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Exploring Travelers' Characteristics Affecting their Intention to Shift to Bike-Sharing Systems due to a Sophisticated Mobile App †

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Abstract: Many cities have already installed bike-sharing systems for several years now, but especially in recent years with the rise of micro-mobility, many efforts are being made worldwide to improve the operation of these systems. Technology has an essential role to play in the success of micro-mobility schemes, including bike-sharing systems. In this paper, it is examined if a state-of-the-art mobile application (app) can contribute to increasing the usage levels of such a system. It is also seeking to identify groups of travelers, who are more likely to be affected by the sophisticated app. With this aim, a questionnaire survey was designed and addressed to the users of the bike-sharing system of the city of Thessaloniki, Greece, as well as to other residents of the city. Through a descriptive analysis, the most useful services that an app can provide are identified. Most importantly, two different types of predictive models (i.e., classification tree and binary logit model) were applied in order to identify groups of users who are more likely to shift to or to use the bike-sharing system due to the sophisticated app. The results of the two predictive models confirm that people of younger ages and those who are not currently users of the system are those most likely to be attracted to the system due to such an app. Other factors, such as car usage frequency, education, and income also appeared to have slight impact on travelers' intention to use the system more often due to the app.

Keywords: bike-sharing systems; mobile application (app); ICT; classification tree; binary logit

1. Introduction

In the last few years, there is a great debate about micro-mobility schemes, which are constantly gaining ground. It seems that these schemes have a great role in the transport systems of many cities around the world. One of the most popular and historic micro-mobility schemes is the bike-sharing systems, for which many different definitions have been used. According to the European Cyclists' Federation, a bike-sharing system is defined as "a self-service, short-term, one-way-capable bike rental offer in public spaces, for several target groups, with network characteristics" [1]. A more illustrative explanation is provided by Shaheen et al. (2016) who, among others, describe bike-sharing as a system where "users access bicycles on an as-needed basis for oneway (point-to-point) mobility and/or roundtrips" and also distinguishes two main bike-sharing categories, the station-based and the free-floating [2].

The first bike-sharing system operated in 1965 in the city of Amsterdam [3]. This system, which became known as "White Bikes" because of the color of the bicycles, failed extremely quickly due to the complete absence of rules. However, this system was the starting point for the development of many new systems, which by their characteristics are classified in the following four generations [3,4]:

- 1st generation, "Free Bike Systems" or "White Bikes": its name originates from the "White Bike system in Amsterdam. The failure of this generation is attributed to the vigorous phenomena of vandalism and theft, which are the result of complete anonymity and lack of surveillance.
- 2nd generation, "Coin-Deposit Systems": they owe their name to the fact that bike rental in this generation's systems was carried out through coin deposit in the stations. The coin was returned to the user after completing the rental. These systems firstly appeared in Danish cities in 1991 and the establishment of the Bycyklen system in Copenhagen was a landmark. As in the case of the first generation systems, the anonymity of the users resulted in frequent phenomena of vandalism and theft.
- 3rd generation, "Information Technology-Based Systems": through the utilization of information technology, it was sought to collect data about the rentals and the users. Bike-sharing systems launched smart cards or mobile phone applications, through which the rental process was being done. Advertising companies (Clear Channel, JCDecaux) had a significant contribution to the growth of such systems and the establishment of the Velo'v system in Lyon can be considered as an important milestone.
- 4th generation, "Demand Responsive, Multi-Modal Systems": the characteristics of this (current) generation are not clearly defined, but it is anticipated that the main attributes that will differentiate it from the third generation are the following: (a) integration with other sharing systems (e.g., car-sharing, scooter-sharing) and public transport, (b) further utilization of technology (e.g., usage of GPS devices for bicycle tracking, usage of electric-assist bicycles), (c) improved methods and algorithms for the re-distribution of bicycles, (d) flexible/mobile stations, which can be relocated according to the usage patterns or total absence of stations (dockless systems). It should be mentioned that the international experience has shown that specific regulations are needed for the dockless systems since they can cause important defects within the built environment [5,6].

The history of the evolution of bike-sharing systems shows that European cities led the developments to a large extent. The history of the North American and Asian systems is much shorter, but they are growing rapidly over the last few years [7,8]. What is more important, the presentation of the four generations makes obvious that Information and Communications Technologies (ICT) played a significant role in the evolution of bike-sharing systems.

Nowadays, all modern and advanced bike-sharing systems (e.g., Vélib' Métropole, Vélo'v, Santander Cycles, Bicing, Villo) use mobile apps, which greatly facilitate the users by providing them useful information and facilitating the process of getting and returning a bicycle from/to the bike stations. More specifically, the mobile apps of those systems provide to the users services such as (a) finding the nearest station, (b) information about the availability of free bikes and free docks in every station in real-time, (c) confirmation of the successful return of a bicycle to a station, (d) routing, (e) information about the rentals that a user has conducted, as well as charts showing their progress, (f) subscribing or renewing their subscription to the system, (g) evaluating the quality of the specific bicycle, (h) evaluating the quality of the path that they used for their trip. Also, many of the mobile apps of those systems include gamification features in order to gather useful data from the users, engage them in the system and utilizing them in the bike-redistribution process.

An essential prerequisite for the success of bike-sharing systems is the change in behavior of commuters, in order to shift to active modes of transport, such as cycling. According to the literature, the use of bicycles for daily commuting is to a large extent correlated to the attributes of:

- Cities: cycling usage levels are higher in cities with greater density and intense mix of land use [9,10]. The prevailing weather conditions [11], as well as the topography of a city [12], also have a significant impact on the levels of bicycle use.

- Infrastructure: the existence of appropriate infrastructure and in particular bicycle lane networks providing safe and comfortable movement, in any destination, is a key factor for bicycle use [13], especially for commuters with limited cycling experience [14]. Except for the bicycle lane networks, it is also of great importance to form safe and secure parking spaces for bicycles, to provide cyclists priority at signalized intersections and to implement restrictions for private cars [15].
- Trips: bicycles are considered to be preferable for short daily trips, but not shorter than one kilometer, since in this case it can be easily replaced by walking [16]. Also, it has been shown that when the final destination is near to the city center, bicycle use is more likely to be preferred [17].
- Travelers: in countries with limited cycling experience and less developed cycling culture, it has been identified that males and especially those of a young age are more likely to choose cycling for commuting. However, it should be mentioned that in well-established cycling cities, no differentiations based on gender or age can be found [16,18]. Private car ownership and attitudes towards cycling are also two aspects of great importance [17].

In some of the abovementioned factors, transport planners can intervene with the aim to promote cycling as a transport mode for daily trips. Also, it is of great significance to implement actions targeting to attract and engage travelers in the use of bicycles. According to Urbanczyk, there are three types of cycling promotion actions [19]: (a) information activities and awareness-raising campaigns, (b) targeted training and educational programs, and (c) individualized promotion.

For maximizing the benefits of implementing those cycling promotion actions, it is very useful to cluster the travelers in groups with similar attributes and common needs in order to prioritize them based on the probability to shift to cycling and at the next stage to approach them with the appropriate messages. The categorization of the travelers can be based on characteristics, such as (a) gender, (b) age, (c) area of residence, (d) area in which he/she works, (e) bicycle ownership, (f) frequency of bicycle use, (g) purpose of bicycle use, (h) attitude towards other available transport modes [20]. Savan et al. strategy for accelerating the adoption of cycling also reveals the need for segmenting travelers [20].

From this section becomes clear that ICT is a determinant element in modern bike-sharing systems' operation. It is also understood that identifying groups of travelers who are most likely to become bike-sharing users is essential for developing appropriate promotion/marketing strategies and communicating the proper messages. Taking the above into account, the present paper mainly targets to identify groups of people who are more likely to shift to bike-sharing systems due to a state-of-the-art app. In addition, the required services for such a sophisticated app are being sought, considering travelers' opinions.

2. Materials and Methods

2.1. Case Study

The study focuses is the city of Thessaloniki, which is located in Northern Greece. Thessaloniki has a population around 1 million people, being the second-largest city in Greece. According to the 2011 census, approximately 45.6% of them are males and 54.4% are females, while approximately 31% of them hold, at least, a bachelor's degree. Regarding the age distribution of the residents of Thessaloniki: (a) 16.2% of them are younger than 20 years old, (b) 37.4% of them are aged between 20 and 45, (c) 25.1% are aged between 45 and 65, (d) 21.3% are older than 65 years old [21].

Thessaloniki is a city with very low levels of cycling use, particularly for trips with mandatory purposes, like reaching the workplace [22]. These low levels of cycling are attributed to the lack of appropriate cycling infrastructure, which results in an unsafe and uncomfortable built environment for cycling, as perceived by the residents of the city [23]. Thessaloniki's bicycle lane network is approximately 12 km in length. An important defect of the city's bicycle lane network is that it is not completely connected (see Figure 1) and that it fails to provide accessibility in important trip attractors and generators.

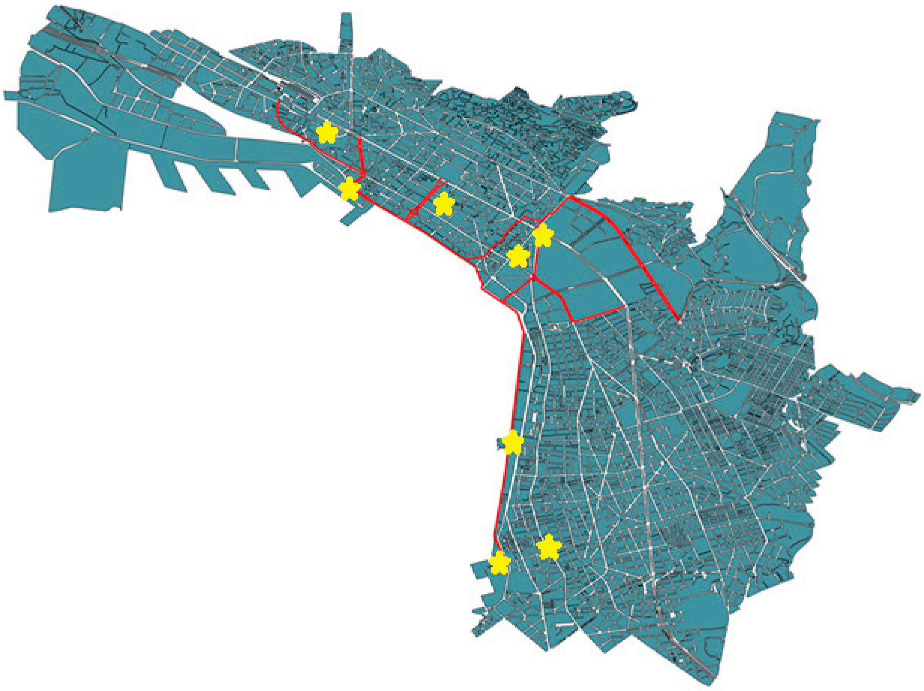

Figure 1. The network of bicycle lanes and the stations of the ThessBike system in the city of Thessaloniki.

In the city of Thessaloniki, a bike-sharing system, called ThessBike, has operated since September 2013. In the period from September 2013 to October 2016, more than 16,000 members have been registered and more than 92,000 rentals have been carried out. At this time, the ThessBike system uses 200 bicycles, which can be rented or returned to eight stations, which are mainly located in the city center and close to the city waterfront. The system seeks to upgrade its services and to attract more users, mainly through better utilization of new technologies and implementation of new bicycle stations. The mobile app of the ThessBike system, in the current situation, provides limited services and information to the users. For instance, the ThessBike app does not allow the users to accomplish a rental and there is a need for using a system's card in some stations or for having employees in other stations to carry out the rental manually. For these reasons, the existing mobile app is not used by the users, who are in their majority aware of the locations of the stations and how to reach them. It becomes clear that the system needs great improvement and renewal and the proper use of ICT is essential.

2.2. Survey Design

The present paper utilizes data from two questionnaires. The first questionnaire applied to the users of the bike-sharing system in the city of Thessaloniki, while the second was applied to other residents of the city (potential users of the bike-sharing system). The development of the two questionnaires was inspired to a large extent from mobile apps that are used by bike-sharing systems, which are mainly located in European countries. Both questionnaires include the following sections:

- Section I: It is exactly the same in the two questionnaires. The questions that it contains concern the following: (a) gender, (b) age, (c) address, (d) occupation, (e) level of education, (f) household income, (g) exercise frequency, (h) private car ownership, (i) bicycle ownership.
- Section II: It is also exactly the same in the two questionnaires. In this section the respondents are asked to describe their most usual trip within the day (origin, destination, purpose, hour, transport mode), to reveal the frequency of using a private car or bicycle, to describe their most usual trip with bicycle (origin, destination, purpose, hour, percentage of the journey carried out through bicycle lanes), and to state the conditions that are needed to be met for using a bicycle more frequently for commuting.

- Section III: The differences between the two questionnaires are identified in this section. Existing users of the ThessBike system were called to complement: (a) an area that they would like to be served by a bike-sharing station, (b) the most usual purpose of their trip when using the ThessBike system, (c) a grade for five different attributes (number and location of stations, quality of bicycles, rental process, rental cost, provided information) of the ThessBike system, (d) a grade for the usefulness of thirteen different services that a bike-sharing app can provide and (e) if a state-of-the-art app, which will provide all the thirteen services, would guide them to use the ThessBike system more often. On the other hand, potential users were asked to fill in: (a) an area that they would like to be served by a bike-sharing station, (b) a grade about the effect that specific factors have in their decision not to use the system, (c) a grade for the usefulness of thirteen different services that a bike-sharing app can provide and (d) if an app, that will provide all the thirteen services, would guide them to register to the ThessBike system. It should be mentioned that for the evaluation of the ThessBike attributes, the usefulness of the app services and the effect of the factors in not using the system, a five-point Likert scale was used [24].

In the first step, a pilot survey was conducted, which resulted in small rephrasing in specific questions, in order to eliminate possible misunderstandings. The final versions of the two questionnaires were developed in electronic format and the link for completing them was shared in local websites, social media, and brochures that they were distributed during events. Additionally to the distribution of the link, questionnaires in printed form were also completed, mainly at the ThessBike stations, in an attempt to gather more data from existing users. The survey was conducted between 30 October 2018 and 20 November 2018. A total of 332 questionnaires were completed, 126 by existing users and 206 by potential users. Despite the fact that the main issue in web surveys is the absence of an interviewer and thus the inability to provide the appropriate clarifications to the respondents, the questionnaires were designed in an easy to follow way in order to avoid misunderstandings.

3. Results

3.1. Descriptive Statistics

Descriptive statistics aim to provide an overview of the sociodemographic characteristics and the mobility habits of the respondents, in order to examine the representativity of the sample. Through the descriptive statistics analysis, it is also sought to give the general picture concerning the attitudes of the respondents and more specifically about the most useful services of bike-sharing mobile applications and about their intention to become members or to use more frequently the ThessBike system due to a state-of-the-art mobile application.

3.1.1. Existing Users

The sample consists of 57.1% females and 42.9% males. The vast majority of the sample (75.4%) is between 25 and 54 years old, but there are also responses in all five age classes (18–24, 25–39, 40–54, 55–64, ≥65). The sample is well distributed regarding occupation, where the two most popular answers are "private employee" (28.6%) and freelancer (23.8%). Most of the respondents have a high education level since 39.7% of them hold a bachelor's degree and 33.3% of them hold an MSc or PhD. Regarding the monthly household income, it seems that the sample is well distributed, having responses in all the income classes (0–400 €, 401–800 €, 801–1200 €, 1201–1600 €, 1601–2000 €, ≥2000 €). Most existing users do exercise activities regularly, while 73.1% responded that they exercise at least two times per week and only 1.6% responded that they did not exercise at all. Of the existing users, 76% stated that they own a private car, while 39.3% of them own a bicycle. The usage levels of private cars are high (46.2% use private cars for the majority of their trips) and relatively high, for the city standards, are also the bicycle usage levels (9.2% use bicycles for the majority of their trips). It is notable that 62.8% of the sample of the existing users of the ThessBike system cycle at least once per week. However, the majority (65.4%) of those who are cycling, usually cycle for leisure purposes and not for mandatory trip purposes, e.g., work and education.

With regards to the evaluation of the usefulness of the thirteen different services that a bike-sharing app can provide, it seems that existing users give priority on having real-time information about the availability of bikes and free docks in every station. They also consider very important to have static information about the location of all stations and dynamic information about the nearest station to them. The confirmation of the successful return of the bicycle in the station is also evaluated high by the existing users. On the other hand, services such as: (a) routing based on the preferences of each user, (b) storing key elements from previous rentals, (c) visualizing progress and (d) getting personalized information about offers and news of the system, does not appear to be decisive for the existing users. Concerning the last question of the survey, it can be understood that a new and sophisticated mobile app can have a great role to play in the success of a bike-sharing system since 69% of the existing users state that this app would guide them to become more frequent users of the ThessBike system.

3.1.2. Potential Users

The sample of potential users consists of 46.6% females and 53.4% males. Most respondents (90.3%) are aged between 18 and 54, but there are also responses from older potential users. As in the case of the existing users, the two most popular answers concerning the occupation are "private employee" (28.2%) and freelancer (27.7%). However, in the case of the potential users also students consist an important proportion of the sample (16.5%). A similar pattern between the two samples is also followed regarding the education level since 35.9% of the potential users hold a bachelor's degree and 34.5% of them hold an MSc or PhD diploma. Also, the monthly household income of the potential users seems well distributed, with an adequate number of responses in the six classes. Potential users stated much lower frequency levels of performing exercise activities in comparison with the existing users since 52.9% of the potential users' sample exercise at least two times per week and 5.8% do not exercise at all. 65.5% of the potential users responded that they own a private car and 53.7% that they own a bicycle. Of the potential users, 38% revealed that they use a private car for the majority of their trips, while a significant proportion of the sample (23.9%) revealed that they use public transport for most of their trips. Concerning the frequency of cycling, it becomes obvious that potential users of the ThessBike system cycle much rarer compared to the existing users. More specifically, only 26.2% of the sample cycle at least once per week and a notable 47.6% do not cycle at all. It should be mentioned that the low usage levels of bicycle, which are observed in the case of the potential users are much more representative of the prevailing conditions in Thessaloniki. As in the case of the existing users, 65% of the potential users revealed that in most cases they use bicycle for leisure purposes.

Concerning the assessment of the usefulness of the thirteen services, that a bike-sharing mobile app can provide, it becomes understood that potential users consider critical the provision of information about the location of the stations both in a static way and in a dynamic way, by taking into account users' location in real-time. In addition, potential users attach great importance to the provision of real-time information about the availability of bikes and free docks in every station and to the facilitation of the rental process, by conducting it through the mobile app. The development of a new and sophisticated mobile app seems crucial for the potential users too since 84.5% of them state that they would be guided in registering to the ThessBike system.

3.2. Classification Tree

3.2.1. Classification Tree Development and Evaluation

In this part of the analysis, a classification tree is being developed. Classification trees are a machine learning technique and they form one of the two types of decision tree family algorithms. This type of algorithm is being used for classification purposes when the outcome variable gets discrete values. The second type of algorithms owning to the decision tree family is known as "regression trees" and it is being applied in the case that the outcome variable gets continuous values [25]. The graphical display of the classification tree outcomes consists an important advantage since they become easily explained and interpreted even by people with limited knowledge in statistics [26]. Moreover, it is very important the fact that classification trees have the ability to handle qualitative variables without needing to set up dummy variables and that they mirror human decision-making more closely, compared to other statistical approaches [26]. Due to these advantages, but also due to the fact that classification trees are appropriate for customer segmentation, this method was chosen.

The usage of the classification tree method in this paper mainly targets in assisting the process of determining a group of people (including existing and potential users), that is more likely to shift towards the ThessBike system owing to a state-of-the-art mobile app. It is also sought to examine the current mobility characteristics of those who are more likely to be affected by the app. Based on the above, variables coming from the first and the second section of the questionnaire were used as possible predictor variables.

It is very important to highlight that a joint analysis of the two groups of users was carried out. This option was considered preferred in order to conduct the analysis with a sufficient sample. It was also considered acceptable since only variables that were in common between the two questionnaires were used. The classification tree was developed, evaluated and optimized through the tree package [27], in the R programming language [28].

The first step for the classification tree development was to separate the whole dataset randomly into two different sets. The training set includes 166 (332/2) rows and the test set which includes the rest 166 observations. Utilizing only the data from the training set, an initial tree was developed with the tree () function in order to predict the outcome variable (shift towards the ThessBike system owing the sophisticated mobile app). This initial tree consists of seventeen terminal nodes. The next step of the classification tree development process was to prune it, which is to optimize it by reducing the number of terminal nodes, with the aim to avoid overfitting. For the determination of the optimal number of terminal nodes, the cross-validation method was applied and the minimization of the classification error was used as a criterion. The final tree, which was created after the application of the abovementioned process, has eight terminal nodes and 79.88% accuracy on the test set.

3.2.2. Interpretation of the Classification Tree Results

The final tree resulting from the application of the modeling procedure described above is shown in Figure 2. In an attempt to facilitate the interpretation of the results, except for the predicted category (yes or no) in each node, the final tree also includes the percentage and the frequency of each category. These percentages and frequencies derived from the complete database and not only from the training set.

The results of the classification tree show that the most influential characteristic that affects the intention to shift towards bike-sharing systems due to a sophisticated mobile app is age, which is at the top of the tree. More specifically, it seems that the likelihood of shifting towards bike-sharing systems due to a mobile app is much higher for those who are aged between 18 and 54 comparing to those who are aged over 54. Also, it appears that potential users would be more easily affected by the mobile app in comparison with the existing users of the ThessBike system. The occupation of travelers is also a characteristic that differentiates the intention of users of all ages. Regarding the frequency of using private cars, there is a more positive attitude among respondents who use a car for their trips, but not on a daily basis. Finally, no safe conclusions can be drawn for the impact of the education level and the income on users' intention, since in these lower levels of the tree the model works with limited observations.

Concluding, from the tree presented in Figure 2, it can be demonstrated that:

- the group of people that has the highest probability to shift towards the bike-sharing system owing to the mobile app, is the one that includes potential users aged between 18 and 54 (green box),

- the group of people that has the lowest probability to shift towards the bike-sharing system owing to the mobile app, is the one that includes people older than 54 years old, who are retired or they are occupied as private employees (red box),
- regarding the existing users, the group of people that has the highest probability to be positively affected by the mobile app is the one that includes people aged between 18 and 54 that they are occupied as state employees or they are students.

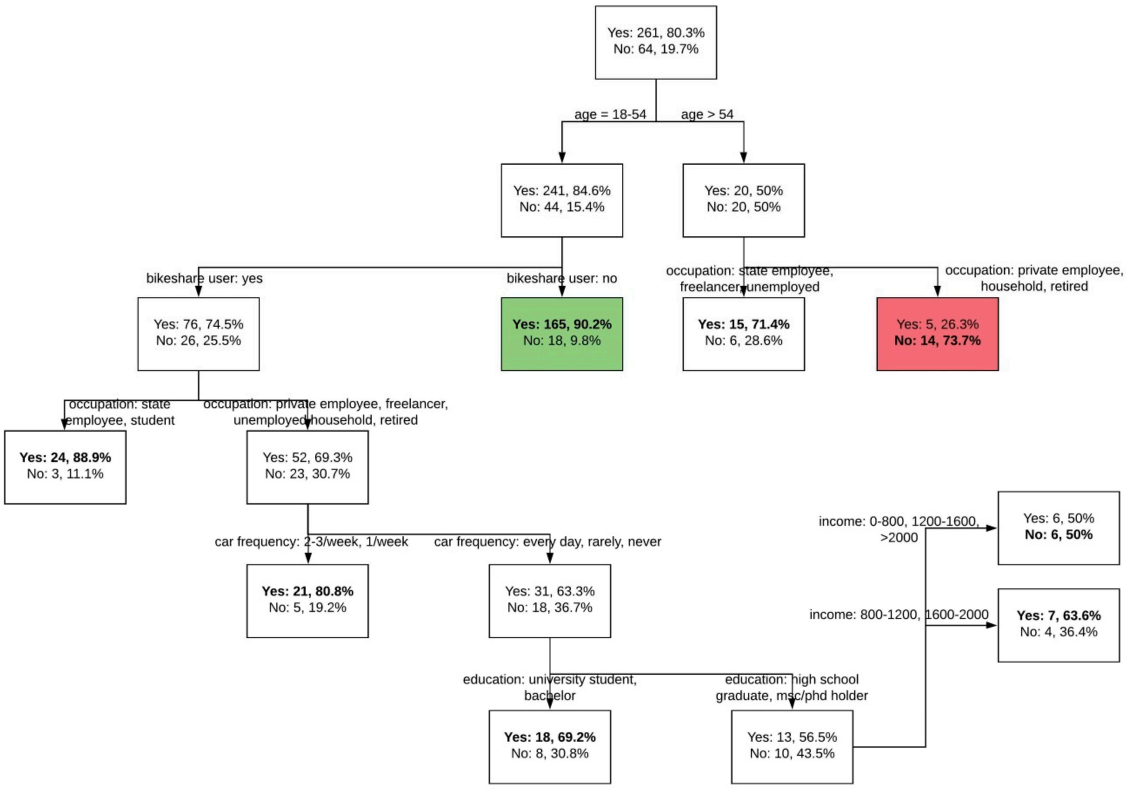

Figure 2. Classifying travelers based on their intention to shift to the bike-sharing system due to a sophisticated mobile app.

3.3. Binary Logit Model

3.3.1. Binary Logit Model Development and Evaluation

Complementary to the classification tree it was considered appropriate to develop a binary logit model. The main aim of the development of the binary logit model is to validate the results of the classification tree, as well as to quantify the impact of the significant predictors.

The development of the binary logit model was also conducted in R programming language, through the aod package [29]. It should be mentioned that the base alternative (value 0) is the one in which the advanced app would have an impact on potential and existing users. As a first step, all the missing values were excluded from the analysis and as a result, the database, which was finally used consisted of 197 observations. Also, in cases where the first level of each variable had limited responses, the relevel () function was used to change the reference category. In all cases either the first or the last level was used as a reference category to facilitate the interpretation of the results. The independent variable selection was made with the objective to minimize the Akaike information criterion (AIC) value, which penalizes the complexity of the model [30]. Table 1 presents the coefficients of the binary logit model, the standard error, the z-value (also known as Wald statistic) and the p-values. It can be seen that only the "user" and "age" variables are statistically significant predictors of the dependent variable.

The evaluation of the final model is being achieved through the following metrics:

- Akaike information criterion (AIC) value: the selected model achieves the lowest AIC value, which is 161.37.
- Pseudo R^2: McFadden's R^2 suggests that the selected model can explain about 20% of the variance of the dependent variable.
- Prediction accuracy: the accuracy of the model has been found to be equivalent to 78.68% (true positive rate = 95.68%, true negative rate = 25.71%).
- Receiver Operating Characteristic (ROC) curve: Figure 3 plots the sensitivity (true positive rate) against the specificity (false positive rate). The area under the curve (AUC) is an index of accuracy since it shows the ability of the model to distinguish the two classes. The greater this value (maximum AUC value equals 1) the better the prediction power of the model. The AUC value of the selected model is equal to 0.7864, indicating that there is approximately a 79% chance that the model will achieve to distinguish between positive class and negative class.

Table 1. Parameter estimates.

	Estimate	Std. Error	z-Value	p-Value
Intercept	−2.7973	1.1514	−2.429	0.01512
user: no	−1.2866	0.4591	−2.802	0.00508
age: 25–39	0.9286	1.1104	0.836	0.40302
age: 40–54	1.5090	1.1620	1.299	0.19407
age: 55–64	2.9870	1.2176	2.453	0.01416
age: >64	20.1348	1160.8338	0.017	0.98616
private car owner: no	0.8164	0.5405	1.511	0.13090

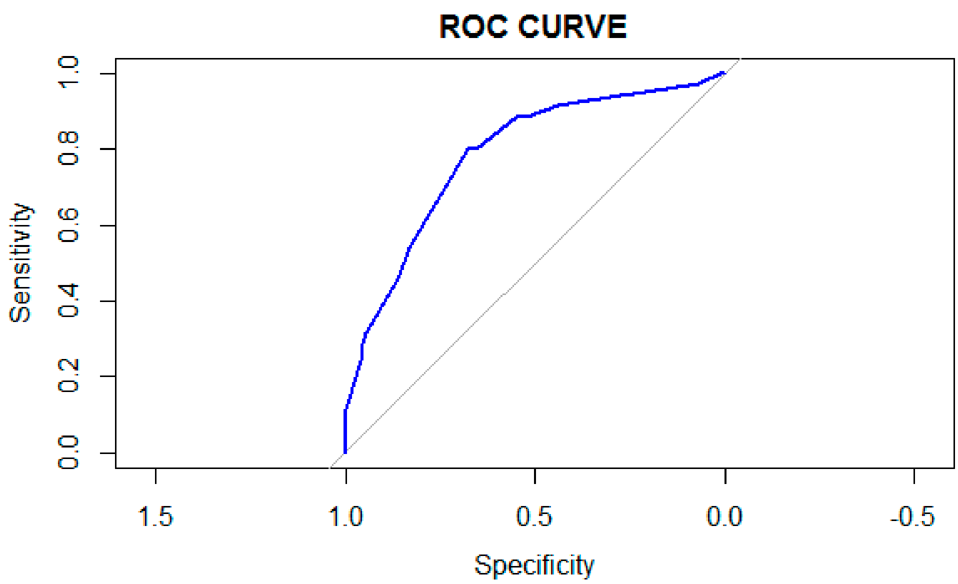

Figure 3. Receiver operating characteristic (ROC) curve.

3.3.2. Interpretation of the Binary Logit Model Results

For the facilitation of the interpretation of the results, it was considered advisable to exponentiate the model coefficients and to interpret them as odds ratios. Table 2 presents the odds ratios of the variables, which were included in the model, along with their confidence intervals. It should be noted that no safe results can be drawn for the last level of the "age" variable (age > 64), since this level collects only limited responses, as well as for the "private car owner" variable, which was not found to be a statistically significant predictor.

Table 2. Odds ratios results.

	Odds Ratios	**2.5%**	**97.5%**
Intercept	0.061	0.003	0.412
user: no	0.276	0.106	0.655
age: 25–39	2.531	0.407	49.432
age: 40–54	4.522	0.641	93.485
age: 55-64	19.825	2.465	436.928
age: >64	5.551533×10^{8}	5.123544×10^{-49}	na
private car owner: no	2.262	0.777	6.629

Two main conclusions derived from the odds ratios. Firstly, the age of the potential and existing users of the bike-sharing is an extremely important factor which affects users' intention to shift to bike-sharing systems due to a sophisticated app. It is observed that as age increases, the likelihood of users being affected by the advanced app is reduced. The second conclusion from the odds ratios results is that those who are not currently users of the bike-sharing system are much more likely to shift due to an advanced app. More specifically, potential users are approximately 3.6 times more likely than existing users to be affected by the mobile app.

4. Discussion

ICTs are an essential element of the operation of modern bike-sharing systems. In this context, the contribution of mobile applications is crucial, as they provide valuable services to users and facilitate the use of the system. From the questionnaire survey, which was addressed to the existing users of the ThessBike system, it can be concluded that the services that are evaluated as most important are the provision of real-time information about the availability of bikes and free docks in every station, the provision of information about the locations of the stations and how to find the nearest station, as well as the confirmation of the successful return of the bicycle in the station. On the other hand, from the questionnaire survey, which was addressed to the potential users of the system, it is demonstrated that higher significance is assigned to the provision of information about the locations of the stations and how to find the nearest station, the provision of real-time information about the availability of bikes and free docks in every station, as well as to the conduction of the rental process through the mobile app. Thus, it can be concluded that a new bike-sharing mobile app should necessarily provide to the users the ability to manage the whole process of the rental from the beginning to the end, that is from the stage of providing the appropriate information for the stations before the rental till allowing the user to unlock a bike and to return it successfully to the station. It should be also stated that in cases of systems with many bike stations and greater activity, the provision of information about the location and the real-time status of the stations becomes even more important.

The classification tree results show that the likelihood for those who are not currently users of the ThessBike system and they are aged between 18 and 54 to subscribe to the bike-sharing owing the mobile app, is high. Also high is the likelihood for the existing users, that are between 18 and 54 years old and are either state employees or students, to use more frequently the system, owing to the state-of-the-art app. In contrast, people older than 54 years old, who are private employees or retired or their primary occupation is the household, concentrate low probabilities to modify their behavior due to the mobile app.

Despite the fact that the binary logit model fails to identify additional significant predictors to those which were already identified by the classification tree approach. It achieves to confirm that younger travelers and those who are not currently users of the system are much more likely to be affected by the mobile app and to shift to the bike-sharing system.

The procedure which was described in this paper for identifying those who are most likely to shift to bike-sharing systems due to an advanced mobile app can be a guide for operators and practitioners in the specific field, in order to develop marketing strategies targeted to the appropriate users and non-users. Also, in the case of experiencing difficulties in collecting responses from users and non-users, the results of the present paper could also consist an important assistance.

As in other studies examining the impact of new technologies on travelers' behavior [31], so in the case of this paper, it can be thought that the extremely high proportion of respondents who state that the mobile app would affect their behavior is too ambitious. It becomes very questionable if the intention stated by both existing and potential users will become an actual behavior. Taking this questioning into consideration, a step further for this study could be the investigation of the impact of the state-of-the-art app, after its development, on the actual behavior of the existing users and the other residents of the city of Thessaloniki.

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