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Mobility management at Politecnico di Milano: New infrastructures and behavioural change

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Abstract. Transportation has significant and long lasting economic, social and environmental impacts, making it one of the main challenges to be addressed by policy makers, public managers and scholars worldwide. For Universities, students and staff transportation represents one of the largest impacts on the environment and society, since in many cases it represent a noticeable share of urban traffic. A wide literature is available on the policies that support reducing car usage and improve the environmental and social sustainability of commuting to University. This paper presents the situation in the Politecnico di Milano, recorded through mobility surveys carried out in 2015 and 2017 to investigate the key issues and design possible solutions. The aim of this study is to share the set of actions and activities planned to improve the current mobility patterns of the Politecnico di Milano in favour of more sustainable means of transport. The main strategies will be the redesign of the campuses and the new infrastructure to be installed, together with the promotion of sustainable behaviours among the whole University population thanks to various activities in the framework of the '*Città Studi Campus Sostenibile*' initiative. A special mention will be given to the '*Vivi.Polimi*' project, which aims to improve the liveability of the Politecnico spaces, and which will give sustainable mobility a new impulse. Indeed, the planned measures include the reduction of the parking spaces inside the historical main campus while providing new infrastructure targeted at the promotion of alternative means of transport, like increasing the number of bike shelters to encourage active mobility or installing new charging stations for electric cars.

Keywords: sustainable mobility, mobility management, University mobility, infrastructures for sustainable mobility, campus renewal, sustainable behaviour, environmental impact, social impact, mobility policy,

1. Introduction

Achieving sustainable mobility is a relevant contemporary goal, addressed worldwide by scholars, planners and policy-makers, not only because it is related to the high greenhouse gas emissions of transportation, but also because it affects the quality of the living environment, e.g. in terms of air and noise pollution, and of lifestyles [1]. The term sustainable mobility should encompass all mobility related strategies leading, among others, to a better public transport network, more liveable and walkable neighbourhoods, education to proactive movement, and a stronger cycling culture, for example, and not only to cleaner vehicles [2].

Sustainable mobility is particularly relevant for Universities, which are significant poles of attraction for frequent travellers, because of their role as centres of employment, teaching, research and dissemination [3]. Hence, the mobility generated by Universities has to be taken into account in the planning of urban mobility. The overuse of private cars by people commuting to University campuses results in many negative externalities like atmospheric and noise pollution along with a general worsening of the overall landscape and urban environment [4]. In the last decades, these kinds of problems related to non-sustainable mobility and high dependency on motorized private vehicles have been detected in multiple campuses all over the world [5] [6] [7] [8]. Therefore, one of the main challenges for Universities should be the promotion of sustainable mobility, thus helping reshaping society's transportation patterns. Such Institutions have a key role in the education of the citizens and professionals of the future and they are usually similar to small cities within the city, where new solutions could be tested and studied [9].

Many States from Central and Northern Europe have been pursuing urban planning policies aimed at fostering sustainable mobility for decades with undeniable success, as demonstrated by their urban modal shares where bicycles have gained an important or even primary role while car use has dropped substantially [10]. Several studies have been developed by European Universities to identify the most effective mobility management policies to shift the modal choice to more sustainable alternatives [3] [4] [11].

This kind of urban planning is still pretty new in Italy which means that Universities need to take a proactive role in fuelling the debate, contributing to the spreading of sustainable mobility with concrete actions. Italian Universities, which are often quite big players counting tens of thousands people within their communities, usually have a big impact on urban mobility: in fact, the overall daily distances travelled to reach the campuses tend to be very high [10]. Moreover, in Italy private cars are the predominant mean of transport, mostly relying on fossil fuels with traditional combustion engines; this generates high energy inefficiency and use of space, while also causing air and acoustic pollution and greenhouse gas emissions.

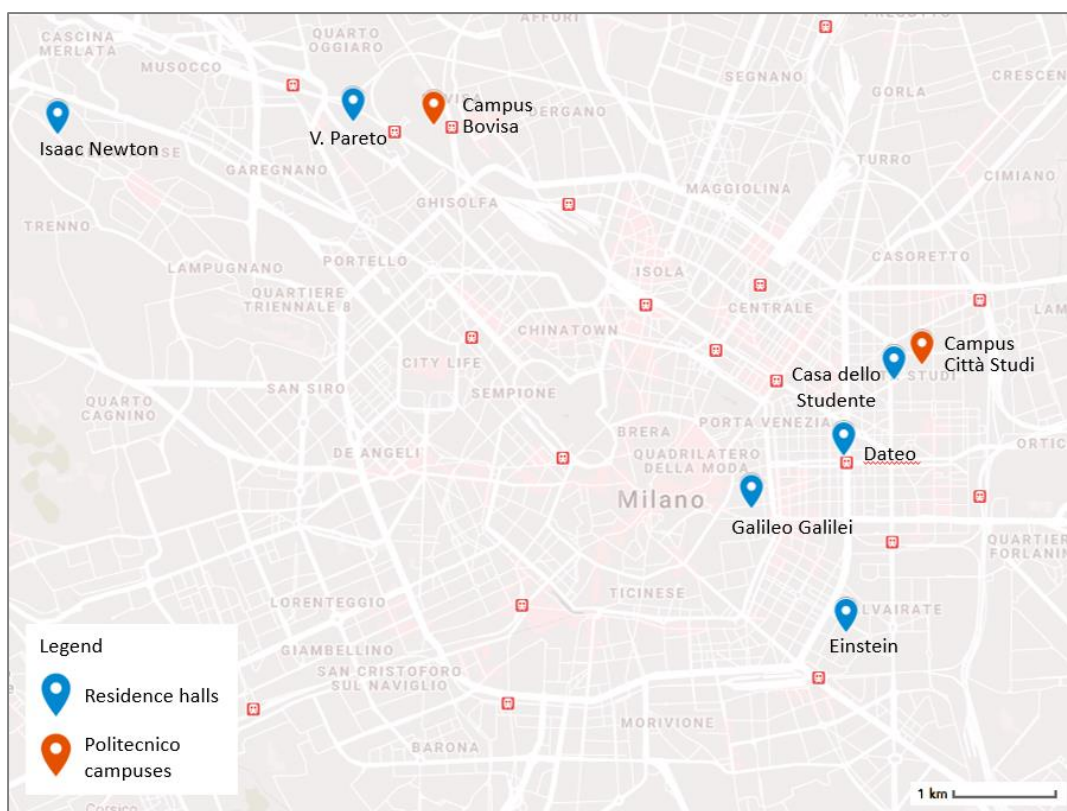## 2. Mobility at the Politecnico di Milano

In this framework, Politecnico di Milano and Università degli Studi di Milano launched in 2011 the '*Città Studi Campus Sostenibile*' project (CSCS) with the aim of transforming the Città Studi University district into an example of quality of life and environmental sustainability. The project addresses six main topics: people, energy, environment, mobility, city and food & health. One of the main focuses of the mobility working group has been studying and promoting solutions aimed at reducing the modal share of private vehicles commuting to the Politecnico di Milano. In 2013, the University Sustainability Office was established, aiming at managing the CSCS project and supporting the University Mobility Manager in the implementation of sustainable mobility strategies. In 2017, a new project was launched, called Sustainability@Polimi, revamping the sustainability mission of the University, including mobility as one of the main objectives.

In particular, commuting patterns have been analysed for both students and staff, in order to plan how to enhance campuses accessibility while reducing traffic and containing the emissions into the atmosphere.

2.1. Campuses features

Before analysing the mobility data, it's important to understand the layout and composition of the Politecnico di Milano campuses.

The University is composed of 7 different campuses, 2 of which are located in Milan (Città Studi and Bovisa), while the remaining ones are located in Lecco, Como, Mantova, Piacenza and Cremona. The University buildings are usually located outside the city centre and they accommodate classrooms, laboratories, libraries and staff offices; no dormitories are available directly on campus. There are some residences for students in Milan, Lecco and Como, but they can only accommodate a very small fraction of all the Politecnico students and are mostly not close to the main buildings (Figure 1). This generates high commuting rates towards and inside each city, which explains the importance of short- and medium-range commuting for Politecnico.

Figure 1. Location of the Milanese Politecnico campuses and of the 6 residences available.

2.2. Mobility surveys

In order to gain the necessary data on the mobility habits of the Politecnico community, the University Sustainability Service periodically implements and submits a mobility survey to all the community members. As of today, two editions of the survey have been carried out, in 2015 and 2017, and a new one is planned for the spring of 2019.

The first survey, obtained about 12,000 answers, representing 27% of the total University community at that time (48,633 people). The results showed that 67% of CO_2 emissions were related to private vehicles accessing Politecnico campuses, while accounting only for 20% of the total students' trips and 28% for staff [12]. The 2017 survey reached 59,140 people and gathered about 14,000 answers, yielding an overall response rate of 24% [13]. Comparing this survey results with the previous ones, it was possible to note a slight modal shift (almost 10%) from private means of transport to public and non-motorized ones [14], thus demonstrating a positive turn towards sustainable mobility habits.

The most recent results of the survey have also been used for the drafting of the Politecnico home-to-work travel plan named "Piano Spostamenti Casa-Lavoro" (PSCL), a document developed to analyse commuting patterns and habits, in order to plan the best strategies to improve mobility to and from the University. Such study [13] showed the complexity of Politecnico di Milano in terms of mobility: the commuting patterns are very different between the Milanese campuses and the regional ones. However, all Politecnico campuses are close to important transport nodes: students mainly use public transportation to commute to the University and private motor vehicles are mostly used to travel between home and a public transport node, while University personnel is more likely to use this kind of vehicles to commute all the way to the campuses. The mobility demand for campuses outside Milan features a higher use of private cars at the expense of public transport.

Politecnico mobility demand can be summarised as follows (Figure 2):

- public transport is widely used both as the only mean of transport or in combination with private vehicles (car, motorcycle or bicycle);
- private motor vehicles are more frequently used by the personnel, probably because of higher income and the availability of staff dedicated parking lots inside the campuses;
- active mobility, like walking, cycling and every other form of transport that only requires human physical activity for the locomotion, already represents a big part of the modal share for both categories but could be even higher.
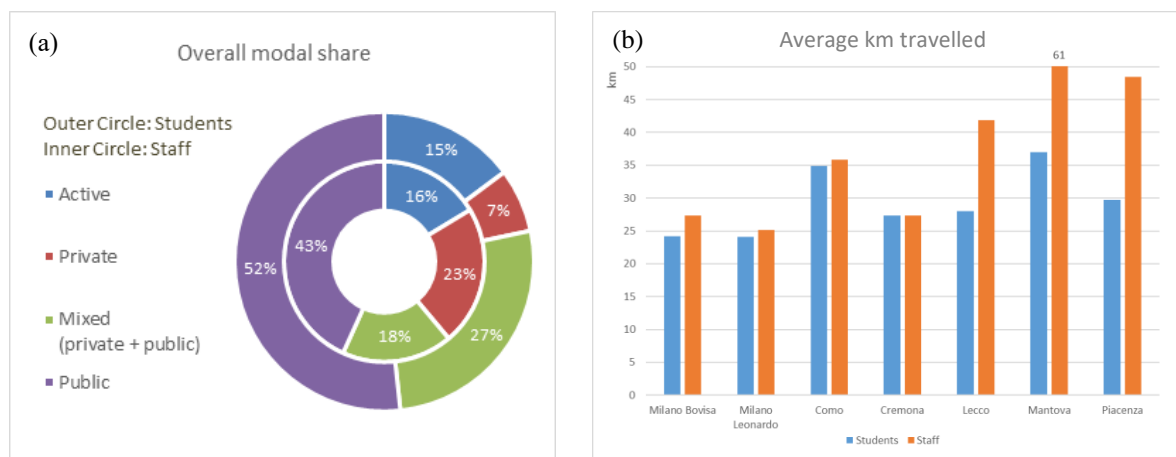
Figure 2. Modal share for the Politecnico community (a) and average distance travelled for each campus (b) as of 2017.

By analysing the trips distributions and distances [13] [15], it is possible to note how:

- Milanese campuses attract both students and staff from all over the region (and beyond) while secondary campuses have mainly a local catchment area;
- students' trip length is only slightly higher toward territorial campuses while for staff it can be remarkably higher when they are commuting from Milan;
- average distances travelled by bike are comparable to those by bus and in some cases are even higher.

The last bullet point is particularly interesting because of the chance to promote a further modal shift towards bicycles. Moreover, in 2017, 31% of the students were travelling 6 km or less by car [13], distances that are easily covered by bike too, but obtaining such shifts requires behavioural change which is a very slow process in most cases. For this reason, the surveys were designed to also collect users' opinions on the best incentives that could help quicken the shift; the results show how safety is seen as the main issue, both when travelling and from theft. Moreover, 40% of the students and 27% of the personnel declared they would use the bicycle more if they could take advantage of preferential prices for the bike-sharing service. Shared mobility is fairly common in Milan and the latest mobility survey

revealed that 75% of both our students and personnel knew about this kind of services. Still, the percentages of people actually using car or bike sharing services were much lower, only 17% for students and 20% for personnel.

According to the 2016 Report, CO_2 emissions related to transport activities account for 42% of the total Politecnico emissions [15]. While the 58% of the emissions are linked to the energy sector, the daily commuting of more than 48,000 people still has huge impacts, even though the campuses are highly accessible and most of the people do not use private cars. Given this high share, a study was developed to estimate the total distance commuted yearly with each mean of transport and compute the related emissions. The aim was to identify in which context sustainable transport policies could be more effective. Interestingly, the metropolitan scale seems to provide the best results: even though trips originated from this area are considerably less than those from outside Milan metropolitan area, a change in their modal share leads proportionally to the most relevant change in the overall CO_2 emissions [13]. This can be easily explained by the fact that shorter trips are generally travelled by car, while people coming to Milan from outside its metropolitan area use the train. Moreover, it was concluded that a change in staff mobility behaviour would have proportionally a wider impact than the same change for students.

2.3. Strategies

Building on these results, the University already adopted many policies aimed at fostering the development of sustainable mobility and behavioural changes within its community, both when commuting to Politecnico and in their private life. The main objectives are discouraging private motor vehicles use, stimulating the use of public transportation and of shared mobility and promoting active mobility.

The activities carried out by Politecnico can be subdivided into four main categories:

- facilitations and agreements, such as: the allocation of funds to subsidise the purchase of public transport subscriptions; the activation of agreements with the main companies providing shared mobility services in Milan to obtain discounts and organise awareness raising activities; the availability of a full electric car provided for free by the University for the business journeys of its employees and the promotion of smart working to reduce the overall number of trips;
- infrastructural interventions, such as: the installation of bike racks and shelters to increase the parking capacity inside the campuses, perceived as safer by users; the requalification of the historical campuses which includes the reorganization and reduction of car-parking spaces and the installation of teleconferencing infrastructure;
- awareness raising campaigns and behavioural change initiatives, which include: various events and seminars held every year mainly during the European Mobility Week and the Italian Sustainable Development Festival; the publication of the Code of Conduct for a Sustainable Campus with a focus on mobility; the launch of the University bike repair workshop (PoliCiclo), managed by students, where people can learn how to fix their bikes for free; the participation to activities for the promotion of active mobility (e.g. annual participation to the Bike Challenge competition and involvement in the testing phase a of new hybrid bike sharing service developed by a Politecnico start-up);
- networking activities with various stakeholders at local, national and international level: e.g. the participation to the working group with the Municipality of Milan and its Agency for Mobility and Environment, the Infrastructures, Transportation and Sustainable Mobility Department of the Lombardy Region and the University Mobility Managers, participation to the Italian University Network for Sustainable Development and in particular to its mobility working group, participation to the European Network for Sustainable Mobility at University.

We will now focus on the new infrastructures, in particular those for the promotion of active mobility, and the redesign of the campuses, which will be described in detail in the next chapters.

3. Bike shelters in the Milanese campuses

Since 2012, many infrastructural measures aimed at increasing bike parking spaces inside the Milanese campuses have been carried out. First of all, the available bike racks have been identified (Figure 3), together with the user habits. The results of this census have then been used to plan repairs when needed and to select where to position new bike racks: the available bike parking spots were 1,155 and the planned interventions provided 280 more.
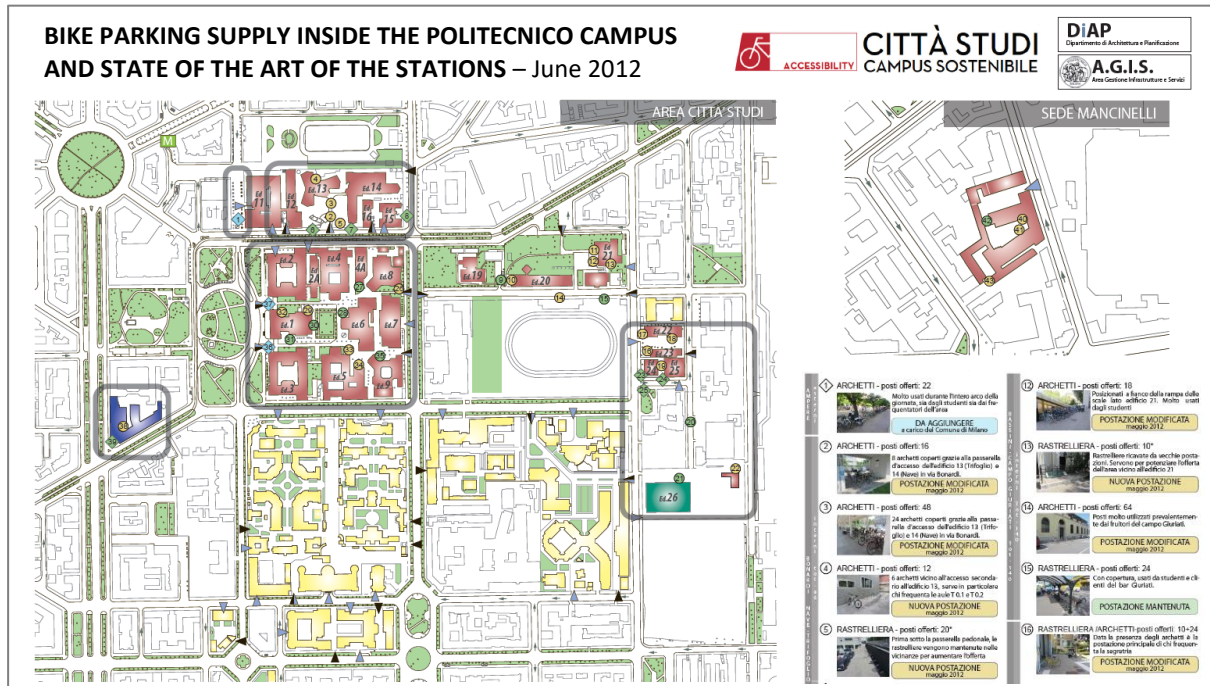
Figure 3. Politecnico bike parking supply in the historical campus as of 2012.

In 2017, Politecnico could rely on 1,437 bike parking spots, both inside and outside the campuses, most of which concentrated in Milan (677 in the Città Studi campus and 459 in the Bovisa campus). This supply increased once more in 2018 thanks to the addition of four bike shelters, providing 48 more parking spots covered with an overhang to protect the bicycles from bad weather (Figure 4).


Figure 4. Bike racks and shelters on the Politecnico campuses.

Many bike racks have currently been relocated due to the construction sites (introduced below), but the number of available bike shelters will become even higher by the end of the renewal process.

4. Structural renewal of the two historical campuses in Milan

The two main urban campuses in Milan are consolidated built environments, offering regeneration opportunities rather than new construction. Two main renewal projects are going to reshape the imagery of the campus in the near future, aiming at improving the liveability of the Politecnico. These transformations will also impact on people's behaviour, including mobility aspects, offering new tangible 'affordances' to improve sustainable mobility. That is why these projects have to be taken into account as an opportunity for the University mobility management, because many of the planned measures are going to enhance sustainable mobility as well.

The first project was already defined in 2015 by archi-star Renzo Piano, world-wide known alumnus of our University, who generously offered a design scheme for the renewal of Bonardi Campus (Figure 5). The project scheme reinvents a two-hectare large block of the main campus, characterized by high quality buildings, representatives of the Italian modernist heritage, turning the former parking lot into a pedestrian public space filled up with trees. The main idea is to recreate a liveable space, rebalancing the relationship of built-up spaces and voids: this was achieved by Renzo Piano through a selective demolition of low quality superstructures that have filled the open spaces over time, and getting back the lost volume by providing three new building on the borders, hence creating an intimate courtyard. The new public space of about 8000 square meters will include accessible rooftops and will be completely pedestrian, as an effective response to students claiming for more leisure and study areas in our dense campus. The furniture will provide sitting areas and 100 new trees, with particular attention to human comfort that will benefit from the cooling effect of trees due to shadowing and evapotranspiration. Having more people enjoying the campus is a mobility strategy, because it will reduce the demand for traveling off campus for lunch or for work activities.
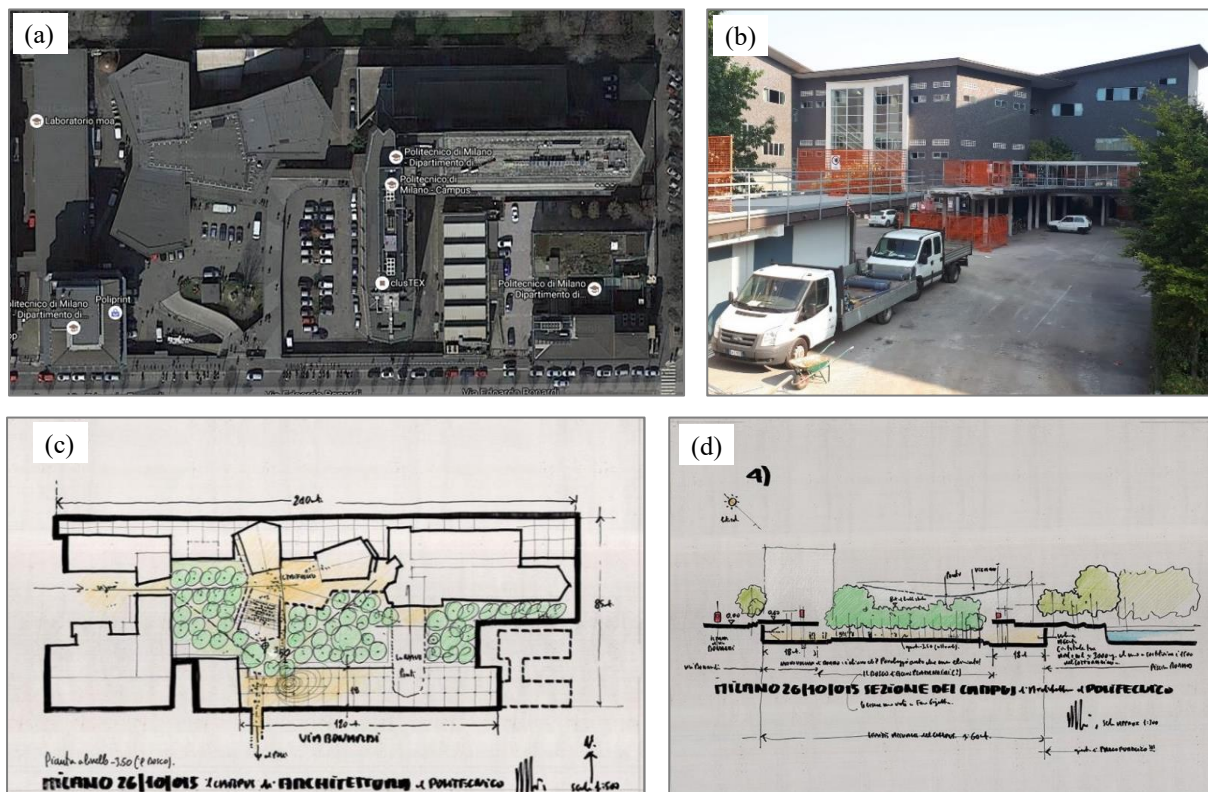
Figure 5. Above, aerial photo of the Bonardi Campus (a) and photo of the current building site (b). Below, sketches by Renzo Piano (c and d), showing the great attention to the redesign of open spaces with the plantation of new trees replacing a former parking lot (courtesy of the Politecnico di Milano).
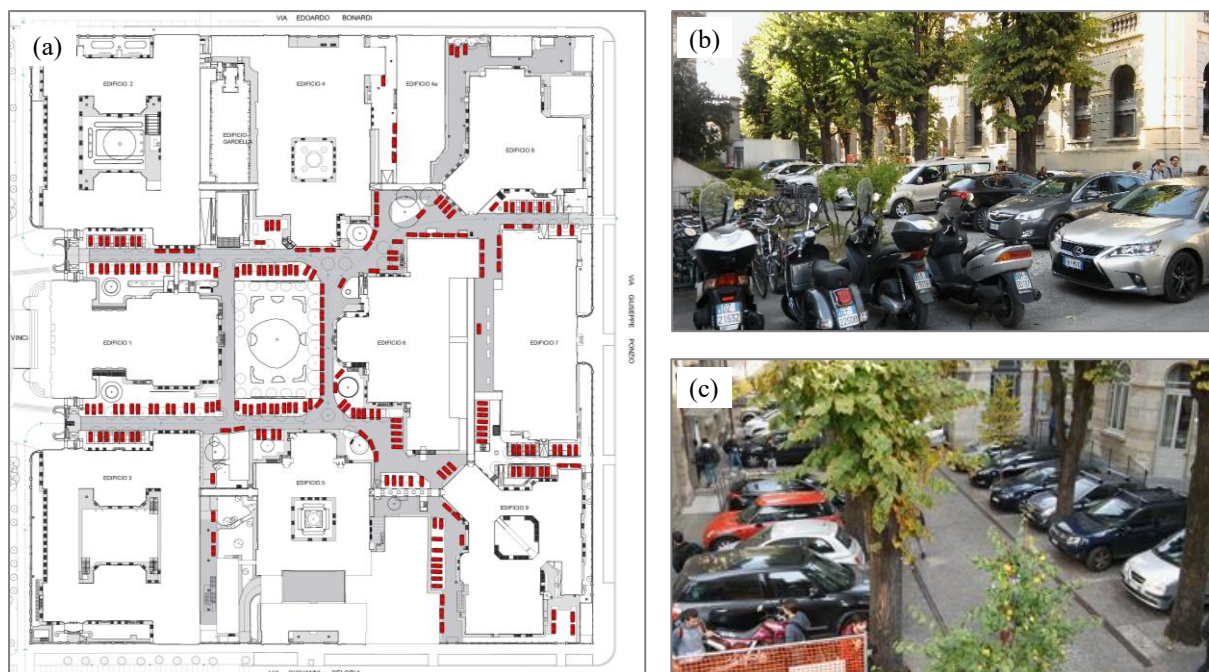
4.1. The Vivi.Polimi Project

The new emerging ways in the use of open space and the new demands to which it is exposed, build a new theme and represent an opportunity for innovation in the redesign projects promoted by the Vivi.Polimi university strategy. In fact, within this different thematization, open spaces cannot be understood as areas to be used only to respond to the anarchic microcosm of needs – more or less necessary – that have produced the current generalized fragmentation of individual places, preventing a real, rich and multifaceted liveability in daily practices.

It is therefore necessary to give back to the students and to all the staff of the Politecnico the Leonardo and La Masa campuses with open spaces to be accessible in an integral way, fully dedicated to the many activities that can be carried out by our community, from the study to the leisure. At the same time, it is necessary to confer formal order and architectural quality to the common areas, to make them comfortable and appreciable even in slow perception, like stopping to chat, studying or simply resting, strolling or cycling.

In order to achieve these objectives, internal traffic (except necessary and exceptional circulation) that generates noise, pollution and danger, will be reduced or eliminated, restoring tranquillity and better liveability to the open spaces of the campuses, hence reconfiguring the relationships between the different functions and the related uses. All this will change the place that the open space of the campuses occupies in the collective imagination: not a mere technical space, mainly used a parking lot, but a "common good", to be used and protected collectively.

In the case of the Leonardo Campus (Figure 6 and Figure 7), it is a matter of critically re-reading the original project of the open spaces and proposing its actualization, improving its use and liveability to meet the many new needs of the numerous people who join it every day. Specifically, the envisioned actions are as follows: to start a progressive elimination of parked cars; to increase the endowment of equipment related to the development of slow mobility; to propose new functions and experimenting with new spaces in relation to changes in use practices and habits; to rationalize the space allocated to technical installations and/or their disposal; to redesign the geography of the ways of use, through the creation of new space opportunities for a comfortable (both formal and informal) use of the open space; to mend together Campus Leonardo, Campus Pascal and the surrounding district.

Figure 6. Leonardo Campus - current state: parking spots plan (a) and photos of parked vehicles (b, c).
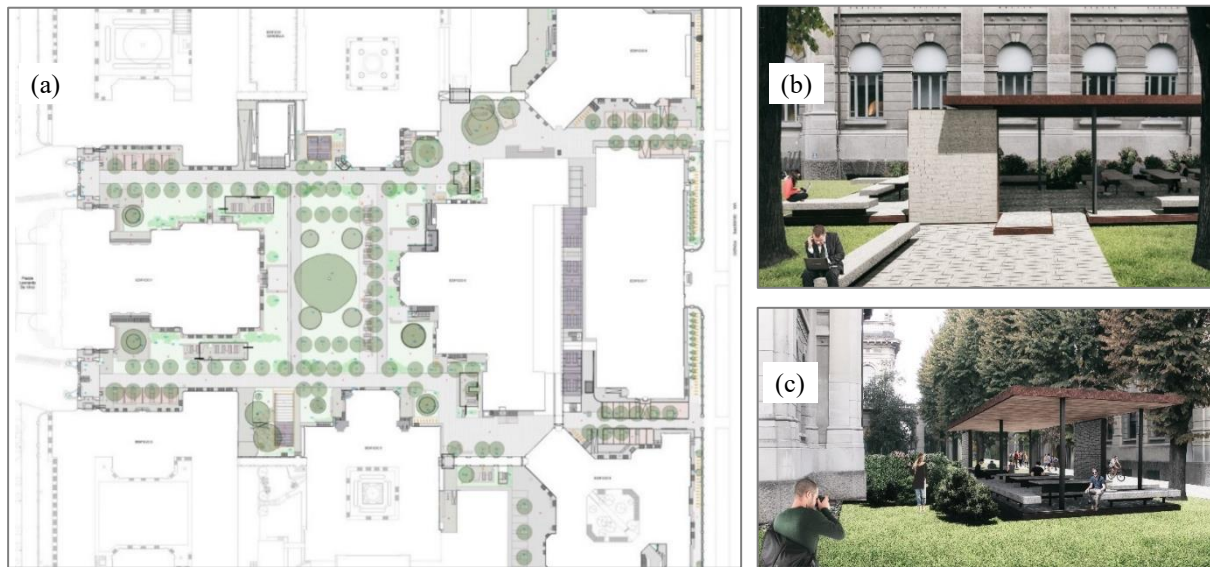
Figure 7. Leonardo campus - Vivi.Polimi project: overall design plan (a) and render of "Il Giardino di Leonardo" (b and c), the project of morphological and functional reconfiguration of the external public space.

Currently, the first lot of the construction site has started, bringing a reduction of the available parking spots and a regularization of the remaining ones with an electronic device to check the presence of vehicles (Table 1). Less than 80 out of the 190 parking slots currently available on campus will remain after the renovation: 50 will be dedicated to the Politecnico staff and 30 will be reserved for people with disabilities, the operations and the vehicles owned by Politecnico. The existing bike parking spots are now 170 and 70 more will be positioned, 30 of which will be covered by a shelter.

**Table 1.** Leonardo Campus - Vivi.Polimi project: facts for the first renovation lot.

Leonardo campus – data for the first lot	Today	Tomorrow
N. of cars parked inside the campus every day	190	77
N. of bike parking spots (uncovered racks)	170	214
N. of bike parking spots (covered shelters)	0	30
N. of not wired study spots (uncovered)	90	0
N. of wired study spots (uncovered)	0	130
N. of not wired study spots (covered)	0	65
N. of outdoor seats	0	140
Surface of concrete paving	1400 m^2	0 m^2
Surface of gravel paving	1500 m^2	0 m^2
Surface of stone paving	600 m^2	2500 m^2
Green surface (lawn)	1600 m^2	2600 m^2

In the case of the La Masa Campus (Figure 8 and Figure 9), it is a question of creating a new identity for open and public spaces, starting from existing practices, from emerging questions by students, teachers and university staff, managing, starting from addressing some important local microclimatic issues. In particular, main objectives of the redesign project will be the following: to create a new internal

landscape that is articulated and able to host different practices while sharing the same spaces; to increase the permeable surfaces and the space in the shade, aiming at counteracting the urban heat island phenomenon; to define car free areas and limit vehicular flows to service circulation; to rationalize the space to be allocated to the warehouse, eliminating the proliferation of the containers used for this purpose; to redefine the geography of ways of use, through the creation of new space opportunities; to redefine the relationship between the campus and the city, seeking a renewed relationship of integration, as it currently happens with the Lambruschini Campus.
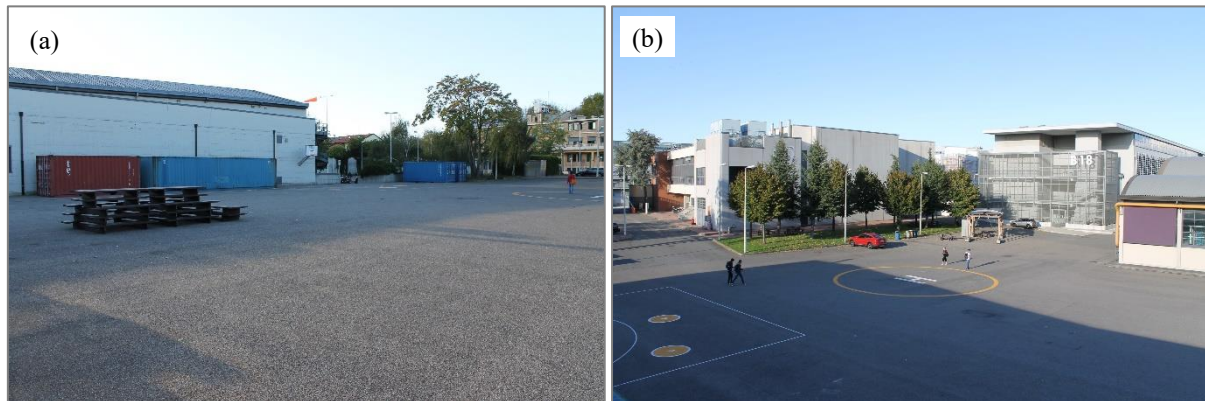
Figure 8. Bovisa Campus - current state: photos of the project areas.
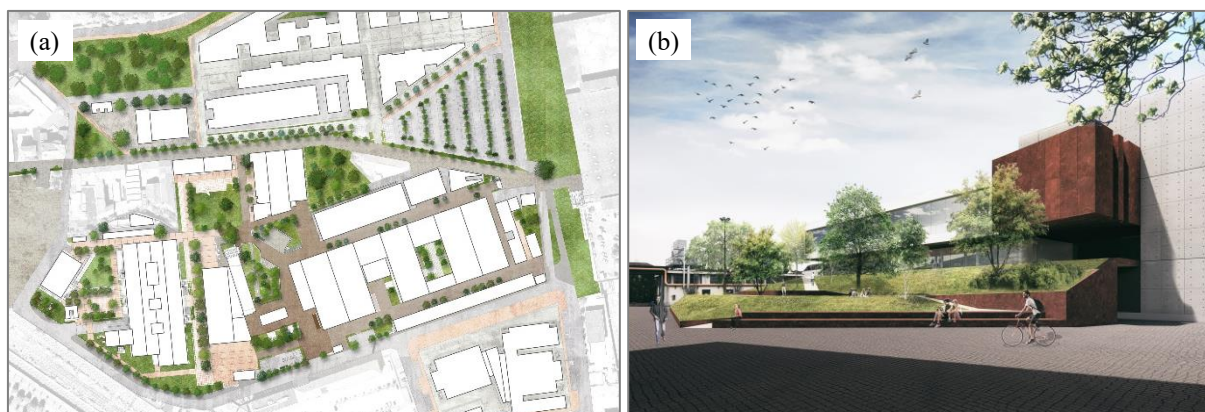
Figure 9. Bovisa Campus - Vivi.Polimi project: masterplan (a) and render of the new building "La Collina degli studenti" (b).

On both campuses, some common objectives and measures will influence mobility in a positive way both directly and indirectly. Regarding direct measures that will be adopted, we can list the following: the increment of the supply of available bike parking spots through the realization of an extensive system of racks and, possibly, the provision of a lockable shelter (a real bicycle parking station) on the Bovisa campus, the installation of at least ten new charging stations for electric cars distributed among the two campuses; the redevelopment of driveways around the campus, by replacing current access control bars with retractable hydraulic bollards; the review and implementation of the wayfinding systems inside the campus, i.e. providing the totems for internal signage with QR-Codes.

Concerning the measures that indirectly will affect mobility; the ones related to the improvement of the overall environmental quality of open spaces will increment the pedestrian accessibility of the campus and reduce mobility demand of our community, which will benefit from a "densified" offer of facilities in a walkable distance. We can also mention, among others: the improvement of human

comfort through the creation of shaded areas both over resting areas (study, eating areas and so on) and movement areas (pedestrian and cycling paths); comfort and safety perception will be achieved also through the reconfiguration of the outdoor lighting design according to criteria of sobriety and functions. "Sticky" open spaces will be achieved also by providing free wireless connection and new physical furniture, including benches and tables, and punctual and linear exhibition spaces, as a way to improve the storytelling of the university. Finally, the relocation, redesign or shielding of technical facilities, including waste collection areas, that pervade the campus will be crucial for achieving a better use of precious open spaces.

5. Conclusions

University campuses are unique testbeds for envisioning and experimenting innovative solutions to be later spread out to the city, if successful. This paper illustrated the wide spectrum of mobility strategies that can be activated within a campus, ranging from strictly transportation related actions, to physical design of spaces, to education and behavioural change initiatives. The multiplicity of the topics that are only apparently tangent to mobility require the Mobility Manager to adopt an open approach to transportation and develop skills to recognize multi-actor, multi-scale and multi-sector opportunities within a highly dynamic environment. Moreover, a rapidly changing and young population (most of the students stay on campus only two to three years) requires continuous engagement of the community and the ability to intercept and interpret generational changes. Sometimes, the Mobility Manager has to deal with conflicting interests or priorities of different stakeholders inside the University, which could lead to delays or to less effective interventions. Still, providing a wide range of mobility alternatives and delivering projects of high quality that facilitate good practices could change people attitude and behaviours and thus reduce the conflicts.

Future activities will enhance the strategies already in place to further move our community towards more sustainable mobility choices (liveability of open areas including bike-related services, LPT and sharing mobility agreements, engagement campaigns and mobility surveys).

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