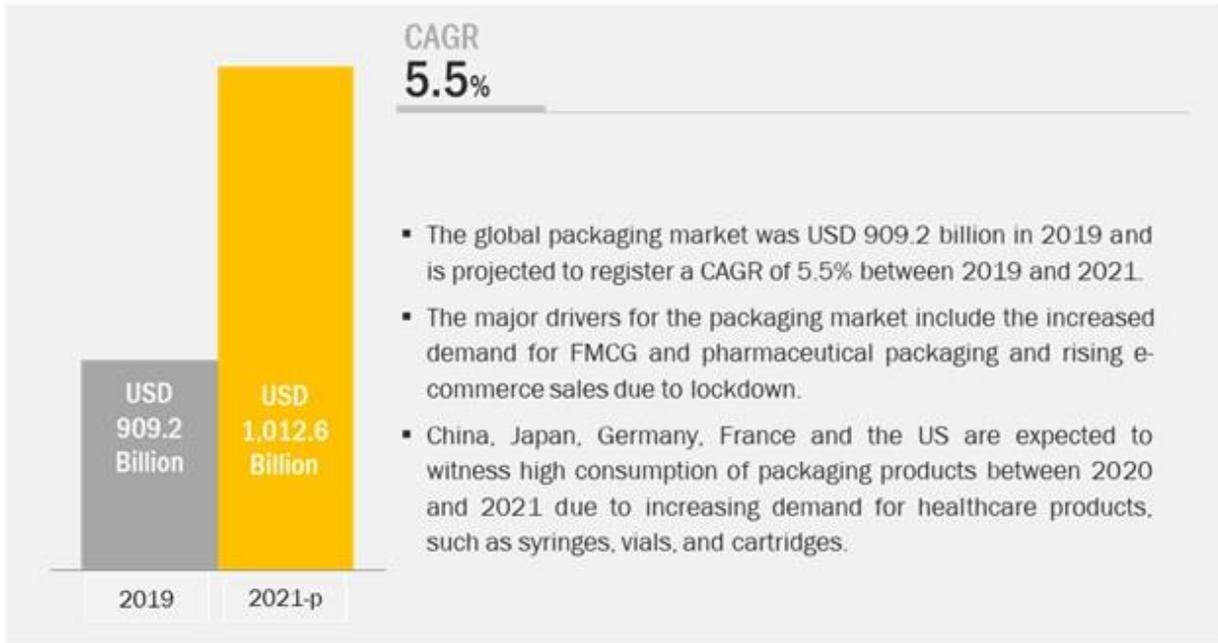


**Image 1: Turtle swims in contaminated water (UNCTAD, 2020)**



**Image 2: Blue ray swims amidst nose mask (United Nations, 2020)**

## Growth Opportunities in the Packaging Market During Covid-19 Pandemic

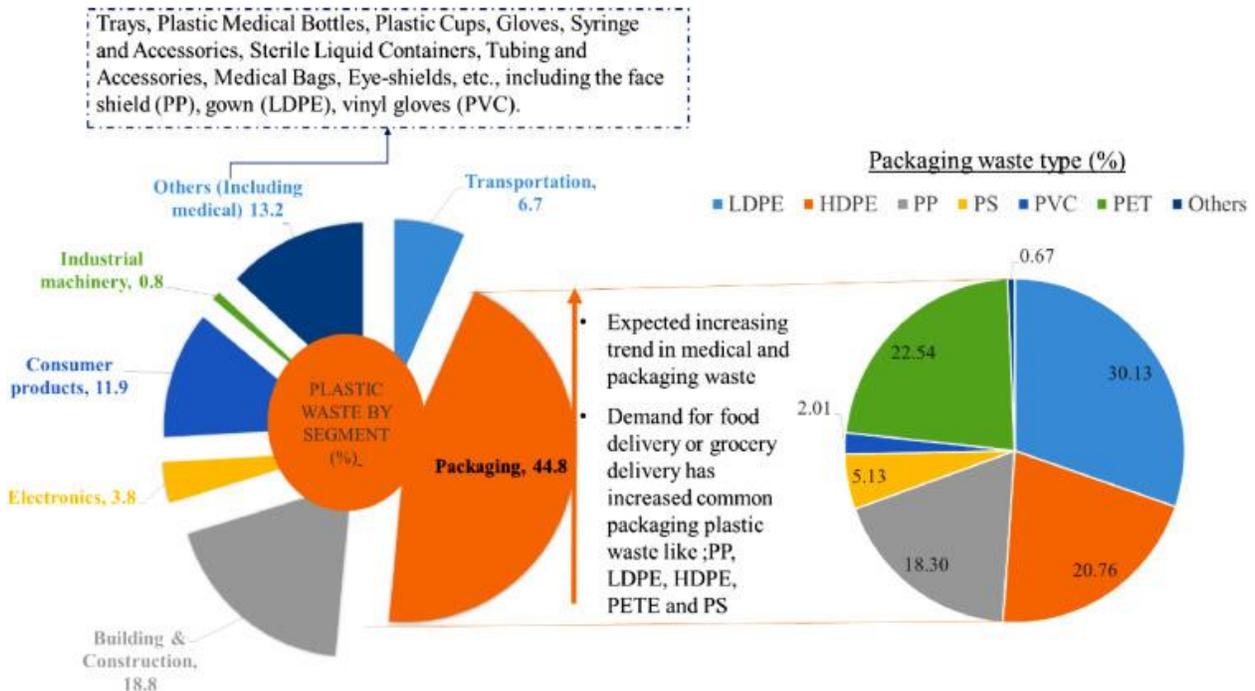


**Figure 2: Packaging Industry during covid-19 (Market, 2020).**

In a study conducted by Silva et al (2020), evidence reveals surge in the total percentage of the overall consumption of the production and consumption of single-use plastics. According to Silva et al (2020), governments across the world implemented partial or total lockdown to contain the spread of COVID-19 thereby motivating shift in people's shopping patterns which led to the explosion in online purchases. For instance, 40 percent increase in single-use plastics was reported by Silva et al (2020). Also, an estimated 129 billion face masks and 65 billion gloves went into circulation thereby raising the specter of increased single-use packaging during the covid-19 lockdown (Silva et al., 2020). With reference to Sharma et al (2020), there was

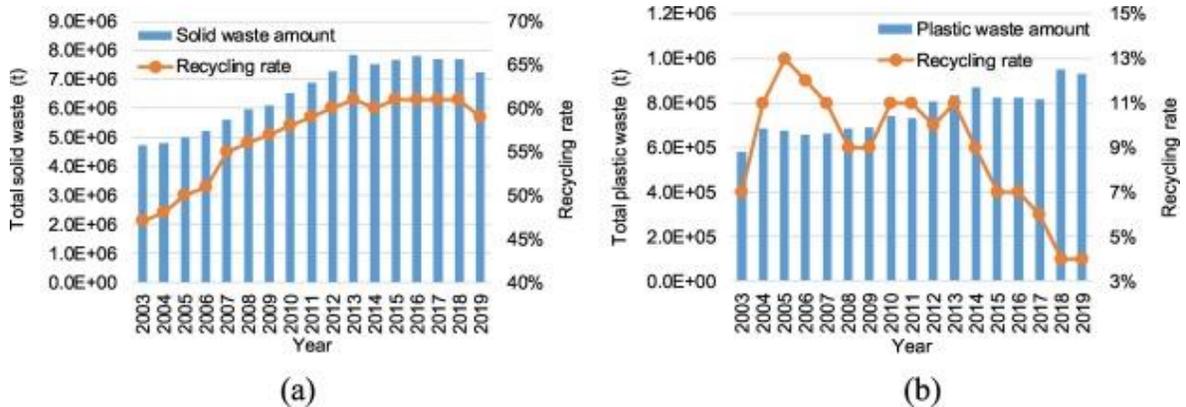
indeed uncontrollable increase in packaging of single-use plastics during the COVID—19 pandemic. According to Sharma et al (2020), the world experience sharp rise in the quantity of single—use packaging for a variety of reasons. Sharma et al (2020) further stated that there was a rise of 92.5 percent in online as well as 44.5 percent on daily necessities. Data derived from Sharma et al (2020) reveal that Vietnam experienced surge in online demand for packaged food and groceries by 57 percent; India by 50 percent; 32 percent surge in Italy and 12 percent surge in Spain.

**Figure 3: Breakdown of increased single-use packaging (Sharma et al., 2020)**



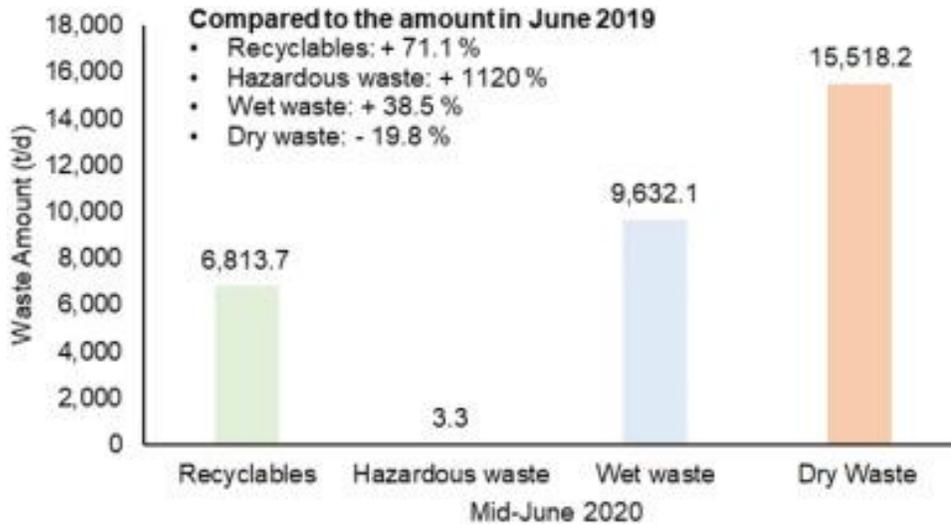
44.4 percent of single-use plastics are attributed to packaging single-use plastics while 13.2 is attributed to medical wastes generated by the increased use of PPEs, syringes and other medical equipment’s used in fighting the disease (Sharma et al., 2020).

According to Fan et al (2021), the impacts of increased single-use packaging has been varied depending on geographic and other factors. The most visible impacts of increased single-use packaging is the amount of wastes generated and how the wastes are managed (Fan et al., 2021). Shanghai shows a ~23% decline in household waste amount and ~3% increase for Singapore (Fan et al., 2021). Brno shows a ~1% increase in waste generation involving single-use packaging, but ~40% decline in business and industrial waste (Fan et al., 2021). The most obvious environmental impacts of single-use packaging during COVID-19 lockdown, according to Fan et al (2021) is waste generation and management.

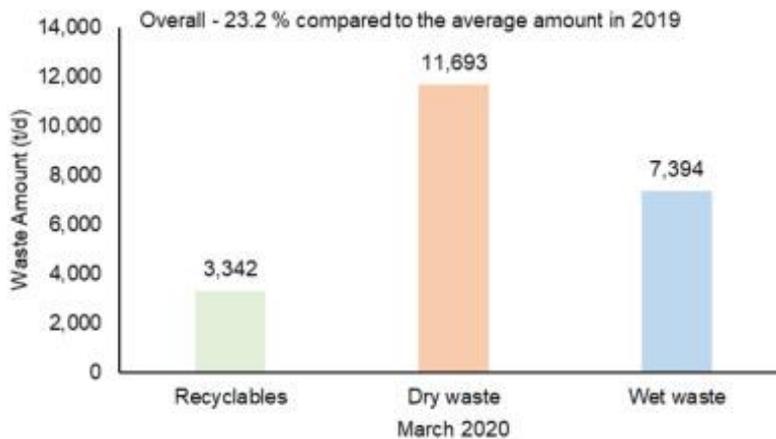


**Figure 4: Waste generation during COVID-19 lockdown (Fan et al., 2021)**

According to Fan et al (2021), waste generation and recycling are clear instances of increased generation of waste due to increased single-use packaging. More data distilled from Fan et al (2021) demonstrate more correlation between increased single-use package, waste generation and recycling, as graphically shown figures 5 and 6.



**Figure 5: Waste generation (Fan et al., 2021)**



**Figure 6: Waste generation (Fan et al., 2021)**

United Nations Conference on Trade and Development, UNCTAD is another primary source with credible data on the environmental impacts of increased single-use packaging. UNCTAD passes the information regarding the environmental impacts of increased single-use

packaging to the public through graphical representation. In image 3, the image of a man displaying used nose and face mask.



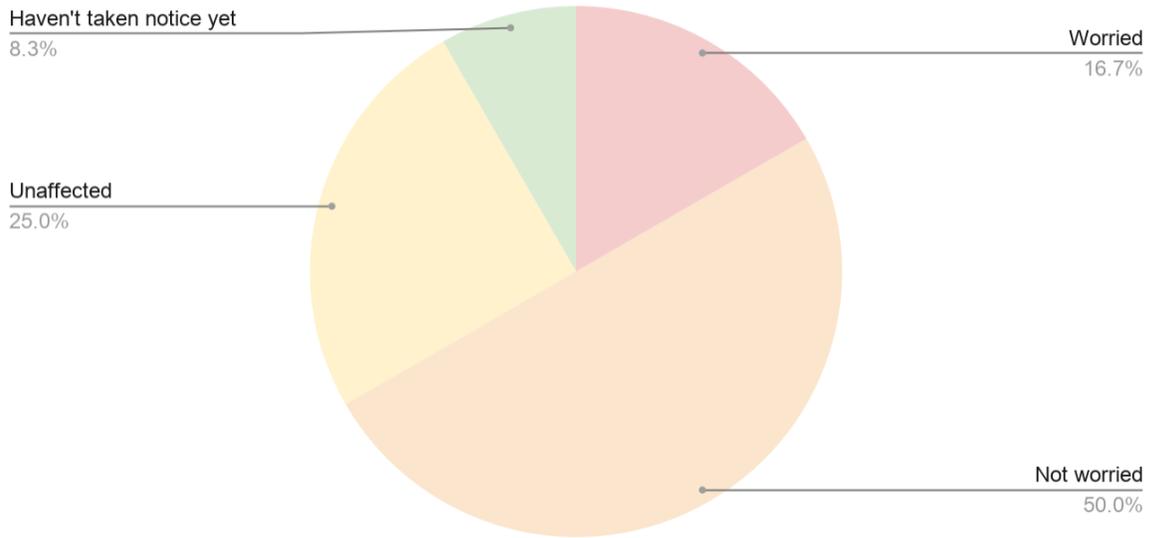
**Image 6: Nose mask from Beach (Fan et al., 2021)**

Another prominent source that gives an insight into the environmental impacts of increased single-use packaging is the BBC. In image 7, one of the negative impacts is graphically depicted.



**Image 7: Nose mask at the beach (BBC, 2020)**

## How do you feel about the increase in single use packaging?

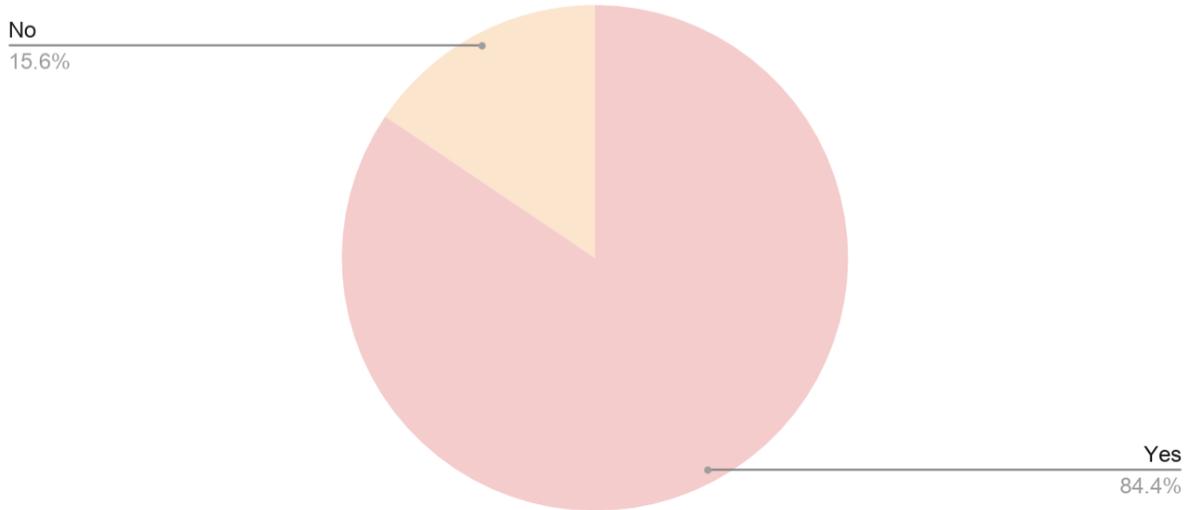


**Figure 7: Survey done via Google Forms**

In numerous random survey that were held via Google Forms and Instagram Polls, with no particular target audience kept in mind, the results yielded demonstrated how the average person viewed the increase in single use packaging in relation to the COVID-19 pandemic. When those who had participated in the survey were asked how they felt about the increase in single use packaging, the variables were kept limited to simplify the results of the survey. The survey in figure 7 presented that exactly half of the responses fell towards not being worried about the increase in single use packaging. The remainder of the responses to the survey in figure 7 reported that  $\frac{1}{4}$  remained unaffected, and the rest were not worried or had not taken notice to the increase in single use packaging in relation to the COVID-19 pandemic. This survey was

limited in its ability to reach larger audiences, as well as reaching other nations that were arguably more affected by the COVID-19 pandemic.

Have you noticed an increase in single used packaging since the beginning of the COVID-19 pandemic?



**Figure 8: Survey done via Instagram Polls**

When I asked the question of whether or not the audience had noticed an increase in single use packaging since the beginning of the COVID-19 pandemic, as figure 8 shows, majority of the responses claimed that they had in fact reported to see an increase. The variables in this survey as shown in figure 8 were kept to a maximum of two responses: Yes or No; as per the limitations of Instagram Polls. This limitation did prove to be a disadvantage to this kind of survey; however, this survey was able to reach a larger audience, with approximately 45 participants of the survey. Another limitation to this survey held via Instagram was that the survey was only viewable for a period of 24 hours before the results were concluded.

## CHAPTER 4

### 4.0 DISCUSSION

One of the purposes of this report is to find out whether or not there are environmental implications for increased use of single-use packaging. The extensive search for primary and secondary researches yielded vast amount of data that could be designated into categories or themes. One of the obvious themes is the variable that represents or captures obvious changes in people's behaviours in response to certain events. These can be separated into two broad categories. The first category is the evidence of increased single-use plastics and their implications on the environment. The second category is the management and recycling of waste generated from the increased use of single-use plastics. Evidence from Silva et al (2021) emphasizes changes in the consumption pattern of single-use plastics during COVID-19 pandemic and the impacts of such changes on the environment. The obvious evidence is the carbon footprint that resulted from increased production and utilization of single-use plastics. Carbon footprint is the amount of carbon and other greenhouse gases emitted into the surrounding or atmosphere as a result of anthropogenic activities. Therefore, a carbon footprint of  $2.00E + 008$  Kg CO<sub>2</sub> eq is not without implication.

The carbon footprint of  $2.00E + 008$  Kg CO<sub>2</sub> eq could only mean two things. First is the increased production of single-use plastics. Second is the incineration of wastes that emanate from the increased utilization of the plastics. Regarding the increased production of single-use plastics for packaging purposes, Silva et al (2021) provides convincing evidence that production

and packaging of single-use plastics rose sharply during the COVID-19 period. Although production and utilization of single-use plastics has always remained high prior to the COVID-19 pandemic, intergovernmental efforts were already forcing the production to decline (Silva et al., 2021). However, in the wake of COVID-19 pandemic across the globe, multiple evidence show that the production and usage of single-use plastics spiked. For instance, Silva et al (2020) stated that COVID-19 pandemic significantly raised the quantity of rubber gloves to about 40,000kg in the environment. This is a huge amount of single-use plastics within the environment capable of disrupting the natural process of interdependence of species. Therefore, massive production of single-use plastics significantly raised the carbon footprint of the environment which introduces more greenhouse gases. Therefore, more packaging of single-use plastics due to COVID-19 impact the environment by raising carbon footprint and changing the climate. This confirms that climate change negatively impacts biota at all ecological levels such as plant and animal genes, the exact population at any given climatic niches, ecosystem and biomes. Several studies have proven that many animal and plant species are already extinct as a result of rise in the average global temperature while several others are on the verge of extinction (Wiens, 2016).

Waste generation and management of waste is another indicator that captures changes to people's behaviour regarding their usage of single-use packaging. This is another plausible explanation for the carbon footprint of  $2.00E + 008$  Kg CO<sub>2</sub> eq which is the massive wastes generated by the single-use plastic and the method of disposal during COVID-19 pandemic

(Silva et al., 2021). Typically, the most preferred method of disposing or management wastes is recycling (Fan et al., 2012). The restrictions imposed by COVID-19 lockdowns, and the vast amount of wastes generated, made it almost impossible for waste management authorities to recycle the wastes (Fan et al., 2021). Mounting evidence reveal that incineration and landfilling are prioritized over recycling (Fan et al, 2021). Landfilling and incinerating of huge volumes of single-use plastic is yet another pathway through which more packaging impacts the environment. Meanwhile, the prioritized method of waste disposal exposes the environment to poor air quality because of significant release of carbon dioxide and methane to the environment. According to Fan et al (2021), incinerating plastic-based materials release copious quantity of greenhouse gases into the atmosphere thereby increasing the average temperature. It is therefore understandable why incineration contributes – 0.179 t CO<sub>2</sub> eq./t MSW to the environment and landfilling contributes 0.395 t CO<sub>2</sub> eq./t MSW to the environment as well.

The data filtered from Zeidenberg (2020), Adyel (2020), Silva et al (2020) proved very useful because these findings do not only serve as signifiers to the obvious changes in people's behaviours towards waste generation, the findings from these articles also creates a link between increased use of single-use packaging and waste generation. Typically, waste generation is closely linked to the degree of economic and/or social activities in a given socio-geopolitical zone in response to society's production and consumption patterns. By implication, increase or decrease in waste generation acts as a benchmark that signifies that something is obviously amiss in the production and consumption of economic and social activities. As a yardstick to gauge

activities and events within a geopolitical space, waste generation and management come handy as a useful barometer to measure the use or abandonment of single-use packaging.

Relying on waste generation and management as possible signifiers, data provided by Zeidenberg (2020) clearly suggest a correlation between the increased use of single-use packaging and COVID-19. COVID-19 is an infectious disease that is transmitted through droplets generated when an infected person coughs, sneezes, or exhales (Bonfanti et al., 2020). To curtail the transmission of this disease and mitigate its impacts on the society, virtually all countries imposed partial or total lockdown (Bonfanti et al., 2020). The lockdown changed people's shopping behaviours as many scrambled to stockpile necessary goods and services (Bonfanti et al., 2020). Pieces of evidence provided by Zeidenberg (2020), Adyel (2020), Silva et al (2020) clearly prove that the movement restrictions associated with the COVID-19 lockdown is a stimulant that compelled people to change their shopping behaviours. Additionally, Adyel (2020) further provided more clarifications. Figure 3 clearly identifies the consumable items that increased as a result of the COVID-19 disease. Figure 3 is one of the vital data that confirms the correlation between single-use packaging and the fight against the disease and infection.

As obviously indicted in Figure 3, vital medical items significantly increased the quantity of single-use plastics used in fighting the disease and infection. For instance, trays, plastic medical bottles, syringes, gloves, plastic cups, tubing and accessories, gloves, face shield largely contributed to the proliferation of single-use plastics in circulation and eventually large number of medical wastes generated in the process of fighting the infection and disease (Sharma et al.,

2020). Data from Sharma et al (2020) clearly segregate the wastes generated during COVID-19 into three distinct categories that create a clearer picture of possible environmental impacts of the increased wastes generated during the COVID-19. Medical wastes and the wastes generated from packaging medical items is the first set of waste identified by Sharma et al. The second category of waste identified by Sharma et al is the set of waste that emanates from food deliveries or grocery packaging. Another interesting data is the one distilled from Fan et al (2021) which are represented in figure 4. The trending solid waste and rate of recycling, and plastic waste and recycling rate further corroborate the correlation between COVID-19 and increased plastic waste. Moreover, the downward decline of recycling rate for plastic wastes for both figures A and B clearly suggest that restricted movement during the COVID-19 lockdowns and the massive plastic wastes generated from the consumption of single-use plastics obviously signifies connection between increased single-use plastics and the infectious disease. Figures 5 and 6 finally confirm the association between COVID-19 and increased single-use packaging. The multiple data that establish the relationship between COVID-19 and surge in single-use address one of the key objectives of embarking on this project which is to find out whether or not there is a connection between recent lockdown due to COVID-19 and surge in single-use packaging.

Back to the research question that aims to find out whether or not increased use of single-use packaging has environmental implementation, the unequivocal answer to the question is affirmative. The attestations to this affirmation is everywhere in the report. An obvious indicator

to the environmental implications of increased single-use packaging is poor health outcomes for both humans and animals. It is germane to state that poor health will arise due to improper waste disposal and poor waste recycling. As noted in figure 1 where the demand for polymers are high; in figure 2 where increase in global packaging market also denote higher demand for single-use packaging; in figures 5 and 6 where high waste generation is obvious; increase in single-use packaging leads to uncontrollable medical and domestic waste generation. Uncontrollable waste generation leads to the collapse or dysfunctional waste recycling process. The implications of collapsed or dysfunctional waste recycling or management system are quite numerous. As indicated in figure 4(a), the recycling of solid wastes between 2003 and 2019 improved dramatically. However, figure 4(b) shows that the recycling of dry weight to which single-use packaging belong to started dropping dramatically around 2013 after it managed to remain relatively stable for a short period of time. However, 2013 appeared to be the peak after which the recycling rate of dry waste nosedived.

As a clear indicator of recycling problem, accumulation of dry weight due to COVID-19 and decline in rate of recycling dry weight clearly signifies waste problems. The linkage is quite clear. Either waste management authorities are unable to recycle or manage wastes because of the movement restrictions caused by COVID-19 or waste management authorities are overwhelmed due to the copious quantity of waste generated, landfills are inevitable. Soil contamination is one of the environmental impacts of increased single-use packaging. Majority of the single-use packaging are plastics (Chen et al., 2021). At landfills, plastic wastes release

toxic chemicals such as dioxins, phthalates, vinyl chloride, ethylene dichloride, lead, cadmium and other toxic chemicals into the surrounding soil which cause significant problems to the plants in such area or the animals in such area and its environs (Chen et al., 2021). Dioxins are a group of toxic chemicals often found in plastic-based products or packaging (Tuomisto, 2019). Dioxins are believed to be risk factor for developing myriads of health conditions such as reproduction, developmental, and the immune system problems (Tuomisto, 2019). This group of chemicals is also known to disrupt hormones and lead to cancer (Tuomisto, 2019).

Typically, plastic-based single-use packaging is detrimental to the physical environment. Generating too much dry weights which are composed of single-use plastics, as noted in figures 4(a) and (b), implies that landfills across the world contaminate surrounding soil with toxic and heavy chemicals considered very dangerous to the health of both human and animals (Chen et al., 2021). Figure 3 further emphasizes the reality of single-use packaging and how accumulation of wastes generated from single-use packaging contaminates the environment. The fact that most of the wastes are plastic-based calls for concerns. Vinyl chloride, ethylene dichloride, lead, and cadmium from single-use packaging find their way into the environment or landfills thereby contaminating the soil, reducing the capability of the soil to support plant and animal life (Tuomisto, 2019). Also, diethyl hydroxylamine (DEHA) is an organic compound often seeps from landfills into the surrounding soil (Tuomisto, 2019). DEHA is implicated in several cases of reproductive problems, liver dysfunction and unexplainable cases of weight loss (Tuomisto, 2019).

More packaging due to the pandemic also impacts the environment by contaminating water bodies thereby impacting on marine life, ecosystem and water quality. With reference to the data distilled in the course of the research, there are two pathways water bodies are contaminated by more packaging during the COVID-19 pandemic. The first pathway is via direct deposits of single-use plastics into waterways. Images 1 and 2 display the pictures of aquatic animals swimming in the midst of nose mask and other plastic debris. Image 1 has a turtle and image 2 shows a blue ray swimming in the midst of nose masks. Nose or face mask proved indispensable in controlling the spread of coronavirus responsible for causing COVID-19. Some of the massive plastic-based wastes generated during the pandemic are dumped directly into waterways as noted in image 6 and 7. The messages are obvious from the images. For several reasons ranging from inability to recycle the waste possibly due to restrictions or the recycling is simply not feasible to undertake, the nose masks which are used in abundance during pandemic are directly dumped into nearby waterways which negatively impacts aquatic ecosystem.

The nose masks and millions of other single-use plastics enormously utilized during the pandemic reduce water quality by competing for oxygen with marine life. Reduced oxygen levels in waterways significantly affect fishes, aquatic animals and other microscopic plants and animals. This explains why the turtle and the blue ray in image 1 and image 2 appear a little uncomfortable in their contaminated environment. Apart from competing for oxygen with aquatic life, the massive amount of single-use plastics directly deposited in waterways release toxic chemicals into the water which kills aquatic animals, and also induces certain behavioural

changes that disturb the natural breeding and spawning cycles of the fishes and other aquatic animals.

This phenomenon has been widely reported by the media which is also supported by empirical studies. For instance, it was reported by the New York Times about the dangerous trend of people dumping dirty wipes, gloves and personal protective equipment on waterways which tend to aggravate on a daily basis (Fazio, 2020). The report stated that the fast-food containers and the face masks could break down over a period of time into microplastics and attract algae which in turn attract other big fishes that end up feeding on the face masks (Fazio, 2020). The report also states that the plastics could kill the aquatic animals, or their bodies absorb the toxic substances and passed on to human beings when the fishes are consumed (Fazio, 2020). The same incident was reported by *The Conversation* where it claims that in the United Kingdom alone, a single use mask each day for a year have so far created 66,000 tonnes of contaminated waste and 57,000 tonnes of plastic packaging of which increasing numbers of these wastes end up in waterways (Wijayasundara, 2020). Such narrative is widely reported by several media outlets which also enjoys the support of scholarly evidence. In a study that explores the sources of microplastic in waterways during the COVID-19 pandemic, findings reveal that millions of nose masks and other single-use plastics are sighted on waterways fuelling the fears of another impending pandemic caused by single-use plastics (Fadare & Okoffo, 2020).

The second pathway that water bodies are contaminated by more packaging during the COVID-19 pandemic is through seepage of the wastes from landfills and incinerators. With

reference to figure 2, movement restrictions imposed as a result of the COVID-19 lockdown spurred massive movement of packaged medical and food items which led to corresponding wastes. Figure 4(b) also confirms huge waste generation due to the increased packaging. As stated by Silva et al (2021), most of the wastes end up incinerated or at landfills. Due to the poor management of the wastes, heavy and toxic chemicals seep from landfills to underground waters and nearby waterways such as images 1 & 2. The implications of the waste seeping into waterways are quite similar to the impacts of having dumping the wastes directly in waterways.

Based on the outcome of the evidence gathered so far, there is overwhelming evidence to conclude that the impacts of COVID-19 is not limited to the victim's bodies, the impacts far extend the physical site of infection. It can be authoritatively stated that the packaging industry was already experiencing boom which may or may not be associated with the large and increasing production of single-use plastic. However, it can be convincingly stated that COVID-19 spurred tremendous activities at the packaging industry. While enhanced production rate is a good thing on the one hand, it has negative environmental impacts. Increase in packaging of single-use plastics is responsible for the negative environmental impacts of the more packaging. So far, it has been proven that there is indeed a correlation between movement restriction and shift in peoples buying behaviour. It can also be that there is a connection between recent lockdown due to COVID-19 and surge in single-use packaging. It is also obvious that there are environmental implications of more packaging due to the COVID-19 pandemic.

## **CHAPTER 5**

### **5.0 CONCLUSION**

This report explored the environmental impacts of more packaging due to COVID-19 pandemic. It was mentioned that single-use packaging is mostly plastics or substances that are derived from petrochemicals, and which are meant to be used once before disposal and single-use goods are mostly used for packaging other goods and services that are daily used by humans. The main purpose of this report was to identify the correlation between movement restriction and shift in peoples buying behaviour; to find out whether or not there is a connection between recent lockdown due to COVID-19 and surge in single-use packaging; and to find out how more packaging during the covid-19 pandemic impacts the environment. This research adopted a non-experimental design typology and a thematic analysis approach. It involved an extensive search of literature from multiple databases. The exclusion criteria were set to filter sources that adequately cover COVID-19 issues without due reference to the environmental impacts of the disease on the sample population. The outcomes of the extensive search were separated into two broad categories. The first category was the evidence of increased single-use plastics and their implications on the environment. The second category was the management and recycling of waste generated from the increased use of single-use plastics. Conclusion was reached based on the cumulative evidence that there were changes in the consumption pattern of single-use plastics during COVID-19 pandemic. It was also concluded that more packaging significantly impacted the environment because more packaging involved the extensive use of single-use plastics that

increased the carbon footprint of the environment. Another reason from the pieces of evidence gathered so far was that the vast amount of wastes generated from the production and consumption of the single-use plastics impacted the environment in no small measure.

## References

- Adyel, T. (2020). Accumulation of plastic waste during COVID-19 pandemic. *Science*, 369(6509), 1314 - 1315. DOI: 10.1126/science.abd9925
- Abu-Qdais, H.A., Al-Ghazo, M.A., & Alghazo E.M. (2020). Statistical analysis and characteristics of hospital medical waste under novel Coronavirus outbreak. *Global J. Environ. Sci. Manage*, 6, 1–10. doi: 10.22034/gjesm.2020.
- Bonfanti, N., Goff, K., Gundert, E., & Drewry, A. (2020). Core warming of coronavirus disease 2019 (COVID-19) patients undergoing mechanical ventilation: protocol for a randomized controlled pilot study. DOI: 10.1101/2020.04.03.20052001
- Barboza, L. G. A. and Gimenez, B. C. G. (2015). Microplastics in the marine environment: current trends and future perspectives. *Marine Pollution Bulletin*, 97(1/2), 5-12. DOI:10.1016/j.marpolbul.2015.06.008
- Beitzen-Heineke, E. F., Balta-Ozkan, N. and Reefke, H. (2016). The prospects of zero-packaging grocery stores to improve the social and environmental impacts of the food supply chain. *Journal of Cleaner Production*, 140(2017), 1528-1541. DOI: 10.1016/j.jclepro.2016.09.227
- Cash, P, Štorga, M, & Stanković, T (2016). An Introduction to Experimental Design Research, In Synthesizing knowledge in design research, pp. 3 - 12. DOI: 10.1007/978-3-319-33781-4\_1

Chen, Y., Awasthi, A., Wei, F., Tan, Q., & Li, J. (2021). Single-use plastics: Production, usage, disposal, and adverse impacts. *Science of The Total Environment*, 752.

DOI:10.1016/j.scitotenv.2020.141772

Charlebois, S., Walker, T., McGuinty, E., & Music, J. (2019). *The single-use plastics dilemma: Perceptions and possible solutions*. Dalhousie University.

[https://www.researchgate.net/publication/333646421\\_The\\_single-use\\_plastics\\_dilemma\\_Perceptions\\_and\\_possible\\_solutions](https://www.researchgate.net/publication/333646421_The_single-use_plastics_dilemma_Perceptions_and_possible_solutions)

Cook, B., & Cook, L. (2008). Nonexperimental Quantitative Research and Its Role in Guiding Instruction. *Intervention in School and Clinic*, 44(2), 98-104. DOI:

10.1177/1053451208321565

Danielli, F., & Sousa, B. (2020). Pros and Cons of Plastic during the COVID-19 Pandemic. *Recycling*, 5(27), 1 - 17. doi:10.3390/recycling5040027

Ertz, M., Huang, R., Jo, MS., Karakas, F. and Sarigöllü (2017). From single-use to multi-use: study of consumers behavior toward consumption of reusable containers. *Journal of Environmental Management*, 193(2017), 333-344. DOI: 10.1016/j.jenvman.2017.01.060

Fan, Y., Jiang, P., Hemzal, M., & Klemes, J. (2020). An update of COVID-19 influence on waste

management. *Science of The Total Environment*, 754.

DOI:10.1016/j.scitotenv.2020.142014

- Fadare, O., & Okoffo, E. (2020). Covid-19 face masks: A potential source of microplastic fibers in the environment. *Sci Total Environ*, 737. Doi:10.1016/j.scitotenv.2020.140279
- Fabris, S., Freire, M., & Reyes, F. (2006). Plastic packaging: Types of materials, food contamination and legislation aspects. *Revista Brasileira de Toxicologia*, 19(2), 59-70.
- Fazio, M. (2020). *Your used mask needs to make it to the trash can*. The New York Times.  
<https://www.nytimes.com/2020/07/25/climate/covid-masks-discarded.html>
- Hale, R. & Song, B. (2020). Single-use plastics and covid-19: Scientific evidence and environmental regulations. *Environ Sci Technol*, 54(12), 7034–7036.
- Proshad, R., Kormoker, T., Islam, S., & Haque, M. (2018). Toxic effects of plastic on human health and environment : A consequences of health risk assessment in Bangladesh. *International Journal of Health*, 6(1), 1 - 5. DOI: 10.14419/ijh.v6i1.8655
- Prata, J., Silva, A., Walker, T., & Duarte, A. (2020). COVID-19 pandemic repercussions on the use and management of plastics. *Environmental Science and Technology*, XXXX(XXX), DOI: 10.1021/acs.est.0c02178
- Robertson, G. L. (2012). *Food Packaging: Principles and Practice*, CRC Press, Boca Raton, FL.
- Sharma, H., Vanapalli, K., Chela, V., Ranjan, V., Jaglan, A., Dubey, B., Goel, S., & Bhattacharya, J. (2020). Challenges, opportunities, and innovations for effective solid

waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling*, 162. DOI:10.1016/j.resconrec.2020.105052

Statista 2018: Global Plastic Production from 1950 to 2016.

<https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/#0>

Silva, A., Prata, J., Walker, T., Campos, D., Armando, C., Duarte, C., Soares, A., & Barcelo, D.

(2020). Rethinking and optimising plastic waste management under covid-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Science of The Total Environment*, 742(10), 1 - 10.

DOI:10.1016/j.scitotenv.2020.140565

Silva, A., Prata, J., Walker, T., Duarte, A., Ouyang, W., Barcelo, D., & Rocha-Santos, T. (2021).

Increased plastic pollution due to COVID-19 pandemic: Challenges and recommendations, *Chem Eng J*, 405. Doi: 10.1016/j.cej.2020.126683

Tuomisto, J. (2019). Dioxins and dioxin-like compounds: toxicity in humans and animals, sources, and behaviour in the environment. *WikiJournal of Medicine*, 6(1): 8-14.

<https://doi.org/10.15347/wjm/2019.008>

Xanthos, D. and Walker, T. R. (2017). International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): A review. *Marine Pollution Bulletin*, 118, 17-26.

Zeidenberg, E. (2020). *Pandemic leads to more single-use plastic; company on a mission to reduce waste with smart food packaging that won't harm the environment*. Associated Press. <https://apnews.com/press-release/accesswire/8c87be3a403f334f993df5d9f9956be7>

Wiens, J. (2016). Climate-related local extinctions are already widespread among plant and animal species, *PLoS Biol*, 14(12): e2001104. doi:10.1371/journal.pbio.2001104

Wijayasundara, M. (2020). *Millions of face masks are being thrown away during COVID-19. Here's how to choose the best one for the planet*. The Conversation. <https://theconversation.com/millions-of-face-masks-are-being-thrown-away-during-covid-19-heres-how-to-choose-the-best-one-for-the-planet-147787>

Zambrano-Monserrate, M.A., Ruano, M.A., & Sanchez-Alcalde L. (2020). Indirect effects of COVID-19 on the environment. *Sci. Tot. Environ*, 728, 1 – 4.  
Doi:10.1016/j.scitotenv.2020.138813

## Appendices

How do you feel about the increase in single use packaging?

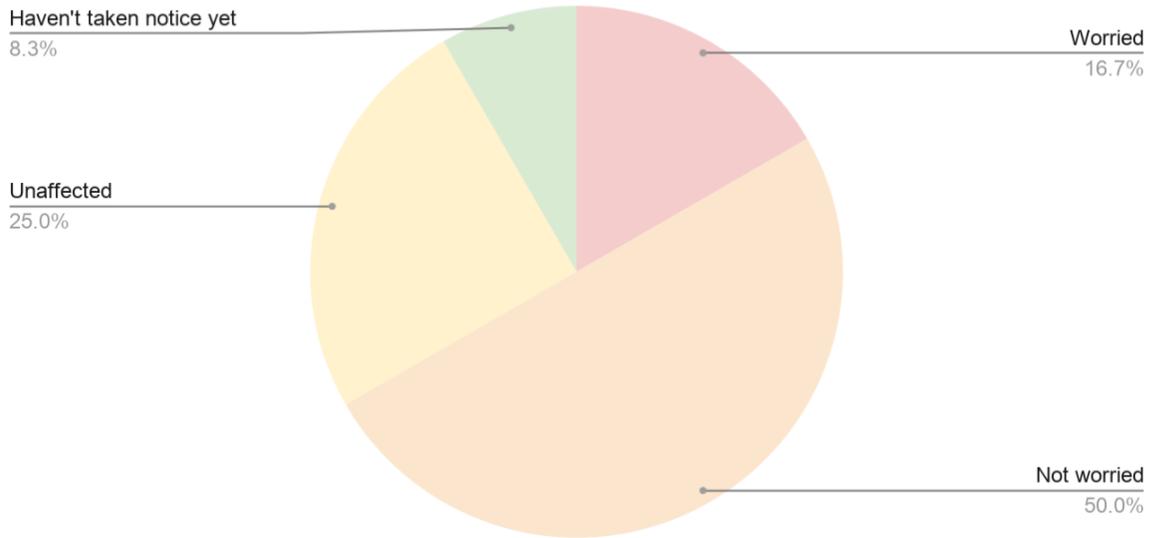


Figure 7: Survey done via Google Forms

The data from this survey presents the following:

- Not Worried 50% (15 people/persons)
- Unaffected 25% (approximately 4 people/persons)
- Worried 16.7% (approximately 3 people/persons)
- Haven't taken notice 8.3% (approximately 2 people/persons)

This survey was sent out on Monday, November 9, 2020 and was concluded within five business days, landing on Friday, November 13, 2020.

Have you noticed an increase in single used packaging since the beginning of the COVID-19 pandemic?

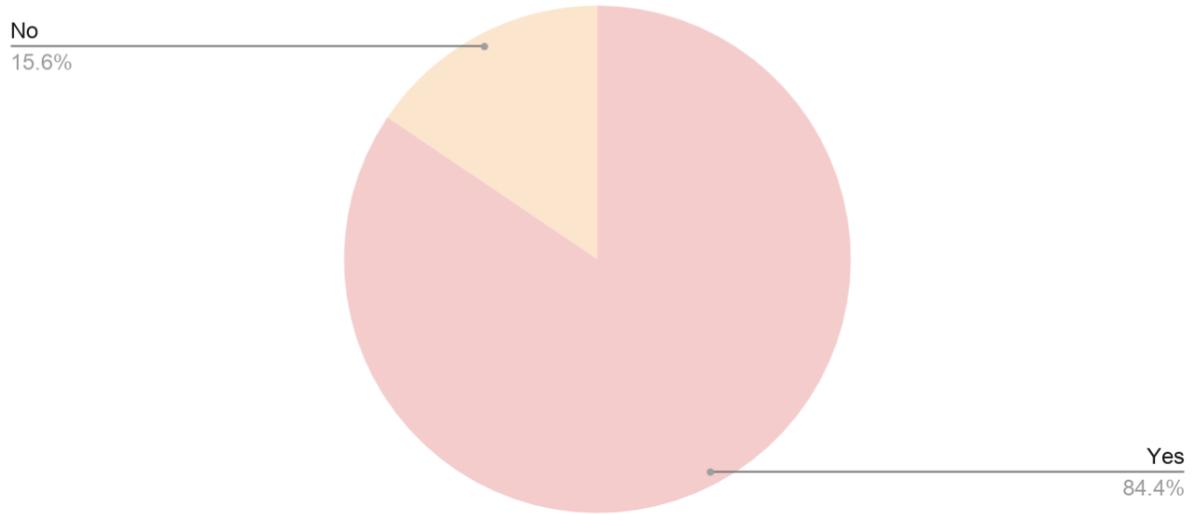


Figure 8: Survey done via Instagram Polls

The data from this survey presents the following:

- A total of 45 responses were recorded from the survey
- Of that total, 38 (84.4%) people/persons responded with “Yes” to the survey
- 7 (15.6%) people/ persons reports “No” to the survey
- This survey was only viewable for 24 hours before the results were concluded