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The impact of mobile device applications in the improvement of public transportation

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Abstract — **In order to achieve carbon emissions' target imposed by the European commission, there were exceptional measures executed. The goal was to encourage the use of public transport in urban areas. It was assumed in this study that digitalization at the service of users and managers of public transport networks is a key instrument to improve their efficiency and attractiveness. Given the topicality and importance of the subject, it was pertinent to establish as the core goal of this work, not only the study of the currently used mobile applications within the urban areas of Lisbon and Porto, but also its impacts on the development of public transportation. Ultimately it was intended to identify among the users, the need for possible developments. As a methodology, an exploratory focus group was used at first. Therefore, it was possible to gain a comprehensive understanding on the users of public transports, their preferences, and which applications they most commonly use. Additionally, at the end of the focus group an inferential survey was also analysed, amended and validated. This survey had the main objective of collecting the necessary data for analysing the impact of an application for mobile devices, with the goal of improve the quality of public transport. After reviewing the results, it was possible to conclude that it exists a wide range of digital applications available on the market. In fact, these applications allow the mitigation of some transport problems/issues, thus improving the user experience of public means of transportation. This leads to the conclusion that it has a positive impact on the user. Finally, the need to improve current functions and even add new features was also identified.**

Keywords - *Mobile Applications; Technological Development; Dynamization; Security; Public Transport.*

I. INTRODUCTION

The rapid growth of cities in recent decades has led to an unprecedented population density. In 2007, more than 50% of the world's population lived in urbanized areas [1]. This population growth in urban areas created numerous challenges. One of those challenges was the need to streamline the mobility. The response to this challenge was the development of complex public transport systems. According to Vuchic [2]: "It is often said that transport is the lifeblood of cities". "The high density of activities makes it possible and necessary for high-capacity modes such as buses, subways. This transports are more economical, more energy efficient and require much less space than private cars." [2]. With public transport systems being essential to respond to the needs of populations, these were developed and put into circulation. Transport means such as the bus, metro and train. In general, the use of these transports implies the payment of a transport ticket, with a cost that is at least symbolic. Centralizing this theme in Portuguese territory, it can be said that there are two large urban centres where the issue of mobility is more relevant: Lisbon and Porto. These urban centres are both equipped with public transport systems that are quite complex, covering the entire urban fabric. Despite their extension, these transport networks are often inefficient in terms of speed, frequency, and quality of support services. In an attempt to counter these problems, state supports and incentivizes its use, with the purpose of making public transportation the first choice of populations. This is even a bigger challenge when it comes to commuting on a residence-work-residence basis. According to an investigation carried out by ISCTE, on public transport in the metropolitan area of Lisbon, the main reasons given for not being the first choice are their lack of comfort and the excessively long time spent traveling. As an alternative to these conventional transports, other means of transportation have been created more recently, such as a public network of bicycles and electric scooters or even shared cars. Formalized transports are managed by applications residing on mobile devices, which makes these services efficient and flexible when compared to traditional public transports.

II. CITIES DEVELOPMENT

Cities are major population centres, according to the United Nations report on the prospects of global urbanization. In 2018 around 55% of the world population lived in urban areas, and this indicator has maintained a growing trend, expecting to reach 68% until 2050 [3]. The population tends to move and gather in urban centres pursuing of better living conditions and safety benefits that cities offer, often ignoring their negative aspects. Cities offer countless opportunities, such as jobs, access to healthcare, education, security, among others. In parallel with these opportunities and benefits, the concentration in high-density population agglomerates resulted in new and increasingly serious problems, including mobility. In order to improve the quality of life in cities, the concept of 'smart cities' was developed. Accordingly, this concept has been developed over the last few decades. There are several different interpretations of what defines a smart city, and most authors argue that a city can be considered a smart city if it has a set of key attributes. A smart city is a city with a forward-looking development in the six categories, "smart economy, smart people, smart governance, smart mobility, smart environment,

smart living" [4].In fact, a large number of definitions exist, sometimes quite distinct given the diversity of movements that created them, such as: Cybercities, Smart Growth and Intelligent Communities[5]. This panoply of movements has drawn within what a smart city means to each of them, each movement adopting its own language, definition and specific objectives. Although the movements are not contradictory, not all of them coincide in the definitions of the factors that characterize and define a smart city. Cities are major population centres, according to the United Nations report on the prospects of global urbanization. In 2018 around 55% of the world population lived in urban areas, and this indicator has maintained a growing trend, expecting to reach 68% until 2050 [3].

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III. TRANSPORT SECTOR

Here we return to the focus of our theme, which, as demonstrated above, is a fundamental and obligatory axis of the "smartness" in cities and also in the decarbonization of the economy. Transport is part of the daily life of human beings, particularly city dwellers, whether these transports are intended for the movement of people or goods. Currently, these movements can be ensured in four different ways: air, road, sea or rail transport. The good development of urban areas in growth and expansion is directly related to the availability of an adequate and efficient transport system [6] .With the growth in number and dimension of aforementioned urban areas, accompanied by the growth of the world population, the need for sustainable development in this sector is often a pressing issue. This development has generated great challenges, as urban centres grow. The pressure on the transport sector increases. For a smart mobility to be effective it is necessary to jointly use information and knowledge technologies. Smart mobility is often achieved using technological applications, combining existing systems in cities with the latest technologies [7].

IV. MOBILE DEVICES AND APPLICATIONS

A. Mobile devices

During the last year, mobile devices like smartphones and tablets have become more popular than the traditional technologies, like desk based devices. These mobile devices such as laptops, mobile phones, tablets, among others, have given human beings the ability to obtain information and transport it in a digital way. Mobile devices allow access to information anywhere, at any time, offering various features through computer applications that simplify the daily tasks of users[8]. The convergence of communication and processing through mobile devices is evolving, making it possible to leverage the capacity and services in addition to functionality of each sector. In this convergence, smartphones are the main devices [9].

B. Mobile operating systems

Following the advances in hardware, it has been witnessed the continuous evolution of operating systems, using all the potential that technology allows, opening the frontiers for the introduction of new functionalities.

With the development of mobile devices, operating systems for other existing technological devices were also designed. Currently, there are numerous operating systems available on the market, although two of them constitute about 99% used in mobile displays.

IOS and Android are the two operating systems referred. Both are based on the UNIX operating system developed by Kenneth Thompson, which is the first system to introduce concepts such as multiuser support, multitasking and portability. (https://www.tecmundo.com.br/macos/10556-unix-o-pai-de-todos-os-sistemas-operacionais.htm)

Android

The android operating system is supported by the use of the Linux Kernel, being the Kernel system the main responsible for the usability of the device. The main differentiating factor of the Android platform is its open-source functionality, allowing its users to view the code, download it, change it and even redistribute it without having to pay fees, royalties or any other type of costs (https://www.android.com/everyone/facts/). Given its open-source operating structure, the Android system is the most used in the world, giving freedom to those who use it to customize or use it without any restrictions.

IOS

IOS is the operating system created by Apple.Inc, developed for the use of the brand's mobile devices, such as the iPhone, iPod and iPad. IOS was not the original name of the operating system, just having that name in the release of the software development kit (SDK). The SDK allowed any mobile device application manufacturer to develop their own applications ensuring that they were compatible with the IOS system.

C. Mobile applications

In the last few years, the development of applications for mobile devices, like smartphones, tablets and other devices skyrocketed. These applications are produced in numerous languages like java, phone and gap. Mobile applications can be classified in three different types, as native, web applications, and hybrid [10]. These three categories can be characterized by:

- Native applications: a native application is a software program, built with specific specs for use on a particular platform or device; these applications can be downloaded and installed directly into the devices.

- Web applications: A web application is developed with the purpose of being used across multiple browsers, these applications cannot be downloaded and are accessed from a web browser.

- Hybrid applications: Hybrid applications are a junction of native and web applications.

V. METHODOLOGY

A. Introduction to research

This study aims to describe and characterize the impact of mobile applications supporting the use of public transport. Accordingly, to carry out this study, two distinct methodologies have been adopted. In the first phase, an exploratory study focus group, was carried out, aiming to obtain understanding on public transport's users, their preferences, their mobile application of choice, as well as the features that provide greater value, in order to allow the construction of a more objective survey with greater knowledge of public transport users. In the second phase, an inferential study was carried out based on information collected from the survey, with the main objective of analysing the impact of an application for mobile devices with a view to demonstrate a possible improvement in the use of public transport and consequently the well-being of users themselves. Additionally, the relationship between users and applications is also analysed in this phase.

B. Focus group

The focus group was aimed at users of public transports in the metropolitan areas of Lisbon and Porto. It was carried out online and consisted of 4 participants, two male and two female. Participants were aged between 21 and 25 years. The focus group tried to answer the following questions:

What is the perceived role of public transport in the metropolitan areas of Lisbon and Porto?

How is the quality of public transport service characterized?

How the technological development and the investment in the public transport sector is rated?

What is the impact of mobile device applications on the use of public transport?

What is the perception of the impact of a possible new application that could provide the features chosen and defined by the participants?

The main results obtain in the focus group were:

1 - Role of public transport sector. The public transport sector provides a fundamental service to cities, both in the transport activity of its residents and in supporting tourism. This sector has also become vital to the sustainability of life in cities. Agreeing with this perception, Murray et al [6] defends the importance of transport planning as a fundamental pillar for the development of metropolitan regions and its close relationship with urban sustainability. The public transport systems in the metropolitan areas of Lisbon and Porto are classified as having a quality between average and good, with the lack of means and the long travel times being pointed out as the main weaknesses.

2 - Investment and technological development in the public transport sector.

Despite the state's plans of developing public transportation, it is clear that the investment has been insufficient, mostly due to sector's debt. In fact, this theme is analysed and developed in the Strategic Plan for Transport and Infrastructure[11]. As it happens, In the national context of reduced technological innovation in the sector, where the use of applications to support public transport was identified as one of the few relevant advances.

3 - The impact of mobile device applications on the use of public transport.

Users of public transport have progressively adhered to the use of applications to assist them in their commute. Currently, exist numerous applications for public transport, and users make their choices depending on the features they provide, their accuracy of results and their ease of use. The impact of these applications has been very positive due to features provided and considered essential by users. The most outstanding features are control of waiting time, payment of tickets through applications and route planning, whether multimodal or unimodal.

4 - Perception of the impact of a possible new application that could provide the features chosen and defined by the participants.

The focus group did not consider it necessary to have a new application that would bring together other functionalities. They consider that the current ones have the potential to be improved, also mentioning that the development of features that provide more accurate results is something essential for users.

C. Survey

The main objective for carrying out the survey was the analysis of the impact of an application for mobile devices with a view to possible improvement in the use of public transport. As secondary objectives, the survey sought to collect information on:

• How often public transport is used;

• What are the applications to support the use of public transport in the metropolitan areas of Lisbon and Porto;

• Whether the features provided are suitable for the user's goals;

• What is the perceived usefulness of the application;

• What features would make an ideal application to support public transport users;

• What is the impact of an application to support the use of public transport.

The survey was built on the information collected during the literature review and the focus group. Before releasing the survey, this was validated by the participants of the focus group. The questions have been constructed with the application of a Likert-type scale from 1 to 5. Data processing started after the end of data collection. The program Microsoft Excel and SPSS were used to proceed with the treatment, organization, and analysis of the data.

VI. RESULTS

The sample collected was random, having obeyed the requirement of the participants to be residents and/or users of public transport in the metropolitan areas of Lisbon or Porto. The survey had the participation of 137 people, of which 82 are female (59.9%) and 55 are male (40.1%). The average age of surveys is 28.64 years old, around 62.2% of surveys are between 20 and 30 years old. Regarding education, 20.2% have an education level equivalent to a master's degree or higher and 68.1% have a bachelor's degree. The frequency of use of public transport is far from ideal, as it can be seen below, only 37% of all respondents to the survey use public transport on a daily basis, and 27% only used the public transportation weekly. It can be concluded that individual transport is still the preferred choice. This choice is often justified by the long journey time, being mentioned that individual transport is much faster compared to existing public transport. The results obtained are in agreement with what is defended in the study carried out by João Monteiro, in which the author maintains that public transport is still not the main option, but individual transport [12].
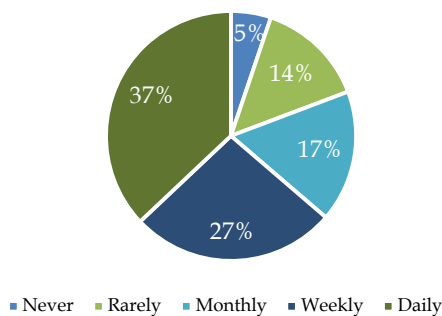
Regarding the mobile apps utilized It is possible to analyse through the results obtained that of the 137 respondents, 69 use applications to support the use of public transport. Based on the responses of 69 respondents, it is possible to see in Figure 1 that the most used application is Lisbon Move-me, followed by Google Maps and CP.
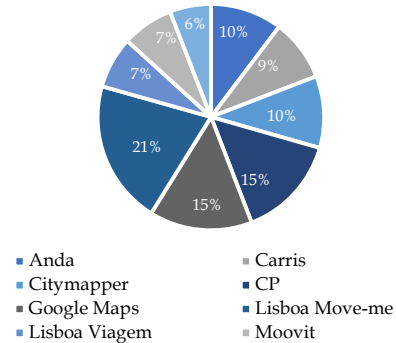
Figure 2. Distribution of used applications.

Regarding the availability of features, it can be concluded that users are satisfied with the features made available by the mobile applications Analysing the applications present in the Figure 2, it is possible to verify that the vast majority of applications do not provide a satisfactory delivery of accurate results. Although the functionalities are similar, there is a clear distinction in the way they were classified by the respondents, which allows us to consider that their provision has different levels of quality. With the results shown in Figure 3, we can also verify that respondents consider that the applications are very useful, and that they have a positive impact on the use of public transport. The application that obtained the best results in these two parameters was Lisboa Viagem, which had an average of 5 responses on the Likert scale. In order to specifically analyse each application, the non-parametric Kruskal-Wallis test was performed, which allows the comparison of three or more groups of independent samples. The results obtained showed that the answers provided by respondents depended on the application they were using. Based on these results, it is possible to say that although the applications have similar features, they do not have the same quality.

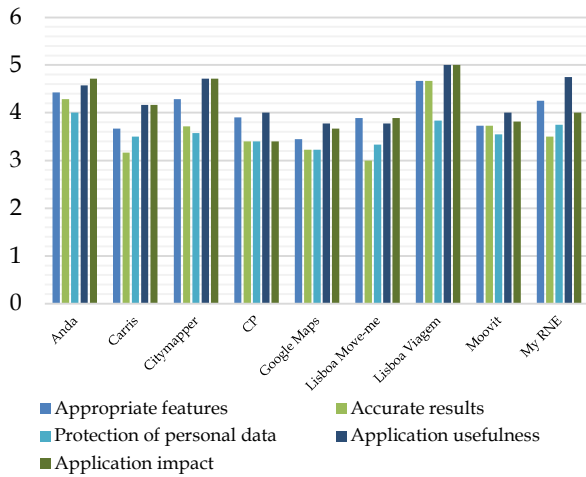Figure 1. Frequency of use of public transport.

Figure 3. Evaluation of used applications.

To carry out the analysis of which functionalities are ideal for users, a descriptive analysis was carried out where in each functionality was analysed independently in order to obtain a more accurate view.
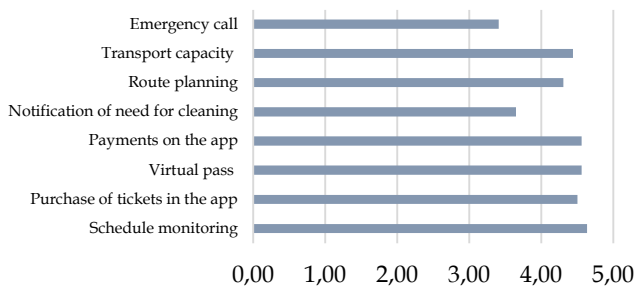

Figure 4. Feature valuation.

There were eight features selected from previous researches, some are already available in some apps in Portugal and others just available in other countries. By analysing the Figure 4 it can be concluded that only two of the eight features were not so appreciated. The emergency call and notification of need for cleaning are features that are not available in any app in Portugal and may have generated some lack of interest as there is no prior knowledge compared to the other features.

Regarding the utility and the impact that an application has with the features selected by each respondent, the vast majority considered that the app does support the use of public transport, is useful and has a positive impact.

VII. CONCLUSIONS

The main goal of this study is to understand the impact of an application for mobile devices, in view of improving public transports. The analysis focused on the applications currently available for public transport in the metropolitan areas of Lisbon and/or Porto.

As verified through the literature review, the growth and sustainable development of urban centres is, nowadays, often associated with the available public transport services. The data collected allows to conclude that the investment made in the public transport systems of these two urban areas, Lisbon and Porto, is not enough and sometimes considered by users to be inefficient. Applications have made it possible to find solutions to improve the weaknesses of the transport system. Having it been developed for mobile devices aiming to improve user experience and the quality of the public transport services. In light of these realities, this investigation considered pertinent to study the impact of an application for mobile devices with the goal to improve public transports.

Regarding the applications to support public transport used, it was verified that there is a wide range of applications in the market. The most used applications are Lisboa Move-me, Google maps and Cp. Of these three applications, only one is held by a transport company, Comboios Portugal.

It was found that most applications provide users with the same set of functionalities, sometimes with some differentiation, such as the possibility of paying for tickets in the CP application. It was possible to conclude that users are reasonably satisfied with the type of features provided. However, regarding some of the applications, the need to improve the rigor of the results is highlighted. The waiting time was presented as the feature that needs to be improved the most.

Regarding the impact of applications available on the market, it was possible to conclude that they have a positive impact on the use of public transport. It is possible mitigate some of the public transports problems relying on features currently available in the applications. These improves the service provided by the public transports. With regard to usefulness, it was possible to conclude that users see applications as being very useful, having defended the latter during the focus group and asserting that they are almost essential these days. As a final conclusion, it is worth highlighting the

Concluding it is worth highlighting the relevance of these applications in the public transports environment. It is necessary to continue making efforts further developing the applications. The data collection between public transports service providers and applications developers must be streamlined ensuring the accuracy of the data delivered to the users.

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