Product Packaging by E-commerce Platforms: Impact of COVID-19 and Proposal for Circular Model to Reduce the Demand of Virgin Packaging

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Abstract
E-commerce packaging waste is a matter of concern, especially with the increasing popularity of online shopping due to the COVID-19 pandemic. This leads to the generation of a massive amount of e-commerce packaging waste as well as resource utilisation and CO₂ emissions that go into the production of packaging. The aim of this study is to analyse the impact of COVID-19 on consumer trends in the e-commerce industry, quantitatively analyse the carbon emissions of packaging used, and present a circular model to reduce the demand for virgin packaging. Using a convenience sampling method, an online questionnaire was administered to 285 respondents to gather data on changes in shopping practices due to the COVID-19 pandemic, consumer awareness levels and observations on packaging materials, and practices employed by e-commerce companies. It was found that the number of orders placed per month increased after the onset of the pandemic and that most households dispose of packaging with household wastes as opposed to reusing or recycling. Primary data (study participants packaging waste production) in combination with secondary data (emission factors) was further used to calculate emissions due to mixed packaging waste, which came out to be 2,705.94 kg CO₂e per metric tonne of waste produced. In addition, the paper presents a practical solution to reducing virgin packaging material production, as well as modifications in packaging used to ensure efficient working of the packaging reuse model when implemented by the e-commerce companies.

Keywords COVID-19 · E-commerce packaging questionnaire · Carbon footprint assessment · Packaging reuse model · Sustainable E-commerce · Packaging waste minimisation

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Introduction

In India, e-commerce platforms were first introduced in the year 2004 and ever since, the industry has grown exponentially [1]. The COVID-19 pandemic played a crucial role in the shift from brick-and-mortar shopping [2]–3. This was primarily due to three factors: Internet penetration and digital transformation, health and safety concerns, and an increase in comfort, variety, and affordability provided by the e-commerce industry [4]–5.

Research into the environmental impact of e-commerce and traditional in-store shopping has revealed that in-store shopping can reduce CO₂ emissions by up to 70% or even 84% in some cases [1]. It has emerged that the present model of the e-commerce industry is hence flawed and has not entirely been optimised [6]. Several studies have succeeded in establishing a direct relationship between the increase in the usage of e-commerce platforms, CO₂ emissions and energy use [1, 7]. Infrastructure, product packaging and design, and transportation are the three major factors that influence the impact of the e-commerce industry on the environment [4, 8]. Since these topics are widely dispersed in nature, this paper focuses on one of the factors, i.e. product packaging and design in the e-commerce industry.

The utilisation of packaging has seen an evident increase due to its three-fold function: aesthetic and appealing nature; health, hygiene, and safety; and preventing damage to the product during the multiple levels of manual handling [2, 9]–10. A single parcel sometimes can use up to 7 different types of packaging materials such as envelopes, cardboard, plastic bags, woven bags, tape, buffer material, and paper waybills [6]. According to the Indian Institute of Packaging, packaging consumption seems to have doubled in the past decade from 4.3 kg per person per annum to 8.6 kg per person per annum [11].

Globally, packaging waste management is an essential issue in urban areas—one of its main causes being, the lack of an effective and well-planned packaging waste management strategy. The packaging problem is one of the most visible problems related to land pollution and has begun to pose one of the biggest challenges for the e-commerce industry on its route to sustainability, especially due to the global pandemic [6, 12, 13]–14. According to the World Bank report ‘What a Waste 2.0’, India at present generates over a tenth of the global waste produced (highest globally) and in South Asia, packaging materials such as paper and cardboard account for 10%, followed by plastic which accounts for 8% of the net waste [15]. Despite the presence of solid waste management laws and regulations, in India, most of the waste is discarded without segregation at the source with 75% being openly dumped, 4% landfilled, 16% composted, and 5% recycled [15]–16. Packaging waste is also responsible for microplastic marine and land pollution, overconsumption of resources, and has a significant impact on the energy use for transport [1, 4, 11, 12]. Certain types of packaging are also known to contain chemical residue from their manufacturing that is hazardous to human health. On subsequent use, disposal, and recycling, these chemicals may transfer to the products being used by an individual, and thereby increase the exposure of humans and environments to toxins [4, 5, 12, 17, 18].

As such unsustainable packaging practices continue to thrive and threaten the concept of sustainable development, it has become essential to develop the concept of a circular economy for the e-commerce packaging industry. Exploring packaging systems through the circular economy perspective would also help shape innovative restorative and regenerative models that do not require as much technological and financial input as other means such as redesigning packaging and developing new packaging materials [14]. Such systems would also further allow maximum utilisation of resources and win the support of
consumers who are known to prefer circular and incentive-based systems over government tax levying solutions, in addition to reducing the overall environmental impact of the packaging over the long term [19].

This study set out to answer the following questions: (1) whether the COVID-19 pandemic led to an increase in the usage of e-commerce platforms for purchases; and (2) subsequent impact on the environment, if any, due to the increased use of virgin packaging materials as well as possible solutions.

In view of all of the above, the objectives of this study are to (1) analyse the impact of COVID-19 on consumer trends in the e-commerce industry; (2) quantitatively assess the carbon footprint of packaging material used; and (3) present a circular model to reduce the demand for virgin packaging.

This paper is organised as follows: the “Methodology” section describes the methodology used for data collection and analysis. As part of the study, a questionnaire was floated, the results of which have been discussed in the “Results and Discussion” section. In addition to this, it also contains a computation of the carbon footprint of e-commerce packaging used, based on the online shopping practices of the survey respondents. The “Proposal and Recommendations” section presents a possible solution to the problem raised in the form of a packaging reuse model along with modifications that can be made to existing packaging. Finally, in the “Theoretical and Practical Implications” section, several conclusions are drawn and suggestions for future research are made.

Methodology

Study Settings

The study was conducted in India. Being a developing country, it is currently seeing a rise in industrial growth rate and urban population [20, 21]. Both of these factors have together played a crucial role in the growth of the e-commerce industry. However, the above two factors may also result in an increased rate of packaging waste generation in India. Consequently, the country may be seen as an ideal location to conduct the survey. There is a need for a study to provide ways to manage packaging waste and mitigate environmental problems. The study involves a comparative analysis of the amount of packaging used by e-commerce companies pre and during COVID-19 as a result of the difference in the number of orders in both periods. Pre-COVID-19 is taken as the period prior to March 2020 and during COVID-19 as post-March 2020. This division was done due to the start of the lockdown period in India in March 2020 which is the period being monitored for an increase in the usage of e-commerce platforms [22].

Data Collection

Descriptive and remedial research approaches are both used in this study. The sources of data for the study were both primary and secondary. Questionnaire surveys were used to collect the primary data sources. The secondary data sources for this study have been collected by performing a literature review of relevant books, established news media, and journals published over the past two decades.

The survey was collected through a structured questionnaire comprising 17 questions, arranged and segmented into four sections as follows: (1) demographic attributes of study
participants; (2) comparison of shopping practices prior to March 2020 and post-March 2020; (3) awareness levels and observations of the consumer on packaging materials and practices employed by e-commerce companies; and (4) views of the consumer on online shopping. The questionnaire used for the study is attached in the Online Resource along with the survey results. A pilot survey was conducted amongst research colleagues and acquaintances prior to sharing them with the participants; this measure was performed to test the accuracy of the survey questions.

The survey was performed using Google forms between September 9, 2021, and September 27, 2021. This platform was preferred because of the easy user interface. Our target population involves customers of e-commerce websites and includes the old and young population residing all over India in rural, suburban, and metropolitan cities. The gender of the respondents was considered irrelevant to our study since a collective response was collected from each household. Convenience sampling was used to float the questionnaire and a total of 285 responses were collected, thereby satisfying the rule of thumb that 200 responses provide a fairly good survey accuracy [23]. There was no reward system in place for taking part in the survey.

All the questions were made compulsory to answer. The survey included an attention check question as well. Respondents were given sufficient time to study the questionnaire, ask questions, and obtain clarification, if necessary, on issues associated with the research and questionnaire before completion.

**Data Analysis**

For data analysis, the primary method of collecting data was through an online questionnaire, and the data was stored in MS Excel. This helped with the data processing and representation in graphical and tabular forms. Out of the 285 respondents, 213 answered the attention check question correctly and only these responses were taken into consideration while conducting the analysis.

The survey was carried out by the means of convenience sampling, due to which there is an unequal representation of respondents in terms of region and locality. Nevertheless, it has provided us with some reliable insights that contributed considerably to the paper.

**Results and Discussion**

**Demographic Features and Age Groups of Study Participants**

Table 1 shows the demographic features and age groups of study participants. The study included individuals from a wide range of age groups from diverse localities spread across India.

The largest group in terms of age (66.7%, \(n = 142\)) was between 18 and 24 years, whereas those under 17 (1.90%, \(n = 4\)) and above 55 (2.30%, \(n = 5\)) were under-represented. 74.60% of the surveyors were situated in Northern India, whereas few were from Northeast India (0.92%, \(n = 2\)) and twice that amount from East India (1.88%, \(n = 4\)). Many people from the sample group (76.10%, \(n = 162\)) resided in urban/metropolitan cities, whereas few study participants were from rural areas (4.2%, \(n = 9\)). Unequal distribution of the sample space may be observed due to the utilisation of convenience sampling.
Comparison of Shopping Practices Prior to and Post-March 2020

Figure 1a displays the number of orders placed by consumers via e-commerce companies per month prior to and post-March 2020. This data is further used to compute the difference in the average number of orders purchased by the study participants on a monthly basis for both cases. It may be noted that for the case of ‘over five times’, both the maximum and minimum number of orders are taken as 6.

The minimum and maximum number of orders placed by the survey respondents have been computed as follows:

**Minimum number of orders:**
\[ \Sigma \text{(Lower limit of frequency of orders per month} \times \text{number of respondents who chose each option)} \]

**Maximum number of orders:**
\[ \Sigma \text{(Upper limit of frequency of orders per month} \times \text{number of respondents who chose each option)} \]

Table 2 shows the computed average number of orders prior to and post-March 2020. The average has been computed by calculating the minimum and maximum number of orders per month based on the survey responses and calculating the mean. The average number of monthly orders was observed to be more for the ‘prior to March 2020’ period than for the ‘post-March 2020’ period by a value of 199.

Figure 1b shows the different kinds of products ordered prior to March 2020 and post-March 2020. A significant increase was observed in the frequency of products purchased from the groceries sector (by 122%). Following this, there was an increase in the purchase of household products (by 48%) and footwear, cosmetics, and personal care (by 28%). This trend of increasing frequency of purchase was displayed by the rest of the product types as well. The COVID-19 pandemic has thus led to an increase in society’s dependence on the e-commerce market for a variety of products ranging from groceries to fashion, and even furniture, electronics, and household products.
Consumer Observations on Packaging Materials and Practices Employed by E-commerce Companies

Table 3 displays the consumer observations on packaging materials and practices employed by e-commerce companies. Study participants were allowed to choose multiple options for
this question. It was observed that most of the orders of the study participants came packaged in poly mailers (138), bubble wrap (132), and finally corrugated boxes (124).

E-commerce companies enwrap their products in multiple layers of (excessive) packaging materials to ensure health and safety conditions as well as increase the aesthetic nature of their product [2, 9–10, 14]. As displayed in Fig. 2a, majority (72.3%, \(n = 154\)) responded that they do get an average amount of excessive packaging materials with their products, such as bubble wrap, styrofoam, packing peanuts, and air pockets.

### Consumer Awareness, Practices, and Opinion on Handling E-commerce Packaging Waste and the Packaging Waste Problem

Figure 2b shows the different methods that were selected by the study participants for the handling and disposing of packaging materials that come along with their order. In the results, 38.5% \((n = 82)\) stored the items that could be reused and disposed of the rest with household wastes, 25.4% \((n = 54)\) disposed of the waste without carrying out segregation at the source, 22.5% \((n = 48)\) stored items that could be reused and segregated the rest in order to dispose of it carefully by means of recycling and composting, 7.5% \((n = 16)\) dropped off recyclable items for recycling and disposed of the rest with other household wastes, and 0.5% \((n = 1)\) returned the packaging to the e-commerce company or any other third party for reusing. Disposal of packaging material is observed to be the chosen method of dealing with packaging wastes for a majority of the study participants.

Furthermore, according to the survey result analysis, most study participants (70.4%, \(n = 150\)) were aware of the impacts of packaging, and of this majority, 77.9% \((n = 117)\) considered it to be a major problem in the present world. From this, it can be understood that consumers are in fact aware of the problem and would possibly be well receptive to solutions. It should be noted however that this would be dependent on multiple factors such as the efforts that would have to be put in from the consumer’s side, additional expenses, convenience, etc. [24].

As displayed in Fig. 2c, the respondents identified the bodies they hold responsible for the ongoing excessive packaging problem. Apart from the options given below, there were 4 individuals who had mentioned through the ‘others’ option, who they thought was responsible for the excessive packaging problem. These included the following: inefficient distribution, transport and delivery companies, the logistics team, and the lack of feasible alternative options in the market.

| Table 3 Frequency of most common kinds of packaging materials |
|---------------------------------------------------------------|
| Type of packaging material | Frequency |
| Poly mailers | 138 |
| Bubble wrap | 132 |
| Corrugated boxes | 124 |
| Tapes | 114 |
| Paper bags | 93 |
| Plastic packaging sheets | 92 |
| Bubble mailers | 75 |
| Sustainable packaging materials | 31 |
| Cloth bags | 27 |
It can hence be observed that the majority of the respondents believe that the e-commerce company and sellers have played a major role in the packaging problem and would want the solutions to be mainly e-commerce company and seller centric.

Calculating Carbon Footprint

From the survey results, the most common packaging materials were poly mailers and corrugated boxes. Poly mailers are made out of plastic which is known to have a surprisingly low carbon footprint [25]. But on investigating the environmental impact of the non-biodegradable product made out of fossil fuels, it is evident that it has a significant impact on the waste problem in the country affecting both the environment and biodiversity [6, 12, 13]–26. Corrugated boxes may be thought of as an eco-friendly option since they’re biodegradable, unlike plastic. However, according to a life cycle analysis of the two, corrugated boxes exceed poly mailers in emission release, fossil fuel, and water consumption by a margin of 595%, 135%, and 404%, respectively [25].

In India, only 48% of the waste is segregated and only 37.2% of waste is processed [26]. The rest of the waste is disposed of in dumping zones and landfill sites. The survey results presented above Fig. 2b also indicate this result, by revealing that almost 69.4% of the individuals dump most of their wastes in the general waste bin indicating unsegregated waste in their households.

Carbon footprint is a measure of the amount of equivalent carbon dioxide released due to an action and hence acts as an environmental indicator [27, 28]. The purpose of carrying out a carbon footprint analysis of the discarded packaging which is usually disposed of by landfilling in India is to display that packaging often leads to excessive resource consumption and greater greenhouse gas emissions thereby contributing to climate change.

The carbon footprint calculation was done in accordance with the Greenhouse Gas Protocol [29, 30]. Through the method, one can estimate the emissions by computing the product of the activity data and the emission factor.

The activity data, as observed in various studies, usually indicates the activity, in this scenario, the quantity of waste. To estimate the quantity of corrugated boxes and poly mailers respectively, a unique methodology was employed. Firstly, the survey results were used to calculate the ratio of the number of orders received in corrugated boxes and plastic polybags (two of the most used packaging materials), respectively; the ratio was then used to calculate the number of corrugated boxes and poly mailers and their proportions (by weight) in one collective ton of waste.

Secondly, the emission factors for landfilled poly mailers and corrugated boxes were derived from secondary data sources.

As mentioned in a comparative study, there exist four different methodologies to compute the carbon footprint of a product; these differ based on greenhouse gas choice, system settings, method of quantification, and other aspects. However, quantisation based on GHG activity data multiplied by GHG emission factors is the most widely used and recommended [31].
(a) A pie chart showing the distribution of responses to the question of how items can be disposed of.

- None/Minimal (17%)
- Average (11%)
- High (72%)

(b) Bar charts showing the percentage of responses for different disposal methods:
- Store the items that can be reused, and dispose the rest with household wastes (38.50%)
- Store items which can be reused and then segregate the waste and dispose it carefully (Recycling, Composting, etc.) (22.54%)
- Segregate the waste and dispose it carefully (Recycling, Composting, etc.) (5.63%)
- Return the packaging to the e-commerce company or any other third party for reusing (0.47%)
- Dropping off recyclable items for recycling and dispose the rest with other household waste (7.59%)
- Dispose everything off with the other household waste (25.35%)

(c) Bar charts showing the number of responses for different groups:
- Others: 4
- I don't believe the issue of excessive packaging exists: 13
- Sellers: 113
- Government: 60
- Consumer: 87
- The E-Commerce Company: 150
Fig. 3  User interface flow chart for the packaging reuse model
Assumptions

(A) Each order is delivered in one single poly mailer or one single corrugated box. (B) The poly mailer and corrugated box are both assumed to be medium-sized, and their weights have been estimated with the help of secondary data we received on an e-commerce website that sells them. (C) Assume that at the end of their life they are discarded by the user (without recycling) and are disposed of by landfilling (majority result). (D) Carbon footprint is calculated for 1 tonne of waste generated due to disposal of poly mailers and corrugated boxes by landfilling, using the ratio we have derived from our survey.

Table 4 displays the material characteristics taken into consideration for the calculation of the carbon footprint of e-commerce packaging. A majority of the respondents (73%, \(n = 156\) for corrugated boxes; 56%, \(n = 114\) for poly mailers) chose medium as the most common size of the packaging they received. The corresponding material weight for medium-size packaging was decided upon after consulting the product packaging catalogues of various e-commerce platforms.

Steps Involved in Evaluating Carbon Footprint of 1 Tonne of Waste Comprising of Poly Mailers and Corrugated Boxes in the Ratio We Have Obtained from Our Survey

Step 1 Find the ratio of the number of orders received in poly mailers to the number of orders received in corrugated boxes:

\[
\text{Ratio} = \frac{\text{Number of Corrugated Boxes}}{\text{Number of Polymailers}} = \frac{124}{138} = \frac{62}{69}
\]

Step 2 Extrapolate the ratio using the respective weight of the packaging material to obtain 1 tonne of mixed waste (poly mailers and corrugated boxes). Assume \(x\) to be the common number to multiply the ratio with. In this case, the net number of poly mailers and corrugated boxes would be \(69x\) and \(62x\), and their net weight is \(69x \times 15\) and \(62x \times 150\), respectively.

Finding \(x\):

\[
\text{Net weight of Polymailers} + \text{Net weight of Corrugated Boxes} = 1 \text{ tonne} = 10^6 \text{ grams}
\]

\[
(69 \times x \times 15) + (62 \times x \times 150) = 1,000,000
\]

\[
1035x + 9300x = 1,000,000
\]

\[
10335x = 1,000,000
\]

\[
x = \frac{1,000,000}{10335} = 96.76
\]
Step 3  Find the net number of poly mailers and corrugated boxes by substituting the value of $x$ in the table above

$Net \ number \ of \ Polymailers = 69x = 69 \times 96.76 = 6676$

$Net \ number \ of \ Corrugated \ Boxes = 62x = 62 \times 96.76 = 5999$

Step 4  Net weight of poly mailer and corrugated boxes respectively in tonnes

$Net \ weight \ of \ Polymailers \ in \ Tonnes = \frac{Net \ number \ of \ Polymailers \times \ Weight \ of \ 1 \ Polymailers}{10^6}$

$= \frac{6676 \times 15}{10^6} = 0.1001 \ tonne$

$Net \ weight \ of \ Corrugated \ Boxes \ in \ Tonnes = \frac{Net \ number \ \times \ Weight \ of \ 1 \ Corrugated \ box}{10^6}$

$= \frac{5999 \times 15}{10^6} = 0.8999 \ tonne$

Step 5  Net emissions due to 1 tonne of landfilled poly mailers and corrugated boxes

$Net \ emissions = Emissions \ due \ to \ 0.1001 \ tonne \ of \ Polymailers$

$+ Emissions \ due \ to \ 0.8999 \ tonne \ of \ Corrugated \ boxes$

$= (0.1001 \times 1240) + (0.8999 \times 2869) = (124.124 + 2581.813)$

$= 2,705.937 kg \ CO2e \ per \ Metric \ Tonne$

According to the above results, it is visible that one tonne of waste consists of poly mailers and cardboard boxes, when discarded in the landfills result in the emission of 2705.937 kg CO2 equivalent. Table 5 summarises the carbon footprint computation.

Considering the majority of our sample has begun to realise that packaging poses a major problem and that they mostly place responsibility on the e-commerce companies, it is evident that people would support action to be taken up by the higher authorities (e-commerce companies).

Hence, keeping in line with the Governments’ revised Solid Waste Management Rules (mandating Extended Producer Responsibility—for the management of product and packaging waste) and our survey, we have put forth a model through which companies can not
only reduce virgin packaging and hence reduce their carbon footprint but also become more economical and comply with the government rules [1, 5, 16, 28, 32, 33].

Proposal and Recommendations

Reusing packaging materials as many times as possible before disposal can cut down on the emissions associated with producing virgin packaging material [5]. So far, there is no reusable packaging system available for e-commerce that is less expensive than single-use options [34]. In order to tackle this problem, we designed a packaging reuse model for e-commerce companies through which they can reuse packaging as long as it is in good condition.

Overview

E-commerce companies can take back the packaging if it is in usable condition (refer to quality standards section) and reuse the packaging for future orders. The customer will receive a cashback (amount to be determined by the company) according to the condition of the packaging returned.

Packaging Pickup

The user interface will be as in Fig. 3. The customer is provided with the following options:

Case 1: Returning packaging at the time of delivery.

A. Return packaging from the previous order when the new order is delivered.
B. Return packaging from previous as well as current orders when the new order is delivered.

Case 2: Scheduling an appointment for package pickup. In case the customer is not able to return the packaging at the time of delivery (e.g. due to not being at home or the package being a gift), the customer can schedule a time for the packaging to be picked up. Pickup timings displayed to the customer will be when packages would be delivered to nearby areas (radius can be determined by the company) in order to reduce extra trips to pick up packaging (to avoid higher fuel consumption and emissions).

Table 5  Summary of carbon footprint computation

|                     | Poly mailer | Corrugated boxes |
|---------------------|-------------|------------------|
| Number of orders received in each packaging | 138         | 124              |
| Weight of one mailer/box | 15 g        | 150 g            |
| Net number of the packaging to make 1 tonne in the same ratio as derived in survey | 6676        | 5999             |
| Net weight in tonnes of each type of packaging | 0.1001 tonne | 0.8999 tonne     |
| Net emission due to each packaging type for respective net weight | 1240        | 2869             |
Quality Standards Chart

The quality standards correlate the condition of the packaging to the expected cashback. It serves the purpose of conveying the preferred condition of the packaging to the customers and maintaining a standard in terms of the packaging returned.

Three cases may be considered: (A) for packaging as good as new or in reusable condition, the cashback would be as determined by the company; (B) for packaging in recyclable condition, the cashback may be 25–50% lower than cashback in case A; and (C) for packaging in unusable condition, no refund may be offered by the company.

Cashback

The cashback is an incentive to ensure that customers handle packaging responsibly and encourages customers to return packaging.

Advantages of the Packaging Reuse Model

A. Reduces costs for the e-commerce company: The e-commerce company would have to invest substantially less in new packaging once the model stabilises. There will not be significant fuel costs to pick up packaging as delivery men would only be picking up packaging when delivering orders to nearby areas.

B. Reduces energy consumption and emissions: With recycling rates of packaging being low due to contamination and/or lack of resources, this model prioritises poly mailers over recycling thereby reducing energy used at recycling facilities and consequently emissions produced.

C. Ensures responsible handling of packaging: The customers would handle the packaging carefully, keeping the incentive in mind. This further increases the rate of reuse.

D. Increased customer loyalty: With the option of returning packaging at the time of the next delivery, customers are more likely to choose that particular e-commerce platform for subsequent orders.

E. Attract environmentally conscious customers: Customers who care about the environment are more likely to order from e-commerce companies adopting such models [5, 9, 14, 34–36].

Modifications to Packaging

There are a few changes to packaging that can be made in order to make the circular packaging system more efficient [5, 14, 25, 35, 37]. They are listed below.

Resealable Plastic Poly Mailers

Poly mailers are cut or torn open due to the adhesive being too strong. These cut poly mailers can only be reused a couple of times if they have to be cut every time to open, as the size of the poly mailer would keep decreasing. Along with this, the reused packaging would not look as neat as virgin packaging and customers may not opt for reused packaging. Resealable plastic poly mailers would enable the packaging to be reused multiple times. In order to ensure that the packaging has not been opened by someone else and the
contents emptied, there can be a seal such as a sticker across the opening which serves as an indication.

Translucent Pocket for Order Invoice

The order invoice is usually a sticker that is stuck on the packaging. Removal of the sticker might cause the plastic poly mailer to tear or the top skin of corrugated boxes peeling off. This disables the plastic poly mailers from being reused and reduces the aesthetic appeal of the cardboard boxes and consequently reduces its structural integrity when the sticker gets peeled off multiple times as a result of reusing. New stickers cannot be placed on old stickers as this is a privacy concern in addition to the limitation of the number of times new stickers can be repeatedly placed on top of old ones. In order to avoid this, translucent resealable pockets can be provided on the packaging into which the order invoice can be slid.

Reusable Packaging

Cardboard boxes and poly mailers are designed to be single-use packaging materials. They are hence subject to wear and tear easily and are limited in terms of the number of times they can be reused. There are several private foreign companies that have launched reusable packaging products (that last between 20 and 1000 cycles) specifically for e-commerce. However, research still needs to be done to identify whether emissions released by these products are in fact lesser than those by the conventional ones. And whether they are more economical.

Theoretical and Practical Implications

This study has contributions to the research on e-commerce virgin and overpackaging solutions. First, this study connected the COVID-19 pandemic to an increase in the usage and disposal of virgin e-commerce packaging. Previous literature has discussed the impact of COVID-19 on the e-commerce industry, most papers focusing on the increased popularity of e-commerce platforms [3, 38, 39], but very few linking it with an increase in e-commerce packaging [1]. Some papers have discussed COVID-19 and packaging but explored the aspect of food-related e-commerce only [2, 13, 40].

Second, this study also proposes a novel solution to the e-commerce packaging problem. Solutions proposed by previous studies focus on reusable materials and alternative materials [1, 24, 35] and changes in packaging design [1]. Although the adoption of reusable packaging is a promising solution, there are some inconveniences such as e-commerce companies having to restructure their business model, reluctance of customers to pay more for reusable alternatives, etc. [24]. This implies that there could be a possible delay with regard to the implementation of these solutions. Not only does this study propose a solution that involves extending the lifespan of the single-use packaging materials already in use, it also offers an incentive to encourage customers in the form of cashbacks. E-commerce companies would not have to make drastic changes in the packaging process thereby enabling easy and quick implementation and they would also gain customer support.
Third, this study uses a survey questionnaire to gain consumer insight and feedback on multiple aspects of e-commerce packaging such as changes in e-commerce practices due to the pandemic, packaging received by customers, how consumers deal with the packaging waste produced, and finally, consumer awareness and feedback. Although survey centric studies related to packaging have been carried out previously, they were to establish only qualitative results [6, 19]. To our knowledge, this is the first study related to e-commerce packaging to conduct both quantitative and qualitative analyses on the survey results. The survey results were used to conduct carbon footprint calculations of the estimated packaging waste produced by the respondents. The method although logical is not something that has been applied previously. It not only took the survey responses into account but also accounted for the weight of the packaging material. The method would hence be applicable for quantifying waste breakdowns in future studies.

To the best of our knowledge, this is the first study to analyse the consumption of packaging by the e-commerce industry with the help of a household survey and propose a circular model for packaging reuse in India. From the viewpoint of developing countries, this research would contribute to increased awareness and the subsequent adoption of sustainable practices by e-commerce companies on the handling of delivery packaging. It also sheds light on public awareness and attitude towards solid waste management practices in the country. The current paper’s findings will benefit the following groups: manufacturers, who on reusing their packaging would eventually cut down on their raw material expenditure; and informal agents, who would be engaged in job creation to allow ease in the collection of packaging material from the consumers. This will help in limiting the environmental impact of virgin packaging, while also reducing the load on solid waste treatment plants.

Conclusion

The packaging problem is associated with environmental degradation, land pollution, and a negative impact on the health of humans and biodiversity alike. It has been further exacerbated due to the COVID-19 pandemic and is one of the biggest drawbacks of the e-commerce industry. On analysing the valid responses (by 213 respondents), the following conclusions were laid down on e-commerce packaging trends and consumers’ purchasing behaviour: (A) the average monthly orders and sales of e-commerce companies have increased considerably when compared to the pre-Covid era; (B) with respect to packaging waste management, the majority of the individuals stored the items that could be reused, and disposed of the rest with household wastes; (C) the most common packaging materials included poly mailers, bubble wrap, and corrugated boxes; and (D) majority of the sample were aware of the impacts of packaging on the environment, and believed that the E-commerce company played a crucial role in the packaging problem. For our survey respondents, it was computed that 2705.937 kg CO₂e is released for 1 tonne of waste consisting of poly mailers and corrugated boxes when discarded in the landfills.

The incentivised packaging reuse model can prove to be an effective method in order to cut down on the emissions associated with producing virgin packaging material. To optimise the model, certain modifications can be made to current packaging materials like resealable plastic poly mailers and translucent pockets for the order invoice. Furthermore, reusable packaging materials can be introduced into the packaging reuse model to extend the longevity of the packaging materials. Large enterprises that are not able to manage
their own packaging waste may hire PROs (Producer Responsibility Organisations), to manage the packaging waste for them [32].

There are a few limitations of the study: (1) the utilisation of a convenience sample as the primary data set and the limited number of responses (213 valid responses) has resulted in an unequal representation of individuals and hence prevent the study from being generalised to the population of India; and (2) non-inclusion of materials like tape, bubble wrap, and styrofoam while calculating the carbon footprint, due to lack of concrete data. But nevertheless, the study gives direction to future researchers regarding the e-commerce packaging problem and possible solutions. Future studies aimed at calculating and reducing the environmental impact of packaging for an increasingly hi-tech world, should be oriented towards analysing the feasibility of launching a packaging reuse model, understanding the consumers’ propensity to abide by such packaging reuse models, and tackling the over-packaging problem through innovations in packaging design and material.

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Author Contribution TA and SRC drafted the article, designed and circulated the survey, and analysed and interpreted the survey responses. NS designed the packaging reuse model and aided in the designing the survey and editing the manuscript. LG offered guidance, performed critical revisions of the article at several stages, and aided in designing and circulating the survey. All authors read and approved the final manuscript.

Data Availability The data that support the findings of the study are the survey responses. They have been included in the supplementary material. The spreadsheet containing the responses is also linked here.

Declarations

Ethics Approval and Consent to Participate The study involved the use of human participants in the form of an anonymous survey. All participants were fully informed that their anonymity is ensured, why the research is being conducted, as well as how the data would be utilised. This information was included in the email body which was sent with the survey link as well as the introductory section of the questionnaire. Personal data collected involved age, which part of India they reside in as well as the locality. This was purely for demographic analysis and to observe any trends. It was made clear to the survey respondents that participation in the survey was voluntary and as per the participant’s consent.

Consent for publication Not applicable.

Competing Interests The authors declare no competing interests.

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