

# Bike sharing for students' mobility: the case study of the new engineering hub in Naples, Italy

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**Abstract**—The mobility choice of university students represents one of the most interesting issue within the scientific literature of the sector, considering the impacts that these choices might have on congestion. In all the European cities where cycling mobility and bike sharing are experiencing a continuous growth, mobility policies have fostered the use of these transport alternatives. The bicycle, in the period between the end of the nineteenth and the first decades of the twentieth century, was the mostly chosen means of transport thanks to its characteristics of cheapness and elasticity in use. However, with the continuous technological development, the use of bicycles has increasingly reduced in favor of a mobility based mainly on private cars and motorcycles. The progressive deterioration of the livability of urban centers and neighboring areas has led public administrations of northern Europe to an overall reorganization of the transport system. The key words of the reorganization of transport are: "sustainable transport", "intermodality", "traffic calming". In this context, urban mobility policies have focused on fostering the use of bicycles at the urban level, increasing bike sharing in cities. In the city of Naples no initiative is promoted to make bike sharing accessible within university areas. In 2016 a new engineering hub was inaugurated located in San Giovanni a Teduccio, an Eastern borough of the city of Naples. The neighboring municipalities have proposed the idea of encouraging the use of bicycles to reach this hub. Among them there is the city of Portici, one of the most densely inhabited areas in the territory (with 12,000 inhabitants / km<sup>2</sup>), 4 km away from the new engineering hub in San Giovanni a Teduccio. Starting from these considerations, after showing the history of bike and bike sharing, the aim of this research is to evaluate the attitude to choose bike sharing for potential engineering students residing in Portici. For this reason, a mobility survey (RP and SP) was conducted at the high schools of the city of Portici. The results show that on average a student is willing to walk up to 900 meters to reach the bike sharing station. In the case that the bike sharing service is with pedal assistance charged of an annual cost of 30 euros, there is a higher attitude to choose bike sharing, but less attitude to walk to reach the station. Indeed, in this case a student on average is willing to walk up to 600 meters to reach a bike sharing station.

**Keywords**— bike sharing, transport planning, university students

## I. INTRODUCTION

The mobility choice of university students represents one of the most interesting issue within the scientific literature of the sector, considering the impacts that these choices might have on congestion. Between 1969 and 2003, a significant increase (from 17% to 55%) of students using cars both as a passenger and as a driver was observed [1]. This trend is not in line with the principle of sustainable transportation development, which is expected for people to take public transports, walk, or cycle in their daily trips [1]. For this reason, among the urban sustainable policies [2-6],

the mobility choices of the university students have been analysed in literature during the years [7]-[13]

The modal choices of students are not the same all over the world. For example, in America where the majority of students live in a campus and therefore the distance between universities and home is limited to few kilometres, the most used transport mode for reaching university is the bike or on foot (eg in California 77% of students reach the university on foot or by bike) [14]. European universities are easily accessible by public transport and thus are reached by students mainly by bus or metro (e.g. 74% in Milan, 66% in London, 63% in Auckland, 55% of students in Birmingham choose bus or metro to reach the university) [14]. In cities where the car is the main transport mode to reach the university, several studies have been conducted to identify planning strategies aimed at reducing the use of private transport in favour of more environmentally friendly transport modes [15]- [17]. In many studies [18]-[22] policies have been proposed to encourage the use of bicycles to reach university. This is because the bicycle, which increases the positive environmental and social impacts since it is environmentally sustainable, is a winner w.r.t. short distances in terms of travel time [19]. In fact, pedalling slowly, with a normal bicycle, the speed of 15 km/h can easily be reached and therefore, without a big effort, 3 km can be covered in 12 minutes.

One of the strategies to encourage the use of bicycles is bike sharing. It is a bicycle rental system, whose translation means "shared bicycle", as the service allows the user to be able to pedal and make his/her trips in the city by renting a means of transport, shared with all those who are registered in this service.

The case study of students mobility in the city Naples (South Italy) is particularly interesting. Indeed from the analysis of the mobility choices of university students, it has been revealed that only 2% of them use sustainable transport modes (bike and walking) [14] to reach the universities, 38% uses the private car [14]. It is therefore interesting to identify mobility policies aimed at encouraging the use of more eco-friendly transport modes. Furthermore, in 2016 a new engineering hub was inaugurated located in San Giovanni a Teduccio, an Eastern borough of the city of Naples. The neighbouring municipalities have proposed the idea of fostering the use of bicycles to reach this engineering hub. Among them there is the city of Portici, one of the most densely inhabited areas of the territory (with 12,000 inhabitants/km<sup>2</sup>), 4 km away from the new engineering hub in San Giovanni a Teduccio.

Starting from these considerations, the aim of this paper is to evaluate the attitude to choose bike sharing for potential engineering students residing in the city of Portici. For this reason, a mobility survey was conducted at the

technical, scientific and classical high schools of Portici. The students of the last two years of the high schools in the city of Portici were interviewed, willing to enrol at the engineering faculty. The analyses are based on a Revealed Preferences (RP) and Stated Preferences (SP) survey. SP scenarios vary according to the service offered (traditional bikes vs. pedal assisted bikes) and to the location of the bike sharing stations. In order to quantify the students' willingness to walk to reach the Bike Sharing station (both in the case of traditional bike and with pedal assisted bike), 8 different scenarios (SP survey) were proposed to the respondents, diversifying and distancing the origin (residence) more and more from the bike sharing station. The paper is divided into 4 sections, in section 2 there is a short history of the bicycle and the bike sharing service, in section 3 the case study and mobility survey are shown, in section 4 the main results of the survey are discussed. In the last section the conclusion and research perspective are presented.

## II. THE HISTORY OF THE ORIGIN OF BIKE SHARING

In 1791 the "célérifère" was created in France, the first ancestor of the bicycle. Its rudimentary form lacked steering, pedals and brakes which will be invented later. In 1839, the Scotsman K. Mac Millan and the French blacksmith P. Michaux in 1842 introduced the pedals for the first time, connected with levers to the axles of the wheel [22]. The bike, in the period between the end of nineteenth and the beginning of the twentieth century, was the mostly chosen means of transport thanks to its main characteristics: it did not and does not require large spaces, nor great skills and abilities to be conducted; it is cheap. However, with the new technological development, whose direct consequence was the mass motorization, the bicycle has suffered the competition of the new needs, the progressive marginalization of spaces on the road network and the collapse of the appeal, in the collective imagination, of a simple, economical and silent vehicle.

The car and the other vehicles, at first means of movement and transport, then more and more "status symbols", to the point of becoming a mandatory choice, due to transport policies systematically aimed at fostering private road transport [22].

To cope with this progressive deterioration in the livability of urban centers and neighboring areas, bicycle has once again become a sustainable alternative to be encouraged for travel in urban areas. In such an urban scenario, redeveloped and more citizen-friendly, the bicycle rediscovers its original function as a means of transport, supported in this also by the technical evolution that has dramatically increased its potential and flexibility of use. The bicycle is today the most popular and widespread personal vehicle in the world, as well as having become one of the symbolic vehicles of sustainable mobility [23]. To encourage the use of bicycles, one of the most encouraged policies is to guarantee a bike sharing service.

The origins of this new type of transport system are probably to be found in The Netherlands in the 1960s. Everything arises not from the search for more sustainable mobility, but it arises from political motivations.

The idea comes from the "Provos", an eccentric group from Amsterdam, which uses the bicycle as a critical anti-consuming model. The "White Bike Plan" was born in this

context. It was about distributing thousands of white painted bikes around the city, inviting everyone to use them and leave them without locks, so that anyone could get out on the street and get one. The plan was successful and was reproduced in other cities including Stockholm, Prague, Oxford and Milan. The echo of their happenings was spread around the world of music: "Bike" by Pink Floyd, "Bicycle race" by Queen and "White bikes" written by Guccini after a youth trip to Amsterdam. This is therefore the story of the first generation of bike sharing. It is in Copenhagen that the second generation was born. The idea was born when in 1988, Morten Sadolin and Wessung Ole, two young Danish returning from an evening with friends, no longer found their bikes. When walking back home, they imagined a shared bike service where each user could take a bike for his/her own journey, then leaving the bike free once they reached their destination for another user. Therefore it is from this story that in 1995 the "Bycyklen" was born, a system consisting of a network of bicycles parked to a fixed support unlocked by the use of a coin (a principle similar to that of supermarket trolleys) to then be left in another parking point, thus recovering the coin left as a "deposit". Obviously, the low cost of the deposit and the lack of an identification system did not encourage the systematic return of bikes.

It is in England in 1996, and exactly in Portsmouth, where it is possible to find the third generation of bike sharing, born to try to overcome the problem of vandalization of bicycles, with the help of technology.

The university of this English city, as part of its environmental program for transport, thanks also to the European funds, organized a bike sharing system available to employees and students for their travel between different locations of the faculty. In order to access the bicycles, it was necessary to obtain a "smart card", which allowed the collection and storage of the bicycles, trips that were thus recorded electronically and the user was charged an additional cost (in addition to that of the subscription to the system) in case of use longer than 3 hours. In addition, the stations were under video surveillance to minimize vandalism. The experiment, in addition to the high costs, was not particularly successful, as because a bicycle sharing system, in order not to turn into a failure, should have among its characteristics that of a widespread diffusion throughout the territory and certainly cannot be limited only to the exchange between different locations on a campus.

In any case, by now "alea jacta est" and even if it will take another ten years before this new mode of transport will see its real boom, the foundations of its functioning have now been laid and the system is beginning to expand, in different ways around Europe. First in Renne in France in 1998, with its "velò à la carte" service, then with Munich with the "Call a Bike" service, which, as the word says, provided and provides for the call to a switchboard for the use of the bicycle.

The bike sharing system began to take its current role in 2005. In the city of Lyon, 1500 bicycles were deployed throughout the city and the service was managed by JC Decaux (multinational based in Paris, known for its advertising bus-stop systems, public bicycle rental systems and street furniture). This is the experience that will be the school for the next case, which will give the Bike Sharing the world showcase that has changed its fortune. On July the 15th of the year 2007 or the day after the "Storming of the

Bastille", symbolic date of the French revolution, the Parisian Bike Sharing, called Velib, was born, short for "vélo libre" service which can be intuitively and emotionally be referred to "vélo libéré", which means "free bicycle", considered the best system currently in operation, which has led to a 41% increase in cyclists on the streets of the French capital since the year of its launch. Here there are 24,000 bicycles parked in 1,700 stations.

From this moment onward, the BS has become an unstoppable phenomenon and by 2015 hundreds of cities around the world will adopt it as an alternative for sustainable mobility. In recent years, technological innovations [24]-[27] have involved the world of transport, modifying the behavior, mobility choices of users and have facilitated the spread of BS services. In particular those related to Information Transport System (ITS), Information and Communication Technology (ICT), satellite localization and the development of the APP-economy (transactions and services offered via Apps of smartphones). To date it appears that an advanced bike sharing system is hosted in at least 600 cities divided into 52 countries around the world (if even the smallest services were calculated, the number would be enormous). The largest BS system in the world is in China, in the city of Wuhan, the sixth largest city in the country hosting 9 millions people. About 90,000 bicycles have been made available to them. After the initial boom, several Chinese bike sharing companies went bankrupt in 2019, but now the COVID-19 pandemic is promoted a new passion for cycling in China as people avoid buses and subways for fear of being infected. Sharing companies have learned from their past mistakes and are providing more efficient services. According to data collected by Hellobike, a bike sharing company, nearly 300 million trips a day were made in China on conventional bicycles in 2020. Also in Italy, shared mobility services spread quickly immediately after the lockdown for the COVID-19 pandemic. Bike sharing continues its irresistible rise, registering an increase in the cities involved and in the number of bicycles available to users, with a fleet of around 39,000 (of which over 5000 electric) in 31 cities [28]. As it can be seen from Fig. 1, the main sharing services are placed in northern Italy.

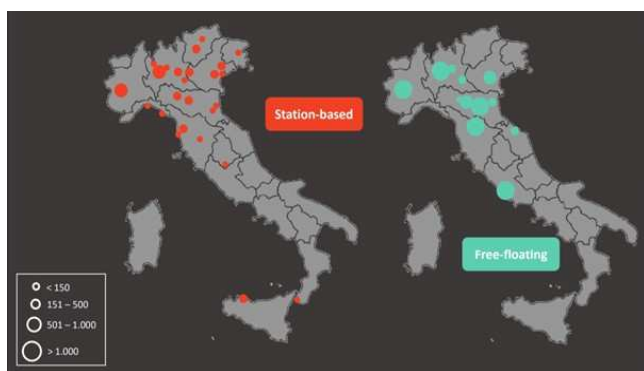


Fig. 1. Bike sharing in Italy [28]

### III. THE CASE STUDY

The case study under analyses is the city of Naples, one of the main cities in South of Italy. The Bike Sharing service was born from the idea of having the "last kilometer" travelled by bicycle, that is the path that one should travel from the stop of any public transport to the final destination

without taking the car or motorbike. The service is designed to allow users to reach any corner of the city in less than half an hour. For this reason, unlike other systems, which require the payment of a subscription and a fee for the use of the shared bicycle, this is the only one free, as long as the time use of the bike is less than thirty minutes.



Fig. 2. Bke Sharing in Neapolis city

The project promoted by the city of Portici was born in this context. In particular, since the 2016-17 academic year the Faculty of Engineering of the University Federico II of Naples has a new hub located in San Giovanni a Teduccio, a borough located in the eastern area of the city of Naples. The new hub is about 3 km from the central station of Naples in Garibaldi square and it can be reached through Line 2 of the Metro, from the Cirumvesuviana line and from bus and tram services. The main municipalities close to San Giovanni a Teduccio are San Giorgio a Cremano and Portici, about 4 km from the Naples (Fig.2).

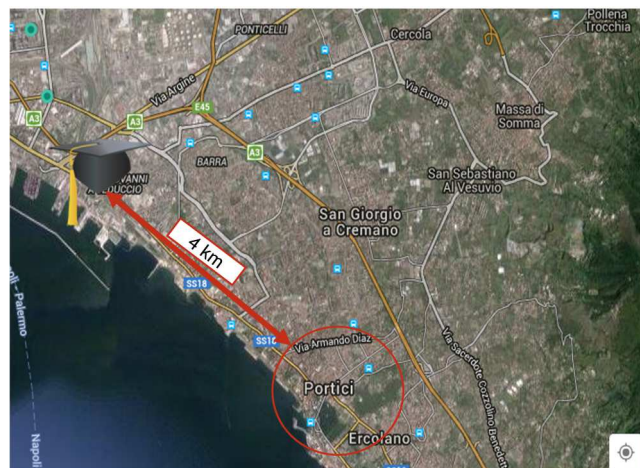


Fig. 3. The case study

The focus here is on the city of Portici, where a mobility survey was carried out interviewing students of the last two years of the high schools. The objective is to assess the availability and attitude to use the bike or the bike sharing to reach the University in San Giovanni a Teduccio. Portici has an extension of 4km<sup>2</sup> and is the second largest Italian city in terms of population density counting about 12,000 inhabitants/km<sup>2</sup>. It rises on the slopes of the west side of Vesuvius and occupies a small part of the territory along the coast of the Gulf of Naples, bordering with San Giovanni a Teduccio. The following sections illustrate the mobility survey and the main results.

#### IV. THE MOBILITY SURVEY

The Cawi (Computer-Assisted Web Interviewing) survey was proposed with the development of a dedicated mobile application (App). The estimated sample universe is represented by 109 students belonging to 3 high schools in the Portici area, which represent about 50% of 4th and 5th year students attending these institutes. The sampling strategy is of the probabilistic type estimated and two types of surveys have been carried out: an RP (Revealed Preference) part, where the actual preferences indicating the characteristics of the students' current mobility choices to reach the school have been highlighted; an SP (Stated Preference) part, where declared preferences representing an estimate of the willingness to walk to reach the bike sharing station have been presented. Through this analysis, it was possible to identify and analyze the factors influencing the attitude to a bike sharing service and the willingness to walk to take advantage of this service.

The questionnaire submitted was divided into three parts.

The first part is a RP (Revealed Preference) survey and the following information were collected:

- Socio-economic characteristics of the respondent (i.e. gender, ownership of bikes and / or cars in the household);
- Trip characteristics (i.e. trip origin, transport mode).

In the second part of the questionnaire, the attitude to use bike sharing for travelling was investigated. The last part of the questionnaire was submitted only to students interested in enrolling at the faculty of engineering. In this section an SP (Stated Preference) exercise was conducted investigating the willingness to use the bike / bike sharing / bike sharing with pedal assistance to reach the university.

The results of the statistical analysis show that students are a category of users who tend to use the bike for their trips. Indeed, only 18% of students believe they are not the kind of person who would ride a bike (estimated as the sum of absolutely disagree and disagree in Fig. 4), percentage that increases to 22% if we consider the answers of only women (Fig.4). Furthermore, 72% of students believe that bike is the best transport mode for short trips, but 40% of students do not own a bicycle.

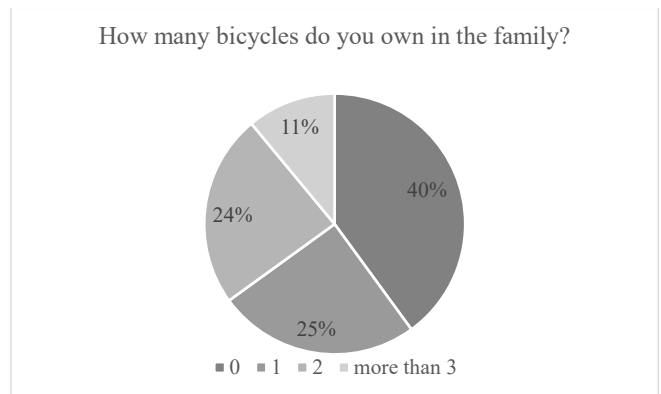
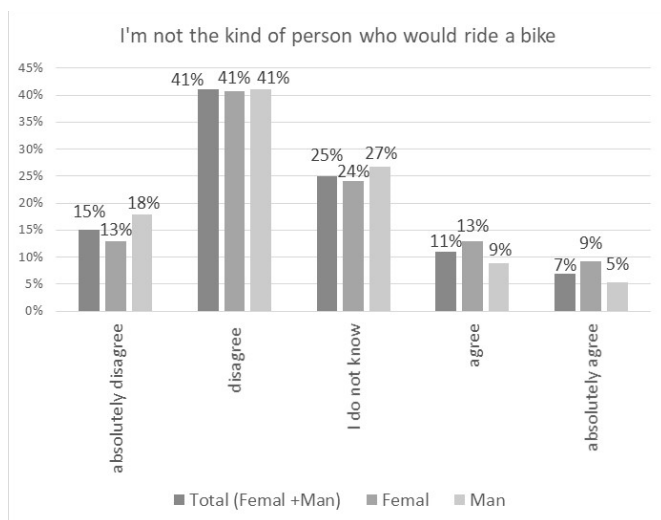


Fig. 4. Some results of the mobility survey

The last section of the questionnaire (SP) was submitted to only 40% of the students, the ones who declared that they will continue their studies by enrolling at the engineering faculty.

These users were asked if they were willing to use the bike sharing service to reach the engineering site in 8 different scenarios.

In the first 4 scenarios, it is foreseen the possibility of using a free bike sharing service with a traditional bike model. The scenarios differ from each other on the location of the bike sharing stations in the city of Portici. In particular, in scenario 1 a bike sharing station is located 200 meters away from home; in scenario 2, three bike sharing stations have been located in the main squares, 1 km far from each other and strategically chosen to cover most of the territory (as shown in figure 5); in scenario 3, two bike sharing stations are located in San Ciro Square and Poli Square; in scenario 4 there is only one bike sharing station in the main square of Portici, in San Ciro Square. If the interviewed student declared that he/she was not available to use the bike sharing, the same scenario was proposed to him (intended as the location of the bike sharing station) with the difference of being able to rent a bicycle with pedal assistance, instead of a bike traditional.

In the last 4 scenarios, a bike sharing service is located with the use of pedal assisted bikes, with an annual cost of 30 euros. Also in this case the 4 scenarios differ from each other based the location of the bike sharing stations in the city of Portici following the framework of the first four scenarios.

The results (Fig. 6) show that 85% of the students interviewed are available to use the bike sharing service with traditional bikes if the stations are located close to home (200 meters). In the scenario where there is only one bike sharing station in the main square, the students willing to use bike sharing to reach the engineering university is reduced to 45%, but 93% change their answer by stating to be available to use bike sharing with pedal assisted bikes. In the event that the bike sharing service is with pedal assisted bikes charged by an annual cost of 30 euros, 87% of students declare that they are willing to use it to reach the engineering university, if the station is close to house (about 200 meters from home). This percentage is reduced to 38% if there is only one bike sharing station in the main square (Fig.7). Finally, in the case that the bike sharing service is with pedal assistance charged by an annual cost of 30 euros, there is a higher attitude to use bike sharing, but a less attitude to walk to reach the station.

It is interesting to note that women, despite a higher percentage declared that they are not "that kind of person suitable for bikes", are then more likely to use bike sharing to reach universities, especially if the bike sharing station is below home or if the service offered is with pedal assisted bikes (Fig.6 and Fig.7).

Finally, by combining the results obtained from the SP surveys plus the origins declared by the students in the first section of the questionnaire, it was possible to estimate that a student is on average willing to walk up to 900 meters to reach the bike sharing station, and in the case in which the bike sharing service is with pedal assisted bikes, a student on average is willing to walk up to 600 meters to reach the bike sharing station.

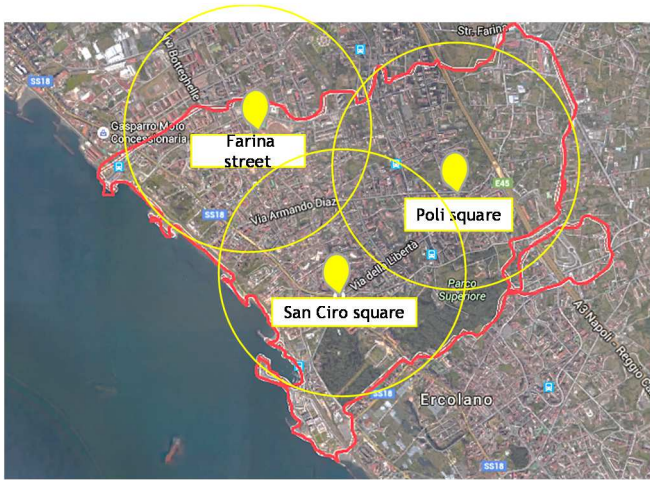


Fig. 5. The location of the bike sharing stations in the Portici area in scenario 2

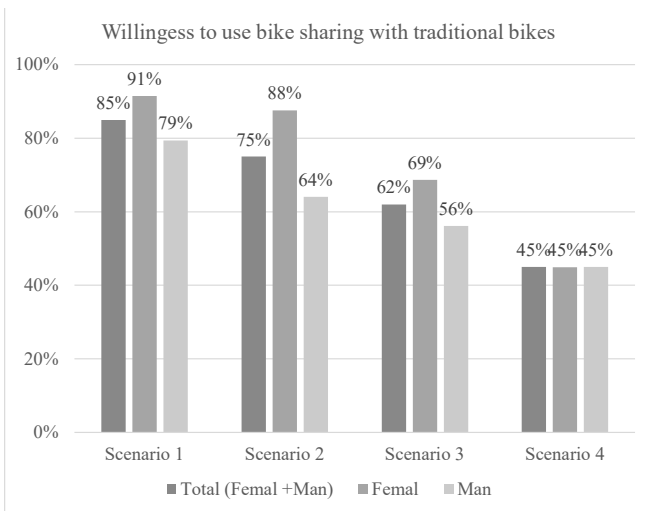


Fig. 6. The willingness to use bike sharing with traditional bikes in the 4 scenarios proposed distinct for women and men

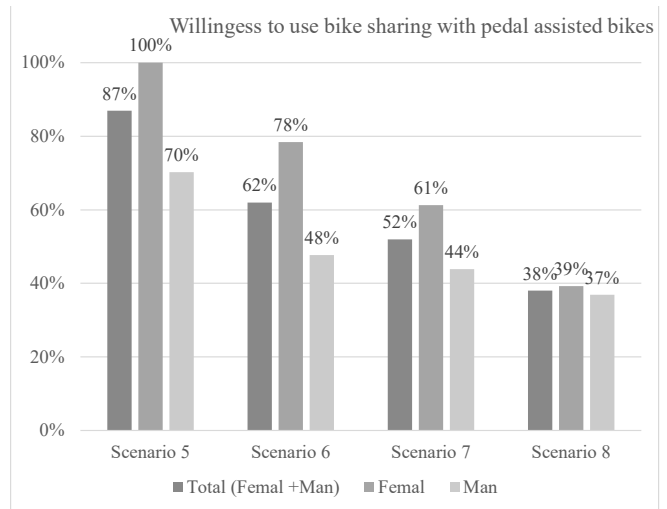


Fig. 7. The willingness to use bike sharing with pedal assisted bicycles in the 4 scenarios proposed distinct for women and men

## V. CONCLUSIONS

The mobility choice of university students represents one of the most treated topics within the scientific literature of the sector, considering the impacts that these choices might have on congestion. Mobility policies, in the recent years, have encouraged more sustainable mobility. From the analysis of the mobility choices of university students from city of Naples, it has been highlighted that only 2% of them use sustainable transport modes (bike and walking). The aim of this research is to evaluate the propensity to use bike sharing for potential engineering students residing in the city Portici. For this reason, a mobility surveys was conducted interviewing students at the high schools of Portici. The objective has been that of investigating students' attitude in the use the bicycle to reach the new location. In order to quantify their willingness to walk to reach the Bike Sharing station (both in the case of traditional bike and with pedal assisted bike), 8 different scenarios (SP survey) were proposed to the students diversifying and distancing the origin (residence) from the bike sharing station.

The result show that on average a student who lives in Portici and wishes to enrol at the faculty of Engineering of the University of Naples Federico II is willing to walk up to 900 meters to reach the bike sharing station. In the case that the bike sharing service is with pedal assistance charged by an annual cost of 30 euros, there is a higher attitude to use bike sharing, but less attitude to walk to reach the station. In fact, in this case a student on average is willing to walk up to 600 meters to reach the bike sharing station. The future research perspectives are: to explore the factors affecting bike-sharing demand, to estimate travel behaviour modelling [29] and therefore to design (considering the costs, the organization) a bike sharing service for the engineering hub in San Giovanni a Teduccio also in addition to already present transport service on rail.

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