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Electronic Government services in Brazil: an analysis of impact factors on the citizen's usage decision

Luiz Claudio Mendes Vargas [1]
Marie Anne Macadar [1]
Peter Fernandes Wanke [1]
Jorge Junio Moreira Antunes [1]

[1] Universidade Federal do Rio de Janeiro (UFRJ/COPPEAD), Rio de Janeiro – RJ, Brazil

Abstract

This article focuses on factors that influence the use of electronic government services by citizens. The academic literature has promoted reflections on the influence of various factors and, therefore, this article aims to assess whether socio-demographic factors influence the Brazilian citizens' decision to use Electronic Government services. This study adopted a quantitative methodological approach, using statistical tests and a logistic regression model, based on the microdata of the ICT Household 2019 survey, coordinated by the Regional Center of Studies for the Development of the Information Society (CETIC.br). The results indicate a significant influence of age, family income, activity condition, economic class, level of education, type of access device, and use of e-commerce services on the probability of using Electronic Government services by Brazilian citizens. The article contributes to a more comprehensive understanding of the factors that impact demand and aims to subsidize public managers' discussions about these services' implementation.

Keywords: Electronic Government. ICT Household. Logistic Regression.

Serviços de governo eletrônico no Brasil: uma análise sobre fatores de impacto na decisão de uso do cidadão

Resumo

Este artigo trata dos fatores que influenciam a utilização de serviços de governo eletrônico pelos cidadãos. A literatura acadêmica tem promovido reflexões sobre a influência de diversos fatores, e este artigo tem como objetivo avaliar se aspectos sociodemográficos têm influência sobre a decisão de uso de serviços de governo eletrônico pelos cidadãos brasileiros. O estudo utilizou uma abordagem metodológica quantitativa, valendo-se de testes estatísticos e modelo de regressão logística baseados em microdados da pesquisa TIC Domicílios, coordenada pelo Centro Regional de Estudos para o Desenvolvimento da Sociedade da Informação (Cetic.br), referente ao ano-base de 2019. Os resultados desta análise indicam que há influência significativa de fatores como idade, renda familiar, condição de atividade, classe econômica, grau de instrução, tipo de dispositivo de acesso e uso de serviços de *e-commerce* sobre a probabilidade de uso de serviços de governo eletrônico. O artigo contribui para o entendimento mais abrangente dos fatores que impactam a demanda e se propõe a servir de insumo para discussões entre gestores públicos sobre a implementação desses serviços.

Palavras-chave: Governo eletrônico. TIC Domicílios. Regressão logística.

Servicios de gobierno electrónico en Brasil: un análisis de los factores de impacto en la decisión de uso del ciudadano

Resumen

Este artículo trata de los factores que influyen en el uso de los servicios de administración electrónica por parte de los ciudadanos. La literatura académica ha promovido reflexiones sobre la influencia de diversos factores y, por lo tanto, este artículo tiene por objeto evaluar si los factores sociodemográficos influyen en la decisión de los ciudadanos brasileños de utilizar los servicios de gobierno electrónico. En esto estudio se usó un enfoque metodológico cuantitativo, valiéndose de pruebas estadísticas y un modelo de regresión logística, basado en los microdatos de la investigación TIC Domicilios, coordinada por el Centro Regional de Estudios para el Desarrollo de la Sociedad de la Información (Cetic.br), para el año base 2019. Los resultados de este análisis indican que hay una influencia significativa de factores como edad, ingresos familiares, condición de la actividad, clase económica, nivel de educación, tipo de dispositivo de acceso y la utilización de servicios de comercio electrónico en la probabilidad de utilizar servicios de gobierno electrónico. El artículo contribuye a una comprensión más completa de los factores que inciden en la demanda y se propone servir de aportación a debates entre los gestores públicos sobre la implantación de estos servicios.

Palabras clave: Gobierno electrónico. TIC Domicilios. Regresión logística.

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INTRODUCTION

This article deals with using information and communication technologies (ICT) by Brazilians seeking a public government service so as to assess whether sociodemographic aspects have an influence on the decision to use a digital means (electronic services in government).

In recent years, the discussion on applying ICT has been at the center of debates on innovation both in the private and public sectors. The term "digital transformation" has become the goal of businesses and governments with digital services being the main focus. In the public sector, the term "electronic government (e-gov)" has been integrated into the agendas of government authorities and encompasses a wide range of services and applications that have digital technology and the Internet as platforms of development and access to the users.

The concept of e-government is not only related to applying new technologies for providing public services, but is the complete idea that through technological innovation – in this case applying ICT – governments will be able to provide services that create public value and are citizen-centered. Creating public value represents the vision of the public administration for generating value for the citizen, which is similar to the concept of value-added generation for clients that is widely used in the disciplines of marketing and strategy (Lopes, Macadar & Luciano, 2018). This is a broad concept that presents as its main focuses the improvement of public sector processes, the relationship between governments and citizens, and the relationship between governments and other institutions.

The most widespread aspect of the e-gov concept is related to services provided to citizens. In Brazil, for example, the services of citizen's electronic filing of income tax adjustment, the services for scheduling a doctor's appointment, enrollment in the public education system, a participative digital budget, and citizen support centers are cases recognized as successful experiences of e-government actions (Araujo, Reinhard & Cunha, 2018).

The evolution of e-government actions presents supply and demand challenges. On the supply side, governments need to develop a strategy for implementing ICT that considers the various levels of management, investments, operating costs, and the perspective of value for the citizen. On the demand side, it is important to understand the necessary conditions and skills that citizens need to develop to become an active user of public electronic services. In this context, the present study intends to contribute to understanding the factors that impact the demand side for e-government services.

The study proposes to answer the following question: which sociodemographic factors influence the decision to use e-government services in Brazil? Considering that the research on the topic has predominantly applied the qualitative method (Cunha, Coelho & Przeybilovic, 2017), this article aims to contribute to the academic literature with a quantitative approach that tests the dependence of e-government services on contextual and sociodemographic conditions based on a regression model.

After this Introduction, the article's second section is dedicated to a literature review on the concepts of electronic services in government, the contribution of the e-government services for public administration, and the factors that influence using e-government services. The third section presents the methodological approach applied, and then two sections (fourth and fifth) are dedicated to presenting the results obtained and to the discussion about the findings from this analysis. Finally, the sixth section presents the final considerations.

LITERATURE REVIEW

The Concept of e-Service in Government

E-Government is a term related to using information and communication technologies by the public sector, initially associated with adopting information systems in internal processes that are later expanded to applying digital technology for providing services to citizens. The term has a broad sense since it covers applying ICT in different stages in which technology impacts the public sector, whether that be by digitizing documents and processes, transforming the internal organization, engaging stakeholders, or by directing public policies (Janowski, 2015).

There is no consensus in literature on the definition of e-government, but studies on the topic in general address the application of ICT to improve processes and management in the public sector, to improve the provision of services to the citizen, and to increase the engagement of society in public policy and democracy discussions. In this context, e-government programs can cover 3 different scopes: e-public services, e-public administration, and e-democracy (Barbosa, Pozzebon & Diniz, 2013). In other words, we are talking about 3 actions focused respectively on providing services to the public, on public administration in general, and on promoting democracy through digital or electronic technology.

E-government programs are not restricted to providing online public services via the Internet, though e-public services have become their most popular and most impacting dimension in society. Furthermore, this dimension is extremely relevant due to the potential to change the citizen's perception as to the quality of the services provided by the public sector (Barbosa et al., 2013).

When the main causes for adopting ICT by governments is evaluated, it is possible to understand why providing online services has been presented as the most popular dimension of e-government. The increased use of technology by citizens, private companies, and government organizations; the replacement of information on paper for electronic media; and the advancement of the public ICT infrastructure itself is pointed out as the main drivers for intensively adopting ICT by the public sector in internal administrative processes and in providing services to society (Przeybilovicz, Cunha & Coelho, 2015).

The theme of e-government is closer to the citizen and to the companies when we talk about providing services via the Internet since it resembles using technology to obtain private services such as e-commerce, food delivery, private transport, banking, among other services that have become increasingly popular. From the perspective of characterizing the form of providing the service, we can consider electronic service as Internet-based, interactive, customer-centered, and integrated with the technology and internal processes of the supplier organization. Thus, in the context of e-government, services are usually related to intangible assets such as exchanging information to receive permissions, benefits, sending a tax return, or similar issues (Lindgren & Jansson, 2013).

The popularization of services such as the electronic filing of an income tax adjustment, electronic voting, and an emergency aid grant due to the crisis caused by the Covid-19 pandemic led to associating the term e-government fundamentally to the dimension of e-public services (Barbosa et al., 2013). In this context, e-government services have been the target of studies and research that seek to identify the attributes necessary for their supply and the factors that motivate them to be used by citizens.

For the purpose of this study, the scope of e-government will be restricted to the dimension of e-public services, which is providing public services electronically to citizens and businesses.

E-Government Services and its Contribution to Public Administration

E-Government represents more than providing digital services to the public. It is also related to using ICT to meet citizen needs and generate greater involvement of civil society with government in all its levels. Expanding the use of new technologies by people and companies is a motivation for applying emerging technologies in the public sector, which have a high innovative potential, but we should also consider e-government projects from the perspective of meeting the needs and interests of the citizen.

To understand the contribution provided by e-government initiatives we need to mention the theoretical concepts of public administration. In the mid-20th century, the traditional public administration was the predominant concept in public administration. Public administration was focused on addressing the challenges of industrialization, urbanization, and market failures. The main value was the operational efficiency of governments, and citizens were simply voters or customers (Bryson, Crosby & Bloomberg, 2014). The successful experience of economic recovery after the world wars and the great depression solidified the notion of the government as the main agent of social welfare.

The concept of New Public Management (NPM) emerged in the 1980s and was based on the understanding that the economic rationality of private markets was more effective and that the government's role as a service provider should be limited, encouraging state decentralization and privatization. It was the concept of a government most agile, responsible, transparent, results-oriented, decentralized, and efficient. It meant a government that works better and with fewer costs (Bryson et al., 2014; Cordella & Bonina, 2012).

ICT plays an important role in the context of NPM since it is a tool to create new forms of providing public service that are more efficient and more transparent, as well as to transform operating procedures and the public management model. In this concept of NPM, the implementation of e-government programs was driven by the cost-benefit rationale coming from the private management model. ICT thus became a central element in the process of reformulating governments under the NPM concept proposed (Cordella & Bonina, 2012).

The criticism of NPM focused on the fact that public administration should not be solely based on the cost-benefit rational as in the private sector since issues such as responding to natural disasters, health, education, and social inequality could not be treated with this same rationale. The results produced by the reforms inspired by the NPM concept generated political-social impacts not addressed by the private rationale.

A new vision of public administration based on the concepts of New Public Service (NPS) and public value thus emerges in which citizens, with their preferences and needs, become the main objective. The NPS concept argues that the government's objective should be to serve, rather than steer. In other words, the main role of the public sector should be to support citizens as they seek to meet their common interests and not to control and direct the path of society through a market economy logic (Denhardt & Denhardt, 2000). The NPS dialogs with the concept of public value, which also gained relevance as a counterpart to the NPM objectives. In this context of public value, the objective of public administration should be to create value for the citizen by providing public services, regulation, promotion of democracy and equality, among other actions (Lopes et al., 2018; Moore, 1994).

Based on the concepts of NPS and public value, e-government has begun to be considered as a means of creating value for citizens, meeting their collective preferences. While during the decades of 1980 and 2000, in the context of NPM, the e-government initiatives were driven by private-sector experiences, in recent decades there has been a change in the debate as to how to deliver public value through e-government services.

More recently the discussions on sustainable development and combating poverty and inequality began to have a greater influence on the evolution of the e-government theme. The commitments made between the member countries of the United Nations (UN), the Agenda 2030 for Sustainable Development, and the Sustainable Development Goals (SDGs) have an influence on guiding governments as they apply ICT policy. Digital technology is considered a key factor for implementing the SDGs (Janowski, 2016). These tools are just as important as the SDGs themselves, so much so that one of the 17 goals focuses on the articulation of these tools and their deployment paths (Marcovecchio, Thinyane, Estevez & Janowski, 2019). There is a strong focus on discussing the deployment paths, which includes public governance and technology, among other issues.

Thus, to ensure that e-government initiatives are effective as tools for achieving the SDGs, it is essential to understand how the sociodemographic situation of the citizens impacts using e-government services. In order for the objectives to be fully and comprehensively achieved, it is important that they reach the entire population, despite socioeconomic conditions. But for e-government services to be an instrument for promoting these objectives, there must be no restrictions on use according to gender, social class, level of education, housing region, and other factors.

Factors that Influence the Use of e-Government Services

The adoption of technological innovations in the public sector and citizen adherence to e-government programs have been the subject of academic studies in Brazil and abroad. In general, these studies focus on analyzing the attributes of acceptance of the technology by potential users, using the models Technological Acceptance Model (TAM) (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Gordon & Davis, 2003) as their theoretical reference.

Some studies point to factors such as usability, security, necessary infrastructure, and availability of technical support as key determinants for using e-government services (Shareef, V. Kumar, U. Kumar & Dwivedi, 2014; Van Dijk, Peters & Ebbers, 2008; Venkatesh, Chan & Thong, 2012). Other studies, using the Capabilities Approach developed by Amartya Sen (1999) present elements of the relationship between ICT and human development. Development must be perceived as the expansion of human capabilities, who must lead life according to their values, in which ICT must be considered as a means of achieving the human development objective (Zheng, 2009).

In this line of reasoning, it is possible to work under an approach that goes beyond the attributes inherent to the service and that somehow presents factors influencing the use of e-government services. This is the case of Brazilian studies that considered as explanatory variables of their models, factors such as the social class and preferred location for Internet access (Araujo et al., 2018; Araujo & Reinhard, 2015; Santos & Reihardt, 2015).

The studies developed by Araujo and Reinhard (2015) and by Araujo et al. (2018) present similar approaches. In them the authors use the research data to understand how using e-government services is influenced by the Internet access location and by the user's skills. The article produced by Santos and Reinhard (2015), however, brings a slightly different approach with an exploratory analysis on the use and motivations of not using e-government services in Brazil. Through an analysis based on descriptive statistics to responses presented in the 2019 ICT Household survey (Brazilian Internet Management Committee [CGI], 2020), the authors identify the main factors pointed out by the interviewees as non-use factors.

The inclusion of sociodemographic characteristics in evaluating the factors influencing the use of e-government services was internationally worked on by Van Dijk et al. (2008). Inspired by the UTAUT model, the authors proposed a multidisciplinary framework in which the intention to use is determined by the service attributes presented in the original model and by sociodemographic factors such as age, gender, level of education, and occupation. Among the studies carried out in the international scenario, Barrera-Barrera, Rey-Moreno & Medina-Molina (2019) consider the sociodemographic profile in their analysis of using e-government services.

By using data from the research carried out by Spain's Sociological Research Center and by applying the multivariate analysis technique known as contingency tables, Barrera-Barrera et al. (2019) concluded that the sociodemographic profile has an influence on the preference for using e-government services. However, the potential impact of the users' sociodemographic characteristics and conditions, which can influence the e-government services, has not yet been academically analyzed in the Brazilian context.

Additionally, attributes such as trust in the Internet and government (Belanger & Carter, 2008); usability, security, technical support (Venkatesh et al., 2012); religious belief, perception of utility, resistance to change (Alomari, 2014); awareness, quality of the information, availability of resources (Shareef et al., 2014); social influence, habit, perceived benefits (Moraes & Meirelles, 2017) can also be added. Box 1 presents a list of studies performed and the attributes considered with potential influences on using e-government services.

Box 1
Attributes influencing the use of e-government services

Authors	Attributes
Van Dijk et al. (2008)	Social influence, attitude toward use, performance expectancy, effort expectancy, choice of preferred channel, access to digital media, experience with digital media, offer of services, age, gender, level of education, and occupation.
Bélanger and Carter (2008)	Trust in the Internet and government.
Venkatesh et al. (2012)	Usability, IT resources, technical support, and security.
Alomari (2014)	Trust in the Internet, website design, religious belief, Internet and computer skills confidence, word of mouth, resistance to change, perceived usefulness, complexity, and adoption.
Shareef et al. (2014)	Awareness, availability of resources, skills for multi-language use, quality of information, trust, security, perceived benefits, and image.
Araujo and Reinhard (2015)	Social class, Internet access location, use of e-commerce, e-financial services, and e-mail.
Santos and Reihard (2015)	Preference for personal contact, difficulty of access, security, unavailability of services, and no return on requests.
Moraes and Meirelles (2017)	Perceived benefits, facilitating conditions, usability, social influence, security, trust, and habit.
Araujo et al. (2018)	Social class, Internet access location, and use of the network for study, work, relationships, and research.
Barrera-Barrera et al. (2019)	Gender, age, educational level, marital status, work situation, and religion.

Source: Elaborated by the authors.

In summary, only 3 studies incorporated sociodemographic variables in their analyses - Araujo and Reinhard (2015), Araujo et al. (2018), Van Dijk et al. (2008), making it possible to expand the discussion on factors that influence the use of e-government services and bring to light the conditions and skills of the citizen to become a user of these services. The context of Brazil was addressed in two articles (Araujo et al., 2018; Araujo & Reinhard, 2015), but sociodemographic characteristics such as age, income, level of education, gender, and region of residence were not considered. Thus, we understand that carrying out an analysis considering the inclusion of such variables will result in a relevant and complementary contribution to studies already carried out in Brazil, bringing a better understanding of the sociodemographic profile of the user of e-government services and to draw up public policies that take into account this profile of the citizen.

METHODOLOGY

In order to analyze which factors have an influence on using e-government services in Brazil, the present study follows a quantitative methodological approach based on the 2019 ICT Household survey prepared by Cetic.br, consisting therefore of a secondary data analysis. Considering that the objective of this article is to evaluate which factors influence the decision to use e-government services, we have a decision analysis that can be translated into the results of a binary or dichotomous dependent variable with 2 options: 1 if the individual uses e-government services or 0 if he/she do not.

In other words, the study aims to evaluate the probability of an individual being a user of e-government services given its sociodemographic characteristics such as gender, age, income, social class, and level of education. Thus, the logistic regression model is the most indicated for evaluating the dependence or association of a binary categorical variable in relation to other qualitative or quantitative variables since it consists of a specialized form of regression that aims to predict and explain the behavior of a variable that assumes 2 specific positions only and it not being a dependent measure (Hair, Black, Babin, Anderson & Tatham, 2009).

In general, the model considers that the dependent variable *y* can take on 2 values:

$$y_i = \begin{cases} 1 \text{ if a particular event occurs} \\ \text{or} \\ 0 \text{ if there is no occurrence} \end{cases}$$

The probability of the event being analyzed occurring is estimated in the model based on the equation:

$$P(y_i = 1) = \frac{1}{1 + e^{-g(x)}}$$

Where $g(x) = + \alpha + \beta_0.x_i$.

DATA COLLECTION

The ICT Household survey aims to measure access to ICT in Brazilian households and their use by the population. This is a survey with a national coverage whose target audience are permanent private households and individuals aged 10 years or over. The responses were collected in person between October 2019 and March 2020. Data collection was performed using an electronic form applied using a tablet following a method called computer-assisted personal interviewing (CAPI).

In addition to the contextual and sociodemographic variables, the 2019 ICT household survey collected data for specific indicators grouped into 9 thematic modules:

- Module A: Access to information and communication technologies at home.
- Module B: Computer use.
- Module C: Internet use.
- Module G: Electronic Government.
- Module H: Electronic Commerce.
- Module I: Computer skills.
- Module J: Use of cell phone.
- Module L: Use of selected applications.
- Module TC: Cultural activities.

Module G, which addresses the theme of e-government, presents 29 questions related to the usage profile of e-government services. The answers to these questions were aggregated into a single variable named G1_Agg, which indicates whether or not the user used e-government services.

This decision is reflected in the result of the G1_Agg variable, which indicates whether the interviewee did use (G1_Agg = 1: Yes) or did not use (G1_Agg = 0: No). The hypothesis of this study is that other variables may influence such a decision.

PROCEDURE FOR PROCESSING AND DATA ANALYSIS

The method defined for analyzing the variables that could influence the decision to use e-government services includes the steps described in Box 2 below.

Box 2
Steps in the treatment and analysis process

Stages	Objectives
Analysis and preliminary choice of the variables considered in the database of the 2019 ICT household survey.	Identify the variables from the 2019 ICT household survey database that have the potential to influence the decision to use e-government services.
Database processing.	Adapt the database for tests, statistical analyses, and the regression model.
Statistical tests and analyses in order to know the degree of association between explanatory variables and the dependent variable.	Based on the variables previously identified, define those that will be used for regression analysis depending on the degree of association with the dependent variable.
Regression analysis using the Logit model.	Using the logistic regression, estimate the equation that determines the probability of using e-government services in view of the occurrence of the other conditions.

Source: Elaborated by the authors.

These stages were performed using the free statistical software R (R Core Team, 2017). The study presents a detail of each of the stages next.

ANALYSIS AND PRELIMINARY CHOICE OF THE VARIABLES

The 2019 ICT Household database (individuals) contains 20,536 questionnaire responses with 249 questions, representing 20,536 observations and 249 variables. For the purposes of this study, the relevant variables are those related to the socioeconomic characterization of the individual present in the following groups of the dictionary of variables from the 2019 ICT Household survey: household information, Internet use, e-commerce, e-government, coverage, and aggregate variables. This information presents aggregated information of variables that are constant in the others.

Considering the household information group, the variables "gender", "age," and "family income" were chosen. The "EAP" (work situation) and "level of education" variables were replaced by "EAP 2" and "level of education 2", from the coverage group, which are versions with adjusted labels from the previous ones.

The variable C1 was chosen from the group that uses Internet, which corresponds to the question, "Has the respondent already used Internet?" As will be presented later, this variable serves as a filter since using e-government services as addressed in this study depends on Internet access.

The variable H2 was chosen from among those presented in the e-commerce group and indicates whether the respondent bought or ordered products or services over the Internet in the last 12 months. In the cell phone group, the variable J5 was chosen, which indicates whether the respondent has a cell phone.

The variables of the e-government group were replaced by the aggregate variable G1_Agg, present in the group of aggregated variables, as mentioned above. In the coverage group, in addition to the variables EAP_2 and Level_Education_2, the variables COD_Region_2, Class_CB2015, and Area were selected, indicating, respectively the individual's geographic region, economic class, and urban/rural area.

Finally, in the aggregated variables group, in addition to G1_Agg, the C5_Devices variable was also chosen, which informs whether the individual uses a computer, cell phone, or both for Internet access. Box 3 below presents a summary with the variables chosen in a preliminary way in order to compose the analysis model of this study.

Box 3
Variables chosen for the analysis model

Variable_ID	Variable Description	Data Type	Variable Code and Label	Classification	Category
Gender	Gender	Numeric	1 = Male 2 = Female	Quali	Nominal
Age	Age of Respondent	Numeric		Quanti	Continuous
EAP_2	Work situation: part of the Economically Active Population (EAP)	Numeric	1 = EAP 2 = Not EAP	Quali	Nominal
H2	Purchase or order of products or services over the Internet	Numeric	0 = No 1 = Yes 97 = Does not know 98 = Did not answer 99 = Not applicable	Quali	Nominal
J5	Has cell phone	Numeric	0 = No 1 = Yes 97 = Does not know 98 = Did not answer	Quali	Nominal
Family_ income	Family income	Numeric	1 = Up to R$ 937.00 2 = R$ 937.01 to R$ 1,874.00 3 = R$ 1,874.01 to R$ 2,811.00 4 = R$ 2,811.01 to R$ 4,685.00 5 = R$ 4,685.01 to R$ 9,370.00 6 = R$ 9,370.01 to R$ 18,740.00 7 = R$ 18,740.01 to R$ 28,110.00 8 = More than R$ 28,110.00 9 = Does not have an income 97 = Does not know 98 = Did not answer	Quali	Ordinal
Class_ CB2015	Economic class according to Brazil Criterion 2015	Numeric	1 = A 2 = B 3 = C 4 = DE	Quali	Ordinal
Level_ Education_2	Level of Education as informed by the respondent	Numeric	1= Illiterate/Kindergarten 2 = Elementary School 3 = High School 4 = College	Quali	Ordinal
C5_Devices	Device used by Internet users exclusively or simultaneously	Numeric	1 = Computer only 2 = Cell phone only 3 = Both 99 = Does not apply	Quali	Nominal
Area	Urban or rural area	Numeric	1 = Urban 2 = Rural	Quali	Nominal
COD_ Region_2	Geographic Region	Numeric	1 = Southeast 2 = Northeast 3 = South 4 = North 5 = Mid-West	Quali	Nominal

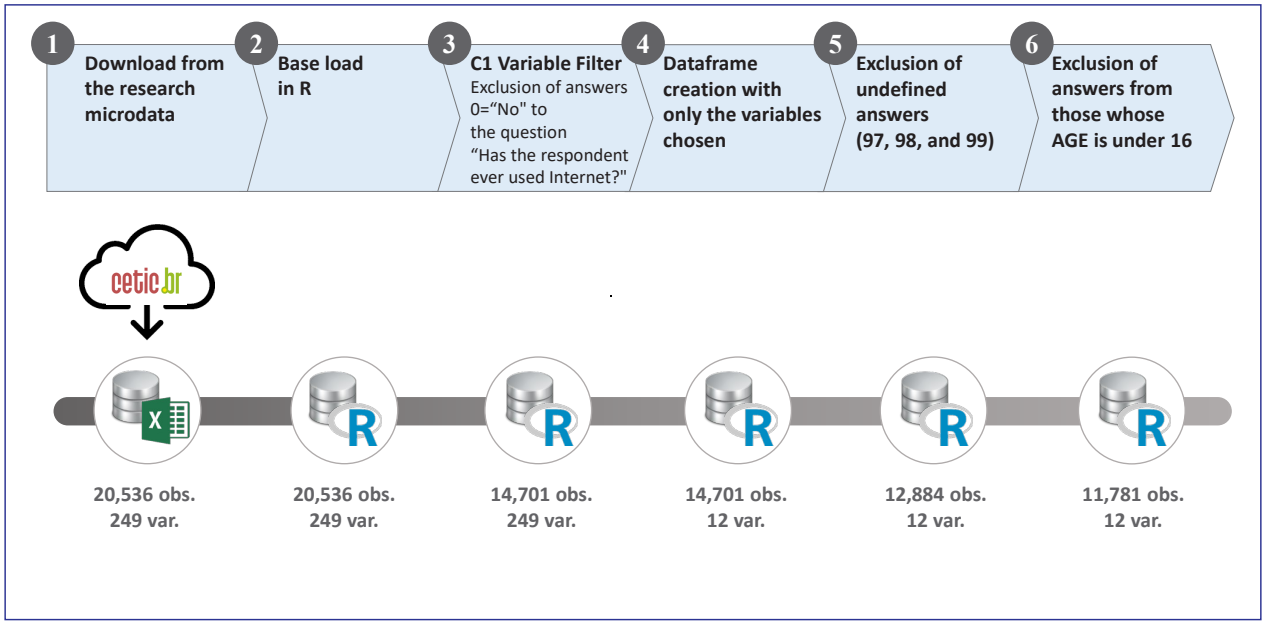
Source: Elaborated by the authors.

DATABASE PROCESSING

The database processing was carried out with the support of the free statistical software R (R Core Team, 2017) as shown in Figure 1 below.

The microdata base of the 2019 ICT Household survey was extracted from the Cetic.br website, which was in an Excel spreadsheet format. The microdata database was then loaded into the free statistical software R using the *readxl* package (Wickham & Bryan, 2019). Some filters had to be performed and a dataframe was created with only the variables predefined for the analysis. For this procedure, *gmodel* (Warnes, Bolker, Lumley & Johnson, 2018) and *dplyr* (Wickham, Francois, Henry & Müller, 2020) packages were installed. After the processing stages were performed, the database was reduced to 11,781 observations and 12 variables.

Figure 1
Data extraction and processing steps



Source: Elaborated by the authors.

For the purpose of the association tests, it was necessary to exclude undefined answers (coded as 97, 98, and 99) for the variables Family_Income, C5_devices, H2, and J5. The questionnaires whose respondents were under 16 years old were excluded since e-government services in general are intended for people aged 16 or over.

In addition to these filters, it was necessary to adapt the codes of some variables for preparing the association tests and the regression model, as presented in Box 4.

Box 4
Adaptations to the codes of the variables

Variable_ID	Variable Description	Variable Code and Label	
		From	To
EAP_2	Work situation: part of the Economically Active Population (EAP)	1 = EAP 2 = Not EAP	0 = Not EAP 1 = EAP
Family_income	Family income	1 = Up to R$ 937.00 2 = R$ 937.01 to R$ 1,874.00 3 = R$ 1,874.01 to R$ 2,811.00 4 = R$ 2,811.01 to R$ 4,685.00 5 = R$ 4,685.01 to R$ 9,370.00 6 = R$ 9,370.01 to R$ 18,740.00 7 = R$ 18,740.01 to R$ 28,110.00 8 = More than R$ 28,110.00 9 = Does not have an income	0 = Does not have an income 1 = Up to R$ 937.00 2 = R$ 937.01 to R$ 1,874.00 3 = R$ 1,874.01 to R$ 2,811.00 4 = R$ 2,811.01 to R$ 4,685.00 5 = R$ 4,685.01 to R$ 9,370.00 6 = R$ 9,370.01 to R$ 18,740.00 7 = R$ 18,740.01 to R$ 28,110.00 8 = More than R$ 28,110.00
Class_CB2015	Economic class according to Brazil Criterion 2015	1 = A 2 = B 3 = C 4 = DE	0 = DE 1 = C 2 = B 3 = A
Area	Urban or rural area	1 = Urban 2 = Rural	0 = Rural 1 = Urban

Source: Elaborated by the authors.

STATISTICAL TESTS AND ANALYSES

After the choice of variables with potential impact on using e-government services and database processing, an independent analysis was elaborated between the dependent variable G1_Agg and the other explanatory variables. Considering the qualitative and quantitative explanatory variables, 3 types of tools were applied according to the combination of the dependent (qualitative) and explanatory (quantitative or qualitative) variables.

G1_Agg versus Qualitative Variable

In this case the cross tabulation between the variables and the chi-square and V-Cramer tests were analyzed. The following hypotheses were defined for the independence tests:

- H0: The variables are independent.
- H1: The variables are not independent.

Considering that the chi-square distribution is not symmetrical with a confidence interval (CI) of 95%, which would be a significance level equal to 5%, the null hypothesis (H0) will be accepted when p-value > 0.05.

The analyses were elaborated in R using the *CrossTable()* function for preparing the cross tabulation and the *assocstats()* function from the *vcd* package (Meyer, Zeileis & Hornik, 2020) for calculating the statistics of the chi-square and V-Cramer tests.

G1_Agg versus Quantitative Variable

In this case, descriptive statistic measurements and distribution and boxplot graphs were analyzed in order to identify the probable association between the variables following the exploratory data analysis techniques (Bussab & Morettin, 2010). The statistics and graphs were generated in R.

Correlation Matrix

In addition to the analysis tools indicated above, a correlation matrix was prepared among the variables based on the Spearman method, which was more indicated for the evaluation involving qualitative variables. The matrix was generated in R using the *pairs.panel()* function in the *psych* package (Revelle, 2020).

REGRESSION ANALYSIS

The variables that present a significant probability of association with the dependent variable use of e-government (G1_Agg) were defined based on the results of the statistical tests and analyses. Next, the study applies the logistic regression model to estimate the decision to use e-government services based on contextual and sociodemographic variables.

To calculate logistic regression, it was necessary to transform the variables Family_Income, Class_CB2015, Level_Education_2, and C5_Devices into dummy variables. To do this, a new dataframe was created in R using the *dummy_cols()* function from the *fastDummies* package (Kaplan, 2020). The logistic regression was calculated based on the *dataframe* containing the dummy variables using the *multinom()* function from the *nnet* package (Venables & Ripley, 2002). The model's responses to the dependent variable was estimated using the *predict()* function from the *caret* package (Kuhn, 2020).

Finally, the model's performance was evaluated based on preparing a confusion matrix that consists of an associative table of estimated answers versus real answers and the analysis of the accuracy indicators (Accuracy and F-score) and of the ROC curve (Kubat, 2017; Kuhn & Johnson, 2013; Tharwat, 2018). The *confusionMatrix()* function from the *caret* package was used to prepare the confusion matrix (Kuhn, 2020), which also provides the results of the Accuracy and F-score indicators. The *roc()* and *auc()* functions from the *pROC* package (Robin et al., 2011) were used for analyzing the ROC curve.

RESULTS

The results of tests and correlation analysis between the dependent variable and the other qualitative variables are presented in Box 5 below.

Box 5
Results of the qualitative variables tests

Variable_ID	Description	Chi Test *p-value*	V Test	Correlation	Conclusion
Gender	Gender	*p-value* = 1.154e-11 Reject H0	0.063	-0.06	Not relevant
EAP_2	Work situation: part of the Economically Active Population (EAP)	*p-value* = 4.251e-94 Reject H0	0.190	+0.19	Relevant
H2	Purchase or order of products or services over the Internet	*p-value* = 6.764e-309 Reject H0	0.346	+035	Relevant
J5	Own a cell phone	*p-value* = 1.297e-14 Reject H0	0.071	+0.07	Not relevant
Family_income	Family income	*p-value* = 4.66e-121 Reject H0	0.223	+0.22	Relevant
Class_CB2015	Economic class according to Brazil Criterion 2015	*p-value* = 2.285e-138 Reject H0	0.233	+0.23	Relevant

Continuation

Variable_ID	Description	Chi Test *p-value*	V Test	Correlation	Conclusion
Level_Education_2	Level of Education as informed by the respondent	*p-value* =9.762e-276 Reject H0	0.329	+0.32	Relevant
C5_Devices	Device used by Internet users exclusively or simultaneously	*p-value* = 4.212e-232 Reject H0	0.301	+0.30	Relevant
Area	Urban or rural area	*p-value* = 1.255e-19 Reject H0	0.084	+0.08	Not relevant
COD_Region_2	Geographic Region	*p-value* = 2.658e-09 Reject H0	0.062	-0.03	Not relevant

Source: Elaborated by the authors.

The chi-square test result indicated the rejection of the null hypothesis (H0), which means independence between the variable representing using e-government and the other qualitative variables. However, the results of the V-Cramer test and from the correlation showed values below 0.1 for the variables that represent gender, owning a cell phone, urban or rural area, and geographic region, which indicates a weak association relationship between the variables.

Based on these results, these variables were discarded for the regression analysis. There was a doubt as to the variable representing urban or rural area because even though the results of the tests suggest that the association between this and the variable use of e-government is weak, the correlation table between this variable and the dependent variable G1_Agg shows an inversion in the proportion between users and non-users of e-government when there is a change from rural to urban area, as shown in Table 1. However, despite this, it was decided to exclude this variable from the regression analysis.

Table 1
Correlation Table: using e-gov services and rural/urban area

	Rural/urban area		
Use of e-gov services	Area = 0 (rural)	Area = 1 (urban)	Line total
G1_Agg = 0 (No)	462 *48.8 %*	3700 *34.1 %*	4162
G1_Agg = 1 (Yes)	484 *51.2 %*	7135 *65.9 %*	7619
Column total	**946**	**10835**	**11781**

Source: Elaborated by the authors.

For the quantitative variable Age, descriptive statistics were calculated as presented in Table 2 and the correlation analysis was prepared as presented in Box 6. The results of the tests indicate that there is a dependence relationship between the variable representing using e-government and the variable Age.

Table 2
Quantitative variable statistics

Use of e-gov Services	Mean	Standard deviation	Median
G1_Agg = 0 (No)	43.38	16.54	43
G1_Agg = 1 (Yes)	36.13	14.40	33

Source: Elaborated by the authors.

Box 6
Results of the quantitative variable tests

Variable_ID	Description	Descriptive statistics Graph analysis	Correlation	Conclusion
Age	Age of Respondent	The age of the users is lower than that of the non-users	-0.15	Relevant

Source: Elaborated by the authors.

The regression analysis presented the following results.

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1.0532948	0.3161304	-3.3318	0.0008627	***
Age	-0.0215132	0.0015091	-14.2557	< 2.2e-16	***
EAP_2	0.5584534	0.0524883	10.6396	< 2.2e-16	***
Class_CB2015_1	0.2105292	0.0525329	4.0076	6.35E-02	***
Class_CB2015_2	0.2379410	0.0936015	2.5421	0.0110200	*
Class_CB2015_3	0.3481345	0.2775756	1.2542	0.2097704	
Level_Education_2_1	0.4283330	0.1228478	3.4867	0.0004890	***
Level_Education_2_2	0.9302344	0.1242343	7.4877	7.007E-11	***
Level_Education_2_3	1.1445511	0.1410431	8.1149	4.862E-13	***
C5_Devices_2	0.4207865	0.2358820	1.7839	0.0744423	.
C5_Devices_3	1.0915803	0.2395162	4.5574	5.178E-03	***
H2	1.0552418	0.0542522	19.4507	< 2.2e-16	***
Family_Income_1	-0.0060700	0.1600424	-0.0379	0.9697457	
Family_Income_2	0.1893167	0.1604950	1.1796	0.2381673	
Family_Income_3	0.4414333	0.1653371	2.6699	0.0075874	**
Family_Income_4	0.3680310	0.1712689	2.1488	0.0316464	*
Family_Income_5	0.4954595	0.1895137	2.6144	0.0089392	**
Family_Income_6	0.4227457	0.2604689	1.6230	0.1045856	
Family_Income_7	0.3334971	0.4863970	0.6856	0.4929351	
Family_Income_8	0.0349981	0.5717860	0.0612	0.9511932	
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					

The model considers that the dependent variable G1_Agg (use of e-government services) can take on two values:

$$y_i\,(\text{G1\_Agg}) = \begin{cases} 1 \text{ if the individual uses e-government services} \\ \text{or} \\ 0, \text{ if does not use} \end{cases}$$

The probability of the event "use e-government services" was therefore estimated in the model based on the equation:

$$P\,(y_i = 1) = \frac{1}{1 + e^{-g(x)}}$$

Where: g(x) = -1.0532948-0.0215132 x (Age)+0.5584534 x (EAP_2)

+0.2105292 x (Class_CB2015_1)+0.2379410 x (Class_CB2015_2)

+0.3481345 x (Class_CB2015_3)+0.4283330 x (Level_Education_2_1)

+0.9302344 x (Level_Education_2_1)+1.1445511 x (Level_Education_2_3)

+0.4207865 x (C5_Devices_2)+1.0915803 x (C5_Devices_3)

+1.0552418 x (H2)-0.0060700 x (Family_Income_1)

+0.1893167 x (Family_Income_2)+0.4414333 x (Family_Income_3)

+0.3680310 x (Family_Income_4)+0.4954595 x (Family_Income_5)

+0.4227457 x (Family_Income_6)+0.3334971 x (Family_Income_7)

+0.0349981 x (Family_Income_8)

As previously described in the methodology section, the performance of the logistic regression model applied was evaluated by preparing the confusion matrix. The results are shown in Table 3.

The analysis indicated that the model presents an adjusted response with an acceptable level of accuracy, as can be observed by the results of the Accuracy and F-score indicators presented in Table 4.

Table 3
Confusion matrix results

	Actual observations		
Values predicted by the model	G1_Agg = 0 (No)	G1_Agg = 1 (Yes)	Line total
Estimated result = 0 (No)	2196	1198	3394
Estimated result = 1 (Yes)	1966	6421	8387
Column total	**4162**	**7619**	**11781**

Source: Elaborated by the authors.

Table 4
Results of the model's performance indicators

Indicators	Result
Accuracy	0.7314
F-score (F1)	0.8023
Recall	0.8428
Precision	0.7656

Source: Elaborated by the authors.

In summary, the logistic regression model presented a satisfactory response regarding estimating the decision of an individual to use or not e-government services, confirming the hypothesis of association between the dependent variable and the explanatory variables chosen.

DISCUSSION

The results of the analysis indicate that there is a significant influence depending on age, family income, work situation, economic class, level of education, type of access device, and use of e-commerce services on the probability of using e-government services. On the other hand, there is no significant influence depending on gender, type of area (urban or rural), and geographic region.

The preliminary statistical tests and analyses serve to confirm which variables should be considered in the logistic regression model. Thus, the low correlation between the variables that represented gender, type of area (urban or rural), and geographic region led to the conclusion that they should be excluded. E-government services are for any citizen, regardless of gender.

The profile of the respondents who indicated that they used e-government services, and those who indicated that they did not, did not show significant differences in relation to their geographic region. As for the type of household area, whether urban or rural, although the percentage of users in rural areas is lower than that of users in urban areas, the number of observations from the respondents to the survey in an urban area is much greater than the number of observations from respondents in rural areas. This bias implies in a low correlation between this variable and the dependent variable. In theory, the availability of Internet access infrastructure in rural areas is lower than in urban areas, which would lead to the understanding that this would be a relevant factor for the analysis. However, the high concentration of observations in urban areas did not allow such a condition to be verified.

According to the study, younger users are more likely to use e-government services. This may be related to stronger skills of young people in dealing with technological resources.

Being part of the working population has a positive impact on the likelihood of using e-government services. This result may be related to the fact, for example, that active workers use services provided by the Brazilian government, such as electronic filling of income tax adjustments, which would be different from those who do not have an occupation.

As for family income, individuals in the higher income ranges present a higher probability of using e-government services. The same is observed in relation to the economic class and the level of education. In thesis, income, economic class, and level of education are associated, indicating that a higher income is associated with a higher level of education, implying in a higher economic class. Individuals in higher economic classes have more access to computers, cell phones, and to the Internet, while tending to have more ability to use digital services.

The correlation between being a user of e-commerce and e-government services can be explained by the similarity between the conditions for access to the two types of service, such as devices and skills for use.

Finally, the model points out that adopting the cell phone as an access device, whether solely or in conjunction with the computer, has a very significant impact on the likelihood of using e-government services. The hypothesis is that there is greater awareness and ease of use of digital services via mobile applications.

Therefore, we can understand that the demand for e-government services will increase as there are investments in education, employment, and income of the population in an attempt to equate the economic conditions of rural areas with those of urban areas and improve the quality of access to the Internet via cell phone.

FINAL CONSIDERATIONS

The present study aimed to evaluate whether sociodemographic factors have an influence on the decision of using e-government services by Brazilian citizens. In order to achieve this objective, a quantitative approach was adopted based on the 2019 ICT Household survey carried out by Cetic.br. The methodology applied for carrying out the analysis was based on the logistic regression model considering the behavior of the dependent variable that assumes only 2 specific positions, which makes it a binary variable (Hair et al., 2009).

The results obtained by analyzing the data and the logistic regression model applied demonstrate that the sociodemographic conditions have an influence on the decision to use e-government services. According to the initial hypothesis, questions such as level of education, level of income, age, etc. have a significant influence on the choice of the citizen to use e-government services or not.

The present study fulfills its objective of contributing to the academic literature with a quantitative approach, which tests the dependence on using e-government services in relation to the contextual and sociodemographic conditions, based on a logistic regression model. Additionally, it reinforces the necessity to consider contextual and sociodemographic variables in the models for analyzing technology adoption by governments.

In this context the public managers responsible for the strategy for applying ICT and consequently for developing e-government programs should take into account these sociodemographic characteristics for creating public policies. Similarly, it is important to consider the sociodemographic differences in evaluating the results from the programs implemented. The success in accepting a particular e-government service depends not only on the intrinsic technical characteristics of the service, but also on the sociodemographic characteristics that define the profile of the target public or the standard profile of the citizen who will be the user of this service.

It is recommended that future studies consider a new analysis that includes a larger number of observations from the rural area in order to test the hypothesis that the sociodemographic variable regarding the type of household area has an influence on using e-government services. Additionally, considering that the dependent variable chosen represents a consolidation of 29 questions from the ICT Household survey related to the profile of using e-government services, a more specific analysis is recommended as proposed for future studies based on some types of service or specific usage characteristics. The results of this analysis can also be compared with similar results in different countries.

As a final but not exhaustive recommendation, this study can be expanded considering the analysis of the microdata from the ICT Household survey based on using the theoretical framework from the field of information systems theories, thus building a conceptual model of analysis that incorporate sociodemographic factors that have an influence on using e-government services.

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Luiz Claudio Mendes Vargas
ORCID: https://orcid.org/0000-0002-9410-7153
Doctoral student in Administration at COPPEAD from the Federal University of Rio de Janeiro (UFRJ). E-mail: luiz.vargas@coppead.ufrj.br

Marie Anne Macadar
ORCID: https://orcid.org/0000-0003-2744-5352
Doctor in Administration and Professor at COPPEAD from the Federal University of Rio de Janeiro (UFRJ). E-mail: marie.macadar@coppead.ufrj.br

Peter Fernandes Wanke
ORCID: https://orcid.org/0000-0003-1395-8907
Doctor in Production Engineering and Professor at COPPEAD from the Federal University of Rio de Janeiro (UFRJ). E-mail: peter@coppead.ufrj.br

Jorge Junio Moreira Antunes
ORCID: https://orcid.org/0000-0003-3199-5912
Mechanical Engineer and Researcher at COPPEAD from the Federal University of Rio de Janeiro (UFRJ). E-mail: jorge.moreira@coppead.ufrj.br