SUSTAINABLE MOBILITY STRATEGIES IN AN ITALIAN UNIVERSITY

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The demand for sustainable and efficient mobility options may be critical in contexts that host large public bodies, since public transportation systems can be overloaded. The present paper discusses the case of a medium-sized Italian university located in a small Alpine town, whose departments are partially situated on hills around the town center. The current situation, analyzed by a survey, is critical, since students report of overloaded buses and of the poor chance of getting on. However, different solutions are here discussed and proposed for application to this situation and to other contexts concerning large public bodies in the world.

Keywords: sustainability, public transport, urban environment, morphology, Alps.

1. Introduction

The topic of urban mobility and his impact on the environment and human health is of increasing importance if considering that the population living in urban areas is continuously growing [1-4]. At European level, road transport is the main contributor to the emissions of nitrogen oxides and the second most important contributor of fine particulate matter, black carbon, carbon monoxide, ammonia and noise [3,5-9]. In 2016, road transport was also responsible for 27% of the total greenhouse gas (GHG) emissions in Europe, with an increasing trend expected for the next years [10]. Meanwhile, cities must face the growing demand for efficient transportation by workers, students and residents without neglecting the need for pursuing sustainable development targets. However, the growing demand for urban mobility may represent an opportunity for implementing sustainable strategies, especially if supported by technological and political tools favoring the shared use of private means of transportation and/or incentivizing the

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use of public transport [11-14]. Public transport is still one of the most efficient key strategies towards sustainable urban mobility [15].

The problem of ensuring adequate means of transportation to citizens is even more pronounced if the urban area includes large public bodies or companies, whose communities may involve high traffic flows, generating congestions and air pollution. Such problems can be exacerbated by additional traffic attractors, like highways and by-passes, especially in mountainous regions or in narrow valleys [16-18]. Improving the transportation modalities of cities would allow making important steps towards the achievements of two sustainable development goals (SDGs): Sustainable cities and communities" (SDG n. 11) and "Climate action" (SDG n. 13) [19].

Universities attract a large number of people every day [20]. Students are the most numerous fraction of a university community, but the mobility of researchers, professors and administrative/technical staff can be significant too. Mobility is believed to contribute most to the impacts of university campuses on the environment [21]. Recent studies focused on developing strategies to improve the sustainability of universities [22-24]. Concerning the specific sector of mobility, several studies propose efficient solutions consisting in the implementation of mobility management plans, in the creation of suitable conditions for non-motorized means of transportation (e.g., bicycles or pedestrian paths) and car sharing, or in the intensification of the public transport [25-27].

In the light of the situation presented above, this paper describes the case of an Italian university, taken as an example for the discussion that has taken place in the recent years on how to improve the mobility conditions of the university community [28,29].

The present paper aims at proposing strategies to improve the mobility options available to the university's community. The paper will present some issues concerning the current mobility offer, the modalities through which data and community's opinions were collected, new proposals to improve the current situations and a critical analysis of the strategies identified. Though being born in a specific university, such a data collection activity and public discussion of strategies for better and sustainable transportation options represent an example of novel proficient participation mechanisms towards shared sustainable choices taken by a large community of people. Such approach could be successfully exported to other similar contexts in different countries and, in general, to other large public bodies, given the important role of education places and in setting examples of good practices and disseminate virtuous behaviors to the society.

2. Case study

The case study presented in this paper refers to the town of Trento (Italy), with a resident population of 118,000 inhabitants [30]. The center of Trento is located at the bottom of an Alpine valley and has several neighborhoods on the hills around. Trento is the seat of a medium-sized university, whose total community counts 15,200 students and almost 2,800 people among professors, researchers and staff, for a total population of about 18,000 people. The scientific departments of the University of Trento are located on a hilly zone of the town, in two different neighborhoods, Mesiano and Povo, distant around 2 and 4.5 kilometers from the center of Trento (Figure 1).

Daily, thousands of students and workers reach those departments, most of them in the morning, in the period 8.15-9.00 am, and starting from the valley floor area, since few students and workers live in the neighborhoods of Mesiano and Povo. The difference in height makes it difficult to reach the sites by foot or bike. Due to these physical obstacles, the majority of people use cars or the public transportation service. The departments of both neighborhoods are reached by the same bus line (n. 5), and by a train, with different routes. Both services are operated by the municipal undertaking that manages the public transportation service of the Province of Trento. Bus n. 5 starts its route upwards in front of the railway station of Trento. Other bus lines are not relevant for the case study, since they runs far from those two campuses.

The users involved in those two campuses are typical of a medium-sized university: the students of Mesiano and Povo, during the academic year 2017-2018, were around 1,600 and 3,300, respectively. Besides students, more than 1,000 workers among researchers, professors and technical-administrative staff reach the two campuses every day. Furthermore, in Povo, near the university, there is a research center which counts about 600 people. Finally, the inhabitants of Mesiano and Povo potentially involved in commuting from the hill to downtown are 5,800. The last year was characterized by a significant increase in the number of passengers of the public transportation service. Such an increase is due to two aspects: the growth of the departments of Povo and the introduction of the “mobility card”, which is the result of an agreement between the university, the local government and public transportation undertaking. Thanks to the mobility card, undergraduate, master and PhD students are allowed to move in the entire province of Trento by public transport at the tariff of 50 € per year. This initiative has made very convenient to reach departments by public transport.

Fig. 1. Aerial view of the town of Trento and locations of the campuses of Mesiano and Povo; the routes of bus n. 5 and of the train service are represented by yellow and orange lines, respectively; image obtained via Google Earth (Google LLC, USA).

In the morning, the number of bus rides is higher than in the other periods of the day, but they are not enough to cope with the high flow of passengers. The university community reports that the situation on buses is very uncomfortable, since buses are often crowded and the indoor air is usually hot and rarified. Passengers are often not able to get on the buses, due the lack of space available. For these reasons, several people who owns a car or a moped/motorcycle, especially professors, researchers, PhD students and staff, prefer to use their own vehicle. This causes an increase in traffic and problems with parking.

In addition, the bus line n. 5 suffers from chronic delays, especially during rush hours, which normally corresponds to the beginning/ending of classes. The main causes are the traffic on the route, occasional late starts of the bus trip and the accumulation of delay during the boarding/disembark of passengers, especially when buses are close to (or exceed) their passenger capacity. In some cases, it happens that people are not aware of another bus that may come a few minutes later. Consequently, people get (or try to) on the first bus, thus crowding it, increasing the discomfort among passengers and increasing the delay of the

bus. This may contribute to increase the percentage of the students that prefer private means of transportation rather than relying on public buses.

3. Methods

The first step towards the solution of the mobility problems that affect the campuses of Mesiano and Povo consists in the collection of data to investigate the habits of students and their mode of utilization of the public transportation. This would allow studying and evaluating proposals for actions leading to improve the public transportation service. In 2017, an online survey was submitted to the students through several ways, including social networks like Facebook and Whatsapp courses groups, and the Facebook page and the Telegram channel of students' representatives. For this purpose, the survey was elaborated with the Google Forms platform. The students were asked to answer a set of 35 questions. In addition to general questions on the students' residence and on courses they attend, specific questions concerned the starting time of classes in the morning, the means of transportation chosen to reach the university, the problems experienced on public buses (if used), the reasons why they may prefer other means of transportation, which trains or other means of transportation they usually choose to go back home or to come to Trento (in case of commuting students) and open suggestions to improve the service.

Another important set of information comes from the data collected by the public transportation undertaking on the use of the mobility card by the students, which allowed characterising the problem from a numerical point of view.

4. Results and discussion

The percentage of students that replied to the questionnaire was 23%, i.e. over a thousand people. Lessons start between 8.30 and 9.00 am for 72% of the student population, i.e. for more than 3,500 students. As Fig. 2a shows, the large majority of students prefer to reach the campuses by bus n. 5. 56% of the students that use bus n. 5 to get to the campuses declare that they get on the bus in the period 8.30-9.00 am, when the first classes of the day begin. Fig. 2b reports the students' opinion on the bus conditions.

According to the majority of students, the journey by bus exceeds reasonable limits of comfort. Several students (18%) are often obliged to wait for another bus, since the bus they were waiting for is full. Surprisingly, 20% of the students who intend to take the bus at the initial stop declare that they cannot get on, since the bus is often crowded from the start of the route. It is worth noticing that the real capacity of the buses can be lower than the theoretical one, since the students can have backpacks. On Mondays and Fridays, in addition, some students

have luggage, since some students come back to their families during the weekends.

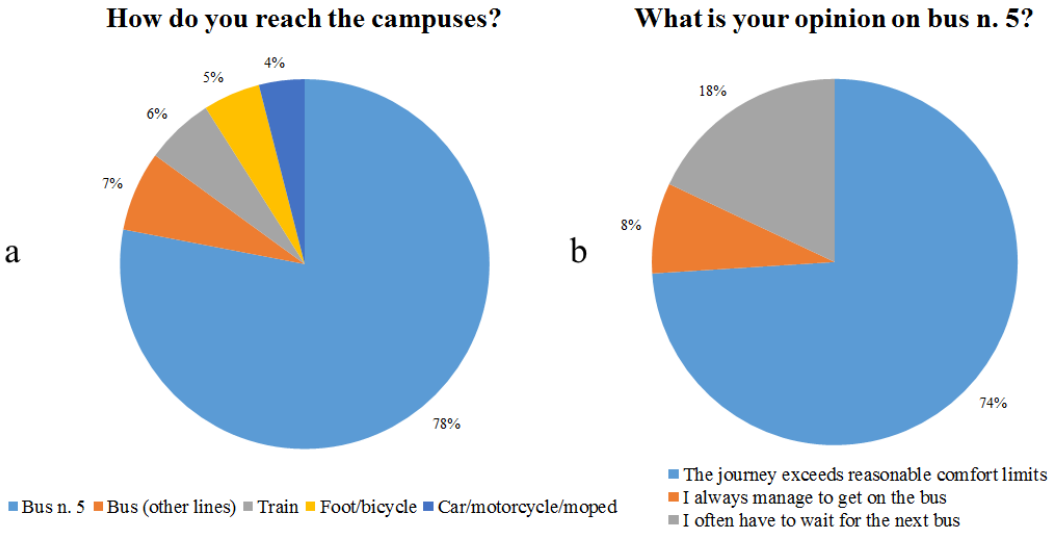

Fig. 2. Results of the questionnaire concerning a) the most used means of transportation to reach the campuses and b) the students' opinion on the service provided by bus n. 5.

The questionnaire highlighted another important aspect that concerns the use of the train. This means of transportation could be useful to the students of the campus of Mesiano, but not particularly to the students heading to Povo, since they should walk uphill for 600 m to reach the campus from the railway station, with a mean slope of about 10%. As a confirmation of this, 10% of the students of Povo declare that they do not use train for this reason. 10% of the respondents are unaware of the opportunity offered by the train, 19.5% get on buses in front of the railway station of Trento, where they could choose the take the train to Povo-Mesiano, and 17% do not use the train because of its poorly functional schedules.

Concerning daily commuters, only 4% of the students who arrive in Trento decide to take the train to get to the campuses on the hill. Such percentage is very low if considered that 80% of the commuters arrive in Trento by public transportation means. The students that do not use the train declare to use the bus because either they are unaware of the existence of the train as an option to uphill transportation or there is not coordination between the trains arriving in Trento and the train leaving to Povo and Mesiano. For this part of the students, it is more convenient to exit the railway station and wait for the bus. The percentage of commuters that prefer the bus to the train for this last reason is 19%.

The survey highlighted some important criticalities on the mobility from the center of Trento to the campuses on the hills around the town. In spite of the existence of a train connection, about 30% of the students does not consider this

option because they are uninformed, because of the lack of coordination with other means of transportation or because of the discomfort to reach the campus of Povo from the Povo-Mesiano railway station. In addition, most of the demand for public transportation is concentrated in the first part of the day, especially in period 8.30-9.00 am, when the classes start. The people that crowd up the buses are mainly composed of students, since only 4% of the bus users come to the university by car.

Following the increasing discomfort for this situation, in 2010 the University of Trento and the Province of Trento started to consider and evaluate different options to solve the problem of the mobility between downtown and the hills. One of the first options concerned a major infrastructure project, consisting in a funicular to connect the valley bottom with Povo and Mesiano. The criticalities of this project emerged quickly. At that time, the campus of Povo consisted of only one building, but the University was planning to enlarge the campus, whose size almost tripled in the following years. The uncertainty regarding the capacity of the transportation options under consideration made the project delay. Presently, due to the increased number of students, professors, researchers and staff, this project is no longer suitable to the current needs. The main reason is related to the low capacity of a funicular with a route of about 2 km, which would have been capable of transporting only 1,300 passengers per hour. Between 8 and 9 am, the bus line n. 5 is capable of transporting 2,760 passengers, i.e. more than double the capacity of the funicular. The high investment costs involved for this system, which would have solved the problem only partially, were considered as not sustainable. In addition, a funicular cannot offer the flexibility that other transportation systems can ensure (e.g., trains and buses).

The current situation could be improved by working on two sides in the meantime. On one side, a periodic round table between university, local government and the municipal undertaking that manages the public transportation system would help finding solutions to optimize the offer of public transportation to the university community. On the other side, internally to the university, the departments should improve the organization of the courses by changing and adapting the starting of the classes to the best solutions found for the public transportation system and should inform the students on the options available for public transportation. The first type of actions would also meet the interest of the public transportation undertaking, since the students that purchased a mobility card or a subscription to benefit from the transportation service are about 7,700, i.e. almost 7% of the whole population of Trento.

A first set of round tables was held in 2018. The dialogue between all the parties involved allowed obtaining a first roadmap to improve the situation. The public transportation undertaking took the occasion to plan the purchase of new three-axis buses, which would almost double the capacity of conventional urban buses. Meanwhile, the same company introduced a new timetable to allow commuting students to take the train at the Trento railway station and optimize the connection between the valley bottom and the campuses on the hills. Since the railway connecting Trento to Povo-Mesiano is one way, the freedom to operate the change in the timetables was limited. A compromise was obtained anyway, since the university decided to modify the start time of classes and postpone it from 8.30 to 8.45 am. In addition, the beginning of most crowded courses was postponed to 9.30 to further reduce the overload of buses. Furthermore, the students were informed on the train service and on the new timetables, in order to increase the awareness of the main users involved. Due to the novelty of these measures, data on the users' satisfaction are still missing. However, such measures are expected to reduce to 0% the fraction of students who often do not manage to get on bus n. 5 for crowding.

The round table was particularly useful to solve the problem of the unawareness of people concerning the chance to get on a second bus a few minutes after a crowded bus has passed. One solution consists in the introduction of an automatic vehicle monitoring system based on GPS devices mounted on the buses. Such system, combined with an app for mobile phone under development of with information panels installed at the bus stops, would alert the passengers on land about the waiting time required for the following bus to arrive. The system is planned for activation in the next months.

As an alternative to the funicular system and to improving the bus service, the University, the Province and the Municipality of Trento are considering the project of an escalator (i.e., an oblique elevator) to connect the valley bottom to Mesiano. The expected investment costs would be considerably lower than the funicular (about 1.8 million € in total, compared to 20 million €/km for a funicular system), and so would be the operating costs. Compared to the funicular, the route of the escalator would be very short, since it would start at the base of the hill of Mesiano. In addition to decongest the bus route, an escalator would incentivize people to arrive at its base by foot or bicycle. The escalator would made the rise to the hill of Mesiano more comfortable, since the current slope of the path leading to the campus is particularly high (about 13%). Furthermore, this project would favor other potential users, like the inhabitants of the hill. The escalator could be used both by the students who already reach the campuses of Mesiano and Povo by foot/bicycle (about 250 per day) and by an additional number of students who could be attracted by this sustainable option. The escalator would also allow for the transportation of bicycles.

The university also searched for solutions that do not directly involve the conventional public transportation service. An alternative to the bus and train services is given by a local car-pooling service based on the "Telegram" app for mobile phones [31]. The service allows the users to offer/accept lifts to and from the university for free. Currently, the service does not consider a fare system for passengers (and thus a reward for drivers). This service has been continuously growing since its activation (November 2015) and nowadays accounts for 112 stops in the Province of Trento and about 1,000 subscribers. By continuing a promotion campaign started by the University of Trento, this number is expected to grow up further and could induce bus users to shift toward this alternative option.

All the options presented here, with the exception of the funicular, whose economic unfeasibility has been discussed, could be evaluated by the public administrations of other similar contexts located elsewhere. The simple re-arrangement of timetables, the implementation of car-pooling services exploiting new forms of communication (e.g., social media) or more complex but extremely useful and convenient infrastructures are examples of initiatives that could reduce the impacts of the contemporary presence of great attractors of people (e.g., large public institutions) and morphological/infrastructural constraints.

5. Conclusions

The present paper highlighted the criticalities that a large public body (e.g., a university) may induce to the mobility of its community and of all the inhabitants of the town/city where the public body is located. The mobility options and services may be negatively affected by the morphology of the area. In the present case, the location of two of the largest departments on the hills around the town determines a limited number of transportation options, which results in the frequent overloading of buses and in the risk of missing classes by the students. Meanwhile, improving communication via information campaigns reveals as crucial to indicate other alternatives in addition to the most obvious ones (e.g., train and car pooling services). In the attempt to improve the mobility in such contexts, the dialogue with the local administrations and with the companies that manage the public transportation service is essential and can be extremely proficient, as the present case study demonstrates.

Investments in the field of public transportation, in car pooling/sharing initiatives and in infrastructures for more sustainable mobility options (e.g., bicycles and electrical vehicles) lead to obvious advantages also in terms of air pollution and GHG emissions, since the sharing of public/private vehicles and the use of zero-emission ways of transportation reduce the number of total vehicles on the roads and the average amount of pollutants/GHGs emitted per passenger.

Analyzing the criticalities in terms of mobility may result in the opportunity of studying alternative ways of transportation and, possibly, applying them to specific situations.

The considerations expressed in the present work could be easily applied to other similar contexts. The latter could be specific contexts that experience mobility problems due to complex terrain, shortage of road infrastructures and environmental pressures caused by the presence of large public bodies.

The article demonstrates that sustainable mobility, in specific contexts, can be performed through a sum of coordinated micro-actions.

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