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Determinants of e-inclusion and digital inequality in the use of urban mobility applications in mobility

Determinantes da e-inclusão e da desigualdade digital no uso de aplicativos de mobilidade urbana

Determinantes de la e-inclusión y la desigualdad digital en el uso de aplicaciones de movilidad urbana en la movilidad

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Abstract
The expansion of cities has altered urban mobility, which has become a challenge for policy makers. At the same time, technological developments and access to mobile applications have also grown, since they provide information in order to facilitate urban displacement. Thus, the eradication of obstacles aimed at e-inclusion contributions to the exercise of citizenship and social equity. The objective of the work is to investigate what are the determinants of e-inclusion and digital inequality to discriminate users and non-users of urban mobility applications. A mixed approach was carried out using a meta-analytical approach, associated with the discriminating statistical technique and hypothesis testing of the data collected through an electronic questionnaire applied to 205 respondents in Brazil. The results found showed four discriminating variables of users and non-users of urban mobility applications, namely: income, age, difficulty in using digital technology and learning to use digital technology. Among these, only the income variable showed significance in the hypothesis tests. The research reveals that income is an important variable in the process of e-inclusion and digital inequality and should be considered by the public managers.
Keywords: Urban mobility; Mobile apps; Discriminating factors.

Resumo
A expansão das cidades alterou a mobilidade urbana, que passou a ser um desafio para os formuladores de políticas públicas. Simultaneamente, a evolução tecnológica e o acesso aos aplicativos móveis também cresceram, uma vez que proporcionam informações de modo a facilitar o deslocamento urbano. E, desenvolver tecnologias para dar melhor fluxo à mobilidade, na mesma velocidade com que as cidades crescem é um grande desafio. Nesse sentido, o objetivo do trabalho é investigar quais são os fatores determinantes da e-inclusão e desigualdade digital para discriminar usuários e não usuários de aplicativos de mobilidade urbana. Foi realizada uma abordagem mista, utilizando enfoque meta analítica associada à técnica estatística discriminante e testes de hipóteses com as variáveis que diferenciaram os usuários e não usuários de aplicativos de mobilidade urbana. O instrumento de coleta utilizado foi um questionário eletrônico aplicado para 205 respondentes no Brasil. Os resultados apontaram quatro variáveis discriminantes de usuários e não usuários de aplicativos de mobilidade urbana, a saber: renda, idade, dificuldade de utilização da tecnologia digital e aprendizagem de uso da tecnologia digital. Dentre essas, apenas a variável renda apresentou significância estatística nos testes de hipóteses. A pesquisa revela que a renda é uma variável importante no processo de e-inclusão e desigualdade digital, devendo ser considerada pelos gestores públicos.
Palavras-chave: Mobilidade urbana; Aplicativos móveis; Análise discriminante; Inclusão digital.

Resumen
La expansión de las ciudades ha alterado la movilidad urbana, lo que se ha convertido en un desafío para los hacedores de políticas. Al mismo tiempo, también han crecido los desarrollos tecnológicos y el acceso a aplicaciones móviles, ya que brindan información para facilitar el desplazamiento urbano. De esta forma, la erradicación de los obstáculos encaminados a la e-inclusión contribuye al ejercicio de la ciudadanía y la equidad social. El objetivo del trabajo es investigar cuáles son los determinantes de la e-inclusión y la desigualdad digital para discriminar usuarios y no usuarios de aplicaciones de movilidad urbana. Se realizó un abordaje mixto utilizando un enfoque metaanalítico, asociado a la técnica estadística discriminante y prueba de hipótesis de los datos recolectados a través de un cuestionario electrónico aplicado a 205 encuestados en Brasil. Los resultados encontrados mostraron cuatro variables discriminatorias de usuarios y no usuarios de aplicaciones de movilidad urbana, a saber: ingreso, edad, dificultad en el uso de tecnología digital y aprendizaje de uso de tecnología digital. Entre estas, sólo la variable ingreso mostró significancia en las pruebas de hipótesis. La investigación revela que el ingreso es una variable importante en el proceso de e-inclusión y desigualdad digital y debe ser considerada por los gestores públicos.
Palabras clave: Movilidad urbana; Aplicaciones móviles; Factores discriminatorios; Inclusión digital.

1. Introduction

Urban mobility is considered a problem in the world's major urban centers. And, developing technologies to give mobility a better flow, at the same speed as cities grow, is a great challenge.

The search for solutions to the problems of mobility and population concentration in cities has become a new research frontier (Lyons, 2016; Sanchez-Sepulveda, et al., 2019) and has become a challenge for public managers (Magagnin, & Silva, 2008; Lyons, 2016). Facing this scenario, governments seek to invest in innovative technological solutions (Weerakkody, et al., 2012; Meotti & Silva, 2016), supported by the premises of the Digital Age.

In this way, the expansion of the technology and connectivity, especially with the active participation of the population, has enabled the content of available technologies to be adjusted to people's needs (Sanchez-Sepulveda et al., 2019), seeking to increase the efficiency of the means of transportation and the interaction between technology and people (Lyons, 2016), such as smart urban mobility (Lyons, 2016; Cohen-Blankshtain, & Rotem-Mindali, 2016).

Information and Communication Technologies (ICTs) cooperate to form new patterns of social behavior, remote work, and consumption, as well as contributing to a more efficient and safer use of the transportation system, especially in reducing uncertainties by making information available to users in real time (Cohen-Blankshtain, & Rotem-Mindali, 2016; Meotti, & Silva, 2016).

Although the spread of ICTs in the form of applications (apps) is a growing reality, the access to this technology is not isonomic, since there is considerable digital inequality among people, currently called the digital divide. This term refers to the difference between those who have and those who do not have access to Internet, electronic devices, knowledge, and skills in dealing with technologies (Yu *et al.*, 2018).

Scientific studies reinforce the importance of digital inclusion of the population as a path to improve the quality of life, towards the reduction the social inequalities, by allowing the dissemination of knowledge in a more equal way (Weerakkody *et al*., 2012). For this, it is necessary to invest in technological infrastructure, aiming to provide access to all the social layers (Cruz-Jesus, et al., 2017; Raya Diez, 2018). Moreover, the empirical results spot that the link between infrastructure and digital development is even more positive in countries with lower levels of economic development (Cruz-Jesus *et al.*, 2017), suggesting an overcoming path.

However, it is observed that the fragility of integration due to infrastructure failure and inappropriate public policies end up increasing the digital divide (Raya Diez, 2018; Yu *et al*., 2018), which could be gradually reduced, better integrating resources, and mitigating existing limitations through the support of products and services (Taco, et al., 2018). Thus, the use of apps on mobile devices may favor the e-inclusion (Sourbati, 2012).

Offering digital technologies and urban mobility apps to the users of public transportation can provide real-time

information on routes, the availability of bus lines and timetables at the desired bus stops, promoting the rational use of means of transport along the route (Ferreira, et al., 2018).

Thus, verifying the factors that discriminate people who use mobility apps from those who do not use gains relief. The research question aims to answer: what factors discriminate users and non-users of urban mobility apps?

It aims to identify the determinants of e-inclusion and digital inequality to discriminate users and non-users of urban mobility apps as digital technology (DT). Municipalities are conducive to digital transformations, especially those that impact urban spaces and expand the exercise of citizenship with inclusion, innovation, and social development. The use of technology for the appropriation of the urban area promotes greater social participation in the formulation and implementation of public policies since it is focused on the motivation, engagement, and experiences of the participants (Sanchez-Sepulveda, et al., 2019).

The increasing use of the Internet and new Information and Communication Technologies (ICTs) have transformed the social relationships and influenced integrations among the individuals (Patterson, & Loomis, 2016; Raya Diez, 2018), creating a sense of belonging, accessibility, and citizenship, based on the social inclusion and equity of opportunities among people (Taco *et al*., 2018).

The emergence of new tools, such as the digital apps, allows new actions to be implemented on Public Management (Recuero, 2012), while providing real-time information to the transportation user facilitates mobility, especially in the use of buses, because the person has data such as route and vehicle schedules at the desired stops of boarding and arrival (Ferreira *et al*., 2018).

In this regard, the expansion of the cities influences and is influenced by the means of transportation that are available to people who need to move according to their commitments. Thus, the mobility is related to displacement (Magagnin, & Silva, 2008), making important the role of the means of transportation in the local and regional development (Nascimento, & Lima, 2017).

Thus, the urban mobility starts to be considered smart from the moment that the connectivity in the cities is focused on accessibility, with the use of communication and information technologies that provide information, preferably in real time, to users and formulators and implementers of public policies (Lyons, 2016).

Technological advances with the development of technological resources allow us to innovate and improve mobility by providing information that contributes to the valorization of the citizen, since it reduces uncertainties in the displacements through urban roads (Nascimento, & Lima, 2017). But technological developments require adequate infrastructure in ICT´s, such as internet access since the use of the apps requires this availability.

The infrastructure of a country influences the digital development, especially in developing countries, such as Brazil, which ranks 57th in the world ranking among 110 countries, in which, 63% of the countries from South America and which are considered digitally developed (Cruz-Jesus *et al*., 2017). Inequality of access in the daily use of ICT´s tools is one of the most relevant indicators to measure digital inclusion among countries and people (Raya Diez, 2018).

In this context, it is especially important that people have adequate information on how to use technologies, as well as to provide digital equity among citizens and provide adequate infrastructure for the emergence of technological innovations.

To reduce digital inequality among people, it is necessary to invest in ICTs, with more affordable or subsidized prices, aiming to facilitate digital equality (Cruz-Jesus *et al*., 2017), to provide the universal access to broadband internet, to improve the means of communication and education techniques, especially for people with disabilities (Sourbati, 2012).

The increase in the use and scope of ICTs leads to transformations in society, covering the economy, the society, and the politics, especially due to the increase in investments in infrastructure in the area (Yu *et al*., 2018). Some factors influence digital and technological inclusion (e-inclusion), such as demographic, political, economic, social, and cultural characteristics

(Weerakkody *et al*., 2012).

The way that information is spread and how people can access these technologies become a matter of inclusion. Investing in a strategy of smart and inclusive economic development, the European Commission launched the European Strategic Plan i2010, sought to promote the competitive and inclusive economy (Weerakkody *et al*., 2012).

The UK Government, for example, has set up a transportation innovation center to explore smart mobility and appropriate emerging technologies with the aim of improving urban mobility (Weerakkody *et al*., 2012; Cohen-Blankshtain, & Rotem-Mindali, 2016). In addition, the data generated allow the shared use of information by people (Lyons, 2016) and institutions, resulting in the efficiency of meeting population needs.

However, it is possible to realize that the issue of the digital divide is still a deficiency that needs to be worked out in greater depth. Yu *et al*. 2018, researching the digital divide among Chinese migrants developed a theoretical model to explain the causes and the determinants of the digital divide creation.

Thus, Yu *et al*. (2018) defined three main factors: access, resources, and forces. Regarding access, they divided it into cognitive, motivational, and social material; in relation to resources, they identified financial, material, cognitive, educational, psychological, and interpersonal resources; and, finally, the forces were categorized into ideological, industrial, public, community and personal administrative.

The result of the research pointed into the direction of a causal relationship between the forces that influence resources and, in turn, facilitate digital acceptance and inclusion, as the important role of the mobile phones that were considered by the respondents as the main electronic device (Yu *et al*., 2018).

As the number of mobile phones and the use of digital technology grow, a new class called "digital subclass emerges. It encompasses those who have difficulties in dealing with the new technologies (Sourbati, 2012), because the use of ICTs requires knowledge of media, informatics and in the search for information (Weerakkody *et al.*, 2012). In addition, the resources are clearly important in mitigating the impact of the digital divide, but the cognitive and behavioral aspect of the population also seems to favor its occurrence and magnitude.

E-inclusion, even if it is a complex interaction between environmental and personal circumstances (Sourbati, 2012; Weerakkody *et al*., 2012), serves as an instrument of equity, facilitating the access to public services and information. Thus, it is inferred that electronic inclusion has an impact on both the individual and the society in which he is inserted (Weerakkody *et al.*, 2012).

ICTs stand out in social inclusion programs and access to public services, making it crucial to create public policies for a large and universal access to public services available, and for the interaction of people with the cities in which they live in (Meotti, & Silva, 2016). Thus, it is necessary to have resources to provide equal access to knowledge (Sourbati, 2012), as an example the smartphones, so that the use of apps permeates the connection among society, government, and entrepreneurs, including the articulation among the actors involved in the realization of the rights of the society (Agovino, & Rapposelli, 2013).

Technological transformation has made the use of mobile phones and *tablets habitual*, especially with the creation of mobile apps that have gained popularity among people, due to their portability, low cost or gratuity, ease of access to information (Griffin-Shirley *et al*., 2017).

New intelligent and sustainable technologies are part of a list of improvement options for mass systems of public transport aiming to improve the supply of transport with embedded technology and, with this, urban mobility. Bonete and Dos Reis's study (2021) presents several evidences or criteria that classify mass urban transportation systems. They are convergence between transport systems, new opportunities arising from this convergence and the challenges to be overcome. The authors also report that socioeconomic and economic indicators favor awareness for the use of technologies to users,

favoring intelligent mobility.

In fact, large population centers make up the largest share of the population around the world, so the quality of life in these urban centers aims to create more sustainable spaces. Brazilian cities, for example, impose on their populations a range of problems that reduce the quality of life of their populations, including this characteristic already occurs in smaller cities. It is worth noting that the population itself is also responsible for part of these problems. A study by Fatima *et al.* (2020) carried out in a small municipality showed that the lack of public policies and urban planning impact and compromise the mobility of people and spaces in general.

A portion of the Brazilian population has some difficulty in locomotion, so urban spaces must be planned to ensure the displacement of all. With regard to the design and planning of these spaces, several problems reflect the lack of compliance with current standards and, mainly, failures in supervision by the responsible agencies. This results in loss of quality of life and insecurity in the displacements of users of these services (Crtoi & Ferreira 2020).

Another important point for quality of life is due to the numerical advance of the elderly population in the world, which signals the need to implement measures that provide a better quality of life to this part of society. In addition, digital technologies are already part of the routine of this group, but many are not yet included, for example, in digital social networks. Therefore, digital inclusion can be an outlet for improving the quality of life of the elderly, facilitating access to products and services and thus enabling integration with new inclusive technologies (Flores-Gomes *et al.*, 2020).

Apparently many elderly people are interested in participating in activities that use technology in an inclusive way. However, a study by Flores-Gomes et al. (2020) concludes that the proposition of a digital inclusion program in a given group did not produce direct or significant effects on the quality of life of the studied group, comparing to the same results obtained from a control group. Low level of skills and social pressure for the use of technology for access to public and private services may have influenced the results of digital exclusion (Flores-Gomes *et al.*, 2020).

For Leone and Oliveira (2021) digital exclusion is evident in Brazilian society. Since the 1990s, interconnected networks have grown in a high way, which requires relevant legislation and legal accuracy. Therefore, education can be the main way of including people who still cannot access services that lead them to have contact with the digital universe. In addition, the pandemic was a factor of great influence in the changes imposed by digital reality, in a period of time different from that which people could learn (Leone & Oliveira, 2021).

However, in Brazil, like other countries with an evolving digital economic development standard, the restrictions on access to groups with less inclusive capacity or market potential impose more affordable technological solutions, in the matter of price, quality and usability.

2. Methodology

The research sample consisted of users and non-users of urban mobility apps in Brazil. The sampling technique used was for convenience categorized as non-probabilistic, not allowing generalization (Malhotra, 2011).

The research protocol occurred in six stages. In the first stage, a systematic review of the literature was carried out based on the Theory of the Analytical Meta Approach (TAMA), proposed by Mariano and Rocha (2017). The method of systematic review and facilitating approach has three phases, the first is the initial preparation of the research, with the choice of descriptors, definition of the field, temporal space, the area of knowledge, and the choice of the database. The second stage of TAMA occurs with the presentation and crossing of the data, the third phase is the detailing, integrative model, and validation by scientific evidence (Mariano, & Rocha Santos, 2017).

In this present paper, TAMA method was applied in the analysis of 39 studies out of 107 studies extracted in the Web of Science database, published from 2014 up to 2019 using the descriptors: innovation, social inclusion, e-inclusion, APP.

From those 39 studies, the concepts and methods applied for the preparation of the questionnaire were extracted, focusing on the analysis of the causes and determinants of digital inequality (Yu et al., 2018) and int the identification of the inclusion factors of the adopting and non-adopting digital service digital user (Weerakkody et al., 2012).

In the second stage, the semi-structured electronic questionnaire was developed, based on the studies by Weerakkody *et al*. (2012) and Yu *et al.* (2018), but not yet validated in Brazil, which highlights the newness of the research.

In the next stage, a pre-test was used with 15 individuals to verify the understanding of the questions elaborated, and the reverse translation process was adopted. After the adjustments in the content of the questions, the questionnaires were applied from April to May 2020 resulting in 205 respondents.

In the fourth stage, it was performed the descriptive statistical analysis of the collected data. From this analysis, two groups of people were identified, users (121) and non-users (84). In the fifth stage, it was verified that the sample studied met two premises of the discriminant analysis technique, according to Table 1.

Table 1. Assumptions of sample size and group.

Premises	Test	Analysis	Conclusion
Sample size	> 5 cases per variable	23 variables with 205 respondents.	More than 8 cases per variable
Group size	> 20 observations	Non users 125 Users 80	More than 20 observations per group

Source: Hair, Anderson, Tatham and Black (2005) and Prearo, Gouvea, and Monari (2010)

Table 1 pointed out that the research sample met the scientific requirements that support the methodological procedures and the application of multivariate techniques requires a sample size analysis, evidenced by the minimum number of cases and observations.

In the next stage, two more propositions of the use of the discriminant analysis technique were tested according to the results of Table 2.

Table 2. Premises of homoscedasticity and multicollinearity.

Premises	Test	Analysis	Conclusion
Homoscedasticity	Box'M>0.05	4 discriminating variables	0.08 > 0.05
Multicollinearity	VIF	Income (VIF=1,527<5) Age (VIF=1,551<5) Difficulty (VIF=1,019<5) Learning (VIF=1,005<5)	No signs of multicolinearity

Source: Hair, Anderson, Tatham and Black (2005) and Prearo, Gouvea, and Monari (2010)

The results presented on the Table 2 indicated that there is no evidence of multicolinearity and homogeneity of the variance-covariance matrices. The robustness of a model is demonstrated from the premises underlying the use of discriminant analysis technique by the homoscedasticity test (Box'M) and multicolinearity (VIF).

The discriminant analysis technique aims to identify whether statistical differences exist between the scores of a set of variables for two or more groups (Hair *et al*., 2005). Prearo, et al., (2010) state that the discriminant technique fits into the category of dependency investigation between the variables and prediction. Thus, it is understood that this research technique contributes to evaluate the relative importance of independent variables in the context of inequality and digital inclusion of app users.

In the data analysis, the statistical software Statistical Package for the Social Sciences (SPSS 22.0) was used. The variables used in the research are described in Table 3.

Table 3. Variables of the e-inclusion questionnaire.

Factors	Variables	Author (es)
Sociodemographic influence	Social location, social status, social identity, save time, personal satisfaction, use of digital technology	Weerakkody *et al.* (2012)
Economic influence	Occupation, income, investment in digital technology, internet payment	Weerakkody *et al.* (2012)
Influence of the digital inclusion for transactions in the public sector	Digital technology in health, education, lifestyle, culture, knowledge, and traditions.	Weerakkody *et al.* (2012)
Influence of financial resources	Expenses with digital technology	Yu *et al*. (2018)
Influence of the adopted technologies	Use of the digital technology	Yu *et al.* (2018)
Infrastructure influence	Communication tools, use of public space for communication	Yu et al. (2018)
Influence of daily routine activities	Leisure and professional improvement	Yu *et al*. (2018)
Influence of access to cognitive and motivational resources	Skills to use digital technology	Yu *et al*. (2018)
Influence of access to social capital	Difficulty in using my DT	Yu *et al.* (2018)
Influence of the education resource	I use digital technology to learn	Yu *et al.* (2018)
Influence of the psychological resource	Attitudes about digital technologies	Yu *et al.* (2018)
Influence of the social adoption resource	Place of use of digital technology most of the time	Yu *et al.* (2018)

Source: Based on Weerakkody *et al*. (2012) and Yu *et al.* (2018).

Table 3 presents the variables that were addressed in the field instruments, indicating the authors who support the choices of these variables.

After the discriminant analysis, the hypothesis tests of the predictor variables were performed aiming to advance the research results, as presented in the following section.

3. Results and Discussion

The present study distinguished the factors that discriminate e-inclusion and digital inequality for users and non-users of urban mobility apps. Seeking to support the results of the survey, we obtained the demographic profile of the survey´s respondents and the inclusion factors that influenced the adoption of this technology by the digital user (Weerakkody *et al*., 2012), as such as income, schooling, occupation and age, associated with questions about the causes and determinants of digital inequality (Yu *et al.*, 2018) with the results shown in Table 4.

Table 4 – Sample´s Demographics.

Income	**(%)**	**Education**	**(%)**
From zero to R$1,045.00	20,5	Up to complete high school	11,7
From R$1,046.00 to R$2,090.00	9,3	Incomplete high school	2,4
From R$2,091.00 to R$3,135.00	11,2	Complete graduation	35,6
From R$3,136.00 to R$4,180.00	10,7	Incomplete graduation	21,5
From R$4,181.00 to R$5,250.00	12,7	Graduated and over	28,8
Over R$5,251.00	35,6		
Total	100,0	Total 100.0	
Occupation	**(%)**	**Age (years)**	**(%)**
Formal employee (public or private sector)	60,5	9 to 26	25,9
Freelancer	15,1	27 to 38	24,4
Student	19,0	39 to 47	27,8
Informal employee	2,9	48 to 52	15,1
Unemployed	2,4	Over 53	6,8
Total	100,0	Total	100,0

Source: Survey data (2020).

Considering four factors analyzed in the sample profile, as described in Table 4, it is observed that the highest concentration of income is in the range of those receiving above 3 minimum wages, in values related to the eponym of data collection, i.e., 59% of the research participants; regarding occupation, 65% of the participants are formally employed; the degree of complete higher education characterizes the schooling of 64.4% of the research participants. The age factor analysis indicates that 78.1% of the respondents are between 9 and 47 years old, noting that 11.7% of the research participants are high school students. In short, the results of the Discriminant Factor Analysis (Prearo, et al., 2010), shown in Table 4, evidence the discriminant power of the model variables, the premises of the discriminant analysis technique (Hair, Anderson, Tatham, & Black, 2005) and the influence of discriminants on Fischer's function and canonical function.

According to the results presented in Table 4, the demographic aspects partially corroborate the findings of Weerakkody *et al*. (2012). Among the respondents surveyed, the adoption of public transportation apps seems to decline with age. Most of the interviewees adopting the app remained in the age group between 26 and 47 years old, clearly showing that the adopters belong to groups of young age up to middle age.

In percentage terms, the variables formal employment and income, when associated with the variable of age group, seem to indicate that most of the selected sample has autonomy in having access to internet from home, since 69.27% of the respondents declared to be responsible for paying for the service.

Regarding the economic factors of e-inclusion, the results partially contradict Weerakkody *et al*. (2012). Although the results of the variables formal employment, income and who pays for my internet in the original study were significant, in the research sample, only income presented itself as a discriminating factor for users, as shown in Table 5. This difference in the results can be explained or attributed according to the object of the analysis.

Table 5. Evaluation of the discriminating power of the independent variables.

Var.	Variables	Wilks' Lambda	Z	p-value
1	**Monthly income**	**0,980**	**4,019**	**0,046**
2	**Age**	**0,964**	**7,547**	**0,007**
3	Access to health	0,997	0,668	0,415
4	Residents in the house	0,996	0,784	0,377
5	Annual investment in information technology devices	1,000	0,087	0,769
6	Who pays for my internet	0,992	1,653	0,200
7	Education	0,999	0,106	0,745
8	Annual expenses with (DT)	0,995	0,938	0,334
9	Monthly expenses with (DT)	0,998	0,363	0,548
10	Communication tools	0,998	0,313	0,576
11	DT used in public space	0,997	0,611	0,435
12	Leisure and professional improvement I use technology	0,988	2,447	0,119
13	Level of understanding about the use of digital technology resources	0,984	3,279	0,072
14	I use digital technology to save time	0,994	1,314	0,253
15	I use digital technology for my personal satisfaction	0,994	1,136	0,288
16	When I use digital technologies	0,989	2,186	0,141
17	Digital technology help in health, education, and lifestyle	0,999	0,203	0,653
18	Digital technology help in culture, knowledge, and traditions	1,000	0,012	0,911
19	Skills to use digital technology	0,995	1,030	0,311
20	**Difficulty in using my digital technology**	**0,961**	**8,302**	**0,004**
21	**I use digital technology to learn**	**0,969**	**6,448**	**0,012**
22	Attitudes about digital technologies	0,999	0,227	0,635
23	Place that uses digital technology	0,999	0,224	0,637

Source: Survey data (2020).

When analyzing the discriminating power of the 23 variables extracted from Weerakkody *et al*. (2012) and Yu *et al*. (2018) studies, as seen on the Table 5, the result indicated that monthly income (1), age (2), difficulty in using digital technology (20) and the use of digital technology to learn (21) had a p-value (significance) less than 0,05, indicating that they are variables that discriminate the groups of users and non-users of urban mobility apps, as described previously in Table 3.

The results obtained indicate the discriminating power of the economic and sociodemographic factors, in the variables monthly income and age respectively for digital inclusion (Weerakkody *et al*. 2012), and the factors access to social capital and education resource respectively with the variables difficulty in using DT and using DT to learn as an autodidact (Yu *et al*., 2018), for discriminants of digital inequality.

In relation to Weerakkody *et al.* (2012) studies to identify the factors of inclusion of the digital user the variables regarding social location, *status* social, save time, personal satisfaction, use of digital technology, occupation, investment in digital technology, payment of *internet*, digital technology in health, education, lifestyle, culture, knowledge, and traditions used in this research did not present discriminating power for the analyzed sample.

In relation to Yu *et al*. (2018) studies to identify causes and determinants of digital inequality, the factors of the study of financial resources influence, adopted technologies, infrastructure, daily routine activities, cognitive and motivational resources, psychological resources, social adoption resources used in this research did not have discriminant power for the analyzed sample. The results of the Discriminating Factor Analysis (Prearo Gouvea, & Monari, 2010), shown in Table 3, showed the discriminating power of the model variables.

In addition, a new equality test of averages was performed with the four significant variables that presented discriminating power for groups of users and non-users of urban mobility apps, resulting in a stronger model that meets the premises of the Canonical Discriminating Analysis (Prearo, et al., 2010), presented in Tables 1 and 2.

It is evident that the four variables of the new model discriminate the group of users and non-users of urban mobility apps, with emphasis on the variable difficulty in using the technology, which was more significant, as shown in Table 6.

Table 6. Tests of group average equality.

Variable	Wilks' Lambda	Z	df1	df2	Sig.
Monthly income	0,980	4,019	1	202	0,046
Age	0,964	7,547	1	202	0,007
Difficulty in using my digital technology	0,961	8,302	1	202	0,004
I use digital technology to learn	0,969	6,448	1	202	0,012

Source: Survey data (2020).

The results presented in Table 6 indicate the representativeness of factors that stimulate or restrict access to digital resources by the urban population.

When analyzing Fischer's classification function coefficient, it is observed that, within the group of "non-app users", the difficulty in using my digital technology (1,494) indicates that greater the difficulty in using the technology, higher the chances of not being users of urban mobility apps. In the group of users, the use of digital technology to learn (1,225) has a positive relationship in becoming an urban mobility app user, as points out Table 7.

Table 7. Discriminant functions.

Fischer's Linear	App		Canonical
Variable	I don't use	I use	
Monthly income	0,160	0,102	0,086
Age	0,267	0,243	0,036
Difficulty in using my digital technology	**1,494**	1,155	0,503
I use digital technology to learn	0,949	**1,225**	-0,409
(Constant)	-9,224	-7,878	-2,069

Source: Survey data (2020).

As seen on the Table 7, regarding the canonical function, it is observed by the coefficients that the variable that best discriminates between the two groups of users is the difficulty in using my digital technology.

In addition to agreeing in part with Weerakkody *et al*. (2012) studies about the inclusion factors for users of DT, and Yu *et al.* (2018), as discriminators of digital inequality, the findings of this study corroborate with Sourbati (2012) results, regarding to age as a major factor of digital inclusion for urban mobility app users.

Finally, it was verified based on the four discriminants that the model was correct in 63.2% of the original value in their respective groups (users and non-users), indicating to be statically relevant in terms of robustness.

However, a new question arises due to the findings obtained, that is, is there a statistically significant difference in the discriminating variables between users and non-users? In this way, based on the results, hypothesis tests were performed on the predictor variables.

The hypothesis tests involved the discriminating variables of metric income, age, and non-metrics such as the difficulty of using DT and the use of DT as an autodidact person, which results are shown in Table 8.

Table 8. Tests of independent sample hypothesis.

N	Hypotheses	p-value	Conclusion
1.	There is a difference in age between users and non-users of urban mobility	0.012	Reject
2.	There is a difference in monthly income between users and non-users of urban mobility	0.076	Accepted
3.	There is a difference in the difficulty in using the technology between users and non-users of urban mobility apps.	0.006	Reject
4.	There is a difference in using the digital technology to learn between users and non-users of urban mobility apps.	0.035	Reject

Source: Survey data (2020).

As can be observed, of the four variables that discriminate users and non-users of urban mobility apps such as DT, in the studied group, only the income variable was statistically significant. On the other hand, the hypothesis tests pointed that there is no significant difference between the independent samples involving the variables about age, the difficulty in using and learning through DT among the groups. In light of this, it appears that the two techniques applied (discriminant analysis and hypothesis testing) proved that income is an important variable in the process of digital e-inclusion and digital inequality that must be considered.

4. Conclusion

The research aims to identify the determinant factors of e-inclusion and digital inequality to discriminate users and non-users of urban mobility apps as digital technology (DT). The questionnaire was prepared based on the studies by Weerakkody *et al*., (2012) on inclusion factors of the digital user and Yu *et al*. (2018) about the causes and determinants of digital inequality, which were translated and applied in the Brazilian context after performing a pre-test, revealing an unprecedented nature in the research carried out.

The results revealed that among the 23 variables analyzed using the discriminating technique, the variables monthly income, age, difficulty in using digital technology, use of digital technology in a self-taught learning way were statistically relevant to discriminate groups of users and non-users of urban mobility apps. The findings reveal that the variables monthly income and age favor digital inclusion (Weerakkody *et al*. 2012), and that the variables difficulty in using DT and using DT as a self-taught learning user reinforce these variables as elements of digital inequality (Yu *et al*., 2018).

The research findings corroborate the results of the research by Weerakkody *et al*., (2012) in the economic and sociodemographic factors, but they did not find support in the factor influencing transactions in the public sector such as digital inclusion, that is, in the case of the studied sample there is no evidence that facilities or support for user and public company transactions is a stimulus to the use of mobility apps. In this sense, it is interesting that the organizations start to think about didactic and self-explanatory forms as an incentive considering that the variables income and age are relevant.

The evidence observed in the variables difficulty in using DT and I use DT to learn as an autodidact are relevant factors for the inclusion of users and partially corroborate to Yu *et al*. (2018) findings, since these variables reinforce their relevance as a resource for determining digital inequality. However, material, financial, intellectual, and psychic resources were not supported by the discriminant analysis applied in this study, even with additional confirmatory technique performed by equality of means test, Fischer's test and canonical function.

The fact that the study clarifies that the higher the difficulty in using technology, the higher the possibility of not being a user of urban mobility apps and that the use of digital technology to learn is preponderant to become an user of urban mobility apps sheds light on the topic in order to strengthen which would be the attractive elements for the entry of users in

groups or networks represented by mobility apps.

In relation to the additional questioning to identify whether there was a statistically significant difference in the discriminating variables between users and non-users, the results were thought provoking. The discriminant analysis and the hypothesis tests of independent samples revealed that, for the studied group, the income variable is a factor to be considered for e-inclusion and digital inequality.

In other words, despite the income, it was evidenced that the use of DT as an autodidact instrument is antagonized by the functional difficulty of use, which widens the digital divide since if the user feels difficulty in using DT he will certainly not be able to reach the objective of seeking and improving their knowledge, regardless of age group.

This statement is supported by the literature, as it is known that there is a connection between digital inclusion and quality of life and that this relationship can reduce social inequalities through the dissemination of knowledge, especially in countries with less economic development and precarious structure (Weerakkody *et al*., 2012; Cruz-Jesus *et al*., 2017; Raia Diez, 2018).

According to Cruz-Jesus *et al* (2017), Brazil is classified as digitally developed, but despite this, according to the findings of the additional descriptive analysis, it is possible that the ICTs infrastructure constituted in the country is a vector for the expansion of the social inequality and also an obstacle to promote the inclusion of access to DTs.

In general, despite the fact that income is a socially inclusive factor for urban mobility DTs, the situation in Brazil as a digitally developed country still needs, according to Cruz-Jesus *et al.* (2017) and Raia Diez (2018), advances in infrastructure to encourage the population to engage in the use of new everyday technologies, which points to the possible need for public policies focused on this purpose.

In addition to the discriminating technique being considered an advance in the studies referred to, the questionnaire applied also strengthens the originality of the research due to obtaining in the same sample, two analysis (factors and determinants of inclusion and digital inequality) related to the same theme (digital technology users).

Due to the predictive aspect of the adopted technique, the research contribution consists of relating the factors that discriminate groups of users and non-users of urban mobility apps, identifying the variables that best differentiate or discriminate the two groups of people.

Although this research has achieved its objective, it was not possible to offer generalization, since the analysis was carried out specifically with app mode.

The main contributions of the research are in the theoretical, technical, and practical fields. The theoretical contribution consists of joining the two research models, the first by Weerakkody *et al*. (2012) about the inclusion factors of the digital user and the second by Yu *et al.* (2018) about the causes and determinants of digital inequality, which were translated and applied in the Brazilian context.

The support of the use of applications, in the Management of Cities, has the right to transform the ordinary citizen into a valuable member in observing the functioning of public and private equipment made available to the population. Thus, the authors understand that the results presented can contribute to the understanding of the strategy of implementation of facilities, such as this one that was the object of this study.

The technical contribution was the use of the two different statistical techniques: discriminant analysis technique in order to identify the variables with discriminatory power of users and non-users' group of urban mobility apps, and the performance of hypothesis tests to check if there were statistically significant differences in the four variables identified in the discriminant.

The work also allowed, in the practical field, to verify that income was the only variable that presented statistical significance in the hypothesis tests, pointing out that it must be a factor to be considered in the academic studies and public

policies that mention e-inclusion and digital inequality.

For future studies, we strongly recommend the previous application of a semi-estructured interview, having citizens and Public Management representatives aiming to identify new thematic areas of public interest. In our pointy of view, a new cluster of demands for e-inclusion would show up from the interviews.

We also suggest the application of the techniques adopted in this study in a more comprehensive sample, since the data collection was applied during the pandemic. As we understood, urban apps can be become an effective tool of communication among between the urban citizens and the public agents.

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