NEW HORIZONS FOR LAST MILE DELIVERY FOR THE CORONAVIRUS PANDEMIC

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Abstract: The COVID-19 outbreak infected millions of people around the globe, forcing the people to stay home. The new daily life became indoor shopping and the retailers had to adapt to this new reality, causing a high demand for the logistics. This paper presents the willingness of a post-pandemic medium-sized city consumers to adopt new modalities of delivery: reception boxes, delivery drones and crowdsourcing logistics. Through a survey with closed questions applied online to 401 people, the results indicated that younger people tend to buy more online than older ones. People with a higher education level also buys more online. It was possible to affirm that the popular opinion was positive towards experimenting these innovations and the presented results corroborates with the related research.

Keywords: Sars-CoV-2. Logistics. E-commerce. Feight.

Introduction

The Corona Virus Disease, a viral disease caused by the often-called COVID-19 or new coronavirus, is a pandemic virus that infected millions of people worldwide. The epidemic outbreak led to around half million causalities until the first half of 2020, that significantly changed the lifestyle of everyone as the need for social distance and lockdown rises. Due recommendations of the World Health Organization (2020), people were advised to stay home and most of countries complied in order to lessen the virus spread. Aside from the health crisis, the business was directly hit by this lifestyle, since the need of social distance. Tourism and some entertainment activities that involves agglomeration, such as live shows, since march 2020 cannot function fully (ALI; ALHARBI, 2020).

In this context, local restaurants and stores, trying to adapt the challenge, adopted a model of takeout order or delivery, avoiding direct contact (POMRANZ, 2020). Brazil also implemented this kind of behavior, and can even order their groceries from home (GLOBOPLAY, 2020). As the e-commerce intensified, the customers grew more exigent regarding the demand and quality of delivery services, requiring anywhere and anytime demand fulfillment. In order to innovate, the companies tried to gather the distribution system to new transportation solutions integrated with the internet (SACHAN; KUMAR; KUSHWAHA, 2020).

Since retailers have a large reach towards the customers through the internet, they can easily compare offers and the e-commerce faces its major challenge: the last mile, where the order placement and the delivery services take place. The last mile is long known to be the costliest part of the supply chain, due to the expanding market and the inclusion of the stream of packages to be delivered and maybe returned (CORTES; SUZUKI, 2020; SOROOSH; WILDING, 2016).

Wendler *et al.* (2008) define the electronic commerce (or e-commerce) as a cluster of processes and technologies in order to execute transactions through electronic ways. This service provides the possibility to buy and sell products, services or information. This approach changed the way to do business, having a considerable part on the globalization process. In other words, the e-commerce is the exchange of business information, conducted by business transactions between different people or organization. This involves buying and selling online, but since everything is on a virtual level, the orders must arrive physically to its destiny to complete the transaction, this means that a delivery process have to happen.

Thinking about the challenges of the last-mile, this study aims to explore if medium-sized Brazilian citizens are online customers, what kind of goods they are buying online, by which channel and their willingness to try new delivery methods during the e-commerce high demand due the coronavirus novel. This study has exploratory characteristics and a survey was conducted to 401 people to achieve these goals.

New Solutions for the Last Mile Delivery

A common delivery process can be explained in three main steps after a fulfilment process in the retailer' distribution center, as seen on Figure 1. The carrier picks up the packages, then the goods are taken to the truck and loaded; The packages arrives at the sort center closest to the customer's address and the truck is unloaded, the order is now loaded into an urban cargo vehicles and directed to its final destination; The last step, called Last Mile, the urban vehicles delivers to the customer's address, concluding the order. This is the costliest logistic activity, also the most studied (ZHOU et al., 2020).
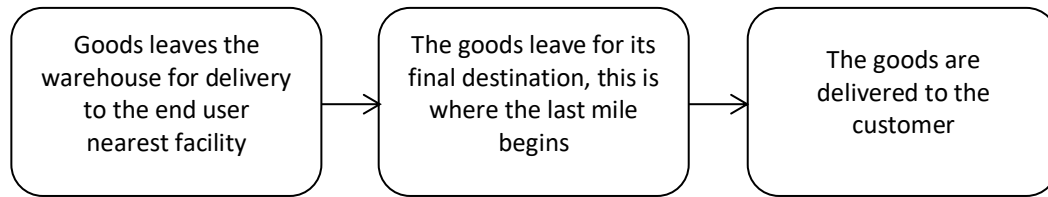
| Goods leaves the warehouse for delivery to the end user nearest facility | → | The goods leave for its final destination, this is where the last mile begins | → | The goods are delivered to the customer |

Figure 1: Delivery process' step (Authors, 2020)

Regarding the last mile, Brazilian courier services delivers goods to customer's doorstep, require theirs signatures and go for the next one. This is the most worldwide consolidated "last mile" type for delivery. With massive orders numbers comes low efficiency due to traffic, the limited possible delivers that can be done in one day of service, waste of time waiting for the customers, and other factors. In order to increase the efficiency, there are a search for new solutions to deal with the challenges prevenient from the last mile, for instance: reception boxes, delivery drones and crowdsourcing (SEGHEZZI et al., 2020).

Reception Boxes

There are four kinds of reception boxes (RBs), another method to handle the last-mile (IWAN; KIJEWSKA; LEMKE, 2016; WANG et al., 2014):

1. Independent reception box located on the customer's propriety;
2. Delivery Box equipped with a docking mechanism, retrieved only after the goods inside are collected;
3. Collection Point, which can be locker point or service point. Locker point or unattended point is an installed shared reception box located on public area. The parcels are delivered and stored at the unattended point, then the customer can may pay, collect and return goods. Service point or attended is built in shop-in-shop concept, installed near residential location (local store, railway stations, hospitals, etc.) where customers can pay, collect, and return goods.
4. Shared password-protected reception box, installed near customers for shared usage. The courier stores the package in the boxes, the customers may pick up their order anytime through password provided to them.

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With the reception boxes, the couriers don't waste time waiting for the customers, improving the efficiency of the deliveries. In the other hand the implementation of reception boxes is expensive, Tiwapat *et al.* (2018) compared the traditional attended home delivery to the reception boxes modalities and found that from the perspective form the customers they were interest about the opening hours, which can allow them to pick their goods up at any time they want.

Regarding the courier services provider, the authors were interested in failed first-time delivery and its cost. If the first-time delivery fails, it affects the delivery cost directly. Hence, if the modalities can reduce the failed first-time delivery, it could minimize the costs of the service providers.

Drone Delivery

In order to contribute positively to environmental outcomes regarding deliveries, there are many innovative initiatives and projects being developed. One of them are the Delivery Drones, also known as Unmanned Aerial Vehicle (UAV), automatically or remotely piloted aerial vehicles. In Europe, they are still on trial phase and deliver only urgent goods, such as medical supplies. The first drone launched, specifically for delivery, is called "parcelcoper" and reached 12 km of distance traveled. Deutsche Post DHL, a German multinational package delivery and supply chain management company, was responsible for this delivery, the first drone weighted less than 5 kg, had a carrying capacity up to 1.2 kg and could travel at an altitude of 50 m at 64.8 km/h (DHL, 2014). However, these features, such as load capacity, power solutions and delivery distances were further improved through research (EDENHOFER, 2018).

Drones are powered by batteries, which have to be replenished when depleted, limited their flight range. They also can carry one package at a time with restricted weight (HONG; KUBY; MURRAY, 2018). Customers concerns about the reliability of the drone delivery service for expensive items, thus, the promotion activities for the drone delivery will be necessary for its implementation (KIM, 2020b). On the other hand, they can deliver parcels with a low cost, high speed, no road restriction with a minimum CO_2 emission. As the drones' technology improves, the logistics' system will have even more competitive advantages over traditional logistics (PENG; SUN; MENG, 2021).

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Crowdsourcing Logistics

Brabhan (2008) best defines the term Crowdsourcing as "the process of posting a problem online, having a vast number of individuals offering solutions and awarding the winning ideas with some form of a bounty". The concept of crowdsourcing was proposed by Howe (2006) based from class of business model that offers temporary asset ownership benefits to the users at a reduced cost.

Big companies are adapting this approach with ridesharing services to perform same-day deliveries that the customers demand, this is known as "Crowdsourced Logistics" (CLS). In this business model, the shipper solicits transportation services through mobile or desktop online service directly to an independent contractor that owns a vehicle asset, which integrates the retailer and the driver that will deliver the goods to its destination, through a good use of communication technologies (BEIRIGO; SCHULTE; NEGENBORN, 2018; GUO et al., 2019).

The crowdsourcing logistics can build customer networks and local communities, which can make a better use of the existing capacity and feedback in order to improve the services, reduce costs of acquisition and maintenance of vehicles and even minimize the negative environmental impact, with an opportunity to serve the customer and creating the image of an environmentally friendly company (HUANG et al., 2020). The obstacles of implementing the CLS include the responsibility of private issues, which can have additional costs; customers may not agree to share their addresses with the so-called strangers; Additional costs for insurance may be needed; software development, its implementation, maintenance, training for contributors and GPS devices have to be considered in the overall costs (JIANG; REN, 2020).

Method

The appliance of the survey aimed to investigate the changes about the means of acquiring products during the pandemics outbreak and also explores new ways to deliver goods that are little explored in Brazil. The data collection was made to gather information about this subject though an online survey. The five-points likert scale was used on questions regarding the customer's opinion, a higher score means a stronger concordance with the affirmative (LIKERT, 1932). Only closed questions were considered, divided in sections that flows

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according with the previous answer. There are four paths depending on the answer in order to analyze each customer profile.

The Figure 2 illustrates the flowchart of questions and each section. It was used two questions regarding demographic information based on IBGE's census (2017) to identify the sample: age range and educational level. The age group on question I considered were under 13 years old, 14 to 17 years old, 18 to 24 years old, 25 to 39 years old, 40 to 59 years old. The education under consideration was the Incomplete Primary Education (IPE), Complete Primary Education (CPE), Incomplete High School (IHS), Complete High School (CHS), Incomplete Higher Education (IHE), and Complete Higher Education (CHE).

The question 3 asks if the interviewee bought online before, at this point depending of the progressing the questionnaire may progress differently. If the answer is "Yes" the respondents will proceed to question 4a, otherwise they will be directed to question 4b, which asks if the interviewee would agree to buy online someday.

The question 4a intends to search if the participants of the survey have made use of the e-commerce by means of three options as solely before the pandemics, exclusively after the pandemics or if the respondent have been buying online regardless the coronavirus novel. For those who placed orders before, they were questioned if they would agree to buy online again. The following questions were measured with the five-points likert scale and were about which kind of products they bought (question 5a, 5b or 6c) and by which means (questions 6a, 6b or 7c), then they were asked about their satisfaction level with the current delivery method utilized by the courier on question 7a, 7b or 8c.

The questions 8a, 8b and 9c were based on the concept of reception boxes explained by Wang *et. al* (2014), in the same way, the questions 9a, 9b and 10c were based on Slabinac (2015) explanation about drone delivery and lastly the questions 10a, 10b and 11c were based on Wang *et al.* (2016) work, which defines the Crowdsourcing logistics, in order to quantify the acceptance of the citizens toward these three modalities.
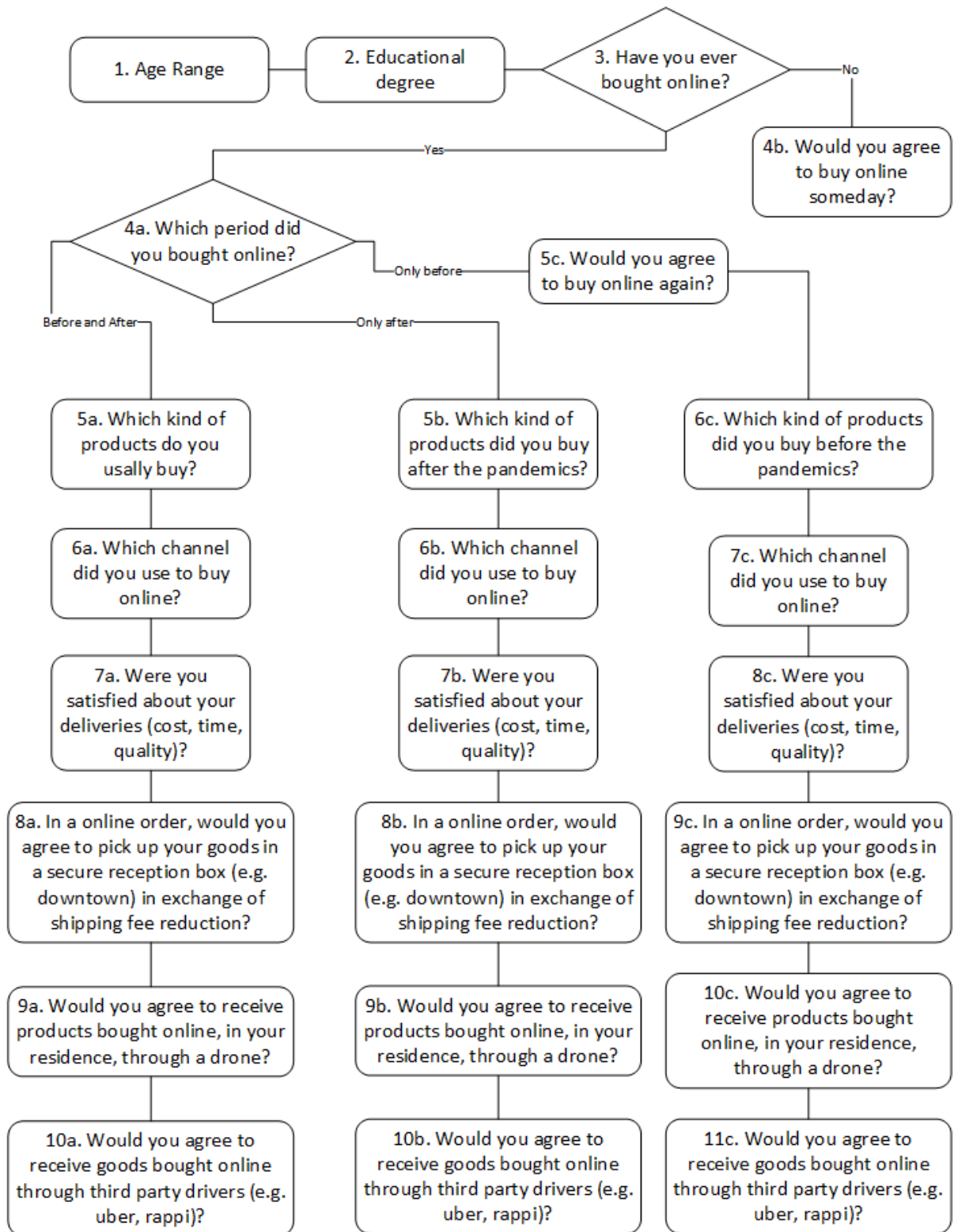
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Figure 2: Questions and paths (Authors, 2020)

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The theorical framework included related articles about e-commerce and innovative ways to attend the high delivery demand caused by the pandemic virus outbreak. The questionnaire was applied between June and July of 2020 to residents of Campos dos Goytacazes. This municipality is located on Rio de Janeiro state, on the northern Fluminense mesoregion. According with the 2010 census, the city has a 463,731 population and a demographic density of 115.16 person per km². The estimative of 2019 populace by the Brazilian Institute of Geography and Statistics (IBGE) is 507,548. The medium monthly income of formal workers in 2017 is 2.5 minimum wages, which is only the 19,6% of overall population (IBGE, 2017).

From the population number, informed by IBGE, the ideal sample was determined by the equation of sample calculation for finite population (GIL, 2008), as seen on Equation (1. The minimum sample calculated corresponds to 384 respondents.

$$n = \frac{z^2.p.q.N}{e^2(N-1) + z^2.p.q}$$ (1)

In which:

n: sample size;

z: confidence level scored;

p: probability of success event (50%);

q: probability of failure (50%);

N: population size;

e: maximum error used (5%).

Results

The results of the research indicated that the majority age range between 18 and 59 years. Younger people tend to buy more online since they are connected to the internet most of the time (BEDNAROWSKA; JEDRUSZEK, 2012). The Figure 3 shows the percentage of each age range and education according to IBGE (2010). The data showed determines the prevalence

of customers with higher level of education, which represents most of customers have already finished university or are finishing it. These results were expected, since the e-commerce and internet usage are related to the Brazilian education. According to Information Resources Management Association (2018), people with higher education tend to buy more online.
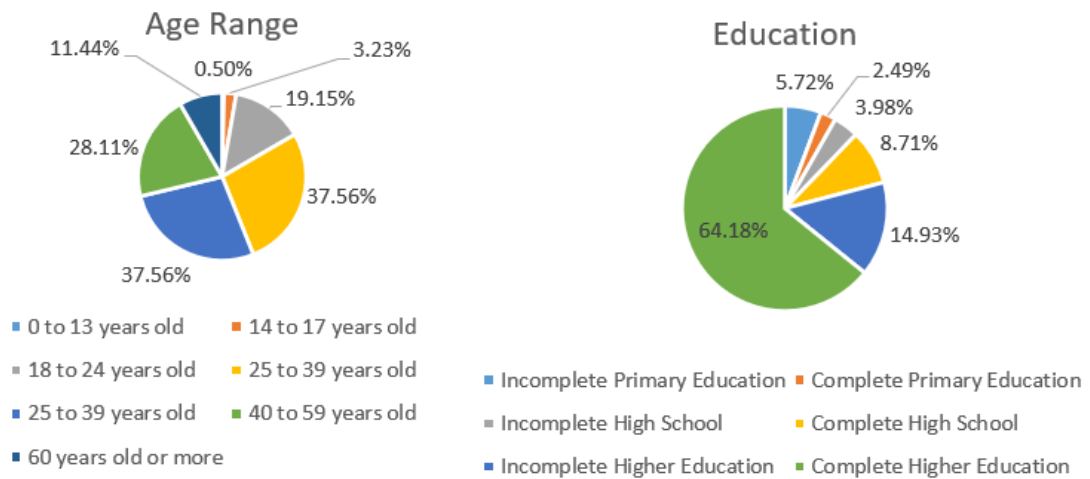

Figure 3: Age range and Education (Authors, 2020)

From the answers shown on Figure 4, 93.03% of surveyed people buys online, those who didn't were asked if they are willing to order something online in the future. The predominant opinion was positive towards experimenting the e-commerce. The customers that only placed an online order before the pandemic outbreak were asked if they agree to order online again someday, they are represented by the blue arrow. The most of the ones that only bought online before may try to buy online again, represented by the orange arrow. It is possible to identify four profiles from the customers: the ones that purchased online only before the beginning of the pandemic novel; the ones that ordered only before the outbreak; the assiduous online buyers that always place online orders and; the ones that didn't order online yet.
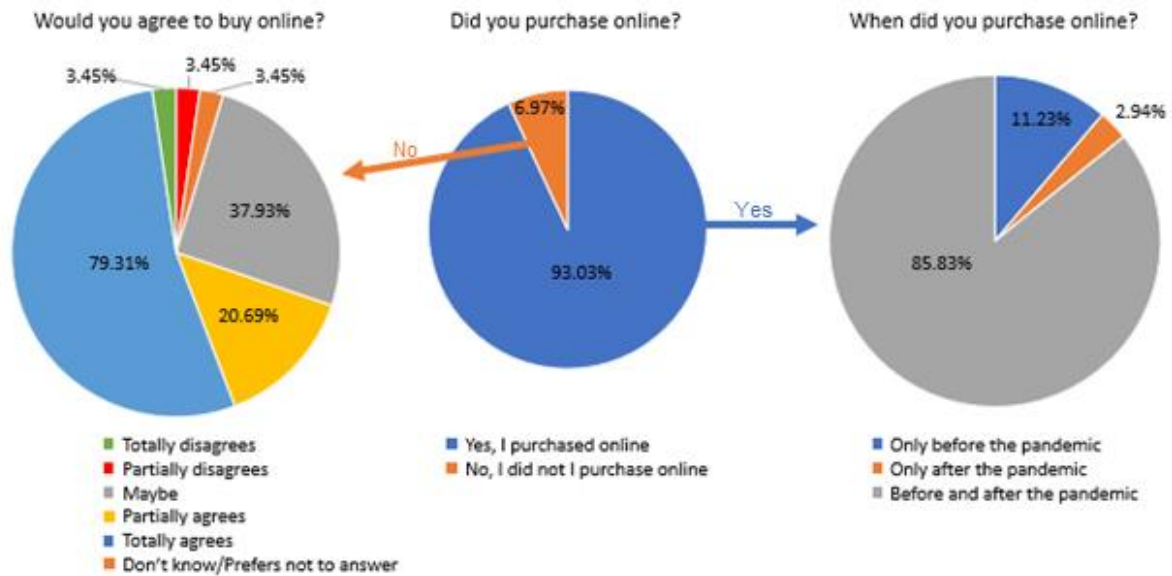
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Figure 4: Online Purchase answers on pie charts (Authors, 2020)

The Table 1 shows which kind of products the city residents buy online. For those who bought before the pandemics, books and stationery were the categories that were ordered the most. New buyers ordered more furniture and home appliance and the assiduous buyers tend to diversify their online shopping, which means a greater variety of products bought.

Table 1: Categories of Producted purched online

Category	Before	After	Before and after
Gas and lubrificants	7.1%	0%	1.9%
Hypermarkets, supermarkets, food products, beverages and tobacco	14.3%	27.3%	26.6%
Fabrics, clothing and footwear	50%	27.3%	56.6%
Furniture and appliances	42.9%	27.3%	68.1%
Pharmaceutical, medical, orthopedic, perfumery and cosmetic	28.6%	27.3%	38.1%
Books, newspapers, magazines and stationery	40.5%	36.4%	49.4%
Office, computer and communication equipment and supplies	33.3%	18.2%	52.8%
Other personal and domestic use items	7.1%	27.3%	53.1%
Vehicles, motorcycles and parts	9.5%	0%	15.9%
Construction material	2.4%	18.2%	4.4%

Source: Authors, 2020

The Table 2 shows, from the higher percentage to the lowest, which means the customers used in order to complete their orders. The store website was the most used channel

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among the costumers, mobile apps also have a great share of online purchases. Before, during and after pandemic novel the order of channels used was maintained.

Table 2: Channels of online purchase

Channel	Before	After	Before and after
Website	92.9%	90.9%	96.3%
Apps	16.7%	45.5%	48.4%
Whatsapp	7.1%	9.1%	24.7%
Instagram	4.8%	9.1%	23.8%
Facebook	4.8%	9.1%	8.1%

Source: Authors (2020)

The participants were asked if they were satisfied with the current delivery method, their answers are displayed on Table 3, from more satisfied to less satisfied. Most of customers were satisfied with the costs, quality and delivery time, but the assiduous buyers have slightly more diversified opinions on the matter, which can indicate new opportunities to improve the quality of the services provided from the curriers.

Table 3: Customer's satisfaction with delivery system

Answer	Before	After	Before and after
Totally satisfied	21.4%	9.1%	26.9%
Partially satisfied	33.3%	27.3%	44.4%
Neutral	7.1%	9.1%	6.9%
Partially unsatisfied	14.3%	18.2%	14.7%
Totally unsatisfied	21.4%	18.2%	6.9%
Don't know/Prefers not to answer	2.4%	18.2%	0.3%

Source: Authors (2020)

In regard to reception boxes, the Table 4 presents the answers ordered, from most to least positive, about the customer's acceptance about this kind of service, they were asked if they would agree to receive their goods in a strategically located locked box around the city, in return the shipping fees would be decreased. The answers were mostly positive, meaning that it would be a good delivery modality to experiment.

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Table 4: Customer's interest for reception box

Answer	Before	After	Before and after
Totally agrees	38.1%	45.5%	32.2%
Partially agrees	16.7%	18.2%	22.5%
Maybe	16.7%	18.2%	23.8%
Partially disagrees	14.3%	9.1%	5.6%
Totally disagrees	9.5%	0%	15%
Don't know/Prefers not to answer	4.8%	9.1%	0.9%

Source: Authors (2020)

According to the results shown on Table 5, the customers are uncertain about this method, but most of them are willing to try.

Table 5: Custumer's interst for delivery drones

Answer	Before	After	Before and after
Totally agrees	38.1%	36.4%	33.1%
Partially agrees	16.7%	27.3%	17.8%
Maybe	9.5%	9.1%	19.4%
Partially disagrees	7.1%	0%	4.7%
Totally disagrees	14.3%	18.2%	18.1%
Don't know/Prefers not to answer	14.3%	9.1%	6.9%

Source: Authors (2020)

The crowdsourcing is a new concept well received by the interviewed sample, companies like Uber and Ifood inserted themselves into their daily lives (YOUNG; FARBER, 2019). The customers now were asked if they agree to receive their goods by a third-party delivery system, in this questionnaire, this concept was the most accepted by the citizens, regardless of their experience of online shopping. The answers can be seen on Table 6, from the most positive to the least positive level of acceptance.

Table 6: Customer's interest for crowdsourcing

Answer	Before	After	Before and after
Totally agrees	42.9%	45.5%	50.9%
Partially agrees	19%	27.3%	25%
Maybe	14.3%	18.2%	12.2%
Partially disagrees	2.4%	0%	5.9%
Totally disagrees	9.5%	9.1%	4.7%
Don't know/Prefers not to answer	11.9%	0%	1.2%

Source: Authors (2020)

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Discussions

One of the ways to deal with the challenges of the last-mile consists of efficient delivery methods. The situation caused by the pandemics around the world impacted the e-commerce and the goods' delivery models both in big cities and smaller cities. In this context, our study attempted to further investigate the issue by directly asking a sample of Brazilian consumers what their perception was regarding their willingness to try new delivery methods during the e-commerce high demand due the coronavirus novel.

The results of the applied survey showed four consumer profiles categorized by their e-commerce usage. This way, it is possible to observe the people that never used e-commerce to acquire goods, people that used this electronic channel only before the pandemics, others that used it only after the pandemics, and lastly, the assiduous customers that bought online both before and after the beginning of the pandemic outbreak.

Most of people that never experienced an online purchase claimed that was difficult and confusing, complying with Dirgantari *et al.* (2020) research, which determined the level of use and satisfaction of e-commerce customers in the COVID-19 pandemic period with the information system success model (ISSM) approach that was formed through system quality, information quality, and service quality. Their approach formed through system quality, information quality, service quality, which proved to affect the level of usage and ecommerce consumer satisfaction, especially in the current pandemics.

When the respondents were inquired about which categories of products they acquired online, fabrics, clothing and footwear, furniture and appliance were highlighted. On the order hand, Kim (2020a) observed that even new online customers are prompted to shop online and household supplies and entertainment at home are the categories that the customers plan to spend more during the pandemics. Aligned with this research, the author analyzed the impacts of the COVID-19 on business and customers, through an analysis of the consumer behavior and how the pandemics affected consumers and marketplaces, suggesting a growth of the e-commerce, but is unlikely to cease or reduce after the COVID-19 passes.

The citizens in this paper were asked how willing they are towards using the reception boxes for their online orders, deliveries from drones and the crowdsourcing logistics, reinforcing the statement made by Ramanathan *et al.* (2014) that shows the relevance of customer feedback regarding online purchases.

Rai *et al.* (2020) analyzed how the consumers used the collection points and how they traveled to these points through street intercepted surveys. They interviewed 385 consumers in Brussels, Belgium's capital, their results show that 72.2% of consumers use collection points following an unsuccessful delivery attempt at their homes, indicating considerable inefficiencies in the last-mile, 47% of consumers use cars to claim their purchase, while 22.3% take public transport, 21.6% walk and 9.1% cycle. They also concluded that most of consumers visit a collection point within a fifteen-minute distance, generally combining other activities, like grocery shopping and running errands. The authors also found that consumers that prefer collection points are generally younger, similar to this research results, they are more frequent online shopping as well.

One of the challenges for the drone delivery is their flight limitation. Moshref-Javadi *et al.* (2020) presented a mathematical formulation and a heuristic solution approach for the optimal planning of delivery route in a multi-modal system that uses a drone and a truck. In their system, one or multiple drones travel on the truck, serving as delivery courier person, each drove delivers a single package per dispatch, while the truck follows a multi-stop route. The authors applied theirs Truck and Drone Routing Algorithm to a real-world case of study for e-commerce delivery in the city of São Paulo - SP, Brazil. Their method may be a solution for the drones' limitations, since they can be charged on the truck while moving.

Kim (2020b) analyzed the consumer preference for drone delivery based on a survey applied to potential consumers' preference between the drone delivery service and traditional delivery services (motorcycle or truck). The author found that young people are more likely to opt for the drone delivery service than old people are, the same statement is observed in this study.

Most of answers about the implementation of crowdsourcing were positive in this study, Gatta *et al.* (2019) investigate the crowdsourcing service relying public transportation as a mean to deliver goods to customer. The author's work collaborates with a sustainable view, considering the environmental issues and avoiding possible traffic accidents. The public transportation considered were the metro lines, since it is more frequent used and reliable where this research takes place, which is Rome, Italy. They concluded that the crowdsourcing is a good delivery service in the last mile and suitable for e-commerce, obtaining the most of potential economic and environmental benefits.

Simoni *et al.* (2019) analyzed through a simulation-based approach the potential impacts of the implementation of crowdsourcing logistics on last-mile delivery operations in a realistic large-scale scenario, considering real traffic conditions, availability of commercial bays and freight demand. They concluded that the crowsourcing can result in very different changes in traffic congestion and emissions, depending on implementation features. These results warn about the challenges of the crowsourcing usage, which must proceed with caution.

Conclusions

The pandemic forced the consumers to go virtual, increasing the demand of the last-mile. The results comply with the statement since there weren't a significant part that didn't make a purchase online yet. This paper explored if the consumer of a medium-sized city in Brazil were open to experiment new ways of delivery, preparing for a post-pandemic world. The outbreak made people to adapt and make a better use of the technology available, changing the traditional way of working and most of these changes may endure after the coronavirus novel.

It was found that most of citizens have been already buying online before the outbreak, and most of those who haven't experimented yet agreed to try the e-commerce. Even though the courier provided satisfactory services, the new trends of delivery are slowly being implemented, and the popular opinion was positive towards experimenting these innovations. With the reception boxes, the costumer may pick up the goods while returning home from work, regarding the drones, smaller packages can be lift and delivered at the customer's door, minimizing the gas emissions from vans and trucks, preventing human contact, collaborating with the social distancing and performing their work. The crowdsourcing is one of the most promising solutions, since its concept is well accepted by the citizens on food delivery or ridesharing applications. It provides at the same place drivers willing to complete the delivery, the courier's services that needs to satisfy their customer and the receiver.

As the fast pacing of technology development, the modalities of last-mile delivery will be increased. There will be many choices of delivery modes available for customers and the wellbeing of mankind will definitely be better than before. For future projects, the authors will implement a discrete event simulation with the scenarios addressed, the reception boxes, the

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drone delivery and the crowdsourcing logistics, comparing their efficiency with the traditional delivery method.

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