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Connecting university facilities with railway transport stations: the case of Catania

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Abstract

Public transport is one of the first mode used by students in Italy and this is confirmed by official data by the Italian National Institute of Statistics. Catania, a city in the south of Italy, takes the distance from these standards by having a modal share of public transport trips, especially train trips, lower than in many other Italian cities. Even if the city has a good network of urban stations located at a cycling distance from university facilities, the accessibility to such transport nodes is not always guaranteed. The aim of this study is to provide a methodological contribution to promote intermodality between cycling mobility and railway transport by connecting railway stations with university venues. A multi-criteria spatial approach is presented to select suitable stations lacking adequate intermodal infrastructures, which match students' mobility patterns, and plan intervention measures towards the promotion of conjoint use of railway and bike. The approach takes into account information on stations' locations and their connectivity, geometric characteristics of the road network, socio-economic data related to university population and students' mobility habits collected by a wide survey. The data acquired are used to build a Geographic Information System and perform a spatial multicriteria analysis which allows to obtain a ranking of the locations, providing suggestions to decision-makers on how to select priority interventions.

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1. Background

Universities play a fundamental role in attracting users, and their location generates high flows of mobility that influence the modal share of an entire city. The role of the university assumes such importance within a territory that in some countries the term "University City" (or "College City") is popular for those cities specialized in providing higher education where colleges and universities have a disproportionately large weight on economic, social and cultural landscape. In these contexts, the ease of access to universities, which can be located on a single campus or scattered across the territory, plays a key role in planning the sustainable mobility of the entire city. At the same time, the needs of university students and in general of those who attend university venues are different from those relating to the traditional users' systematic trips for study or work purposes. Trip frequency for university users may vary according to the day of the week, the site locations and the period of the year (e.g. during the exam period); moreover, these users often have to move from one venue to another during the same day. This highlights the importance of analysing students' mobility habits in order to identify priority interventions towards the promotion of sustainable mobility (Papantoniou et al., 2020; Ribeiro et al., 2020).

In this context, the use of railway transport plays a fundamental role for university students' mobility, since it allows users located in the suburbs or neighbouring villages to reach the study sites quickly and reliably.

In Italy, the debate around this topic is very lively and there are several policies to foster the connections between railway transport and university sites. In particular, according to the Italian National Institute of Statistics (ISTAT) the majority of students aged between 15 and 24 uses public transport, while 1/3 of those aged more than 25 years use private transport[†]. The Ministry of Sustainable Infrastructures and Mobility together with the National Railway Company, Rete Ferroviaria Italiana (RFI), have recently promoted the realization of cycle stations and cycle paths to connect railway stations with the main university sites with a funding of around 4 million Euros. This will be a joint effort between the Municipalities that are in charge of creating the cycle paths and stations and RFI that will provide *ad-hoc* sites for cycle stations at the railway stations[‡]. The project will start from seven cities (Bari, Milan, Naples, Padua, Palermo, Pisa, Rome) that have been identified according to specific criteria like the presence of points of interests, pointing to the need of appropriate procedures to identify priority of interventions when there are multiple University sites.

The topic of university students' mobility is fairly addressed in literature. Papantoniou et al. (2018) investigated the mobility situation in different university campuses taking into account their location (inside or outside urban area). Main results show that campuses outside the city need to extend their current public transport network in order to satisfy the relative supply. Public transport accessibility is also an important issue for university campuses since it allows to facilitate the arrival of students that come from different parts of the city, foster social inclusion and discourage the use of the private car (Kaplan et al. 2014, Giuffrida et al. 2017). Inturri et al. (2021) carried out an analysis considering various indicators: public transport accessibility and ridership, university students' mobility habits and their level of satisfaction about public transport. Zannat et al. (2020) proposed a GIS-based methodology to characterize the zones usually frequented by university students. They calculated the accessibility level of each zone through a multicriteria approach with a focus on active and public transport modes. Most of the literature studies focus on the use of public transport, while just a few deals with active mobility. Recently, Attard et al. (2021) organized a participatory workshop where people were involved to evaluate roads around the campus of the city of Malta. The aim was to analyse the feasibility of paths for walking and cycling, underlining the need to make them more suitable for such active travel modes. In this respect our paper provides a further contribution to this topic, by proposing a methodology aimed at ranking the "bikeability" of university venues by taking into account various indicators of the level of connection with railway and metro stations. The method will be applied to the case study of the University of Catania, located in the south of Italy. Some intervention proposals to improve these connections, encourage the use of alternative and more sustainable mode of transport and foster intermodality.

[†] https://www.istat.it/it/files//2018/11/Report-mobilit%C3%A0-sostenibile.pdf (in Italian, last access 19th May 2021)

‡ https://www.ansa.it/ansa2030/notizie/infrastrutture_citta/2021/03/17/mims-al-via-progetto-da-4-mln-in-bici-stazioni-universita_0726b76e-fd65-4e5a-ba75-84345c34db2c.html (in Italian, last access 19th May 2021)

2. Methodology

The final aim of the proposed method is to provide a ranking of the connection routes between railway stations and university venues, taking into account their "bikeability" potential. The ranking is based on the evaluation of a Venue Connection Score (VCS), a composite measure which takes into account the venue's attendance, the distance from the railway stations and other geometric parameters of the shortest route.

More in detail, the criteria used for the evaluation of the VCS are the following:

- Number of students attending each venue (U)
- Distance (D): the shortest path (SP) on the road network;
- Slope (S): Gradient for cyclists should not generally exceed 6%, although short steep slopes can be acceptable (up to 10%), while longer ascends gradients should be reduced (CHIPS, 2021). In this study, we evaluated slopes for each shortest route, using Google Earth application;
- Road width (W): an average road width of the route has been measured, using Google Earth application.

In order to evaluate the VCS, we decided to take into account the three closest railway stations to each university venue. VCS is computed as the sum of the normalized values of the criteria D, S and W, multiplied by the normalized value of U (Equation 1):

$$VCS = U_n (D_n + S_n + W_n) \quad (1)$$

Values obtained for the criteria D, S, W have been normalized in the range 0-1 according to the maximum and minimum recorded value (Equation 2). For the criteria U, the values have been normalized according to the maximum, avoiding 0 values of U and then null VCS values.

3. Case study

Catania, a medium-sized city located in Sicily (Italy), can be considered a "University city". In this respect, it has a population of 300,000 inhabitants and accounts for approximately 40,000 students coming from different parts of Sicily and outside of it. The University of Catania (UNICT) was founded in 1434 and is one of the academic institutions with the longest history in the country and in the entire Mediterranean basin. It has 17 departments scattered in the city and 2 separate structures, and it counts 2,500 employees among professors and technical-administrative staff.
UNICT's transport problems retrace Catania's ones. In particular, being a car-dominant city, it suffers from road traffic congestion with all the negative externalities, low levels of use of the public transport services, and poor infrastructures for slow mobility (walking and cycling).

In 2006, UNICT established a Mobility Management Office (MOMACT) to promote sustainable mobility habits within the University community. In this respect, a specific plan has been defined in 2009 with clear sustainability objectives and strategies, and several initiatives proposed in the following years (Le Pira et al., 2015). In particular, UNICT started collaborating with the Municipality of Catania and the two Public Transport Companies, providing the bus and the metro service, to some improvements related to the mobility of its community in 2013, a Bus Rapid Transit (BRT) line connecting the Science and Technology campus in the northern part of the city with the city centre has been introduced. In 2017 and 2018, two metro stations have been opened respectively close to the campus and to the sites in the historic centre, and two feeder bus services have been provided to serve as first- last-mile connection with the University venues. A map with the locations of the university venues and railway/metro stations is reported in Fig.1.

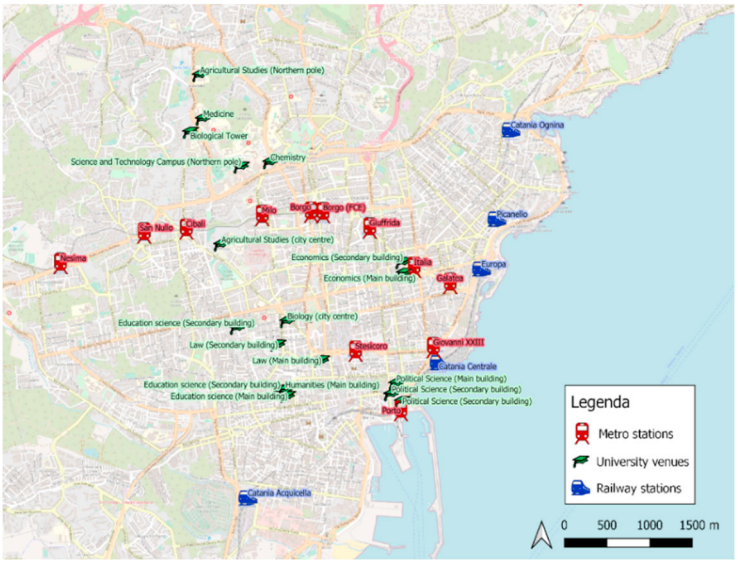

Fig.1. Map of the University venues and the metro/railway stations.

At the end of 2018, an important incentive to public transport use has been given by UNICT by providing an unlimited access to all 40,000 regularly enrolled students to all the urban public transport network (Inturri et al., 2020). Data obtained from a wider survey on the mobility behaviour of university students in Catania conducted between 2018 and 2019 show an unbalanced modal share towards the use of the private car, especially compared with public transport (Inturri et al., 2021) (Fig.2).

For this reason, the effort to promote sustainable mobility has been huge, mainly with respect to local public transport and intermodality in general. However, still a lot has to be done, especially considering the poor accessibility of university venues by walking or cycling. This has become even more evident with the outbreak of COVID-19, with mobility restrictions and the reduced capacity of public transport to guarantee social distancing. It is thus important to take preventive and corrective actions to contrast the risk of increasing the use of private cars to access University sites. In this respect, providing *ad-hoc* connections with the railway network to favour active modes, which is particularly suitable for students who come from outside the city, and the metro network, which is mostly used by students, become very important.

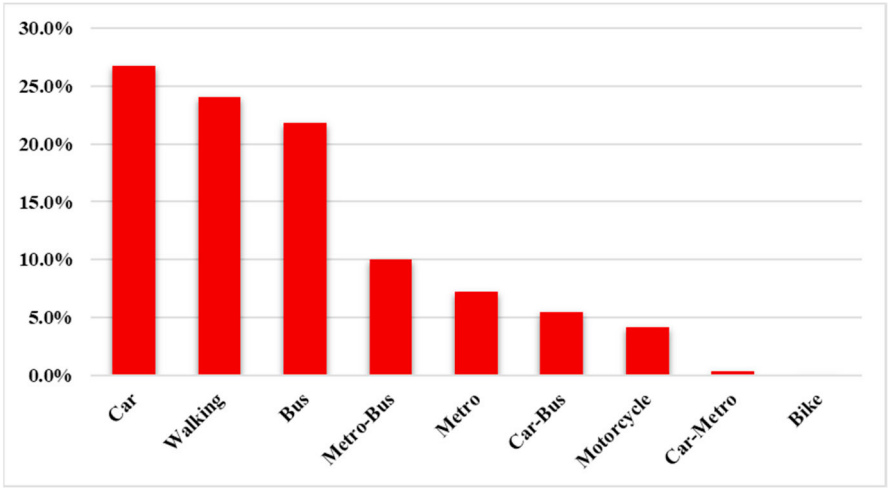

Fig.2. Modal share of university' students of Catania (Inturri et al., 2021)

4. Results and discussion

Table 1 shows the results obtained for each university venue. Distances were evaluated through the ORS Tools plugin in QGIS environment. The ORS Tools plugin allows to use the openrouteplatform utilities in QGIS, so it is possible to evaluate shortest distances between different locations (Fig. 3). Information about the number of students attending each venue (U) has been obtained from the aforementioned survey (Inturri et al., 2021).

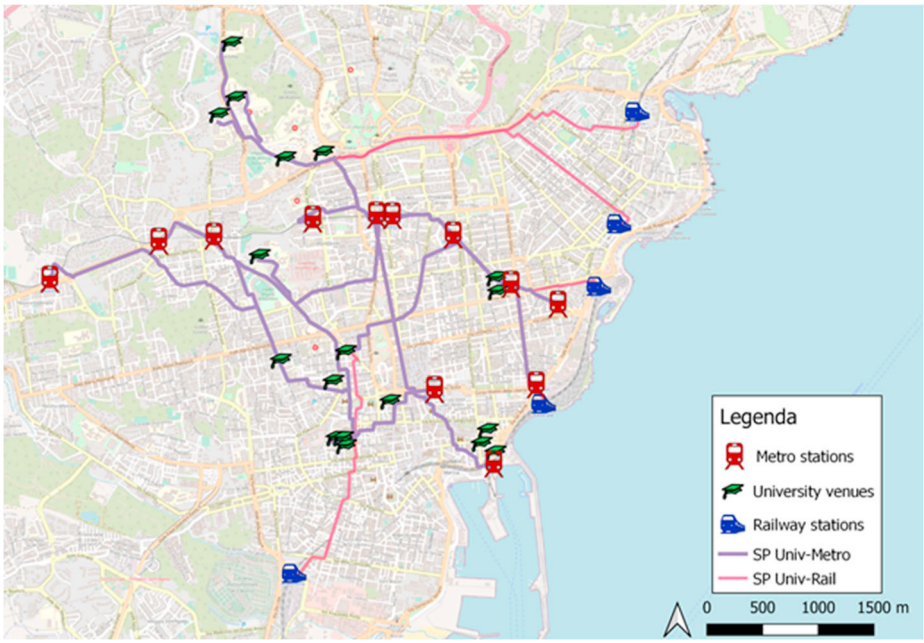

Fig. 3. Example of SPs from university venues to railway stations

To improve the readability, Table 1 includes non-normalized values of criteria and VCS, only for the station with the best VCS, and are ordered according to the final ranking.

Table 1. Criteria and ranking of the VCS values for University venue-station connections

University venue	Station with highest VCS	U	D (m)	S	W(m)	VCS value
Science and Technology Campus (Northern pole)	Cibali	10012	952	0.05	4	1.607
Education science (Secondary building)	Catania Acquicella	2908	1237	0.02	6	0.477
Economics (Main building)	Italia	1580	134	0.01	5	0.422
Agricultural Studies (city centre)	Milo	1552	579	0.02	6	0.404
Biological Tower	Cibali	2540	1091	0.07	4	0.333
Economics (Secondary building)	Italia	1076	139	0.02	6	0.306
Law (Main building)	Stesicoro	1008	410	0.04	5	0.230
Law (Secondary building)	Borgo	976	1543	0.02	6	0.204
Agricultural Studies (Northern pole)	San Nullo	1588	1893	0.04	5	0.219
Biology (city centre)	Milo	844	1230	0.03	6	0.180
Political Science (Main building)	Catania Centrale	540	550	0.01	5	0.133
Political Science (Secondary building)	Catania Centrale	544	610	0.01	5	0.131
Education science (Main building)	Catania Acquicella	544	1237	0.02	6	0.122
Education science (Third building)	Milo	492	1300	0.02	5	0.095
Medicine	San Nullo	400	1459	0.05	5	0.064
Political Science (Third building)	Catania Centrale	204	610	0.01	5	0.049
Humanities (Main building)	Stesicoro	96	929	0.03	4	0.017
Chemistry	Milo	20	603	0.06	5	0.004

The following main results can be derived from the analysis of the criteria and VCS values in Table 1:

- The Science and Technology Campus (Northern pole) has the best VCS, despite its location (very steep); that is due to the very high number of students attending this venue.
- The same reason is the cause of the lowest value attributed to Chemistry.

More in general:

- Road width and slope do not seem to be a discriminating factor compared to the other parameters taken into consideration.
- Universities with the highest VCS are those with either a higher number of students or which are very close to the reference station (e.g. Economics main building).

In this respect, designing intervention measures according to the VCS score could allow decision-makers to solve priority situations (i.e. with more students) or faster ones (i.e. less expensive).

5. Example of intervention measures

In this section, as a design example, we propose the requalification for the connection between the university venue Political Science (Secondary building) and the railway station Catania Centrale. The aim is to suggest potential design tips on how to design a cycle track in urban area. Fig. 4(a) maps the intervention route, which has a length of about 600 m. It consists of three different streets: the first one, which is the one proposed for our intervention (Fig.4(b)) is an urban arterial road with two driving lanes and two parking lanes per direction. The two driving directions are separated by a central median hosting trees and urban equipment. The wide roadway makes it possible to think of an easy intervention to design a cycle lane, by simply removing the parking from the right side, as shown in Fig. 5.

(a) (b)

Fig.4. (a) Path and (b) picture of the street selected for the intervention

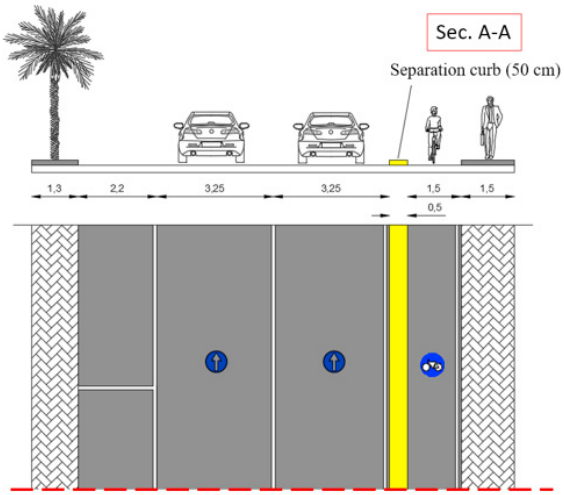

Fig.5. Intervention proposed for Political science (secondary building) – Catania Centrale station connection

6. Conclusion

Promoting the use of sustainable modes of transport and analysing their interactions is the basis of the various processes involved in transport planning. This paper presents a procedure to rank the connection by bike between university venues and railway stations based on different criteria both related to the attendance of the facility and the geometry of the shortest route. The aim is to provide decision-makers with a planning-support method to help them in establishing the priority of investments. The case study is the University of Catania, a medium-sized city in Sicily (Italy); the university is one of the largest in Italy (40,000 students) and it is a widespread campus, with venues scattered throughout the city. The set of evaluation criteria chosen to assess the importance of the connection includes the number of students, distance, slope and the road width; these criteria were used to build a Venue Connection Score - VCS, with the highest values indicating the priority of intervention. First results show that a higher VCS is related to venues with higher attendance or located at a shorted distance from the station; this might help decision-makers to invest at first for improvement of priority situations (i.e. with more students) or shortest routes (i.e. less expensive). Further research could improve the proposed method, by scaling it to different case studies, including other characteristics, e.g. the presence of pedestrian and green areas, available bike-sharing services, pre-existence of cycle tracks including also parameters linked to the connection with public transport, e.g. reliability and availability of the

service, which could influence students' mobility habits (Dell'Olio et al., 2011; Fazio et al., 2020); innovative mobility options, such as e-scooters could also be part of the analysis; in this case, other features should be taken into consideration, such as driving behaviour, trip pattern, road safety and security (O'Hern & Estgfaeller, 2020; Boglietti et al., 2021). In particular, in this case study we analysed the connections related to both metropolitan transport and railways, thus treating urban and extra-urban trips with the same approach. It would be interesting to design a future approach with *ad-hoc* proposals distinguishing these two trip types, also thanks to an in-depth knowledge of the origins of the students attending each location.

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