Sustainable last-mile distribution in B2C e-commerce: Do consumers really care?

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ABSTRACT

Over the past few years, consumers have prioritized cost and speed over sustainability when referring to ecommerce decisions, ignoring the impact of greenhouse gas (GHG) emissions associated with last-mile distribution of the purchased products. There are numerous research calls to enhance our understanding about such a phenomenon. To help address this gap, this work investigates how motivated B2C (business-to-consumer) e-consumers are to prioritize sustainability over speed (delivery time) and cost in their orders. To do that, a survey was applied to 421 respondents, and results showed that delivery speed was the most important purchase criterion to consumers, followed by delivery cost, lastly, environmental information. The potential for consumer flexibilization was greater to delivery speed over cost. Demographic characteristics (gender, age, wage, and education) influenced the motivation to give priority to last-mile deliveries linked to sustainability. Also the delivery speed sacrifice accepted by consumers depends on the purchase order (type of product): categories of products, such as fashion and accessories and sport and leisure are more accepted over health/cosmetics/perfumery or food and beverages. Results also suggest that there is potential to educate e-consumers when purchasing online by helping them revise their priorities with the help of spreading environmental information.

1. Introduction

E-commerce is here to stay, especially in times of pandemic like the current Covid-19 (Kissler et al., 2020), and the literature highlights several benefits associated with it such as high variety of products, competitive prices, efficient delivery, and convenience (Carrillo et al., 2014). There are, however, environmental impacts caused by e-commerce along the supply chain (SC) (Chen et al., 2017). In B2C ecommerce, the transportation accounts for the largest share of greenhouse gas (GHG) emissions (Jaller and Pahwa, 2020). As e-commerce increases, the interest in sustainability studies associated with these type of transactions increases, as sustainability remains as one of the most challenging issues for humanity (Ding and Jin, 2019).

In accordance with the Digital 2021: Global Digital Overview (Hootsuite, 2021), the number of consumers who have purchased goods via e-commerce in 2020 was approximately 3.47 billion people, equivalent to about 44,5% of the global population. During the Covid-19 pandemic, in 2020, the total value of the global B2C e-commerce market was about US$ 2.44 trillion (Hootsuite, 2021). With the increase of the B2C Ecommerce worldwide, the use of road transportation for product distribution has also increased (Huang et al., 2018). According to the International Energy Agency (IEA, 2019), transportation is one of the main contributors to global emissions of carbon dioxide (CO2), accounting for 25% of total global emissions (the second largest share of GHG emissions in 2017). Of that total, 74% of emissions were related to road transportation (IEA, 2019).

Together with the E-commerce volume increase, consumers are becoming more demanding in key aspects like the speed of delivery of products, putting additional pressure on the environmental impacts of such consumption (Manerba et al., 2018; Guo et al., 2019). Several studies suggest that there are ways to reduce GHG emissions from the supply side without high financial investments by improving the use of freight vehicles (i.e., type, age, and driver behavior), optimizing routing, and allocating GHG emissions to specific shipments (Rangel and Cordeiro, 2014; Marcilio et al., 2018). From the demand side, however, other alternatives, such as providing environmental information to allow e-consumers to make more conscious sustainable decisions at the time of purchase, have been gaining traction, giving rise to multiple calls for further exploration of these trade-offs (Carrillo et al., 2014; Ignat and Chankov, 2020).

In this context, consumer behavior has become a key in the process of enhancing sustainability of SC by considering not only economic/financial aspects but also environmental sustainability impacts on their purchasing choices (Lah, 2017; Manerba et al., 2018). Raising E-consumer awareness can represent an important way to influence purchasing habits (Steiner et al., 2017) and make SC operations more sustainable (Gong et al., 2019).

Given this context, this work aims at helping address this gap by investigating how motivated B2C e-consumers are to prioritize sustainability in their purchase orders (through sustainable last-mile distribution) over delivery speed and cost. Therefore, it was discussed the following survey question: *Are e-consumers ready (or aware?) to make sustainable last-mile delivery decisions for any purchase orders?* To do this, we used the theory of sustainable SC management by addressing the knowledge gap that exists with regard to e-consumer awareness for sustainable last-mile deliveries. This paper sheds additional light on this important topic and contributes to the literature in two ways. First, sustainable last-mile deliveries need to be viewed according to the type of product, as there are different levels of consumer awareness for each type of product; second, SC environmental sustainability from the consumer awareness in an emerging market (like Brazil) brings limited possibilities when compared to mature market We adopt a survey method applying 421 questionnaires to address this issue.

This paper is structured as follows: Section 2 reviews relevant studies within this theme and develops hypotheses associated to it. Section 3 introduces the methodology adopted in this study, followed by a description of the statistical analysis and results (Section 4). Section 5 discusses the findings of this research in light of the existing literature; and lastly, Section 6 concludes the paper with its specific contribution and future research perspectives.

2. Theoretical background and Hypothesis development

Managing SC is a challenging task due to high levels of complexity, including the logistics that needs to be in place to transport and deliver an immense volume of B2C E-commerce orders scattered worldwide (Rotem-Mindali and Weltevreden, 2013; Li et al., 2015; Lin et al., 2018; Gong et al., 2019). This demands attention and further discussion especially because of the environmental impact, in the form of GHG emissions, that these operations can bring (Cárdenas et al., 2017).

Factors like intense flows of goods and services and the expansion of digital markets have transformed the nature of the modern SC (Pirvulescu and Enevoldsen, 2019). E-commerce has entirely reshaped the SC by requiring dynamic and innovative logistics activities (Babenko et al., 2020). In this context, transportation operations play an important role for distribution logistics as they consume the interactions between retailers and consumers, however, at the same time, they raise the levels of GHG emissions (Lee et al., 2018). This situation requires SC management and its logistical operations (especially transportation operations) to increasingly deal with trade-offs for green SC planning (Kang et al., 2017).

E-retailer strategies to provide fast delivery may contribute to an increase in GHG emission due to the choice of prioritizing speed over other factors (Ding and Jin, 2019). That is why transportation is considered one of the main causes of environmental impacts associated with E-commerce SC (Hischier, 2018; Cortes and Suzuki, 2020). The problem of GHG emissions from E-commerce becomes complex as demographic and socio-economic changes increase the number of orders, deliveries and, consequently, the volume of freight vehicles in urban areas (Comi and Nuzzolo, 2016).

2.1. Sustainable supply chain management

Over the last decades, SC has sought to improve its sustainability performance worldwide due to pressure from shareholders, governments, and society (Kang et al., 2017). As SC are fundamental systems for

a more sustainable world, it is required that these systems incorporate social, environmental, and financial aspects into their decision-making processes (Castillo et al., 2018; Bubicz et al., 2019). The SC evolve through their sustainability trajectories, which are non-linear and of high complexity (Silvestre, 2015). These SC sustainable trajectories involve collective learning and are operationalized through SC sustainable initiatives designed and implemented by their players (Silvestre et al., 2020).

The existing SC sustainability literature focuses mainly on sustainability practices or initiatives from the supply side (i.e., upstream of the SC), such as GHG emissions control, waste management, standard working conditions (Gold et al., 2015; Lis et al., 2020; Sarkar et al., 2021). On the other hand, there are some recent studies that explore possibilities for SC sustainable practices from the demand side, i.e., downstream of the SC (Hu et al., 2019; Ignat and Chankov, 2020). These views complement each other and, for a SC to be truly sustainable, it must involve consumers who should be willing to take responsibility and awareness for their consumption patterns (Jaller and Pahwa, 2020). For example, Gong et al. (2019) found that consumer awareness has a significantly positive effect on SC sustainable performance. Buerke et al. (2017) point out that the consumer awareness has a direct positive influence on a responsible consumer behavior, and his/her decisions can help solve SC sustainable challenges. However, Sallnäs and Björklund (2020) suggest that consumers currently have limited possibilities to influence the SC sustainability because of the limited communication and availability of sustainability information.

Green logistics and transportation studies constitute a paramount research axis in the sustainable SC management due to several environmental impacts caused by vehicles, such as GHG emissions (Babenko et al., 2020). Given the complexity of logistics, green solutions require an integrated approach involving stakeholders (public and private, as well as consumer behavior) and their trade-offs at all stages of logistics planning (Bjørgen et al., 2019). In the urban logistic context, the last-mile distribution is currently considered one of the most expensive, least efficient, and most polluting stages in the entire SC, so there are several approaches focused on the green last-mile (Morganti et al., 2014; Cortes and Suzuki, 2020). For example, Spijkerman (2016) investigated consumer purchasing preferences (in terms of mobility) in order to reduce last-mile urban area emissions. Bandeira et al. (2019) proposed the use of electric vehicles in the last-mile deliveries of e-commerce to obtain gains in environmental and economic sustainability. Perboli and Rosano (2019) investigated opportunities and threats for the mix of traditional and green logistic models on the products delivery in urban areas showing that both approaches can coexist optimizing the overall system.

2.2. Influence of sociodemographic factors on definition purchase priorities

Researchers agree that there is a need to understand the different e-consumers' profile as the internet has become a necessity for current generations (Rai et al., 2019; Iweala et al., 2019). E-consumer preferences and priorities help SC to define marketing strategies, but also policymakers and SC to identify/develop strategies for promoting e-consumers awareness regarding GHG emissions on last-mile transportation (Lim and Cham, 2015; Oliveira et al., 2017). Contextual factors and consumer characteristics (i.e., sociodemographic factors) can influence the purchase/delivery attributes on online retail, such as delivery speed, delivery cost, and green deliveries (Nguyen et al., 2019).

When investigating consumption patterns among e-consumers, some sociodemographic characteristics were used. Oliveira et al. (2017) adopted factors such as age, wage, gender, and education to study new ways for e-commerce deliveries (automated delivery stations). The same sociodemographic characteristic was used by Steiner et al. (2017) to identify and characterize different consumer segments concerning motivation to ecological behavior when products labeled for carbon and water footprints. Nguyen et al. (2019) found three segments for e-consumers according to their purchase priorities: price-oriented consumers

(that is, influenced by delivery cost), convenience-oriented consumers (i.e., influenced by aspects like delivery speed and flexibility), and value-for-money-oriented consumers (i.e., influenced by both price and convenience-related aspects).

Consumers have been more and more exposed to make sustainable choices; most of them, however, are little informed about how these choices can impact product delivery sustainability (Penz et al., 2019). Chuanmin et al. (2014) employed a survey method applied to Chinese e-consumers and found that the more educated and well-paid e-consumers are, the more prone they are to opt for low GHG emission deliveries, while the high-income young and adult e-consumers showed little environmental awareness. In a study with consumers on how environmental perception may influence their behavior at the time of purchasing, it was found there is still a gap between perception and behavior of individuals from low to medium level of environmental behavior; the work evidences that people tend to have higher perception than their respective behaviors (Deliana and Rum, 2019). Conversely, a survey conducted among young Indian consumers presented sustainable motivation to choose an online sale channel (Nair and Bhattacharyya, 2019). Another survey conducted among Belgian consumers (considering age, gender, and language) showed they agree that driving less kilometers for last-mile deliveries is relevant, even if it is necessary to increase the delivery time; however, they are not willing to pay for deliveries that employ more sustainable alternatives than standard deliveries (Rai et al., 2019). Based on the literature under study, the following hypotheses are suggested:

Hypothesis 1a. Sociodemographic variables (gender, age, wage, and education) influence the e-consumers' willingness to choose more sustainable deliveries for their online orders.

Hypothesis 1b. Sociodemographic variables (gender, age, wage, and education) influence the e-consumers' willingness to be flexible about the delivery speed of products.

Hypothesis 1c. Sociodemographic variables (gender, age, wage, and education) influence the e-consumers' willingness to be flexible about the delivery cost of products.

2.3. Sustainability awareness of e-consumers

The research suggests that online purchases may be less harmful to the environment than those from conventional brick-and-mortar stores (Van Loon et al., 2014). However, there are environmental impacts of e-commerce, which need to be mitigated, particularly the GHG emissions caused by the transport sector (Dost and Maier, 2018). Recently, it has been demonstrated that online purchases may increase GHG emissions due to fast deliveries with short delivery windows as they do not allow high levels of consolidation (Jaller and Pahwa, 2020). Regarding it, some studies argue the importance of retailers and logistic service providers to adopt green strategies for distribution, but also of consumers to have advance knowledge of the potential environmental impacts related to transportation of their purchase because can lead to more conscious decisions and favor better organization for distribution by suppliers (Manerba et al., 2018).

The literature shows that retailers always have motivation to implement ecological strategies when e-consumers present sustainable preferences or attitudes; therefore, consumer-centered sustainability has become a trend in researches in sustainable SC management, especially, in last-mile distribution (Ji et al., 2017; Chen et al., 2017). Consumers have been more and more aware of the environmental performance of B2C e-commerce transportation, but this awareness still needs to be fostered (Schleiden and Neiberger, 2019). This is because, in some cases, there is still a dissociation between theory and practice when giving consumers the opportunity to make sustainable choices (Wang et al., 2018). A study on the participation of e-consumers, e-retailers, and logistics service providers exploring the possibility of consumers to

influence green logistics on e-commerce showed that, at present, consumers have limited possibilities to influence the greening of distribution due to restricted communication among them (Sallnäs and Björklund, 2020).

From the consumer perspective, some studies have also investigated the consumer behavior in relation to sustainable last-mile delivery; nevertheless, researches in sustainability awareness of e-consumers have focused on understanding specifically last-mile delivery options, such as crowdsourcing, pick-up and return locations, and automated delivery stations (Bandeira et al., 2019; Guo et al., 2019; Rai et al., 2019). Ignat and Chankov (2020) provide a new approach in investigating consumers' preference on last-mile deliveries based on environmental, social, and economic factors. The authors conclude that showing the social and environmental impacts of last-mile deliveries makes consumers more likely to choose more sustainable deliveries. Thereby, we contribute to this field by analyzing consumer preferences regarding environmental sustainability in last-mile deliveries in an emerging market, a fact that has still not been found in the literature.

In this context, it becomes necessary to build on the consumer responsibility for multidimensional sustainability, gathering environmental, social, and economic aspects (Buerke et al., 2017; Oláh et al., 2018). Although different results have been observed in the literature, many researchers share the view that e-consumer habit change is needed to address environmental challenges starting with raising awareness of the problem to strengthen sustainable behavior. Thus, the following hypotheses are suggested:

Hypothesis 2a. The availability of sustainability-related information to B2C e-consumers during their online purchases influence their willingness to choose more sustainable delivery options at the expense of the delivery speed.

Hypothesis 2b. The availability of sustainability-related information to B2C e-consumers during their online purchases influence their willingness to choose more sustainable delivery options at the expense of the delivery cost.

The complete model is depicted in Fig. 1.

3. Methodology

A data collection was performed to provide information about consumer awareness in relation to the consumption of fossil fuels and the respective GHG emissions on the last-mile products transportation. The survey conducted had ten questions considering closed-ended questions, dependent questions, and multiple-choice questions. All of them were measured on a 5-point Likert scale, in which a higher score indicates a stronger agreement towards the statement in the scale (Likert, 1932). Such methodology is widely used to conduct opinion polls, and to obtain qualitative insights from quantitative questions (Gil et al., 2008).

The questions were formulated from the themes addressed in the theoretical survey (section 2). Their content corresponded to aspects that characterize the level of awareness of consumers by means of their intention, and perceptions, considering purchase criteria, consumer preference, and consumer flexibility (Chuanmin et al., 2014; Penz et al., 2019; Rai et al., 2019).

The purchase criteria used on the first question were: delivery speed, delivery cost, and environmental information. There were two questions elaborated on consumer preference: the first investigates the influence that the provision of environmental information to e-consumers may have on their purchasing decisions; the second identifies whether consumers would agree to give preference to purchasing products which transportation results in low carbon emissions, to contribute to the environment. E-consumer flexibility to change their purchasing habits online is evaluated from three questions. Respondents were asked how much they would agree to increase the delivery time of a product purchased online to contribute to the environment given a possible low
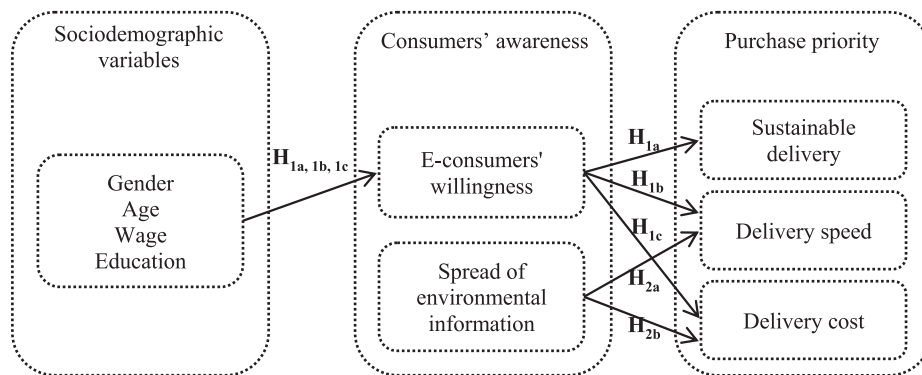
Fig. 1. Model and hypotheses.

carbon emission transport. The same question about the delivery cost criteria was asked. Flexibility was also considered regarding agreeing to an extension of the delivery time depending on the type of product purchased online: health/cosmetics/perfumery; fashion and accessories; home and decoration; household appliances; telephone/cell phones; sports and leisure; books/subscriptions/apparel; computers; electronics; and food and beverages (Ebit, 2018).

It was also used four sociodemographic questions for the identification of the sample (gender, age, wage, and education), in accordance with what is found in the literature (Chuanmin et al., 2014; Lim and Cham, 2015; Oliveira et al., 2017). Regarding genders, male and female were considered. The age group considered were under 25 years old, 25–34 years old, 35–49 years old, and over 49 years old. The income group considered were class A (above 20 minimum wages - MW), class B (10–20 MW), class C (4–10 MW), class D (2–4 MW), and class E (below 2 MW). 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 data of the online questionnaire was collected between February and May 2019 for respondents located in the southeast region of Brazil. It was chosen because its share in total online, in 2018, was approximately 61% purchases in the country (Ebit, 2018). The ideal sample size (with probability of 5%) was determined by the equation of the sample calculation for finite populations considering a population size of 55.2 million people [number of Brazilian e-consumers in 2017 (Ebit, 2018)]. The sample size calculation was performed at 95% confidence level, being determined by Equation (1) (Gil et al., 2008), in which: n: sample size; z: level of confidence scored; p: percentage with which the phenomenon is verified; q: complementary percentage (100 - p); N: population size; and: maximum error used (5%).

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

As a result, an ideal sample (α = 0,05) equivalent to 385 people was determined. Since there was no previous knowledge of each subgroup in the population considered, it was not possible to use the stratified sampling technique, so the simple random sampling was used.

After preparing, the questionnaire was pre-tested with an initial group of 20 individuals from the *Universidade Candido Mendes*, in the municipality of Campos dos Goytacazes, Rio de Janeiro State, Brazil, aiming at checking its comprehensiveness, objectivity, and ease. Subsequently, the final version of the electronic questionnaire prepared by the Google Forms system was sent by email to all clients (ensuring their anonymity) registered in the database of the *Aquário Marinho do Rio de Janeiro (AquaRio)* and *Paineiras-Corcovado*, both in partnership with the *Instituto Conhecer para Conservar*. The questionnaire application was concluded in a total sample of 421 valid questionnaires. Despite the ideal sample size calculated was of 385 individuals (with α = 0.05), it became

possible to apply the questionnaire to a larger number of individuals. Thus, all 421 questionnaires were utilized, resulting in a probability of 4.78%. (α = 0.0478).

Data were collected fully online, which was considered a useful and efficient approach for a survey within the context of e-commerce, besides having been used previously in similar studies (Lim and Cham, 2015; Oliveira et al., 2017; Penz et al., 2019). Nevertheless, it was assumed that there are some limitations to the online survey, such as differences in understanding and interpretation and lack of conscientious responses. To minimize the effects of these issues, it was conducted a pre-test of the questionnaire, preventing to be sent to the same respondent, and filled out, more than one questionnaire.

After applying the questionnaire, it was carried out a statistical analysis of the data collected using the Minitab software. The Ordinal Cronbach coefficient was used to measure the reliability of the survey and to validate the consistency of the data. Emphasizing this index is appropriate for ordinal scales as in the case of the Likert scale (Gadermann et al., 2012). The data obtained from the response variables were submitted to statistical descriptive analysis. Subsequently, the hypotheses were tested by means of averages and standard deviation, at the level of 95% of reliability. There was prior verification of the presumptions of homoscedasticity and normality of the errors by means of Bartlett and kolmogorov-smirnov tests (Montgomery, 2009), respectively. Since the data did not meet these assumptions, the hypotheses were tested by using the non-parametric Mann-Whitney and Kruskal-Wallis tests rather than the parametric tests. It was also carried out a Spearman correlation analysis (ranging from −1 to +1) to study the dependency or independency among variables (Montgomery, 2009). The associations that were established among the questions giving rise to the research hypotheses are found in Fig. 2.

4. Results

4.1. Descriptive analysis

An overview of the characteristics of the sample can be observed in Table 1. The percentage of female respondents reported is 62.2%, with an average age of 38 years, while that of male respondents is 37.8%, with an average age of 42 years. Monthly earnings value (in minimum wages - MW) varies from 2 MW to 20 MW, with average earnings of 6 MW, and 62.5% of respondents, between men and women, have a university degree.

Table 2 displays the respondents' perceptions with regard to the criteria delivery speed, delivery cost, and environmental information. More than half of the respondents stated that the criterion delivery speed is highly important (54.2%). Conversely, the lowest levels of the scale (very low importance and low importance) combined represent only 9% of the respondents. Although the criterion delivery speed was considered the most important compared to the other criteria (delivery cost and
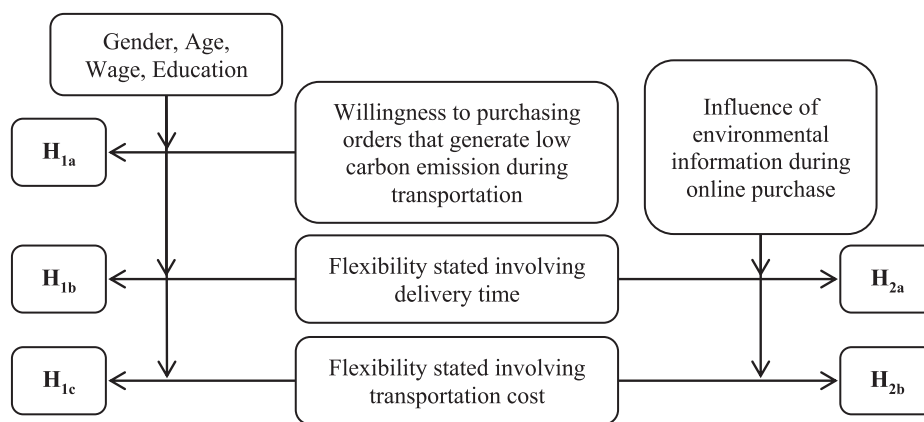
Fig. 2. Variables used to carry out the statistical tests in the research hypotheses.

Table 1
Sociodemographic characteristics of the sample.

Sociodemographic variables	Level	Number of respondents (Response rate)
Gender	Female	262 (62.2%)
	Male	159 (37.8%)
Age	Under 24 years old	63 (15.0%)
	25–34	107 (25.4%)
	35–49	149 (35.4%)
	Above 49 years old	102 (24.2%)
Wage	Under 2 MW	128 (30.4%)
	]2–4]	104 (24.7%)
	]4–10]	117 (27.8%)
	]10–20]	50 (11.9%)
	Above 20 MW	22 (5.2%)
Education	IPE	0 (0%)
	CPE	7 (1.7%)
	IHS	6 (1.4%)
	CHS	55 (13.0%)
	IHE	90 (21.4%)
	CHE	263 (62.5%)

Table 2
Importance stated involving purchase criteria delivery speed, delivery cost, and environmental information.

Likert-Scale	Purchase Criteria		
	Delivery speed	Delivery cost	Environmental information
−2 - No or very low importance	14 (3.3%)	14 (3.3%)	86 (20.4%)
−1 - Low importance	20 (4.7%)	42 (10%)	75 (17.8%)
0 - Medium importance	96 (22.8%)	96 (22.8%)	114 (27.1%)
+1 - High importance	61 (14.5%)	59 (14%)	55 (13.1%)
+2 - Very high importance or necessary	228 (54.2%)	208 (49.4%)	61 (14.5%)
N - I do not know	2 (0.5%)	2 (0.5%)	30 (7.1%)

Table 3
Influence stated about the environmental information on decision of purchase of respondents and preference stated for purchasing orders at low carbon emission levels at the transportation.

Likert-Scale	Environmental information	Likert-Scale	Orders low carbon emission
−2 - Very low influence	74 (17.6%)	−2 - I totally disagree	13 (3.1%)
−1 - Low influence	89 (21.1%)	−1 - I partially disagree	9 (2.1%)
0 - Medium influence	98 (23.3%)	0 - Maybe yes, maybe no	108 (25.7%)
+1 - High influence	85 (20.2%)	+1 - I partially agree	89 (21.1%)
+2 - Very high influence	55 (13.1%)	+2 - I totally agree	187 (44.4%)
N - I do not know	20 (4.8%)	N - I do not know	15 (3.6%)

consider the issue of high or very high importance, which is 116 respondents (27.6%).

In Table 3, the respondents' opinions about the influence that environmental information can have on their purchasing decisions are present in all levels of the scale; yet, it was noted that there is an unfavorable tendency, as the sum of the respondents who attribute low or very low influence is equivalent to 163 (38.7%), exceeding the sum of those who attribute high or very high influence, that is, 140 respondents (33.3%). As for the preference for low carbon transport purchase orders, the respondents were very favorable, since most of them (44.4%) said they totally agree with this suggestion, and only 5.2% totally or partially disagreed.

According to Table 4, concerning the possibility of making the product delivery speed more flexible, most of the respondents stated total agreement in relation to the proposal (40.9%), while the lowest levels of the scale (totally disagree and partially disagree) represent combined only 12.6% of the respondents. In regard to a possible flexibility in the delivery cost, 15.4% of the respondents stated they totally agree with the proposal. However, it is observed a favorable tendency, given that the sum of respondents who partially or totally agree with the item equals 172 respondents (40.8%), exceeding the sum of those who partially or totally disagree, which corresponds to 106 respondents (25.2%). It should also be noted that about 30% of the respondents did not know or did not want to give their opinion on the subject.

Respondents were inquired about which categories of products would have a greater possibility of flexibility in delivery speed, according to Table 5. Categories with greater chance of flexibility (respondents who answered they partially agree or totally agree) are home and decoration (P3 - 267/64%); fashion and accessories (P2 - 263/63%); sport and leisure (P6 - 252/60%); computer (P8 - 230/55%); books/subscriptions/apparel (P7 - 227/54%), while categories with lower flexible potential,

environmental information), delivery cost was also of very high importance for most of the respondents (49.4%). The lowest levels of the scale corresponded together to only 13.3% of the respondents. Lastly, the perception of the respondents regarding the criterion environmental information is found throughout all levels of the scale. It is possible, however, to see a tendency to consider the issue as not very important, since the sum of respondents who attribute low or very low importance is equivalent to 161 respondents (38.2%), exceeding the sum of those who

according to respondents, are home appliances (P4 - 222/53%), electronics (P9 - 222/52%); telephony/cell phones (P5 - 216/51%); health/cosmetics/perfumery (P1 - 182/44%); and food and beverages (P10 - 152/37%).

4.2. Hypotheses analysis

The application of statistical tests to Hypotheses 1a, 1b, and 1c demonstrated that means that do not share the same letter are significantly different at the level of 95% of reliability as observed in Table 6. According to the results on Hypothesis 1a, only gender was significantly different according to the statistical test carried out (Mann-Whitney, $P <$ 0.05); the other variables, age, wage, and education, did not differ among themselves by the Kruskal-Wallis test ($P > 0.05$). On Hypothesis 1b, the variables gender, age, and education were significantly different according to the statistical test carried out (Mann-Whitney and Kruskal-Wallis, $P < 0.05$); only the levels of the variable wage did not differ among themselves (Kruskal-Wallis, $P > 0.05$). On Hypothesis 1c, only gender was significantly different (Mann-Whitney, $P < 0.05$); the other variables, age, wage, and education, did not differ among themselves by

the Kruskal-Wallis test ($P > 0.05$).

The use of the Spearman correlation analysis to Hypotheses 2a and 2b showed positive correlation among the variables tested as observed in Table 7. Both Hypothesis 2a and 2b presented very weak positive correlation among the questions, 0.29 and 0.30, respectively. Such results indicated that spreading environmental information among B2C e-consumers during online purchase may influence their willingness to make delivery speed of delivery costs of products more flexible; however, it was not possible to observe a strong correlation between these two questions. In other words, spreading environmental information did not influence much the group of respondents.

5. Discussion

The study of SC environmental sustainability in a last-mile urban delivery context allowed identifying interesting research implications. Although the sustainable SC management has traditionally been studied from the perspective of the supply aspect (Gold et al., 2015; Lis et al., 2020), recent researches have proved that the consumer engagement is necessary to make the SC really sustainable (Jaller and Pahwa, 2020). Based on this relationship, our study points out that exploring the environmental sustainability from the e-consumer demand is fundamental to

Table 4
Flexibility stated involving delivery speed and delivery cost.

Likert-Scale	Flexibility stated by respondents	
	Delivery speed	Delivery cost
−2 - I totally agree	29 (6.9%)	58 (13.8%)
−1 - I partially agree	24 (5.7%)	48 (11.4%)
0 - Maybe yes, maybe not	78 (18.5%)	128 (30.4%)
+1 - I partially agree	115 (27.3%)	107 (25.4%)
+2 - I totally agree	172 (40.9%)	65 (15.4%)
N - I do not know	3 (0.7%)	15 (3.6%)

Table 7
Spearman's correlations to Hypothesis 4 and 5.

Hypothesis	Observations	Correlation[1]	Z	Significance
H2a	399	0,29	5,72	P < 0,0001
H2b	387	0,30	5,82	P < 0,0001

Notes: [1]Correlation scale r: 0.9 ± very strong correlation; 0.7 to 0.9 ± strong correlation; 0.5 to 0.7 ± moderate correlation; 0.3 to 0.5 ± weak correlation; 0 to 0.3 ± very weak correlation (Mukaka, 2012).

Table 5
Flexibility stated in delivery speed from product type purchased.

Likert-Scale	Type of product									
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
−2 - I totally disagree	24%	10%	9%	13%	14%	10%	12%	13%	13%	27%
−1 - I partially disagree	15%	13%	13%	16%	14%	15%	15%	16%	15%	20%
0 - maybe yes, maybe not	16%	14%	13%	18%	19%	14%	18%	15%	18%	16%
+1 - I partially agree	12%	14%	14%	17%	17%	14%	17%	18%	14%	10%
+2 - I totally agree	32%	49%	50%	36%	34%	46%	37%	37%	38%	27%
N - I do not know	1%	1%	1%	0%	0%	1%	1%	2%	1%	2%

Table 6
Statistical tests carried out among hypotheses 1, 2 and 3.

Sociodemographic variables	Level	H1a			H1b			H1c		
		N[1]	Mean	Test[2]	N[1]	Mean	Test[2]	N[1]	Mean	Test[2]
Gender	Female	254	4.24	A	259	4.05	A	250	3.27	A
	Male	152	3.75	B	159	3.67	B	156	3.03	B
Age	<24	62	4.11	A	62	4.11	AB	61	3.23	A
	25–34	103	4.10	A	106	3.68	B	104	3.10	A
	35–49	145	4.03	A	149	3.79	B	143	3.03	A
	>49	96	4.01	A	101	4.17	A	98	3.45	A
Wage	<2	125	4.10	A	126	3.77	A	123	3.06	A
	]2–4]	98	4.11	A	103	3.83	A	99	3.10	A
	]4–10]	114	4.02	A	117	4.08	A	115	3.33	A
	]10–20]	49	4.00	A	50	4.02	A	47	3.40	A
	>20	20	3.85	A	22	3.82	A	22	2.95	A
Education	CPE	7	3.57	A	7	3.29	B	7	2.29	A
	IHS	6	3.33	A	6	3.50	AB	6	2.67	A
	CHS	52	4.10	A	54	3.50	A	52	3.08	A
	IHE	88	4.09	A	89	3.92	A	88	3.16	A
	CHE	253	4.06	A	262	4.00	A	253	3.25	A

Notes: [1]Number of observations; [2]Means followed by the same letter in the variable strata do not differ significantly from each other, by the Mann-Whitney (genders) and Kruskal-Wallis (age, wage, education) tests, at the level of 5% of probability.

identify its strengths and weaknesses and draw new perspectives to the field of green SC. Our results demonstrate that the convenience factor, represented by the delivery speed, is the most important for e-consumers during the purchase, followed by the delivery cost. This finding is consistent with the literature, showing that there are convenience-oriented consumers and price-oriented consumers (Nguyen et al. (2019). Thus, we reason that sustainable last-mile delivery initiatives can be improved according to the type of consumers, considering what each of them is willing to sacrifice.

Although e-consumers are increasingly exposed to making sustainable choices, our sample indicates that the sustainable factor, represented by environmental information of deliveries, was the least important one. For instance, 65.3% of respondents reported that environmental information is of medium, low, or very low importance to them during an online purchase. The diversity found in the opinions suggests little awareness regarding aspects that go beyond the economic dimension in the process of acquiring and transporting products. This result can be explained by the fact that consumers are little informed about how their choices can affect the sustainability of product deliveries (Penz et al., 2019), thus limiting their possibilities to influence the sustainability of SC (Sallnäs and Björklund, 2020). Based on this, we emphasize the importance to increasing the spread of information about the environmental impacts of last-mile deliveries at the time of purchase, with the goal of increasing consumer awareness and making deliveries more sustainable.

Our results show that sociodemographic characteristics influenced the opinions stated by respondents, evidencing that there are behavioral differences among the strata. For example, female consumers are more likely to choose more environmentally sustainable options for their online purchase, that is, sustainability over delivery speed (delivery time) and delivery cost. This result is contrary of Deliana and Rum (2019), who found the same levels of green consumption for men and women. On the other hand, consumers' age influences the potential for accepting/rejecting longer delivery times. For example, e-consumers younger than 24 years old and over 49 years old are more prone to target more sustainable deliveries at the expense of delivery speed. This result partially corresponds to Deliana and Rum (2019); however, our study also shows a potential for green behavior in older consumers. Also, highly educated consumers also showed a higher prone to more flexible delivery times, a consistent perspective with the literature, which shows that consumers perceive the relevance of drive less kilometers for last-mile deliveries, even if it is necessary to increase the delivery time (Rai et al., 2019). Wage variations in the sample did not represent significant differences regarding flexibility in time and cost; however, it was possible to perceive a trend towards less sustainable responses from individuals with higher remuneration. This occurred despite the literature suggests that the more educated and well-paid consumers are the more prone they are to opt for low GHG emission deliveries (Chuanmin et al., 2014).

Our study shows that the minority of consumers interviewed were willing to make choices to favor the sustainable last-mile deliveries. For example, hypotheses H2a and H2b presented a very weak correlation (0–0.3) between availability of sustainability-related information and sacrifices of time and/or cost of deliveries. This result contrasts with the recent findings of Ignat and Chankov (2020) in a research developed in a mature market. There the results show that displaying the environmental impacts of last-mile deliveries influences e-commerce consumers, and generally makes them more likely to choose a more sustainable last-mile delivery. Notwithstanding these results, this is not yet the case in an emerging market, as Brazil is. The reasons for this difference in awareness among e-consumers are not clear but may be associated with the Gross Domestic Product of each country.

Based on the contributions of Ignat and Chankov (2020), we advanced in the research by considering a delivery specification like type of products. As the potential for making delivery time more flexible was the most prominent factor, we investigated their relative importance when questioning which type of products would most convince

e-consumers to wait longer for delivery. Our results show that the sacrifice in delivery speed accepted by consumers varies according to the order in progress. For example, more than 60% of the group from the sample agree with a flexible delivery time regarding categories of product, as home and decoration, fashion and accessories, sport, and leisure; however, this agreement decreases concerning electronics or telephony/cell phones.

6. Conclusions

This study explores the sustainable SC management from e-consumers demand, emphasizing sustainable last-mile deliveries. The contributions from our study create room for further exploration of this system. This paper contributes to the literature in two ways. Firstly, sustainable last-mile deliveries need to be viewed according to the type of product in question because there are different levels of consumer awareness for each type; secondly, a possibility for SC sustainable practice from the demand in an emerging market brings limited awareness levels over mature market.

Practitioners of SC management may gain insights into how to process their SC increasing the e-consumer participation. Additional information on environmental sustainability at the time of purchase could become a guide for consumers to make well-informed sustainable decisions and consequently to reduce the environmental impacts of their purchase orders. Besides, the participation of e-consumers on their daily basis decision-making process (especially flexible delivery time and cost) has the potential to positively influence the logistics organization and shipment of goods to expand the culture of sustainable deliveries, bringing positive effects in the economic (reducing fuel consumption) and environmental (mitigating GHG emissions) areas. This double effect may interest society and companies, as it generates a mutual gain even if this proposal goes against the current logistics model of speed deliveries.

In terms of policy implications, we propose that educational campaigns should be applied to companies, carries, and consumers by governments to create a culture involving society in distribution and consumption conscious of products/services. It is important to highlight the need to promote environmental education adapted to the needs of each country with a view to raising levels of awareness and involvement of consumer worldwide.

This research has limitations in the scope of its study (one geopolitical region in one country), thus, we assume that, in the face of this sample, the results cannot be generalized to the whole country or to all e-consumers. We invite researchers to further explore other regions or countries, as well as other characteristics, such as cultural, psychological, or even development factors. They should be also included in the analysis because they may be directly or indirectly connected to sustainable behaviors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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this paper into English.

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