Summer 2021

Micromobility challenges in the city of São Paulo: The impact of shared economy services of electric scooters

Luis Hernan Contreras Pinochet

Heloisa Mangini

Vanessa Itacaramby Pardim

Cesar Alexandre de Souza

Micromobility challenges in the city of São Paulo: The impact of shared economy services of electric scooters

Luis Hernan Contreras Pinochet
Universidade Federal de São Paulo
luis.hernan@unifesp.br

Vanessa Itacaramby Pardim
Universidade Nove de Julho
vanessa.itacaramby@gmail.com

Heloisa Mangini
Universidade Federal de São Paulo
heloisa.mangini18@gmail.com

Cesar Alexandre de Souza
Universidade de São Paulo
calesou@usp.br

Abstract
The purpose of this paper is to understand the impact of shared economy services of electric scooters on micromobility in the city of São Paulo, based on the proposal of a theoretical model that sought to analyze antecedent factors of continuance intention. For that, descriptive research was carried out with a quantitative approach. The data were collected from a survey (n=190) with the structural equation modeling technique (PLS-SEM). After analyzing the data, all hypotheses were accepted. The results indicated that the user understands that the electric scooter service is useful. Its benefits were perceived as part of diversifying the possibility of getting around the city in short distances. On the other hand, it is noteworthy that, probably, users who already had low satisfaction, when exposed to the reality of costs, after a period of initial euphoria, tend over time to reduce interest. Despite the slight drop, those who showed high satisfaction tend to continue using the service. Finally, the research results corroborated the understanding of the slow evolution of micromobility in São Paulo, which caused companies to leave the country or restrict the number of cities served by the service.

Keywords: intelligent mobility, micromobility, electric scooters, structural equation modeling.

1. Introduction
Transport is one of the basic needs of any individual. It allows people to experience the possibilities that life in society offers, such as going to work, school, and walking. Even though it is recognized as necessary, mobility has its disadvantages, emphasizing urban environments that demand different yet complementary transport options.

In this context, electric scooters appear part of a micromobility market (Brunner et al., 2018), a trend of diversification of urban transport that includes a variety of small vehicles for individual users to travel short distances (McKenzie, 2019).

The growth in the use of electric scooters, as a new vision of transport for large cities, comes when the world demands the development of new technologies for the transport sector. In Brazil, this also occurred in the main metropolises from 2018, as is São Paulo's case.

In this way, micromobility has become a very popular movement, leading specialized companies that invested in the segment in São Paulo due to the high population density; strong penetration of mobile telephony; public transport and underdeveloped infrastructure; and the presence of an ecosystem, culture and friendly climate for the use of these services (Gössling, 2020).

In this sense, few studies have examined the usage patterns of shared electric scooters, although the literature is growing (Bai and Jiao, 2020; Caspi et al., 2020; Hardt & Bogenberger, 2019). In general, use is considered more flexible than bicycles, as they do not require physical effort or specific skills (Fitt & Curl, 2020). The emerging literature on electric scooters seeks to understand user behavior and what drives them to continue using this service.

This article expands the scope of studying a user group from acceptance in the continuance intention (Cheng et al., 2015) of e-scooters, analyzing a series of factors that influence among them trust (Lai, 2015), perceived usefulness (Wang et al., 2018), confirmation and satisfaction. Perceived cost (Chong, 2013) was used as a moderating variable to verify whether it would affect the behavior between the construct satisfaction about the continuance intention using e-scooters. Therefore, this article aims to understand the impact of shared economy services of electric scooters on micromobility in the city of São Paulo, based on the proposal of a theoretical model that seeks to analyze antecedent factors of continuance intention.

2. Theoretical Background, Research Model and Hypothesis

2.1 Smart Mobility

Smart mobility is one of the dimensions of smart cities that address accessibility, international and local, modern and sustainable transport systems, and the availability of resources provided by information and communication technology (Giffinger et al., 2007; Stolfi & Alba, 2014). In this dimension, the important initiatives identified by Dewalska-Opitek (2014) are

- reduction in congestion levels resulting from the promotion of efficient and low-cost public transport,
- commercialization of transport services through mobile devices (electronic tickets, applications for smartphones, among others), and
- reducing the negative impacts of transport on citizens' lives.

In this sense, mobility is seen as one of the critical and critical services of smart cities. There are countless social and economic challenges resulting from its growing demand and the impacts arising from the use of space and the environment. Thus, it is possible to understand that initiatives related to smart mobility in urban centers are an alternative to improving citizens' quality of life and smart cities' sustainability (Caragliu et al., 2011; Batty et al., 2012).

In this context, alternatives should be sought to the modes of transport already routinely used, such as buses, trains, and subways, including self-propelled vehicles, for example, bicycles and scooters. It must be done considering the different types of special needs and integrating all areas of the city. Logistics in smart cities must be designed to prioritize the public, ecological, and efficient transport, which meets the demands of the internal population and external. Also, they make connections with other areas around them and promote greater social inclusion (Zygiaris, 2013) and connect neighborhoods and cities. In this study, mobility is a crucial factor, as the shared electric scooter service is a relatively recent technology that is still developing. Citizens are adapting to this new way of individual locomotion and the main benefit, in addition to those focused on the environment and technology, is the collective awareness (Giffinger et al., 2007). Information and Communication Technologies (ICTs) tools can optimize access to public transport to be fast, safe, and sustainable (Batty et al., 2012). The information must be passed on to citizens in real-time, making mobility efficient.

2.2 Micromobility and Electric Scooter Services in São Paulo

The integration of information and communication technologies in everyday life through different devices and interactive systems is called ubiquitous computing or environmental intelligence. In this model, the user has a variety of devices at his disposal, including the smartphone, that facilitate his access to information in a simplified and immediate way.

In this sense, the emergence of applications that suggest an inflection in the travel modalities themselves, as is the case with electric scooter rental services, act directly in the micromobility (Brunner et al., 2018; Gössling, 2020), being used for short routes. This model is based on digital location technologies, inserted in the most complex communicational and informational context, marked by the diffusion of applications, and characterized by mobility, portability, and connectivity.

In 2019, many companies, whether in rental or application sharing and equipment sales, invested in the electric scooter segment. This study focused efforts on rental and sharing services through an application.

The city of São Paulo, with a population of 12.33 million inhabitants, is representative for this research because it has road infrastructure projects and transportation services, generating urban mobility that justifies its classification as the most intelligent city in Brazil in the ranking Connected Smart Cities from Urban Systems (Urban Systems, 2020) and in 42nd position worldwide by the Global Power City Index (GPCI Index 2020). However, when analyzed by the IESE Cities in Motion Index (2020), in the classification of Mobility and Transport, it appears only in 126th position among the main smart cities.

Electric scooter services in the city of São Paulo increased considerably in 2019. This event highlights the changes that are taking place in the means of transportation in the urban centers of the capitals, a fact that is explained by the change in the behavior of citizens. Changes in urban centers are part of the term smart city, a theme that several authors are studying and increasingly gaining visibility in academic and political circles. It addresses the adverse effects of urban growth (Mahbub et al., 2011).

Brazilian legislation adapting to this new transport model, with Law No. 13,640, of March 26, 2018, changed the wording of Article 4, item X, of Law No. 12,587, of January 3, 2012, now considering individual private paid passenger transport that performed through digital platforms, using a geolocation system. In addition to Artificial Intelligence and Big Data (data from users that are available to the company, allowing greater market control through the surveillance system) (Brazil, 2012). Companies that operate in the sector work with a “lease agreement” with their users, with payment for the transport time.

Table 1 shows the market for electric scooters that worked in the city of São Paulo in 2019. This refers to a process of connectivity on digital platforms that fits within a perspective of ‘smart city’, whose techno communicational. Techno-informational is explained, in turn, by the ubiquity and environmental intelligence, at the same time that the urban geography of the localities is considered as a central element in the process.

The city of São Paulo was a pioneer in regulation in Brazil, after publishing Decree nº 58.750, of May 13, 2019, which required companies to do a previous accreditation to operate in the activity of sharing electric scooters through an application, after also, the accreditation at the Municipal Mobility and Transport Secretariat (São Paulo, 2019).

At the national level, the Bill of Law (PL) seeks, among others, to eliminate the impasse that exists today between several Brazilian cities that use self-propelled vehicles, such as electric scooters, when establishing decrees that deal with the matter differently. PL 4135/2019 alters the Brazilian Traffic Code (CTB) and also the National Urban Mobility Policy (PNMU) and aims to regulate the service for sharing personal self-propelled equipment in order to allow harmonious coexistence with other vehicles and pedestrians (Brazil, 2019).

Company	Logo	Historic
Yellow		Originally a Brazilian company, it was founded in 2017. In January 2019, after the merger with Grin, it was renamed Grow Mobility (the largest company in the Latin American continent).
Grin		Originally a Mexican company, it was founded in 2018. In July 2020, Grow Mobility filed for bankruptcy to avoid bankruptcy due to the context of the Covid-19 pandemic.
Scoo		100% Brazilian company, founded in 2018, Scoo operated, among others, in technological innovation projects and was responsible for creating the first Brazilian application for the rental of shared electric scooters.
Lime		Lime was founded in 2017 in the United States. The American operator, which had Uber as one of the investors, stayed in Brazil for only six months.

Table 1: Electric Scooters Market in the city of São Paulo in 2019

The challenges of these companies do not stop there, as they need, among others, to deal with the imprudence and/or malpractice of their users, which ends up resulting in fines by the inspection bodies and, also, the need to hire personal accident insurance and liability.

2.3. Research model and hypotheses

For the construction of the research model - presented in Figure 3 - applications of models for accepting the use of technology were analyzed to understand behavioral interactions of e-scooters, concentrating efforts on using the models of Cheng et al. (2015), Chong (2013), Lai (2015) and Wang et al. (2018). Other references were also incorporated in the literature review to support the constructs that make up the model.

2.3.1 Confirmation

The Expectation Confirmation Model (ECM), adaptable to the service area, proposes that an individual's intention to continue using a technology depends on three variables: the level of user satisfaction with the technology, the degree of confirmation of the user expectations, and post-adoption expectations, in the form of perceived usefulness. Thus, the confirmation construct can be understood in this research as the initial expectations about the electric scooter services being confirmed during its use (Bhattacherjee, 2001). Before using a service, the user develops expectations about it. After using it, the user has experiences and develops perceptions about its performance, and this results in the confirmation or disconfirmation of the expectations that existed before use. In turn, the level of trust and user satisfaction with the application service is determined by this confirmation (Chong, 2013; Yuan et al., 2014).

Given that the experience of using the service would confirm or not the expectation, users are led to update their post-adoption beliefs, corroborated by the technology acceptance models (Davis, 1989), and the level of confirmation will also have an influence direct at perceived usefulness (Wang et al., 2018). Based on these studies, adapted to the use of electric scooters, the following hypotheses are presented:

H1a: Confirmation positively affects trust.

H1b: Confirmation positively affects satisfaction.

H1c: Confirmation positively affects perceived usefulness.

2.3.2 Trust

Trust is a determining factor about economic activities, as it influences users' decision-making when hiring a service, causing it to be shaped by rational assessments involving the cost-benefit ratio. Lai (2015) investigated the factors that affect consumers' intention to use an intelligent bicycle sharing system, employing a technology acceptance model (TAM) adapted to the trust construct - consequently - relating it to the perceived usefulness. Besides, it is admitted that one of the consequences of trust is satisfaction (Chong, 2013). Trust is a determining factor as an antecedent of continuance intention in the use of electric scooters (Chong, 2013; Lai, 2015). This allows the elaboration of the following hypotheses:

H2a: Trust positively affects satisfaction.

H2b: Trust positively affects perceived usefulness.

H2c: Trust positively affects continuance intention.

2.3.3 Satisfaction

Satisfaction refers to a general assessment of an information or service system, reflecting a response based on emotion or assessment (Bhattacherjee, 2001; Lam et al., 2004; Kim, 2010). In this way, satisfaction has been understood as an essential element in changing the attitude based on experience. According to Yuan et al. (2014), there are numerous studies related to continuance intention that understand that satisfaction is an essential factor determining it. The electric scooters continuance intention is expected to be positively determined by user satisfaction. Therefore, the following hypothesis is formulated:

H3: Satisfaction positively affects continuance intention.

2.3.4 Perceived Usefulness

Perceived usefulness refers to the extent to which a consumer thinks that using a sharing service is useful for achieving goals, such as reducing travel expenses, increasing travel experience and convenience, reducing greenhouse gas emissions and energy consumption and mitigate traffic that generates congestion (Wang et al., 2018). When consumers are deciding whether to use innovative technology, they are more willing to try it if it is easy to use and beneficial for a purpose that is advantageous and, above all, that can bring Satisfaction (Park et al., 2014; Chong, 2013). In many studies applied in different contexts, perceived usefulness is positively associated with continuance intention (Cheng & Huang 2013; Chong, 2013; Park et al. 2014; Dong et al., 2017; Wang et al., 2018). Thus, based on the same logic, in the context of using electric scooter services, the following hypotheses are proposed:

H4a: Perceived Usefulness positively affects satisfaction.

H4b: Perceived Usefulness positively affects continuance intention.

2.3.5 Perceived Cost

In this study, perceived cost can be understood as the value that consumers of electric scooters expect to incur to evaluate, obtain, use, and dispose of a product or service per kilometer traveled. In their study, Wei et al. (2009) found that cost is among the main factors that affect decisions to adopt a service. Because of the above, we sought to analyze perceived cost as a moderating variable to see if there is an impact on the direct relationship between satisfaction and continuance intention, considering that several public news reports indicated that costs were higher than other modes, depending on, for example, of companies having to pass on operating costs to users due to regulation, short equipment life, taxation on scooter imports, among others (Balago, 2021). Thus, the following hypothesis is formulated:

H5: Satisfaction negatively affects continuance intention when it is moderated by perceived cost.

2.3.6 Continuance Intention

Bhattacherjee (2001) suggested that continuance intention is used when consumers are committed to spending maximum efforts to continue the relationship with a given product or service (Cheng et al., 2015). It is also possible to observe the consumer's effect when using a specific company regularly (Jambulingam, Kathuria & Nevin, 2011). In other words, the continuance intention of a relationship is a fundamental result of the relational effort between companies and consumers, as it plays a central role in the service delivery process. Therefore, in this study, continuance intention is related so that users of electric scooters can maintain the service's credibility as a means of integration with the micromobility transport system in the city.

3. Method

In this research, a survey was used to collect data, and the method for selecting respondents was convenience sampling, which is a non-probabilistic technique (Malhotra, 2014). In all, 215 people participated in the survey. However, after data purification (identifying multivariate outliers using Mahalanobis distance), the valid sample was represented by 190 users of electric scooters who were approached in this survey in various public places across the city of São Paulo, among them: parks, main circulation avenues and in partner companies. Thus, an attempt was made to identify a diversified sample with multiple service users in public spaces (Gössling, 2020).

About the research instrument, it was divided into three sections: sociodemographic information, perception about the use of electric scooters in São Paulo, and a psychometric scale that had 19 items for measurement that were designed to understand the research model developed, organized on a Likert scale with endpoints anchored at 1=strongly disagree and 5=strongly agree for all statements. It is worth noting that, before conducting the research, a pre-test was carried out with 25 individuals to verify the effectiveness of the elaborated research instrument. After this stage, the research was carried out personally by the researchers involved with the individuals to collect the data necessary to test the hypotheses.

In the phase of analysis of sociodemographic data, we sought to incorporate questions to cover aspects of using the e-scooters. Multivariate data analysis was also used through structural equation modeling, with partial least squares estimation (PLS-SEM). The moderating effect was analyzed using the PROCESS v.3.4 macro (Hayes, 2017).

4. Analysis and Discussion of Results

4.1 Analysis of the structural model

The largest group of respondents are men, n=114/60%, and are between 26 and 35 years old, n =96/50.5%. The normality of the data was verified by the Kolmogorov-Smirnov test (K-S) and the respective p value of each variable. This procedure was necessary to limit the possibility of using some statistical analysis techniques that have the normal distribution of data as a characteristic. All individual p-values of the K-S test referring to the indicators were "very significant" with $p < .001$ (Hair, Hult & Ringle, 2016). Regarding the predictor variables related to the latent variable "continuance intention", it was possible to accommodate multicollinearity in the model - all values of the Variance Inflation Factors (VIFs) were below 5, with the lowest being TR3=1.149, and the largest, SAT4=2.644.

After the first interaction, the results of the factor load obtained by the variables were presented and it was possible to verify that only two variables, SAT3 and PU3 had to be excluded to

adjust the model. After the adjustment, the convergent validity was verified, which demonstrates the extent to which the latent variable correlates with the items chosen to measure that variable, and the discriminant validity that involved the correlation between the constructs of the research model were accommodated (Table 3).

The analysis of the measurement model must precede the analysis of the relationships between the constructs or latent variables. The next step was to examine the measurement model (Table 2), which involved: Composite Reliability (CR), Average Variance Extracted (AVE), determination coefficients (R^2) (Hair, Hult & Ringle, 2016).

Construct	**Convergent Validity**			**Discriminant Validity**				
	CR	**AVE**	**Items**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
(1) Confirmation	.842	.641	3	***.801***				
(2) Continuance Intention	.824	.611	3	.583	***.782***			
(3) Perceived Usefulness	.862	.611	4	.714	.565	***.782***		
(4) Satisfaction	.921	.795	3	.783	.553	.742	***.892***	
(5) Trust	.771	.532	3	.630	.522	.649	.713	***.729***

Table 2: Convergent and discriminant validity

The CR coefficients indicated high internal consistency of the scales used, as well as the AVEs (Chin, 1998) to indicate the existence of convergent validity. The R^2 value measures the predictive accuracy of the model, which demonstrated that in this study the model has an accuracy and predictive relevance in all constructs (Satisfaction=.722; Perceived usefulness=.575; Trust=.397 and Continuance intention=.375). In line with the previously presented validities, the SRMR=.083 indicated adjustment in the model after confirmatory factor analysis (AFC).

In the practical application of the structural equation modeling for the Proposed Theoretical Model - Figure 1 -, the measurements performed, individually for each construct, are observed, seeking to verify its internal and external validity and consistency, as well as the results obtained in its paths and hypotheses.

When analyzing the formulated hypotheses is observed that all paths were accepted within the cut-off point of $p<.05$ for the significance. When individually analyzing the direct relationships proposed in the model, it is possible to observe that the Confirmation construct paths as antecedent had the highest β (all $p<.001$). In other words, this is explained by being an antecedent construct that, according to Bhattacherjje (2001), demonstrates that the individual understands that the electric scooter service is useful. Its benefits were perceived as part of diversifying the possibility of getting around the city. over short distances (McKenzie, 2019). Among others, more speed and relieving mass public transport that today is no longer able to cope with the existing demand, especially during business hours.

The **H_{1a}** with the path "Confirmation → Trust" ($\beta = .630$; $p<.001$) was the one with the most significant effect. This is probably because people see electric scooters as a micromobility tool with the potential, among others, to reduce congestion levels in the city, which negatively impact citizens' quality of life (Dewalska-Opitek, 2014), in addition to contributing to the environment as it is a self-propelled vehicle that uses renewable energy to be able to circulate (Giffinger et al., 2007). This indicates that people understand that the shared electric scooter service is reliable and will meet their initial expectations (Yuan, 2014) satisfactorily. Likewise, the paths "Confirmation → Perceived Usefulness" ($\beta=.505$; $p<.001$) and "Confirmation →

Satisfaction" (β=.421; p<.001), respectively **H1b** and **H1c**, brought indications that when the adoption occurred in the city, many individuals showed interest in being a "novelty", but there were also expectations regarding its use and the potential to improve mobility as an advantage of urban mobility, in addition to serving the purpose of leisure on weekends, thus showing that confirmation has a significant influence on variables after the adoption of electric scooters (Chong, 2013).

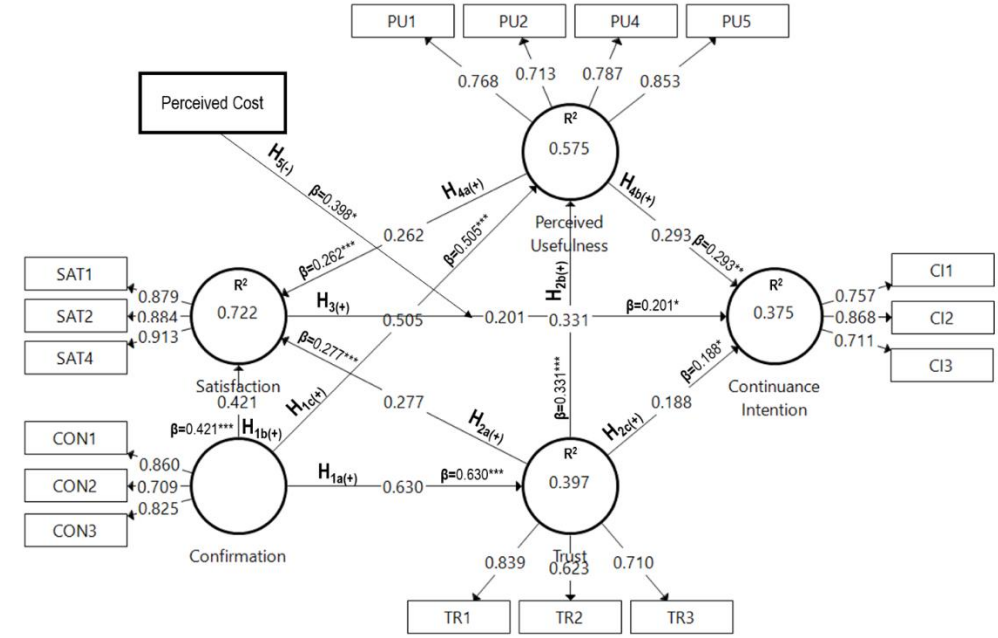

Figure 1: Proposed Theoretical Model
Note: Significance: * p <0.05; ** p <0.01; *** p <0.001.

On the other hand, **H3** represented by the causal relationship "Satisfaction → Continuance Intention" (β=.201; p<.043), despite being accepted, was the one that presented a level of significance closer to the cutoff point (p<.05) and this indicates that, despite the expectations of consumers of this service, the level of Satisfaction in relation to Continuance Intention tends to decrease. This can be explained by the initiative of the agents responsible for handling the matter, which legislate excessively to regulate the use and offer of this type of service. Which has resulted, among others, in a high number of fines for companies, for example, due to the mandatory use of a helmet, to walk on the sidewalks and to exceed the speed limit (Brazil, 2019), responsible agents had no option but to pass on the part of these costs to users, which raised the service price (Balago, 2021).

Other aspects also constituted challenges and affected this shared business model, for example, equipment vandalism. In several situations, the user was faced with damaged and inoperable equipment, conflict, and/or accidents between users of electric scooters and pedestrians or with users of other vehicles. Showing an evident difficulty in establishing a harmonious coexistence between the different existing subjects; slow evolution of infrastructure aimed at micromobility expressed, for example, by the irregularity of the pavements (holes and/or lack of adequate signage) and debris in the cycle paths and cycle lanes. Therefore, even if they have Continuance Intention due to the positive aspects they see in this type of service, Satisfaction ends up being affected by the factors mentioned. As it results from the general assessment of electric scooters' shared service, affecting the decision to repurchase the service (Kim, 2010; Chong, 2013).

H_5 was proposed to understand whether the electric scooter service's perceived cost would be a moderating variable for the Satisfaction and Continuance Intention relationship. Still, this moderation allows a better understanding of **H_3**.

The analysis of moderation involving **H_5** (response variable [Continuance Intention]; predictive variable [Satisfaction]; and moderator [Perceived Cost]), was developed using the macro-PROCESS v3.5. The graph indicates that when the cost perception rises above 3.634 - indicated by the Johnson-Neyman (JN) region of significance, and high satisfaction users tend to maintain the Continuance Intention. Despite the slight drop for the low satisfaction group, users who belong to the low satisfaction group reduce the continuance intention of use of electric scooters. This is explained by an R^2=.418 of the Continuance Intention with a negative effect on the perceived cost (β=-. 917, SE=.243, 95% CI [-1.397; -.437], p<.001) and Negative effect of satisfaction (β=-1,182, SE=.569, 95% CI [.0392; -2,306], p=.003).

It is noteworthy that, probably, users who already had low Satisfaction, when exposed to the reality of costs, after a period of initial euphoria, tend over time to reduce interest. On the other hand, for those who showed high Satisfaction, there is a tendency to continue using the service despite the slight drop. It should be noted that, in addition to cost, other inhibiting aspects of use must be considered, such as the safety of users. From the point of view of equipment quality and public safety, it is an aspect beyond the control of companies. It is a matter of public management, an essential element to improve a smart city's mobility and transport indicators.

5. Conclusions

The study's focus falls on its general objective, which was to understand the impact of shared economy services of electric scooters on micromobility in the city of São Paulo, based on the proposal of a theoretical model that sought to analyze antecedent factors of Continuance Intention.

The results obtained in the analysis of the significance of the paths indicated that all the hypotheses were supported in their formulations and the moderation, Perceived Cost, which measured the effect of Satisfaction on Continuance Intention. The fit of the model - the coefficient of determination of the dependent variable Continuance Intention - was R^2=.375 (37.5%), indicating an acceptable result considering the discussions presented in the analysis and discussion the results.

The path traced by the city of São Paulo in search of alternatives that, among others, guarantee social welfare, protection of the environment, and the development of the market in a balanced way, brought the need to face legal issues in several branches. However, in the context of urban mobility, more specifically of micromobility, the city still faces numerous challenges, mainly to create a harmonious coexistence between the different actors, as is the case with electric scooters.

The slow evolution of micromobility in the country has caused self-propelled vehicle sharing companies to leave or restrict the number of cities served by the service. These challenges are not only faced by Brazil but also by other countries.

In this context, the technology for sharing electric scooters through digital platforms has become a worldwide reality. It has attracted many national and international companies that have started to provide the service. On the other hand, the crisis's main reasons were greater regulation, increased competition, decreased profit margins, and a constant need to update products. With the Covid-19 pandemic, most sharing services were paralyzed, and the collapse

of this business model was present. The social isolation and the new prevention rules imposed by the pandemic inhibited the contracting of the service, impacting the sector at that time and doubting whether this business model will make sense in the future for São Paulo.

5.1 Practical and Social Implications

The article argues that electric scooters can be characterized as a radical micromobility innovation, with the potential to challenge the existing mobility system in cities. Moreover, the dynamic growth of micromobility presents itself in a favorable way for implementing this type of technology.

On the other hand, electric scooters compete for pedestrians, cyclists, and motorized transport, adding complexity to the transport systems. Therefore, it is often divided on its suitability, and there is uncertainty about the appropriate rules and policies. In this sense, to regulate this new form of micromobility, many cities adopt ad hoc policies, sometimes incurring substantial fines for operators or users or even seizure of equipment from those who do not comply with current rules (Gössling, 2020).

Public managers must be aware of the forms of social and cultural resistance that citizens can transmit as a result of living with electric scooter services and infrastructure and technical challenges. From a theoretical point of view, the main barriers to electric scooter systems have focused on the lack of charging infrastructure, reduced subjective safety for other traffic participants, adverse weather conditions, or limited luggage transport capacity (Hardt & Bogenberger, 2019).

Thus, the implementation of mobility applications and the presence of electric scooters in the urban space unthinkable a few years ago makes us question the extent to which these digital technologies and services encourage. Thus, the use of new modes of transportation around the city, contributing to the occupation and redefinition of urban space.

References

Bai, S., and Jiao, J., 2020. Dockless E-scooter usage patterns and urban built Environments: A comparison study of Austin, TX, and Minneapolis, MN. *Travel Behaviour and Society*. 20, 264–272.

Balago, R. (2021). Regulação das patinetes em SP não engata e alto custo dificulta expansão. *Folha de São Paulo*, São Paulo, 16 jan. 2020. - Cotidiano - Folha (uol.com.br). Retrieved from: https://www1.folha.uol.com.br/cotidiano/2020/01/regulacao-das-patinetes-em-sp-nao-engata-e-alto-custo-dificulta-expansao.shtml. Accessed 11 jan. 2021.

Batty M., Axhausen K. W., Giannotti F., Pozdnoukhov A., Bazzani A., Wachowicz M., Ouzounis G., and Portugali Y. (2012). Smart cities of the future. *European Physical Journal: Special Topics*, 214(1), 481–518.

Bhattacherjee, A. (2001), Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly*, 25(3), 351-370.

Brasil (2012). *Lei no 12.587, de 3 de janeiro de 2012*. Brasília: Presidência da República, [2018]. Retrieved from: http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2012/Lei/L12587.htm. Accessed 9 jan. 2021.

Brasil (2019). *Projeto de Lei nº 4135, de 2019*. Brasília: Senado Federal. Retrieved from: https://www25.senado.leg.br/web/atividade/materias/-/materia/137816. Accessed 9 ja. 2021.

Brunner, H., Hirz, M., Hirschberg, W., and Fallast, K. (2018). Evaluation of various means of transport for urban areas. *Energy, Sustainability and Society*, 8 (9).

Caragliu, A., Del Bo, C., and Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, 18(2), 65–82.
Caspi, O., Smart, M. J., and Noland, R. B. (2020). Spatial associations of dockless shared e-scooter usage. *Transportation Research Part D: Transport and E*nvironment, 86.
Cheng, S.-I., Chen, S.-C., and Yen, D. C. (2015). Continuance intention of E-portfolio system: A confirmatory and multigroup invariance analysis of technology acceptance model. *Computer Standards & Interfaces*, 42, 17–23.
Cheng, Y.H., and Huang, T.Y. (2013). High speed rail passengers' mobile ticketing adoption. *Transportation Research Part C: Emerging Technologies*. 30, 143–160.
Chin, W. W. (1998). The partial least squares approach for structural equation modeling. In Modern methods for business research (pp. 295–336). Lawrence Erlbaum Associates Publishers.
Chong, A. Y.-L. (2013). Understanding Mobile Commerce Continuance Intentions: An Empirical Analysis of Chinese Consumers. *Journal of Computer Information Systems*, 53(4), 22–30.
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*. 13(3) 319-340.
Dewalska-Opitek, A. (2014). Smart city concept - The citizens' perspective. *Telematics - Support for Transport*, CCIS 471, 331–340.
Dong, X., Chang, Y., Wang, Y., and Yan, J. (2017). Understanding usage of Internet of Things (IOT) systems in China. *Information Technology & People*, 30(1), 117–138.
Fitt, H., and Curl, A. (2020). The early days of shared micromobility: A social practices approach. *Journal of Transport Geography*, in press, 86, 102779.
Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., and Meijers, E. (2007). *Smart cities. Ranking of European medium-sized cities*. Vienna: University of Technology. Retrieved from: http://www.smart-cities.eu/download/smart_cities_final_report.pdf. Accessed 11 jan. 2021.
Gössling, S. (2020). Integrating e-scooters in urban transportation: Problems, policies, and the prospect of system change. *Transportation Research Part D: Transport and Environment*, 79.
GPCI (2020). *Global Power City Index.* Retrieved from: http://mori-m-foundation.or.jp/english/ius2/gpci2/index.shtml. Accessed 11 jan. 2021.
Hair, J., Hult, G. T., and Ringle, C. (2016). *A Primer on Partial Least Squares Structural Equation Modeling* (2nd Edition). Sage Publications.
Hardt, C. and Bogenberger, K. (2019). Usage of e-scooters in urban environments. *Transp. Res. Procedia*, 37, 155–162.
Hayes, A. F. (2017). *Introduction to Mediation, Moderation, and Conditional Process Analysis*, Second Edition: A Regression-Based Approach. The Guilford Press.
IESE Cities in Motion Index (2020). *City Ranking IESE Business School* – IESE Business School – University of Navarra - https://dx.doi.org/10.15581/018.ST-542. Accessed 11 jan. 2021.
Jambulingam, T, Kathuria, R and Nevin, J. R (2011). Fairness-Trust-Loyalty Relationship Under Varying Conditions of Supplier-Buyer Interdependence. *Journal of Marketing Theory and Practice*, 19(1), p. 39-56.
Kim, B (2010). An empirical investigation of mobile data service continuance: Incorporating the theory of planned behavior into the expectation-confirmation model. *Expert Systems with Applications*, 37(10), 7033-7039.
Lai, W. T. (2015). Exploring Use Intention of a Smart Bike-Sharing System-Extending Technology Acceptance Model with Trust. *LISS 2014*, 1597–1603.

Lam, S. Y., Shankar, V. and Erramilli, M. K. (2004). Customer value, satisfaction, loyalty, and switching costs: An illustration from a business-to-business service context. *Journal of the Academy of Marketing Science,* 32(3), 293–311.

Mahbub, A. Goonetilleke, G. Ayoko, P. Egodawatta, and T. Yigitcanlar (2011). Analysis of Build-Up of Heavy Metals and Volatile Organics on Urban Roads in Gold Coast, Australia. *Water Science and Technology,* 63, 2077–2085.

Malhotra, N. K. (2014). *Essencials of Marketing Research:* A Hands-on Orientation. Prentice Hall, 1 Edition, January 20.

McKenzie, G. (2019). Spatiotemporal analysis of scooter-share and bike-share usage patterns in Washington, DC. *Journal of Transport Geography*. 78, 19–28.

Park, C.K., Kim, H.J., and Kim, Y.S. (2014). A study of factors enhancing smart grid consumer engagement. *Energy Policy*, 72, 211–218.

São Paulo. *Decreto n. 58.750 de maio de 2019*. São Paulo: Casa Civil do Gabinete do Prefeito, 2019.

Stolfi, D. H. and Alba, E. (2014). Red swarm: reducing travel times in smart cities by using bio-inspired algorithms. *Applied Soft Computing*, 24, 181–195.

Urban Systems (2020). *Ranking Connected Smart Cities*. (Portal). Retrieved from: https://www.urbansystems.com.br. Accessed 11 jan. 2021.

Wang, Y., Wang, S., Wang, J., Wei, J., and Wang, C. (2018). An empirical study of consumers' intention to use ride-sharing services: using an extended technology acceptance model. *Transportation*.

Wei, T. T., Marthandan, G., Chong, A.Y.L., Ooi, K.B. and Arumugam, S. (2009). What drives Malaysian m-commerce adoption? An empirical analysis. *Industrial Management & Data Systems*, 109 (3), 370-388.

Yuan, S., Liu, Y., Yao, R., and Liu, J. (2014). An investigation of users' continuance intention towards mobile banking in China. *Information Development*, 32(1), 20–34.

Zygiaris, S. (2013). Smart city reference model: assisting planners to conceptualize the building of smart city innovation ecosystems. *Journal of the Knowledge Economia*, 4(2), 217-231.