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Logistic Model Usage Factors Apps to University Students

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ABSTRACT: In the age digitalized information and technology its show a phenomenon that the applications new technologies with young generate dependence to dispositive, in special the mobile application and smartphones it is are grate tools to process management academic in the higher education institutions. Is intends develop the logit econometric model to determine the probability of using the necessary information tools in an academic App for university students. The study determines five (4) information factors required by students to consider them of quality. The results show that the factors identified are associated with information from academic administrative processes, academic information, interactive connectivity and other general ones. It concludes that observed factors that the prevalence Odds Ratio (OR) of using an App with the tools contained in the factors is twice for each one that does not use it.

KEYWORDS: Computer applications, probability theory, college students, mobile phones, logit, odds ratio, communication statistics, educational management.

INTRODUCTION

The development of technology has allowed the process of industrialization 4.0 to pave the way for ICTs to position themselves in everyday life, making mobile devices play an important role in the modus vivendi activities of people in their work and their family life (ForceManager, 2020; Peralta et al, 2020; trejos-Gil et al., 2024; Trejos-Gil y Castro-Escobar, 2020; Martín, 2015;) where employers consider that the use of mobile phones or smartphones helps to improve labor productivity (Trejos-Gil et al., 2024; Trejos-Gil , 2020) and has become an indispensable element in the lives of adolescents (Ruiz, et al, 2015). The use of mobile devices has permeated all spheres of people's daily life and even more so in the presence of the COVID-19 pandemic crisis, decreed worldwide and that to date the crisis continues (OMS, 2020) it forced people into a total quarantine leading to a recession in the economy and the labour market.

The market presented a resilience through innovation that allows it to implement strategies to offer real and official information to its stakeholders (IMF, 2020; Contreras et al, 2019). The education sector also presents the backlash of decisions to control the spread of the COVID-19 pandemic (Trejos-Gil, 2024; Trejos-Gil y Castro-Escobar, 2020) and its teaching-learning process was reinvented by moving to a virtual modality pedagogy through academic platforms and the use of mobile, table and computer technologies (Cifuentes, 2020; Dialogo Interamericano, 2020; Oliva, 2020; Sanabria, 2020; Trejos-Gil, 2024) in the presence of the pandemic.

University students in their academic work require tools or utilities of Apps for use on mobiles that are efficient allowing access to information in real time and reliable so that the use of mobile devices in educational environments has a positive impact depending on the feedback that the student must have of the information necessary for its management (Figueras et al, 2018; Hernandez, 2017; Trejos-Gil, 2024).

Academic institutions in their resilience process of adaptation in their virtual platforms have implemented App tools for mobile devices that meet the needs of university students with quality (Baxter y Parrado, 2020; Palacios, 2020; Trejos-Gil y Castro -Escobar, 2020; Velásquez, 2020) that increase power, functionality, efficiency and affordability (Basrantes et al, 2017). As mentioned by Trejos-Gil et. al (2020) "University Apps generally provide an audiovisual service to their students seeking to offer specific services for radio, TV and podcast." University students consider that the mobile phone can be characterized by its autonomy, identity and prestige, technological applications, leisure activity and establishment of interpersonal relationships (Ruiz, et al., 2020), in addition to services that are interactive such as scenarios, personal, roles among many others such as reviewing bank balances, consulting social networks, watching short videos, making calls, reading news, playing online and taking photos (Deloitte, 2020; Giraldo, 2019; Trejos-Gil, 2024).

Student users of mobile devices and Apps, such as computer applications (Gil, 2013), of educational institutions have generated a digital society together with the generation of knowledge and the advent of digitalization of social relationships (Riviera-Vargas, 2018; Hernández, 2017; Trejos-Gil, 2024; Trejos-Gil et al., 2023) or information society that offers the implementation of cutting-edge technologies for young people that pose new dynamics for being in a connected world that has demonstrated its resilience to the crisis of the COVID-19 pandemic (Digital, 2019; Trejos-Gil et al., 2023).

In the adaptation process that educational institutions must carry out on their mobile platforms to satisfy the information needs of their students, in their university life that promotes active and interactive learning, and not only to transfer the face-to-face model to virtual presence (Gisbert, 2020; Trejos-Gil, 2024).

The Apps of educational institutions offer students personalized information that improves their perception of the educational institution. The Apps must record as much information as possible regarding schedules, admissions, news, events, among others oriented and related to university life, reaching each student in a personalized way (Meriño et al, 2020; Trejos-Gil et al., 2020) that provides improvements to institutional processes, administrative, academic and cultural (Tinoco y Tinoc, 2018). The transmission of academic information has been reinvented by the effect of the COVID-19 pandemic, generating the need for new mobile platforms that contain robust information to streamline processes by stakeholders in the institutional community that can be used quickly and easily from any geographical location without having to travel to academic offices (Espinoza et al,2018; Chavira y Arredondo, 2016; Trejos-Gil et al., 2020).

University Apps cannot be alien to the "mobile" era (Barquero, 2016) that requires information from various components such as university academic information, enrollment, schedule, grades, courses, teachers, mail, notifications, Wi-Fi, internet, location virtual, interactive connection, library, consultancies, events, photos, dates and calendar, cell phone varieties among others such as payments, chat, sharing and deleting articles among others (Trejos-Gil et al., 2020; Romero, 2018).

Thus, the question arises, ¿what are the information elements that an academic Apps must have to satisfy the information needs demanded by university students? This research aims to build a nested logistic model that allows identifying and relating the information utilities that an academic Apps must have to satisfy the needs of students from various components such as work tools (Briz et al., 2015 Trejos-Gil et al., 2020; Trejos-Gil, 2024) that provide the characteristics of ubiquity, informative personalization and participation (González, 2012; Trejos-Gil et al., 2023) associated with the immediacy of information (Reese, 2013) as determining elements in a university Apps application.

METHOD

The research is based on a quantitative descriptive correlational explanatory approach as mentioned by Cadena et al., (2017); Hernández et al, (2014); They seek to quantify the probability of using Academic Apps due to the information provided through them. A field work was carried out in the application of a questionnaire sent by mail to university students. With a confidence of 90% and an estimation error of 5%, 151 students were selected, representing 80% of the expected successes.

Each student, when making a certain demand for academic information, involves a series of factors that condition the final alternative required and the existence of information restrictions offered by the university Apps, determining the degree of satisfaction with the services offered by the institution (Merino, 2017). This guided the way to pigeonhole research on determining what information tools a university Apps should contain to meet the needs of students.

The construction of the mental scheme of the construction of a university App is structured in four (4) factors that host different aspects of information that students believe are necessary. It begins with the assumption that students use a mobile to connect to their social networks and that this mobile has Apps for their daily use installed initially (Trejos-Gil et al., 2020). The information elements for which it was questioned were grouped into four (4) factors as shown in Figure 1.

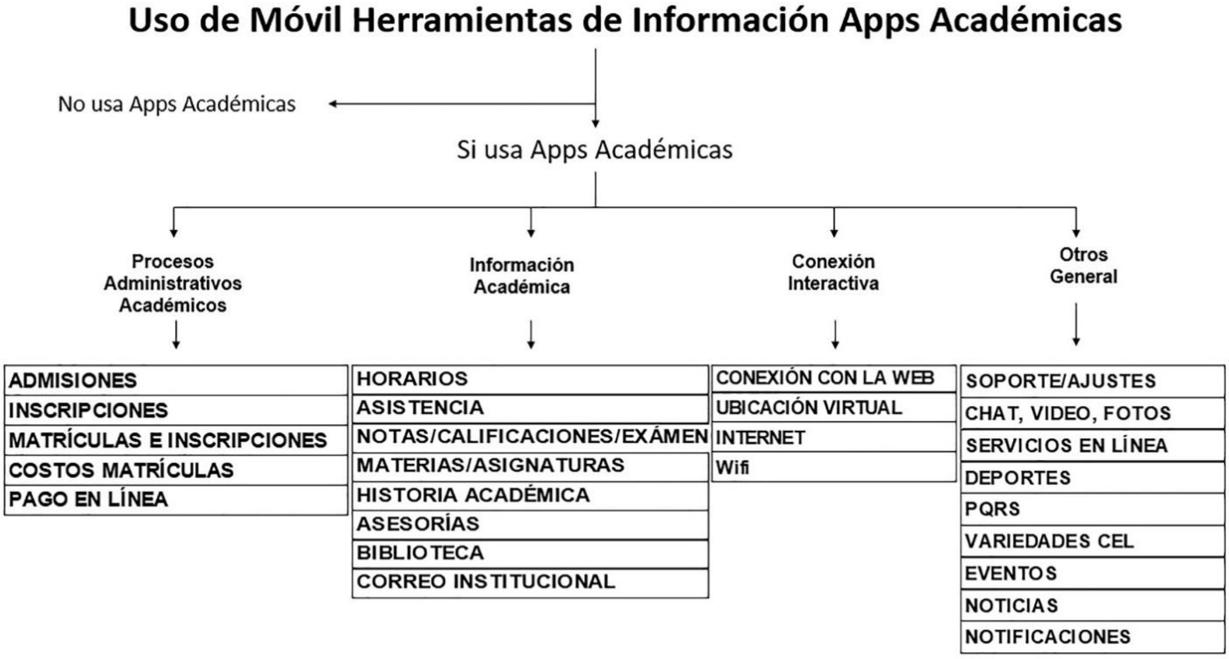


Figure 1. Structure of the modeling.

The student in the use of mobile phones has the possibility of using Apps or does not use university Apps, it is possible that they mentally structure a sequential process of choice, first they decide between not using Apps or using Apps and if they opt for the second alternative, they decide which Apps will be used to acquire the information according to six (4) factors (F) of use such as F1: Academic Administrative Processes, F2: Academic Information, F3: Interactive Connection, F4: Other General. Each factor is structured by various topics of information tools for use by the App that are associated with the possibility of using the App, which presents a total of m types of information required.

Factor F1: Academic Administrative Processes is made up of information tools on admissions, enrollment, enrollment, enrollment costs, online payment; factor F2: it consists of information on schedules, attendance, grades, subjects-courses, academic history, consultancies, library and institutional mail. Factor F3: Interactive Connection is information about the connection to the web, the virtual location and the Internet. The F5 factor: Other General is made up of support / settings, chat / video / photos, online service, sports, questions, complaints, claims and suggestions (PQRS) and varieties, see figure 1.

In the conformation of the factors to determine the use or non-use of the information elements in the Apps, the responses of 1 were added, which means use of the element, as well as of the students who use information elements at most the total sum minus 1 They were rated 1.

It is $\{HI_i\}\ \forall i = 1,2,3,\ldots,22$ the information tools or information elements for use in an academic App; $\{F1{:}\,PAA_i\}\ \forall i = 1,2,\ldots,5$ the information tools for the Academic Administrative Processes Factor (PAA); $\{F2{:}\,IA_i\}\ \forall i = 1,2,3,\ldots,8$ the information tools for the Academic Information Factor (IA); $\{F3{:}\,CI_i\}\ \forall i = 1,2,\ldots,4$ the tools information for the Interactive Connectivity Factor (IC) and $\{F4{:}\,OG_i\}\ \forall i = 1,2,3,\ldots,9$ the information tools for the General Other Factor (OG).

Now, we take the total of the categories 1 we proceed to perform a logic that qualifies as one the use of at most the total sum minus 1 as shown in equation 1

$$Use\ Information = \begin{cases} 0 & if\ at\ least\ 1\ does\ not\ use \\ 1 & if\ at\ least\ \sum Total - 1\ use \end{cases} \qquad (1)$$

The logit model allows obtaining estimates of the probability of the event of the use of useful applications / services on the mobile device, also identifies the risk factors that determine the probabilities associated with the influence or relative weight that the factors have on the use of services in the mobile device.

The use of binary choice models within econometric models is applied in various scientific scenarios (Dávila et al, 2012, p.4) within which the logistic regression model is set, which allows establishing the importance of the tools. of Mobile Use (UM) in cellular devices (Trejos-Gil et al., 2020). The logit model allows estimating an index whose determinants make it possible to classify each of the Mobile Use tools within the applications that can be used by students (Hannon, 2017).

Apps as tools for academic use can be used to give immediate feedback to students (Conference y Conference, 2008) and facilitate their involvement in academic administrative processes, generating efficiency in the use of information through augmented reality (Bower et al, 2014).

Logistic Model Usage Factors Apps to University Students

The logistic model is a multivariate model with a higher degree of use (Canela, 2012) to determine the probability of occurrence of an event that has two possible responses based on one or more categorical and / or quantitative variables (López-Roldán y Fachelli, 2016). The predictor variable of dichotomous nature under study is qualitative with results of Yes or No and that are mutually exclusive. The probability of occurrence of the event is a metric or index that shows how likely it is that the event will occur. (De la Fuente, 2011). The logit model is a non-linear estimate where the returned variable is dichotomous or binary or dummy with values of 0 when there is no presence of the event and 1 when there is presence of the event (Hernández, 2020). The categorical indicator variable called Mobile Usage (UM) is described as shown in equation 2,

$$Dummy = \begin{cases} 0 \; The\ event\ is\ not\ presented \\ 1 \; yes\ the\ event\ is\ presented \end{cases} \quad (2)$$

$$UM = \begin{cases} Mobile\ use\ is\ presented \\ No\ Mobile\ use\ presented \end{cases}$$

The logistic modeling focuses on the treatment of the analysis of crossovers of qualitative variables with reference to contingency tables with log-linear models and the analysis of the estimates by the Ordinary Least Squares (OLS) method (López-Roldán y Fachelli, 2016; Gujarati, 2014). The objective of the logistic estimation is to predict membership in the Mobile Use group from a dichotomous dependent variable explained by several qualitative variables (Hidalgo, 2018). It is about identifying which information tools for use in the Apps are required by students in their need for academic information or another variant (Trejos-Gil et al., 2020).

Logistic model

The binary response logistic regression model for the use of information tools in mobile apps (UMHI) considers two possible results of the event of the presence of the information tool in UM, which are exclusive and exhaustive and are represented by the values of 0 and 1, as shown in equation 3.

$$UMHI = \begin{cases} 1 \text{ yes used of information tool} \\ 0 \text{ No used of information tool} \end{cases}$$

or (3)

$$\text{UMHI} = \begin{cases} 1 \text{ SUHI} \\ 0 \text{ NUHI} \end{cases}$$

Then, the probability that the Use of Information Tools (SUHI) event occurs will be $\boldsymbol{\pi}$, and the probability of the Non-Use of Information Tool (NUHI) occurring is equal to 1 minus the probability of SUHI, as observed in equation 4. The factors are constructed with the sum of the values 1 in the information elements,

$$\Pr(SUHI = 1) = \pi$$
$$\Pr(NUHI = 0) = 1 - \pi \quad (4)$$

The objective is to determine the Information Tools required by students in their academic work by estimating the probability of the dependent variable UMHI (López-Roldán y Fachelli, 2016) In other words, it is to determine the set of independent variables, defined as information tools for the use of students, that efficiently discriminate between the two possible outcomes of the UHMI variable, as shown in equation 5,

$$\Pr\left(SUHI = {}^{1}/_{X_j}\right) = \frac{1}{1 + e^{-(\beta_0 + \sum \beta_j X_{ij})}} + \varepsilon_i = \pi$$
$$\Pr\left(NUHI = {}^{0}/_{X_j}\right) = 1 - \left(\frac{1}{1 + e^{-(\beta_0 + \sum \beta_j X_{ij})}} + \varepsilon_i\right) = 1 - \pi \quad (5)$$

Where $X_{ij}\ \ con\ \ \forall i = 1,2,3, \dots, n\ y\ j = 1,2,3, \dots m$ are the independent variables that represent the Use of the Information Tools that they describe as dichotomous variables and β_j are the rates of change that will determine the relationship between the dependent variable UMHI explained by the independent variables of the information tools according to the interest of receiving relevant information in the right time (Acevedo y Mora, 2017), it also measures the slope, the change in the presence of the event caused by a unitary change in the uses of tools and ε_i they are distributed independently and normally as a binomial variable as shown in equation 6.

$$\varepsilon_i \sim NIID\left(0, \frac{1}{n_i\pi(1-\pi)}\right)$$

(6)

That is, the residuals of the model are normally distributed with zero mean and homoscedastic variance (Gujarati, 2014). The relationship between the *logit* probability and the function that forms a sigmoid or -S function. In general, a sigmoid function is a real function of a differentiable real variable of the form *logit*, that when the limit of the variable tends to minus infinity the function is zero and when the limit of the function has plus infinity it is one, as shown in shows in equation 7,

$$\lim_{x\to-\infty} \frac{1}{1+e^{-(\beta_0+\sum\beta_jX_{ij})}} = 0$$
$$\lim_{x\to+\infty} \frac{1}{1+e^{-(\beta_0+\sum\beta_jX_{ij})}} = 1$$

(7)

As shown in figure 2,

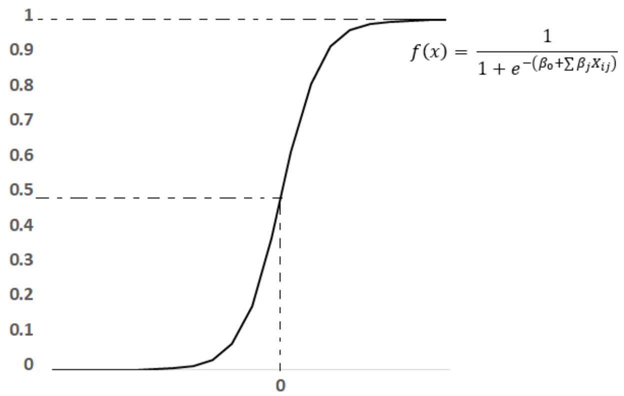


Figura 2. Logit Funtion sigmoide

The model can be expressed in terms of probability as shown in equation 8 and 9

$$ln\frac{\pi}{1-\pi} = e^{\beta_0+\sum\beta_jX_{ij}} = logit \quad (8)$$

$$ln\left[\frac{\frac{1}{1+e^{-(\beta_0+\sum\beta_jX_{ij})}}}{\frac{e^{-(\beta_0+\sum\beta_jX_{ij})}}{1+e^{-(\beta_0+\sum\beta_jX_{ij})}}}\right] = ln\left[\frac{1}{e^{-(\beta_0+\sum\beta_jX_{ij})}}\right] = \beta_0 + \sum_{j=1}^{m}\beta_jX_{ij} \quad (9)$$

Therefore, it can be shown that the expectation of the event occurring is a linear model that meets all the assumptions of the unbiased linear stochastic models of minimum variance-MELI-MV, which is why it is shown that the transformation has a linear model (Green, 2012). Therefore, the expectation of SUHI occurring is described in equation 10,

$$E\left[{}^{UMHI_i}\!/_{X_j}\right] = Pr\left({}^{SUHI\,=\,1}\!/_{X_j}\right) * 1 + Pr\left({}^{SUHI\,=\,0}\!/_{X_j}\right) * 0$$
$$E\left[{}^{UMHI_i}\!/_{X_j}\right] = \frac{1}{1+e^{-(\beta_0+\sum\beta_jX_{ij})}} + \varepsilon_i * 1 + 1 - \left(\frac{1}{1+e^{-(\beta_0+\sum\beta_jX_{ij})}} + \varepsilon_i\right) * 0$$
$$E\left[{}^{UMHI_i}\!/_{X_j}\right] = \pi * 1 + 1 - (\pi) * 0 = \pi$$

With

$$\pi = \beta_0 + \sum_{j=1}^{m}\beta_jX_{ij} \quad (10)$$
$$\pi = \beta_0 + \beta_1X_{i1}\beta_2X_{i2} + \beta_3X_{i3} + \cdots + \beta_mX_{im}$$

(10)

Logistic Model Usage Factors Apps to University Students

The ordinary squares methodology (OMS) that seeks to optimize the minimization of the volatilities of the residuals determines the estimated beta coefficients $\hat{\beta}_j$, which are presented as the variation of the *logit* model due to the variation of one unit in the variable X's (De la Fuente, 2011). The estimation of the nested model by full maximum likelihood allows obtaining values for all the regression coefficients simultaneously, maximizing the unconditional logarithmic likelihood function as shown in equation 11,

$$LnL = \sum_{i,c,j} UMHI_{i(cj)}\, lnP_{i(cj)} = \sum_{i,c,j} UMHI_{i(cj)}\, lnP_{i(cj)} + lnP_{i(cj)} \tag{11}$$

Where $P_{i(cj)}$ is the probability that student i chooses alternative cj and is obtained from the product between the probability that he chooses intermediate alternative c, $P_{i(cj)}$ and the conditional probability that he chooses once he has chosen c, $P_{i({}^{j}/_{c})}$ (Wooldridge, 2019). An important value when estimating the logit model is to calculate the ratio of the probability of using at least 1 tool for App and the probability of not using tools for App called Odds Ratio (OR) (Cerda, Vera y Rada, 2013) and which represents The incidence rate of students who use information tools over those who do not use, measures the strength of association between exposure to use and not to use (Tamaro et al, 2019). The probability OR is shown in equation 12 and figure 3,

$$OR\left({}^{Odds(SUHI=1)}/_{Odds(NUHI=0)}\right) = \frac{\Pr\left({}^{SUHI=1}/_{X_j}\right)}{1-\Pr\left({}^{SUHI=1}/_{X_j}\right)}$$

ó

$$OR = \frac{Odds(\mathrm{SUHI})}{Odds\,(\mathrm{NUHI})} = e^{\beta_1(SUHI-NUHI)} \tag{12}$$

namely,

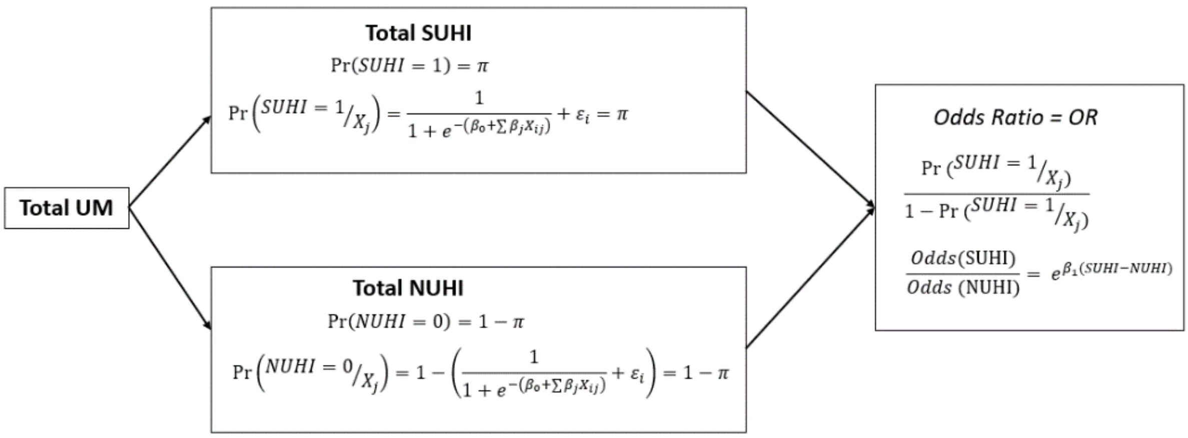


Figure 3. Concept of Odds Ratio

Source. by the authors

In the case of study of 151 students who gave their opinion about the use of information tools for academic Apps, it has been reached that the presence of the event of use of information tools is 117 of them. Therefore, by dividing the probability of using information tools by the probability of not using information tools for mobile academic apps, the OR-Odds Ratio is found with is shown in equation 13,

$$OR\left({}^{Odds(SUHI=1)}/_{Odds(NUHI=0)}\right) = \frac{\Pr\left({}^{SUHI=1}/_{X_j}\right)}{1-\Pr\left({}^{SUHI=1}/_{X_j}\right)}$$

$$OR\left({}^{Odds(SUHI=1)}/_{Odds(NUHI=0)}\right) = \frac{{}^{117}/_{151}}{1-{}^{117}/_{151}} = \frac{{}^{117}/_{151}}{{}^{34}/_{151}}$$

Logistic Model Usage Factors Apps to University Students

$$OR\left({}^{Odds(SUHI=1)}\Big/_{Odds(NUHI=0)}\right)=\frac{117}{34}$$

$$OR\left({}^{Odds(SUHI=1)}\Big/_{Odds(NUHI=0)}\right)=3{,}441 \quad (13)$$

The Odds of using information tools in academic Apps is obtained, which would be worth 3.4, that is, for each student in which the success of the use of information tools was not achieved, there are 3 in which it was achieved, that is, with use of academic information in academic Apps the probability of success is 3 times higher than that of not using information tools in Academic Apps (Aedo et al, 2010).

RESULTS

The field work was carried out in a random sample of 151 students selected with 95% confidence and an estimation error of 6%. Student participation is 20% (31) from Mexico, 15% (22) from Argentina, 36% (54) from Colombia and 29% (44) from Spain. 44% (66) of the students are from public universities and 56% (85) from private. 86.1% (130) of the students rate the Academic Apps with at least 4 stars. 39.3% of students use audiovisual media such as videos, 21.4% use radio, 10.7% use TV and 3.6% use Podcast, see figure 4.

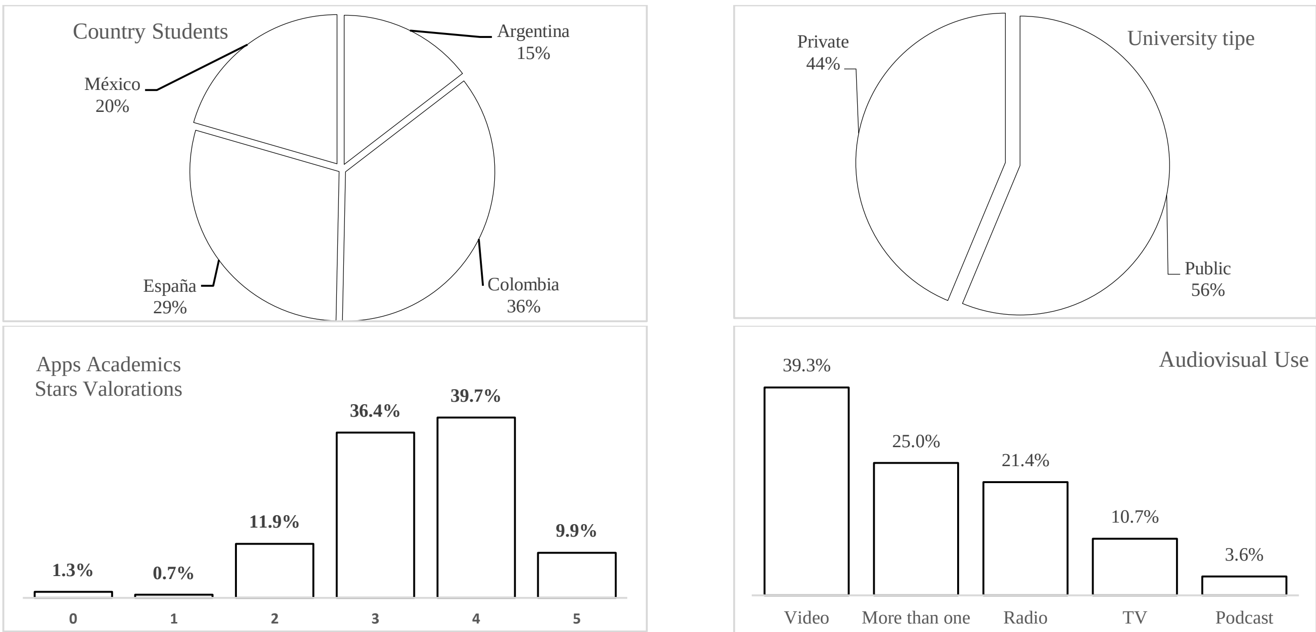


Figure 4. Student profile

Source: by the authors

Of the students of public universities, the social network they use the most is Facebook with 25.9% followed by Twitter with 24.7%, then 14.1% use Instagram and 11.8% use Twitter. In private universities, the social network they use the most is Instagram with 28.8%, followed by Twitter with 16.7%.

The use of the different social media (SM) and the origin of the university are statistically associated with a 5% level of significance (P value = 0.010). Of the students who use Facebook, 25% are from a public university; of the students who use Instagram, 14.1% are from a public unit; 11.8% of those who use Twitter are from public universities, see figure 5.

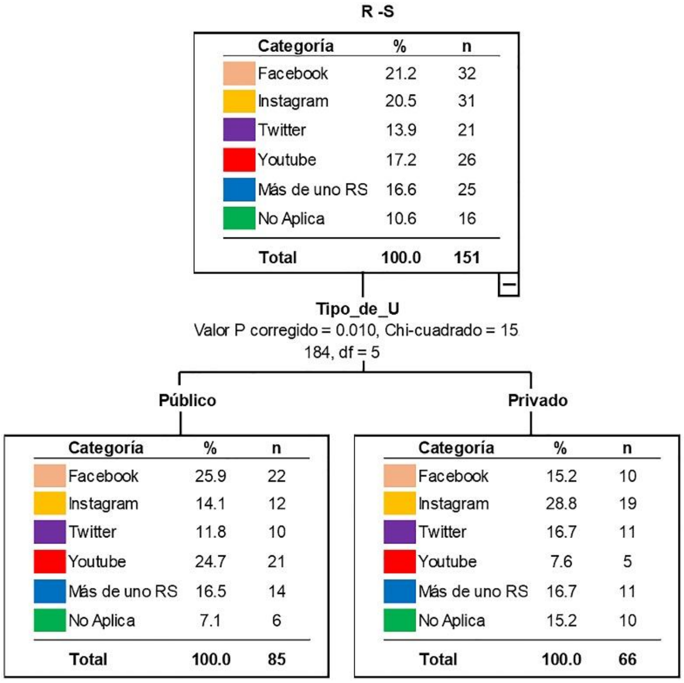
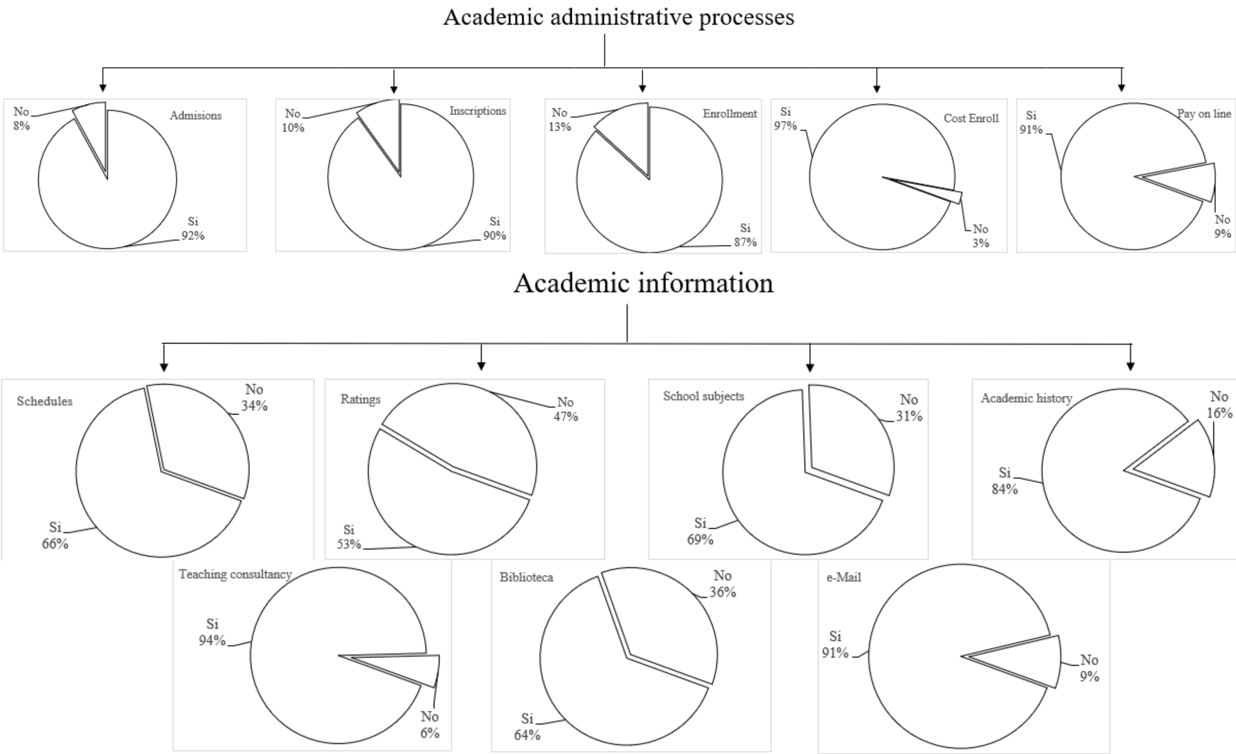


Figure 5. Relationship between the use of types of social networks Vs. Type of university

The chi square that measures the degree of association between the use of different social networks and the type of university.

University Apps present utilities for the use of students. For an Apps to be efficient and robust (Trejos-Gil et al., 2020) it must contain information regarding admissions, registrations, registration process, registration costs, online payment, web connection, events, schedules, attendance, notes and grades, subjects-courses-subjects, academic history, mail, employability notifications, sports, consultancies among others such as PQRS, see figure 6.

It is observed that on average 80% of university Apps have the information tools described above. Of the Apps analyzed, they have information on admissions, enrollment, enrollment, cost of tuition and online payment with a percentage of 92%, 90%, 87%, 97% and 91% respectively.



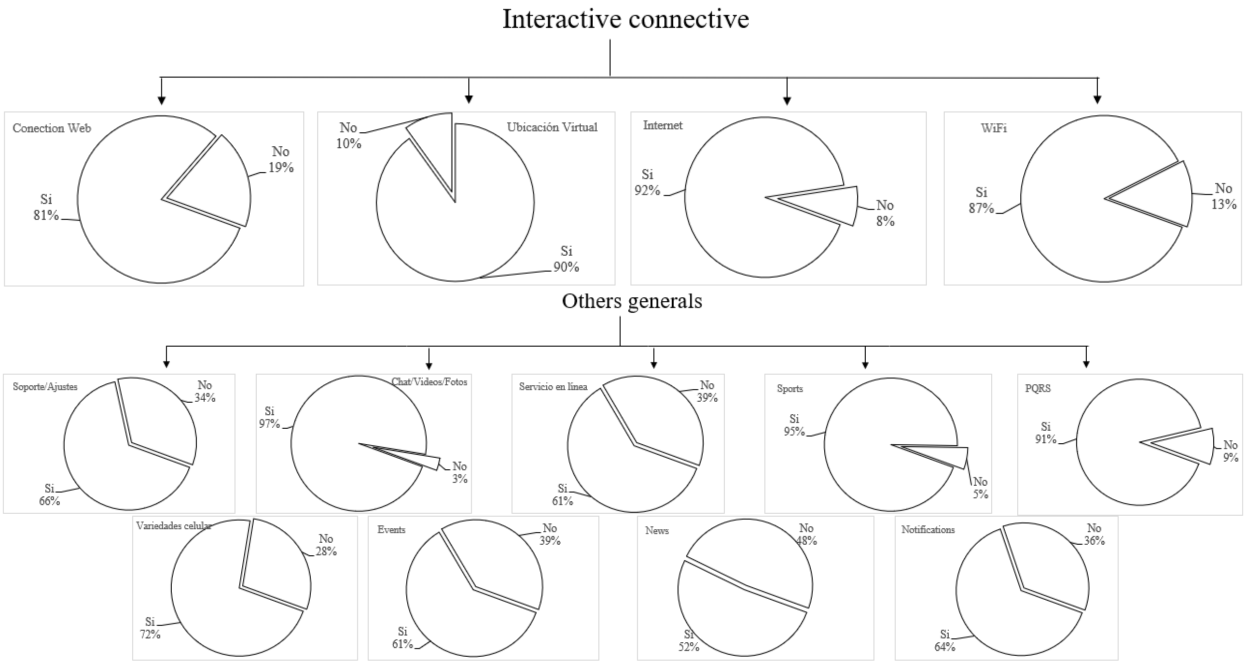


Figure 6. Utilities in the Apps

Source: prepared by the authors. The participation of the utilities in the University Apps is described

The Apps have a web connection with 81%, events with 61%, schedules with 66%, grades with 53% and subjects or subjects with 69%. And other utilities that appear in the Apps are academic history, mail, notifications, employability, sports, consultancies, PQRS among others in an average of 81%.

Logit modeling

The study was based on a quantitative descriptive correlational explanatory approach (Hernández et al, 2014) between the probability of use of mobile information tools Academic Apps (UAppsA), as a dependent variable, on the factors of Academic Administrative Processes (PAA), Information Academic (IA), Interactive Connectivity (CI) and Others in General (OG). The variables are dichotomous conformed as follows,

$$\text{UAppsA} = \begin{cases} 0 \; Not\ used \\ 1 \; Yes\ Use \end{cases}$$

$$PAA = \begin{cases} 0 \; Not\ used \\ 1 \; Yes\ Use \end{cases}$$

$$\text{IA} = \begin{cases} 0 \; Not\ used \\ 1 \; Yes\ Use \end{cases}$$

$$\text{CI} = \begin{cases} 0 \; Not\ used \\ 1 \; Yes\ Use \end{cases}$$

$$\text{OG} = \begin{cases} 0 \; Not\ used \\ 1 \; Yes\ Use \end{cases}$$

To validate the significance of the factors that explain the probability that an academic App is of quality, a questionnaire was used as an instrument to collect the opinions of 151 university students on aspects of the information necessary to satisfy their need for university information. The procedure for applying the questionnaires was via email. The applied questionnaire must indicate that the scales that were applied to measure the variables have the psychometric properties of validity and reliability (Frías, 2020). The validity of the instrument considers that the variability of the responses is due to a true total variance of the use of Academic Apps with respect to the variance of the students' responses (Milton, 2010) as shown by equation 14,

$$\sigma_T^2 / \sigma_X^2 \tag{14}$$

Thus, the reliability of the instrument is estimated with Cronbach's alpha coefficient (Frías, 2020), which considers that the factors in the dichotomous scale and that are correlated, allowing to quantify the probability of uses of Academic Apps. Cronbach's alpha coefficient (Frías, 2020) determines the proportion of variance of the questionnaire caused by the common factors between them. The Cronbach's alpha test takes values between 0 and 1, and values greater than 0.70, the hypothesis of the presence of association between the factors is accepted is equation 15,

$$\propto = \frac{\delta}{\delta - 1}\left[1 - \frac{\sum_{i=1}^{m}\sigma_i^2}{\sigma_T^2}\right] \tag{15}$$

Where $\propto = \{0 < \propto < 1\}$is the value of the Cronbach test δ, it is the number of ítems σ_i^2, it is the variance of each factor and σ_T^2 it is the total variance. The six (6) factors add up to a total of 26 information tools for use in University Apps and each one with dichotomous registration. The estimated Cronbach alpha reliability statistic is 0.843, which indicates that the items are highly correlated (Leite y De Castro, 2020; Núñez, 2018).

To validate the null hypothesis, $H_0 = \mu_{P_1} = \mu_{P_2} = \cdots = \mu_{P_{26}}$, where are the proportional means of each item of the questionnaire, $\mu_{P_j}\ \forall j = 1,2,3, \ldots ,26$ of equality of the proportional means against the alternative of at least one μ_{P_j} is different from the rest of the others, the Tukey test (Núñez, 2018) is applied, which performs an ANOVA analysis to compare the estimated quadratic residuals between the factors on the quadratic residuals of the residuals, such as equation 14, such that $F_{est} \geq f_{(glfactor,glerror)}$ rejects the null hypothesis or if the probability of the Tukey statistic is less than or equal to 5% of the significance level (Núñez, 2018; Wooldridge, 2019) given by equation 16 see table 1.

$$F_{est} = \frac{\sigma_{factores}^2}{\sigma_{errores}^2} = \frac{t\sum_{j=1}^{b}\left(\bar{Y}_{.j} - \bar{Y}_{..}\right)^3}{\sum_{i=1}^{t}\sum_{j=1}^{b}\left[Y_{ij} - \bar{Y}_{i.} - \bar{Y}_{.j} - \bar{Y}_{..}\right]^2} \tag{16}$$

Table 1. Cronbach's alpha coefficient Reliability statistics

Alpha de Cronbach	**N elements**
.843	26
Tukey Estatistic	Pr(Tukey) =0,744

The probability of the Tukey test (0.744) is higher than the 0.05 of statistical significance. That is, it is considered with 95% confidence that the items of the instrument present little variability between them and within them, the null hypothesis of equality of the proportional means of the items of the questionnaire can be accepted, see table 1.

The interest of the research is to estimate the probability that students use university Apps. With statistical significance it is validated that the factors that make up the information tools are not necessary for the probability of using an academic App. The explanatory model of the probability of using Academic Apps on the five (5) factors is shown in table 2,

In the estimation of the logit model, the maximum likelihood methodology is developed that does not establish any restriction regarding the characteristics of the predictor variables, these can be nominal based on Ordinary Least Squares (OLS), allowing the selection of the estimated coefficients that have the maximum likelihood that make it possible to minimize the viability of the model residuals.

The estimated model is an explanatory model where it is possible to estimate the probability of use of information tools in University Apps (UAppsA) on the PAA, IA, CI and OG factors that affect UAppsA output from SPSS v23® as shown in equation 17,

The probability of UAppsA is

$$\pi = \beta_0 + \sum_{j=1}^{4}\beta_j X_{ij} \tag{17}$$

Developing the summation as shown in equation 18,

$$\pi = \beta_0 + \beta_1 PAA + \beta_2 IA + \beta_3 CI + \beta_4 OG$$

$$\pi = -0.544 + 0.722PAA + 0.735IA + 0.885CI - \ 0.650OG \tag{18}$$

And the estimated output model in SPSS v23®, is replaced in equation 19, see table 2.

$$\Pr\left({}^{UAppsA\, =\, 1}\!\big/_{X_j}\right) = \frac{1}{1 + e^{-(-0.544 + 0.722PAA_i + 0.735IA_i + 0.885CI_i - 0.650OG_i)}} \tag{19}$$

Logistic Model Usage Factors Apps to University Students

The estimation of the coefficients of the logit model determines that the relationship between the responses to the use of UAppsA and the PAA, CI and OG factors is direct, and also the relationship with the IA factor is negatively related.

Table 2. Output of the estimation of the SPSS coefficients

	B	SE	Wald	gl	Sig.	Exp(B) Odds Ratio
PAA	.722	.352	4.209	1	.040	2.060
IA	.735	.372	3.902	1	.048	2.086
CI	.885	.357	6.139	1	.013	2.422
OG	-.650	.354	3.375	1	.066	.522
Constante	-.544	.375	2.104	1	.147	.580

The estimation of the coefficients of PPA, IA, CI and OG, with probabilities of the statistic of .40, .048, .013 and .066 respectively, are statistically significant at 5%), see table 2.

To validate the goodness of fit of the estimated logistic model, omnibus tests are used (Fernández y Salinas, 2017; Balló y Bernabé, 2015; López-Roldán y Fachelli, 2016) in which an alternative is not specified, with which it is desired to validate the hypothesis that the explained variance of the estimated logit model is greater than 1 as shown in equation 20,

$$H_{ipótesis}: \frac{Var(Explicada)}{Var(NoExplicada)} > 1$$

$$H_{ipótesis}: \frac{\hat{\sigma}^2_{\Pr\left(UAppsA=1/X_j\right)}}{\sigma^2_{\hat{\varepsilon}}} > 1 \qquad (20)$$

The validation that at least one estimated coefficient is different from zero is carried out using the chi-square with a value of 18.08 and with a significance of 0.001 the contrast is significant, it is concluded that with a 5% level of significance, the hypothesis that the explained variance is greater than the unexplained variance, so it is determined that UAppsA is explained by at least one factor, see table 3.

Table 3. Omnibus tests of model coefficients

	Chi-cuadrado	gl	Sig.
Paso	18.080	1	.001
Bloque	18.080	1	.001
Modelo	18.080	1	.001

The goodness of fit of the global model estimated using the Cox and Snell and Nagelkerke coefficient of determination statistics as shown in equations 21 and 22 respectively. These statistics compare the log of likelihood with the likelihood of the baseline model (García, 2016),

$$R^2_{Cox-Snell} = 1 - \left[\frac{-2LnL_{(nulo)}}{-2LnL_{(modelo)}}\right]^{2/n} \qquad (21)$$

$$R^2_{NegelKerke} = \frac{1 - \left[\frac{-2LnL_{(nulo)}}{-2LnL_{(modelo}}\right]^{2/n}}{1 - \left[-2LnL_{(modelo)}\right]^{2/n}} \qquad (22)$$

The results obtained from the Cox and Snell and Nagelkerke statistics of 0.113 and 0.151 respectively indicate that the goodness of fit of the logit model to estimate the dependent variable UAppsA (Use of Academic Apps) is explained by the factors as independent variables.

Table 4. Goodness-of-fit values

Passed	Logarithm of likelihood -2	Cox and Snell's R squared	Nagelkerke's R square
1	189.332[a]	.113	.151
Hosmer and Lemeshow test			
	Chi squared	gl	Sig.
1	4.794	8	0.779

Taking into account that it is a model with few variables and with items with a dichotomous register, only two results, and a sample size with few cases (n = 151), the Negelkerke statistic that corrects the scale to cover the range from 0 to 1 shows that the goodness of fit is 15.1% to determine the probability of Use of Academic Apps, so it is relatively good (García, 2016), and this is corroborated by the Mosmer-Lemeshow test with a value of 0.779, which implies that there is a confidence that 77.9% of the goodness of fit of the model, see table 4,

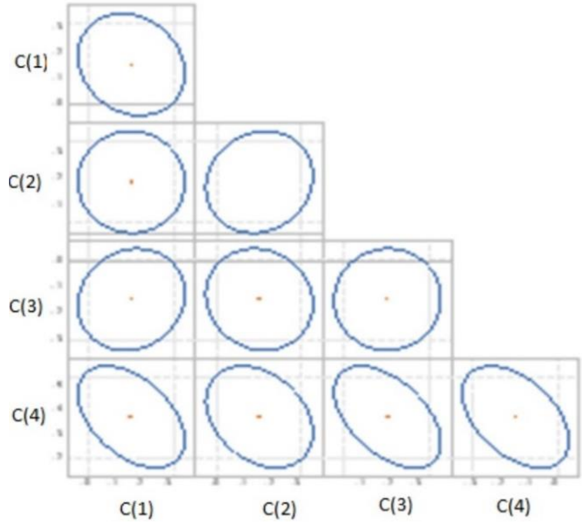


Figure 7. Relationship between the coefficients

The estimated coefficients of the logit model show that coefficient 5 is inversely related to coefficients 1, 2, 3 and 4 respectively. That is, as information elements are added to the Academic Apps, the factors of Academic Administrative Processes, Academic Information and Interactive Connectivity lose strength compared to their use, see figure 7.

Odds ratio

The Odds Ratio (OR) that shows the times that the probability of success of UAppsA on the probability of not success of UAppsA on each factor respectively, is calculated as shown in equation 14,

$$OR_j = e^{\beta_j}$$
$$OR_{PAA} = e^{\beta_{APP}} = e^{0.722} = 2.060$$
$$OR_{IA} = e^{\beta_{IA}} = e^{0.735} = 2.086$$
$$OR_{CI} = e^{\beta_{CI}} = e^{0.885} = 2.422$$
$$OR_{OG} = e^{\beta_{OG}} = e^{-0.650} = 0.522$$

If we have the PAA, IA and CI factors, we obtain an Odds Ratio of 2,060, 2,086 and 2.42 respectively of UAppsA, that is to say that for each student in whom the success of using information tools was not achieved, there are 2 in which it was achieved. That is, with the use of information on academic processes, academic information and interactive connectivity in academic Apps, the probability of success is 2 times greater than that of not using information tools in Academic Apps, see table 5

Table 5. Odds ratio

Factor	B	Exp(B) Odds Ratio
PAA	.722	2.060
IA	.735	2.086
CI	.885	2.422
OG	-.650	0.522
Constante	-.544	.580

Probability estimation example

If the AppsA has elements of all the factors, that is, PAA = 1, IA = 1, CI = 1 and OG = 1, the probability will be as shown in equation 23,

$$\Pr\left(UAppsA = 1 \middle/ X_j\right) = \frac{1}{1 + e^{-(-0.544+0.722(1)+0.735(1)+0.885(1)-0.650(1))}} \tag{23}$$

$$\Pr\left(UAppsA = 1 \middle/ X_j\right) = \frac{1}{1 + e^{-1.1480}}$$
$$\Pr\left(UAppsA = 1 \middle/ X_j\right) = \frac{1}{1 + 0.31727}$$
$$\Pr\left(UAppsA = 1 \middle/ X_j\right) = 0.7591$$

(23)

If the AppsA has elements of the 4 factors, there is a probability of 75.91% that Academic Apps will be efficient and of quality for the use of students.

DISCUSSION AND CONCLUSIONS

The use of the econometric methodology of the stochastic logit models to predict a dependent variable, such as the use of Academic Apps, of a qualitative categorical dichotomous type, with results of zero for the non-presence of the event and one for the presence of the event, as has carried out Ballón and Bernabé (2015), Salinas and Fernández (2017), Aedo et al., (2010) among many other authors; It is an option to determine the factors that an Academic Apps must contain to satisfy the information needs of university students is efficient. The study also talks with the one proposed by Trejos-Gil et al. (2020), that Apps in the academic field contribute to the improvement and management of the students' academic process.

It is concluded that the logit estimation offers advantages by not requiring the assumptions of normality and homoscedasticity of the data, especially those used in the dummy variables. Thus, in the development of the logit model, the maximum likelihood procedure is used to estimate the coefficients of the factors. The methodology presents the contribution of the estimated coefficients of each factor in estimating the probability of occurrence of the use of Academic Apps as a dependent variable.

The method uses several procedures to evaluate the goodness of fit of the model and also allows determining the Odds Ratio (OR) of the prevalence of the presence of the use of Academic Apps over the probability of non-presence of the use of Academic Apps by the students. university students. Finally, models are proposed for future studies to measure and identify key success factors for mobile applications in university settings and in other economic sectors of relevance to the academic population.

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