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Special Issue 1.2022

New scenarios for safe mobility in urban areas

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA Journal of
Land Use, Mobility and Environment

Special Issue 1.2022

NEW SCENARIOS FOR SAFE MOBILITY IN URBAN AREAS

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

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Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | online ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

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TeMA Journal of Land Use, Mobility and Environment

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TeMA Journal of Land Use, Mobility and Environment

TeMA Special Issue 1 (2022) New scenarios for safe mobility in urban areas 147-166
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8655
Selection and double blind review under responsibility of "Living and Walking in Cities 2021" Conference Committee.

www.tema.unina.it

Soft mobility planning for university cities: the case of Pavia

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Abstract
University City concept means a specific urban structure characterized by the maximum expression of the relations system (social, environmental, economic) that can exist between university institution and administrative/political institution: in particular, the physical connections linked to the spatial location of university structures within the urban fabric.
In Pavia, between Municipality and University the development of common mobility strategies has been practically developed since the seventies of the XX century by Giancarlo De Carlo plan. From this period on, the centrality of the city emerged as magnet for the first and second tiers of adjacent Municipalities.
The need to implement forms of sustainable mobility aimed at improving the connections between university and city center, useful also to trigger deep urban regeneration processes, carried to experiment a collaborative planning process between university, Municipality and the main involved stakeholders. The main aim is to develop an overall strategy throughout the entire municipal territory and to define lines of actions (tactics) for the creation of a soft mobility network within the Pavia context as University City. The participatory process is implemented with the use of a Collaborative Planning tool based on Google functionalities. In the paper, authors describe the main elements of this project.

Keywords
University City; Soft mobility; City plan; Road security and safety; Territorial magnet.

How to cite item in APA format
De Lotto, R., Greco, A., Moretti, M., Pietra, C. & Venco, E.M. (2022). Soft mobility planning for university cities: the case of Pavia. *Tema. Journal of Land Use, Mobility and Environment*, 147-166. http://dx.doi.org/10.6092/1970-9870/8655

1. Introduction

Insert here text as institutions of high culture, and as bodies responsible for higher education, universities are made up of a set of scientific structures aimed at teaching, scientific researching and transferring of knowledge. The inner organization of the university system is determined by the complexity and variation of relation with the physical and immaterial territorial and urban context (Mambriani, 1999; Martinelli et al., 2012 and 2013). Cities are an important space of connection between society and university with different implementation methods and times (Bender, 1988; Martinelli, 2012); historically, universities are born in urban contexts, and, as they develop, they interact with the city becoming an integral part of it (Perry et al., 2008). University cities, usually characterized by the presence of historic universities, are the expression of a factual interaction that is not always determined by intentional choices or long-term planning. In all the urban area, the scattered presence of university elements (buildings for didactic activities, laboratory, offices, colleges, canteen and so on) allows to have an active urban fabric, with people, goods and ideas flows, eager to renew itself and to remain connected with the different parts of the city (residential districts or strategic elements as hospital, railway station, etc.). This is the physical and relational structure of Pavia.

Moreover, the Pavia city dimension and its urban structure can make it an example of the "15-minute city" planning approach (Moreno, 2016; Moreno et al., 2021) focusing on accessibility, and on the improvement of life quality. It aims creating contexts where everything a person needs is reachable in 15 minutes on foot, by bicycle or by public transport: density (of people, buildings, services, shops and so on), proximity, accessibility, walkability, land use mix, design diversity and digitization are the main keywords. Minimal spatial and temporal displacements (the so-called micro-mobility) among homes, offices, restaurants, parks, hospitals, and cultural places determine socially sustainable urban environments. It has numerous advantages on a social, economic, and environmental scale: reduction of traffic congestion, pollution (emissions and noise) and an increase in green spaces, livable public areas, and flexible and widespread facilities.

The main goal of the research is the description of the cultural context, the physical characteristics and the social and economic boundaries underneath the development and implementation of the physical links among university and city elements, and therefore the enhancement of cultural and social relationship among them.

The paper structures into seven distinct conceptual parts: after a brief general introduction, authors define the main method and materials use for the research. Chapter 2 describes the Pavia case study with its settlement's peculiarities; Chapter 3 analyzes the current infrastructural system in Pavia considering soft mobility system mainly. Chapter 4 describes the participatory process and the Collaborative Planning tool used to implement the project (Chapter 5) of the new soft urban mobility network, explaining the strategic framework and the specific actions, underlining the important role of the first-tier Pavia's territory and its connection with the urban mobility system, with the University and with the "15-minutes city" approach. Finally, last two sections are about discussion and definition of possible further theoretical and applied research's developments.

1.1 Materials and Method

Cities (as physical space and as a set of relationships among elements) are an important space of connection between society (considering as all the people who live in that place) and University: born in urban contexts, while developing they interact with the city becoming an integral part of it. In an urban area, the scattered presence of university elements (buildings for educational activities, laboratory, offices, colleges, canteen and so on) allows the enhancement of a lively and truly active urban fabrics, full of flows of people, goods and ideas, eager to renew themselves and to maintain the connection with all the different parts of the city (residential districts or strategic elements such as hospital, train station, etc.). The relationship among cities and specific university settlements is complex: it is based on the intent to create a strong network of

connections between university and city, between students and residents and to achieve complete integration between the urban system and the university system (Lazzeroni et al., 2009; Savino, 1997, 1999 and 2013).
In particular, the relationship between University City and the university settlement is more complex primarily because, due to the variety of applications, it is impossible to classify all cases in on way. As theoretical reference framework, numerous settlements models categorize the two systems considering their mutual location (Coppola Pignatelli, 1969; De Lotto et al., 2014 and 2015; Venco, 2015).
It is important underling that the most relevant aspects of these models are not only linked to the geographical location, but to the relationship among the different elements and therefore the role that the university system creates with the urban system. Moreover, also the so-called resources (distributive, spatial, qualitative and quantitative) are fundamental elements: facilities (sports activities, cultural activities, libraries, leisure activities, commercial activities, green areas and so on) and other physical spaces (buildings and areas for teaching and research, residential buildings for students, meeting spaces, parking lots, and so on) (Perry, 2013; D'Alpaos et al., 2014).
Considering Pavia's case study (it counts 70 thousands inhabitants, 20 thousands university students and 63 sq.km of territorial area; it is characterized by the presence of one of the oldest universities in Italy and Europe, and can be defined as a university city by all means) following Giancarlo De Carlo's ideas for city development (see Chapter 2), the University reaches a multipolar structure: in order to connect all the elements (physically and organizationally) it is fundamental the implementation of a very efficient and widespread infrastructural network especially for bikes and pedestrian. Its proposal aimed to define a comprehensive new urban structure able to combine structural sub-systems with architectural design.
In particular, to understand dynamics, characteristics, strengths and criticalities of the urban territory, authors carry out classical urban and morphological analyzes and, then, cartographic analyzes with the support of regional and municipal databases. The main strategy and the specific actions for each intervention in the different city's neighborhoods were then defined with the support of a Collaborative (and interactive) Planning tool, MyMaps application, based on Google Maps and Google Earth was used. The use of a Collaborative Planning tool allows to overcome the rigid top-down urban planning approach, favoring flexible strategies and actions to adapt to the changing conditions and needs of stakeholders and citizens, fundamental condition to reach the spatial, social, cultural and economic objectives successfully. Furthermore, the use of such a process and tool allows the municipality and the stakeholders to choose the most suitable interventions to be implemented having clear, and always available, the global and strategic overview that underlies each specific choice.

1.2 Pavia structure and its territorial settlements

The territory of the first-tier municipalities (Fig.1) of San Martino Siccomario, Carbonara al Ticino, Torre d'Isola, Marcignago, Certosa di Pavia, Borgarello, San Genesio ed Uniti, Sant'Alessio con Vialone, Cura Carpignano, Valle Salimbene, Travacò Siccomario extends for about 131 sq.km.
The territory of the second-tier municipalities of Zerbolò, Bereguardo, Trivolzio, Battuda, Vellezzo Bellini, Giussago, Zeccone, Bornasco, Lardirago, Roncaro, Vistarino, Albuzzano, Linarolo, Mezzanino, Verrua Po, Rea, Cava Manara, Zinasco, Villanova d'Ardenghi extends for about 245 sq.km.
Subsequently, in the presented research, the first-tier territories will be analyzed in depth.
All the municipalities are in the Po Valley with all the typical characteristics: widespread small/medium-sized settlements, a strong agricultural role, important isolated productive realities especially logistics. From a naturalistic point of view, the whole area, despite being included in the Natural Park of the Ticino Valley, is heavily anthropized with predominantly wooded areas with rich biodiversity only near Ticino river, the irrigation canals and the minor waterways.

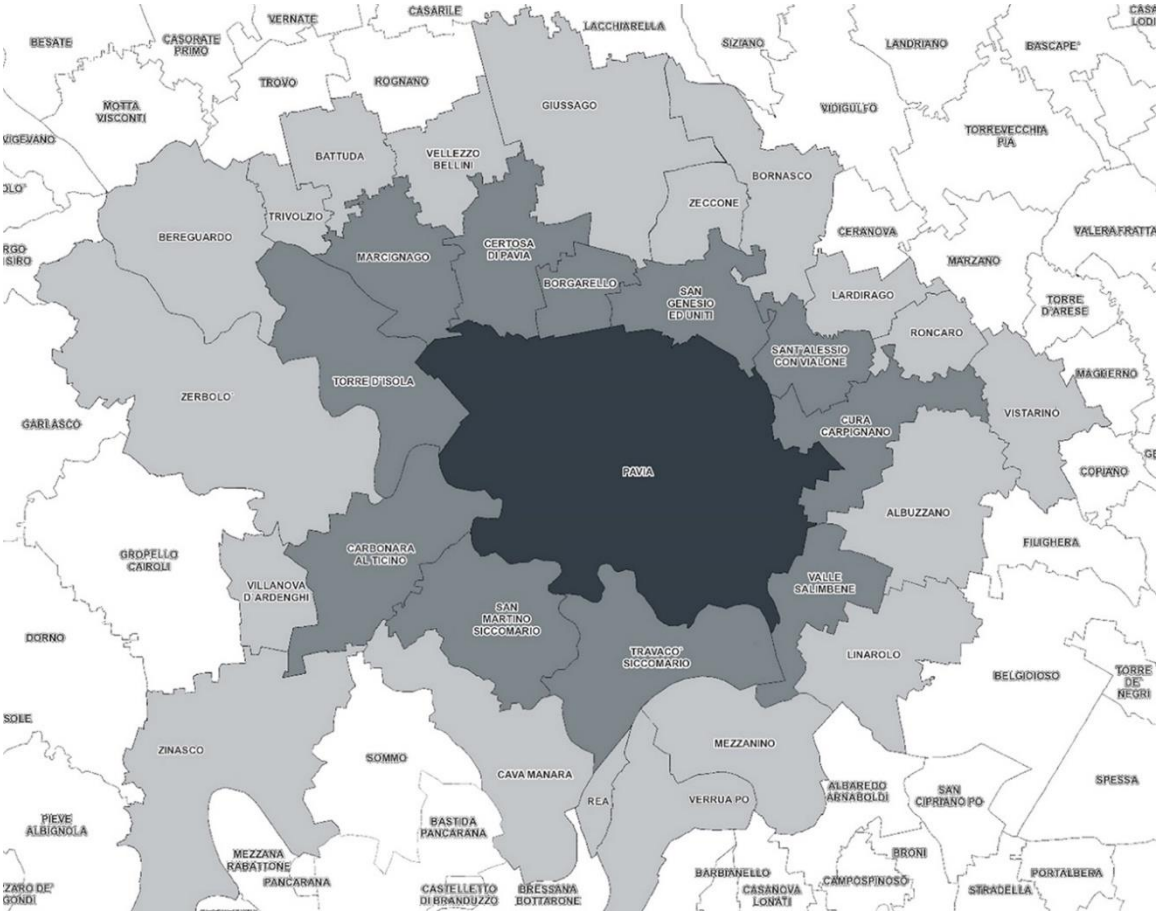

Fig.1 Pavia Municipality with first-tier 11 Municipalities (in dark grey) and second-tier 19 Municipalities (in light grey)

The 11 first-tier Municipalities, despite their specificity, appear to be quite similar in the main environmental, morphological, urban, social and economic characteristics: the main settlements act as attraction poles for the small neighboring rural community with local services and basic commercials activities. In all of them there are at least one compulsory school level, greeneries, areas for sports and leisure time that are destinations (and origins) of relatively considerable flows during the day.

The infrastructures, given the territorial conformation and the decentralized location with respect to the major centers (first of all Pavia and, then, Milan), play a fundamental role: road transport is the most utilized as the railway connections are not capillary and usually too distant to be reach without a car or a bus. Obviously, this involves an important flow of vehicles (including heavy vehicles) in roads with, often, an inadequate section and with an accentuated curvilinear mode. Furthermore, this amplifies all the problems related to air and noise pollution, the increase in the probability of potential accidents and the development of behaviors related to unhealthy lifestyles.

As for cycle mobility, the cycle-pedestrian path on the Alzaia of Naviglio Pavese (an artificial channel that link Milan to Pavia to Ticino river) is of considerable importance: it is a clear example of blue infrastructure which, together with the vegetation buffer along its course, also becomes a green infrastructure, represent a safely and continue route between Pavia and Milan and all the municipality that insist on it. In all the main settlements of these Municipalities there are scattered stretches of cycle paths that do not always form a unit, accessible and safe system: the lack of uniformity of the road surface, the lack or scarcity of horizontal and vertical signs for crossings and the lack of protective barriers are just some of the detected problems. So, it emerges the need for develop a more usable, accessible and safe mobility network as intra and inter-municipal connections. The proximity to Pavia allows to analyze and evaluate the definition of a trans-municipal mobility system that

acts as a driving force to transform the divided realities into a highly interconnected multipolar territorial system.

As shown in the table below (see Tab.1), in the last 50 years, the population in Pavia and in the adjacent Municipalities moved from the main city to the smallest settlements. From 1971 to 2020 Pavia city lost 13.500 inhabitants while the neighbor cities improved totally about 35.000 inhabitants. Since 1971 the loss of inhabitants on Pavia was faster in the first 30 years than in the more recent 20 years. The rise of inhabitants in the neighbor is faster in recent times. The need of residential area increased while the smaller Municipalities continue making use of Pavia services system.

The whole population increased totally about 22.000 inhabitants all located outside of Pavia city. Because most of the services are in Pavia, mobility need increased continuously during the years.

Pavia was the 64% of the total population, now it is about 47%. Pavia lost population without losing gravitational attraction for students, workers, and city users.

Population	**1971**		**2001**		**2020**	**1971-2020**
Tot. First Tier	17.306	8.593	25.899	10.845	36.744	19.438
Tot. Second Tier	29.176	4.569	33.745	11.369	45.114	15.938
Pavia	86.839	-15.625	71.214	2.120	73.334	-13.505
Total	135.292	-2.433	132.859	24.353	157.212	21.871
Distribution of the first tier on the total	13%	7%	19%	4%	23%	89%
Distribution of the second tier on the total	22%	4%	25%	3%	29%	73%
Distribution Pavia on the total	64%		54%		47%	-62%
%		50%		42%		
%		16%		34%		
%		-18%		3%		
Total %		-2%		18%		

Tab.1 Increasing of Pavia population

2. University-city settlement: Giancarlo De Carlo plan for Pavia

In 1967, taking advantage of national law 641 "Standards for university school buildings; financial plan for the intervention in the five-year period '67-71", the University of Pavia, which needed to find new locations for educational activities and related services, commissioned Giancarlo De Carlo to draw up the overall development and building renovation plan. De Carlo's advanced vision (1972) clearly emerges from the 1970 to 1974 plan (but not completely adopted in the 1976 Astengo and Campos Venuti city plan). It aims to create a strong network of connections between university and city, between students and residents and of making a complete integration between the urban system and the university system using a multipolar scheme as placed structure.

The physical location on the territory has generated and helped to maintain a solid and continuous relationship between the two institutions, as well as has implemented and improved urban quality by acting directly on the

functional and social mix, generating the necessary driving forces for development (or revitalization) of local economy.

On the other hand, the physical distance between the different poles and between them and the other attracting points of the city (hospital, historic city center, railway station, etc.) requires increasing attention in physical relation. Above all, the fundamental aspects of mobility (understood as an infrastructural system defined by physical elements and human being) to take into account are road security and safety, transportation means, accessibility, concurrent types of mobility on the existing road network, pollution, noise and quality of urban spaces (De Lotto, 2008).

Strongly inspired by political and social values, the structural idea of De Carlo Plan envisaged complete integration between urban system and university system (plan's motto was "the city campus is the city"; De Carlo, 1974).

It is evident in the macro-localization characteristics; in the idea of territory-integrated management that overcame the barriers of Public/Private soil properties towards a vision of functional and social mix; in the intention of creating a strong connections network between university and city, and between students and residents. According to the architect, the university could no longer be a separate body from cities and territories, nor could be indifferently mixed in the urban fabric, as a mere services (Perin, 1992; Buncuga, 2000).

The University must be an active part of society and the territory and it cannot be conceived as an autonomous body, but must be permeable, open, widespread, but at the same time concentrated in poles that become territorial connectors. With this type of organization, it possible to combine the characteristics of campus, as a model that offers autonomy and spatial concentration to the university system, and those typical of the scattered university model which aim to avoid the isolation of the university from the social context (De Lotto, 2008). In this particular configuration, the mobility network is fundamental to allow the optimal integration levels that can guarantee the different poles and different areas to interact.

As mentioned, De Carlo's project was only partially realized: the university structured on two main poles was confirmed (the humanistic one in the city center and the scientific one in the Cravino area, north-west of Pavia). The first is a natural expression of University City system, perfectly integrated into the urban settlement system; the second has hybrid characteristics: partially campus and partially integrated within the city morphology (Fig.2). In the Cravino area, there are also hospitals, scientific faculties, students' services (a canteen, sports center with swimming pool) and some university colleges and student residences. From a morphological and location point of view, the Cravino area suffers from a certain isolation, while daily life (of students and teachers) revolves around the historic center. Moreover, together with the proposal of a new mixed function and flexible mega-building for the university, De Carlo proposed modifications to the mobility urban system. The aforementioned new university pole in north-west of Pavia was changing the importance of the polycentric city; as shown in Fig.3, the additional decision to locate in every neighborhood some university facilities (colleges, research centers) needed a new hierarchical mobility system that, in fact, the famous architect proposed.

The scheme (Fig.4) was based on new urban railway to connect the south-east of the city center to the north-west of the city; division of the cross-cutting traffic lines from the inner mobility; introduction of main soft mobility routes. The infrastructure forecasts of the actual city plan (so called "first generation plan", approved in 1964) were all car oriented: direct connection of the city center with the Milan-Genova highway; new bypass; rigid road hierarchy (Fig. 5 and 6).

Finally, De Carlo introduced the new public transportation line together with first proposals for pedestrian and cycle mobility considering the range of influence.

As for some of the University renewal interventions, most of the solutions that De Carlo settled for the mobility were not adopted in the 1976 city plan.

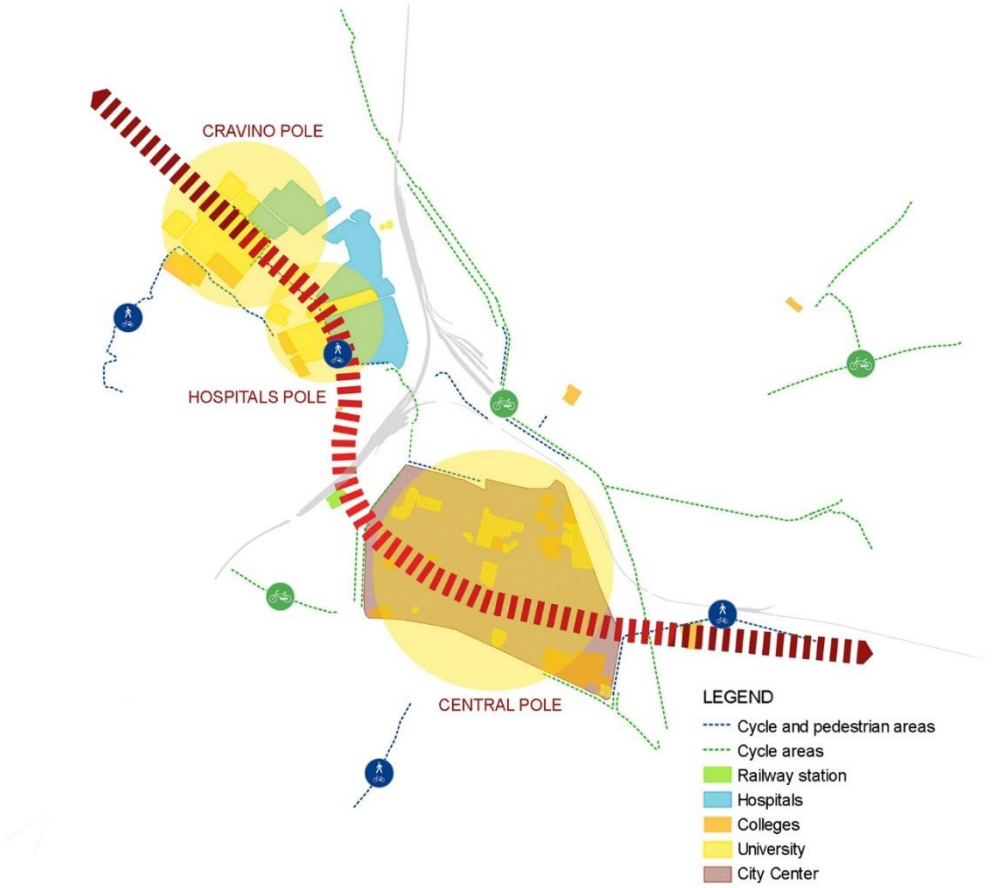

Fig.2 Conceptual scheme of Pavia main planning elements: the poles and the fluxes

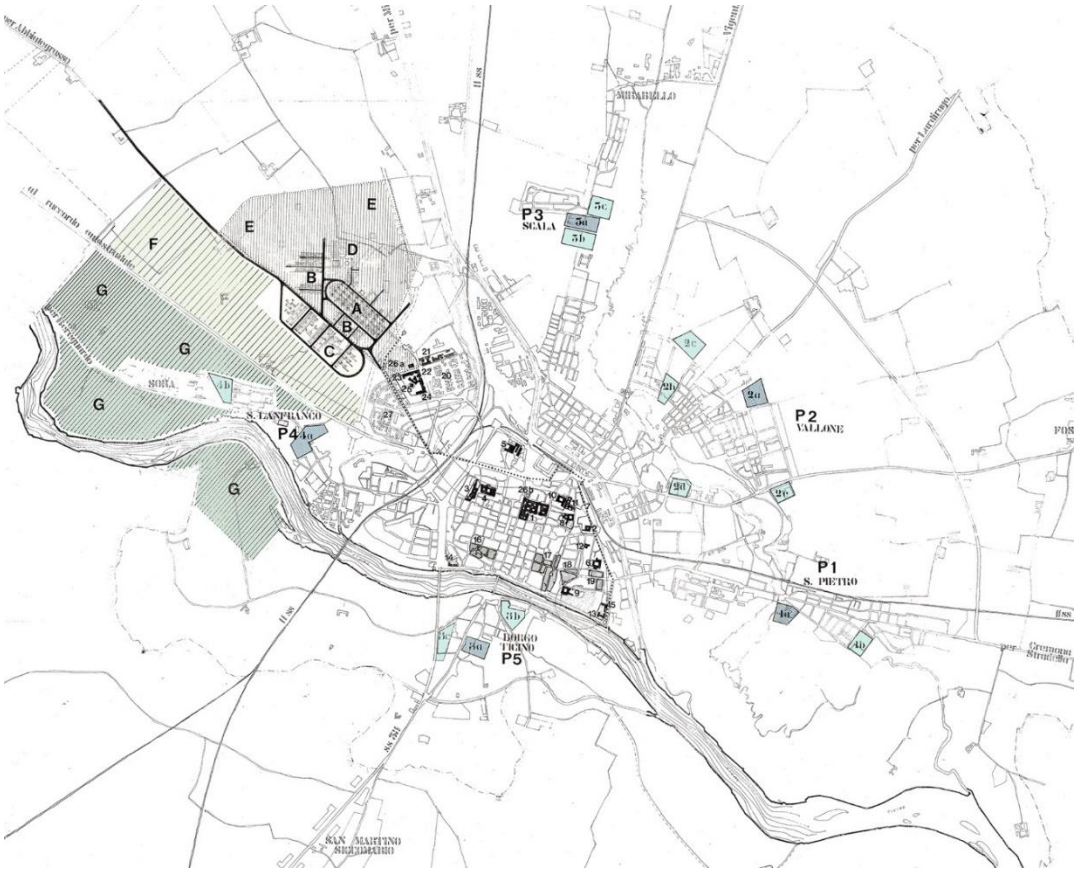

Fig.3 Complete renewal project of Pavia University. Relation among city center, Cravino pole and other intervention in peripherical neighborhoods. (G. De Carlo)

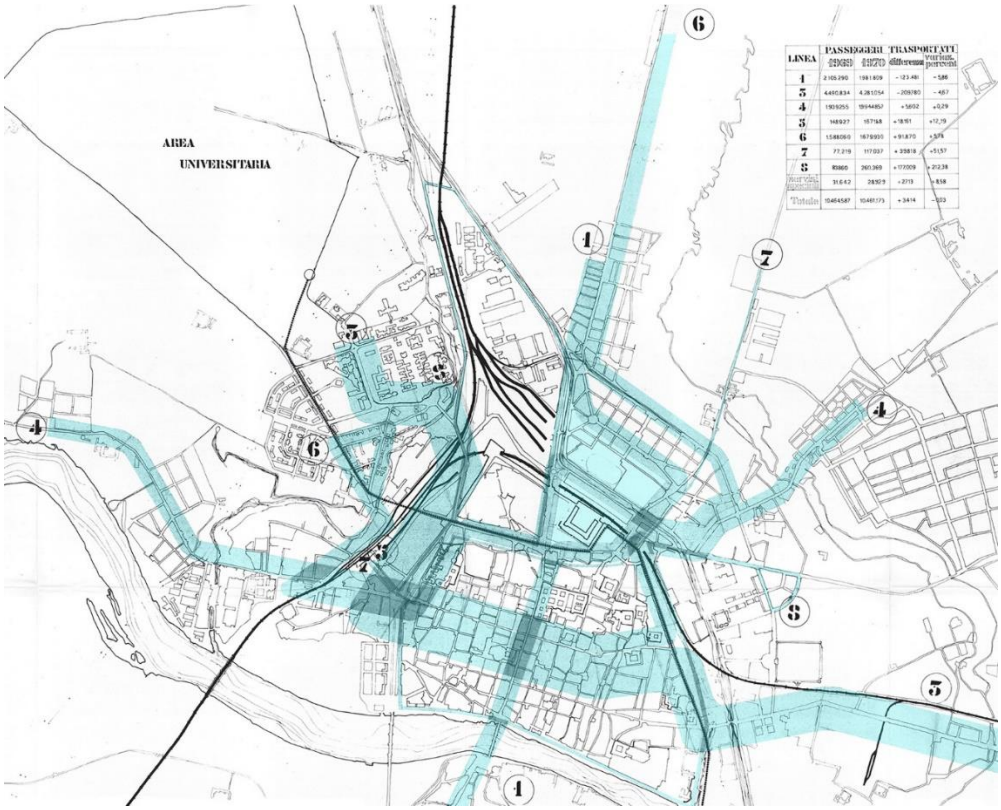

Fig.4 Giancarlo De Carlo general idea of Pavia Urban Mobility (G. De Carlo)

Fig.5 Cravino Pole accessibility. First proposal starting from the existing mobility (G. De Carlo)

Fig.6 Cravino Pole accessibility. Proposal 3bis. (G. De Carlo)

3. Pavia current soft mobility system

Considering the whole dimension and the structural morphology of Pavia (urban area is almost 16 sq.km), travel time and distances are limited: by bicycle, it is possible crossing the city in about 15 minutes. Many citizens bikes systematically, especially in the city center and near large public functions (universities and health care facilities).

Pavia is an attractor pole for people, and therefore for vehicular traffic from extra-municipal territories. The territorial value of movements has a clear influence on the modal choices. In fact, as the picture of the pre-pandemic situation highlight, cars cover a much lower amount (54%) of internal travel than that of inbound and outbound journeys, with over 70%. On the other hand, collective transport shows greater attractiveness in inbound journeys (19%) than in the city area (11%) and outbound (8% of those directed to the provincial territory) (Pavia City Plan, 2013). Considering the different travel reasons for internal journey, private cars are used for 55-60% of trips; public transport is the most used transport mode for study purposes (school and

university), with a percentage value of 28%; bicycle mobility shows substantially constant percentage values for the various travel reasons, between 15-20%.
Although it is clear that non-motorized vehicles are an important factor in city mobility, with bicycles used by almost 2/3 of citizens (Pavia City Plan, 2013), the urban cycle mobility network has some significant, and very common, criticalities that do not make the system functional, accessible and safe completely. In particular, the discontinuity of the network, the lack of radial trajectory from the peripheral neighborhoods to the city center and the main poles, the limited diffusion of cycle paths on the roads with the greatest vehicular traffic per hours and sometimes inadequate safety devices on the network (physical barriers, traffic lights for bikes, illuminated crossings and so on).

4. Strategic idea for Pavia soft mobility plan: the collaborative instrument

Given by Municipality and University the need to implement sustainable mobility to improve usability, accessibility and safety of the route between university poles and historic center, railway station, bus station, residential districts and other school centers, a Collaborative Planning process has been launched (Healey, 1998; Innes et al., 1999). The Collaborative Planning is an interactive process of consensus building and implementation involving University, Municipality, main stakeholder and private citizens (Tewder-Jones et al., 2002; Margerum, 2002; Brand et al., 2007). The Collaborative Planning is described as a heterogeneous and dynamic mix of specific planning theories, or as a particular type within the broader genre of communicative planning theories. One of the most important aim is to co-build knowledge among many social actors, to organize or transform the urban space generating positive effects on society. Those involved in Collaborative Planning underline the importance of genuine and explicit discussions on each step of the planning process and on all topics to highlight the complexities of the real world by bringing out the most felt and experienced social problems from the community involved. Therefore, it requires a shift from representative forms of governance to discursive and participatory forms in which the final decision also takes place through face-to-face interaction in real time.
In this particular case, it is useful to develop a shared overall strategy of soft mobility on the entire city area and actions focusing on the peculiarities of each road sections considering urban morphology, urban open spaces quality, traffic flows, road safety, pedestrian and bike safety, noise and pollution reduction and so on. Here, the interactions are created through the web in order to reach the largest possible number of people and to allow aggregation moments to take place in any circumstance. Only under these conditions, a city can be conceived and designed not for citizens but by citizens in their role as users.
In Pavia, the main objective is to connect places through a system of safe, qualitatively pleasant paths for cyclists and pedestrians by introducing bike lane, 30 km/h zone, raised pedestrian crossings, suggesting, where possible, determined interventions with only ordinary maintenance of the existing routes in order to reduced costs and time of execution.
For the creation of the collaborative (and interactive) tool, the MyMaps application based on Google Maps and Google Earth was used. As shown in Fig.7, this device allows using, on the same platform, the 2D and 3D view functions and the Street view functionality. At the same time, it allows georeferencing the whole project, create new overlapped work layers, insert images, take measurements, and prepare maps with customized layouts.
Fig.6 shows some of the main elements that characterize the Collaborative Planning tool: the first pictures (from high-left, to high-right, to middle-left) represent the current state of mobility system in the city and report a general map with all the existing routes as well as a first proposal for the creation of a network system that embraces the entire urban territory by connecting the various sections already in place. The middle-right picture highlights a specific road section with technical details and images and, finally, in the low-line of Fig.6

there is the comparison between the current state of a typical road section and the project proposal with the corresponding qualitative economic evaluation.

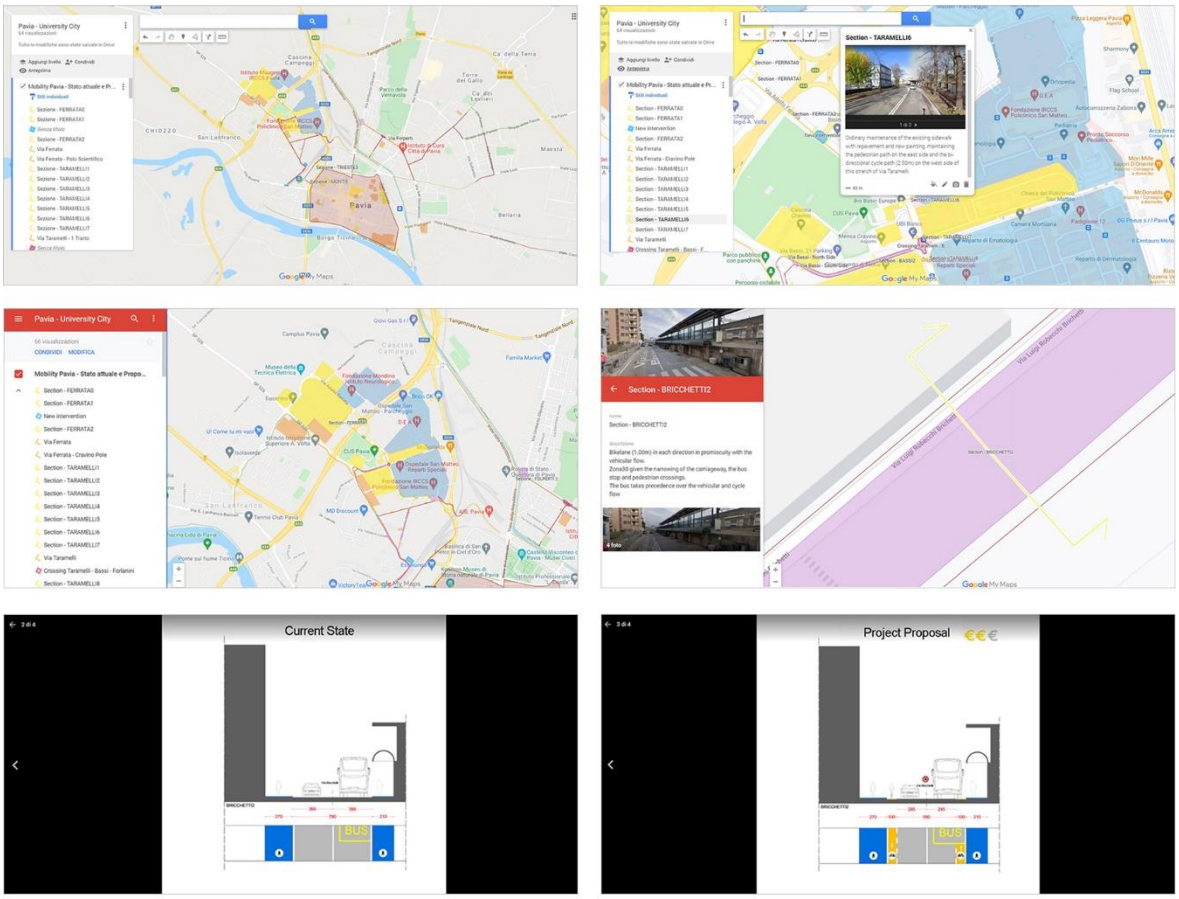

Fig.7 Collaborative Planning tool: methodological steps of analysis and project actions development

Furthermore, the application allows sharing the project defining the degree of accessibility and modifiability of the project itself. This peculiarity permits the operator to share and receive, simultaneously, technical feed backs made directly on the project by competent experts or to disseminate it only for viewing to persons that, despite being interested, do not have the procedural skills to work on it autonomously. In this second case, an online form is also provided to be filled in for general observations or specific comments on precise areas.
On the MyMaps tool a layer on the current situation was created to identify urban roads and, consequently, road sections with the most significant criticalities. For each of them, the listed sections were defined (with the support of GIS tools and municipal and regional database), a photo gallery was inserted and an alert was added in order to define the priority ranking of the various interventions. Therefore, a new layer was created with the project proposals for each selected road section (for this project, over 40 different road sections are considered). In addition to the definition of the general variations on streets and intersections, for each road section, specific comments, technical drawings for each proposal (for almost all the sections, at least two scenarios are defined) and a hypothesis of costs and times of the works executions have been added.
With all this information (in some case, very technical but available on the project canvas intuitively), the tool will be presented to the municipality and stakeholders for comments, reviews and therefore for the final choice of interventions (and priority of interventions).
It should be noted that, in order to verify the accuracy of the cartographic data (CAD and GIS shapefile) provided by Municipalities or downloadable from the Lombardy Region Geoportal (in particular, in order to validate the degree of updating of maps, the precision of different road elements dimensions, the coherence of numerical values and the punctual correspondence with reality), sample measurements were carried out on

some road sections and a comparison was also made between these data and the orthophotos available on the web (Google Earth).
As discrepancies emerged, in some cases even substantial (variations up to 2 linear meters), between the values measurable on CAD, GIS and orthophoto supports (in particular, these variations were found in the dimensions of the sidewalks and in correspondence of the tree-lined flower beds), it was decided to carry out a manual in situ measurement. From the surveys carried out, the greatest values likelihood of each measurement occurs through the Google Earth tool. For the subsequent phases, except for unclear portions in the orthophoto, we proceeded based on the measures that can be deduced from it.

5. Strategic idea for Pavia soft mobility plan: the milestones of the project

After the analysis of current soft mobility system's criticalities and the identification of main destinations (university and hospital poles, historic city center mainly) and origins (historic city center, rail and bus station, residential districts located to the north and east of the city) of flows, the need to implement sustainable mobility to improve the availability, accessibility, use of spaces in a flexible way and the safety of roads is mandatory.
Considering the entire size (the urban area is almost 16 sq.km) and the polycentric structure of Pavia, the travel times and the limited distances, it is clear that medium-distance cycle and pedestrian paths (among poles, city districts and socio-economic-infrastructural-cultural emergencies identified) are essential elements for the development and the sustainable renewal of the urban fabric. Therefore, the project considers the total urbanized territory of Pavia creating a capillary soft mobility network.
In Pavia, the need to improve the dialogue among city, university and hospital structures, the idea of creating, implementing and managing an overall network and a dynamic system of cycle and pedestrian paths, the intention to facilitate active modes of transport in a context already strongly interested in these aspects of mobility, the need to reduce travel times for pedestrians and cyclists through continuous, rapid and direct routes, the responsibility to make roads more safe and accessible to all users, allow to achieve the main objectives of the "15 minutes city".
As a matter of priority, four road sections have been identified: they present potentially very dangerous situations especially for cyclists and pedestrians as they are road with heavy vehicular traffic and with an important flow of persons; they require a massive requalification in terms of recognizability and accessibility and, where appropriate, a new definition of safe routes.
The selected Routes are:

- A. Viale Golgi, via Taramelli, via Ferrata;
- B. Via Brichetti, Via Aselli, Via Flarer;
- C. Via Folperti and the crossroad with Via Marconi;
- D. Via Chiesa, viale Triste, via Filzi.

In all the above areas, the project provides the construction of new cycle path sections, the introduction of new road crossings for bicycles also with traffic lights and the secured of some pedestrian crossings. In some cases, the project defines the insertion of 30 km/h zones where: the section road did not allow the creation of cycle paths duly separated from the vehicular flow; or where the morphology and the quality of intersections and roads section requires a fully redevelopment in order to favor pedestrians and cyclists uses.
In all the considered areas, the directions of travel and urban and extra-urban bus stops have never been changed. Moreover, where possible, the presence and number of car parks are maintained. Only in one case, it is necessary to identify a new public parking area: only few steps from the station, in a dismissed industrial area, the project identify a portion to redevelop that can accommodate this function by allocating about 100 cars now left along the streets).

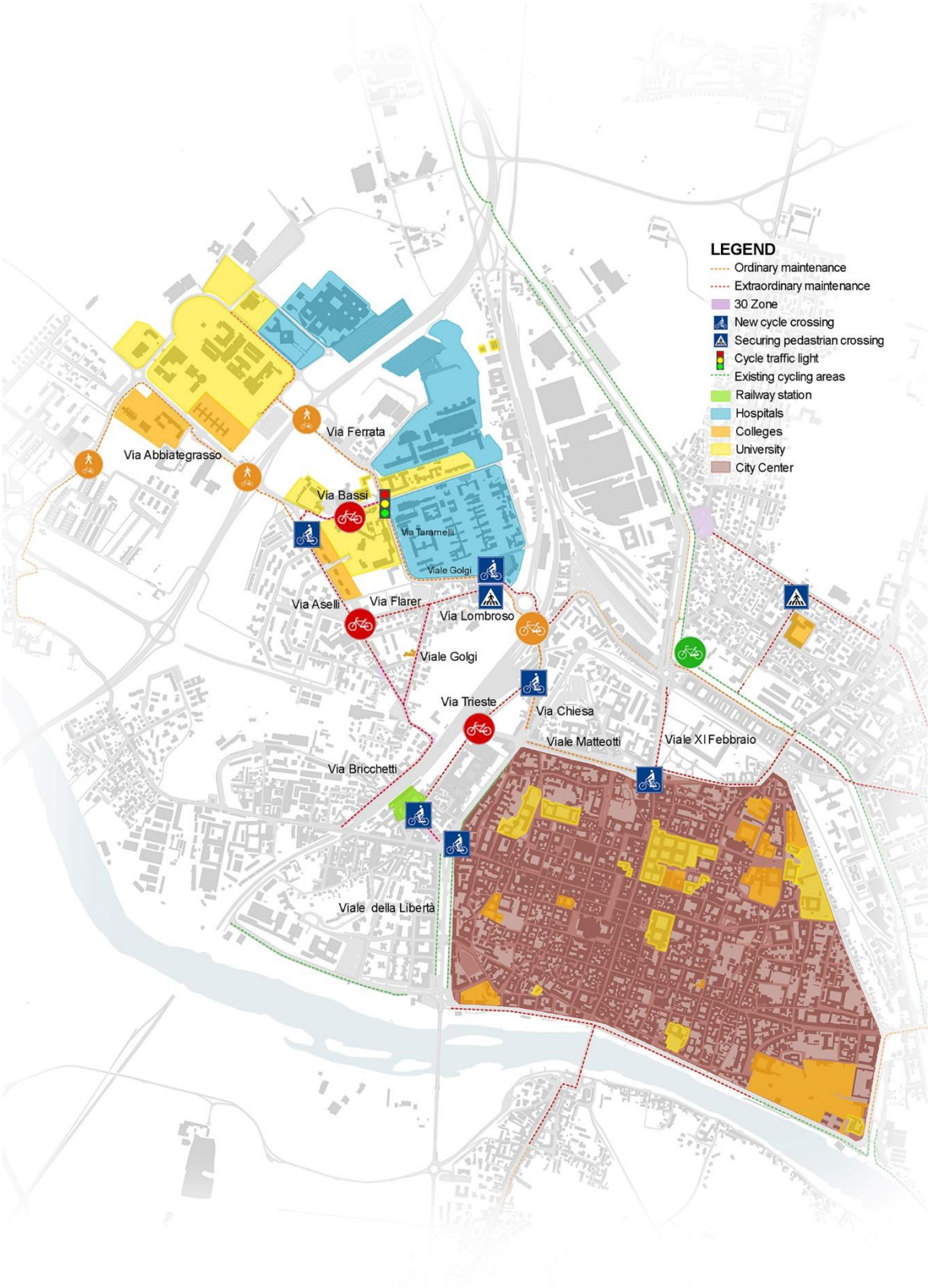

Fig.8 Focus on University Pole (Cravino) and Hospital Pole in relation to the historic city center pole

The entire operation falls on the municipality ordinary and extraordinary maintenance of infrastructural system, so in different chapters of the Municipality economical balance. So, in order to speed up the execution times and also to have a containment of costs, many of the actions were oriented to be ordinary maintenance, such as for viale Taramelli (the road linking Hospital pole and Cravino pole) (the MyMaps tool identifies also the types of intervention necessary for the project development in order to give all the information in just one

device and to ease the decision of University and Municipality). Other project actions, on the other hand, require extraordinary maintenance: here, there is a complete renovation of road surface, inserting pavements and cycle paths, moving parking lots and creating new roundabouts (via Brichetti-via Aselli that connect rail station and Cravino pole directly).
In detail, Figure 8 shows the project conceived for the connections between the historic city center, the railway station area, the Cravino pole (university pole) and the hospital pole (Route A and B). In particular, the roads (with different dimensional and morphological characteristics) such as via Ferrata, via Taramelli, viale Triste, Piazzale della Stazione, via Monti, Corso Manzoni, via Aselli, via Flarer, via Bassi, via Brichetti, viale Golgi, via Folperti distribute almost the whole students, workers and users flows from university and hospital poles to the city center pole and vice versa.
As previously described, the current situation on these roads is quite uneven due to their morphological characteristics (size, proportions, presence of trees), main use (vehicular flows, people flows, urban functions) and degree of safety (sidewalks, cycle paths, safe crossings). Consequently, the proposed interventions are diversified.
The idea to separate flows of those who, starting from the rail station, have the university or hospital as their destination creates two distinct paths. The first, towards the hospital, is located on portion of existing cycle path (via Chiesa, Rondò dei Longobardi, viale Taramelli, viale Trieste) in streets equipped with pedestrian paths and with a wide section that allows, where necessary, to insert the missing portions. In these cases, it is ordinary maintenance work: insertion of bike lane in the carriageway, restoration of horizontal signs and improvement of road pavement.
The same procedure was followed for the road between the hospital and the Cravino poles: also, here there is already a cycle/pedestrian path. Along this road, an important intervention is the insertion of a cycle road crossing with traffic lights between via Taramelli and via Bassi to manage the huge flow of vehicles and bicycles at the entrance to university institutes and related services (canteen and university sports center).
On the other hand, the flow to the Cravino pole was directed to west beyond the railway: in this case, most of the interventions are extraordinary maintenance as there are currently no cycle paths. The need to use this road lies in the desire to connect also colleges and university residences with the rail station and with the Cravino pole as well as redeveloping unsafe roads for pedestrians and bicycles but highly used for route speed. Therefore, on via Brichetti, viale Golgi, via Flarer and via Aselli a bi-directional bike lane was inserted using the space currently occupied parking lots, redirected to a dismissed area nearby. Moreover, a 30 km/h zone is insert: the road section does not allow the creation of separate paths for pedestrians and bikes so, the road secured becomes a starting point to renewal the contiguous square with some commercial and restaurant activities. On the last portion, a new cycle path is obtained from the tree-lined sidewalk up to the already existing cycle-pedestrian path that reaches Cravino pole.

5.1 Pavia city and its wider territory: observations

The analyzed wide territory around Pavia shows its complexity, its variety, its singularities and its similarities. Each municipality works as an autonomous entity on the territory, but it gravitates on major centers due to its small size from the point of view of territorial extension, urbanization and settled population. In particular, each of them needs to use the supra-local services and, especially some groups of people, take advantage of cultural, leisure and aggregation opportunities that cannot be traced in such minute realities such as all the activities promoted by the University.
Each of the eleven municipalities, their territories dotted with hamlets and minor villages such as *cascine* (farms), and the city of Pavia with its peri-urban and rural context represent autonomous complex systems and, together, create a system that is complex at territorial/provincial scale. The physical and intangible interrelationships that can be highlighted are economic, social, cultural, environmental, productive and working

connections. The values of each minor urban centers are well structured to remain effective even in an enlarged territorial system. The functioning of the urban center and its community is highly sensitive to anthropogenic pressures and to environment values.
The territory planning and management flexibility, in addition to the individual citizen flexibility (the ability to adapt and evolve trying to maintain a dynamic balance with the context), becomes a fundamental element both at micro (intra-municipality) and macro scale (territorial area/inter-municipalities).
As already mentioned, the physical distances between all the centers are limited: the 10 km of road to travel to connect these municipalities and Pavia are rarely exceeded. This allows to see the territorial system as a potential "15-minute system" (with the values expressed in the introduction section) where the already strongly present intangible relationships are further facilitated and increased by the geographical characteristics and existing and potential physical relationships.
The role of Pavia as university City overlaps with the role of Pavia as magnet: these two characteristics carry the city to be the center of a wide range of territorial influence. For university students, Pavia is a destination mainly from Lombardy Region, but almost 30% of students come from other Italian regions; for high school students Pavia is the destination mainly from a range of 30-40 Km (that is the average distance from Pavia of the main centers of Pavia Province); for city users (mainly people working in Pavia and patients of the hospitals) Pavia has a various origin scope.
All the first-tier Municipalities are 10 minutes away (in regular traffic conditions; measurements were made on Monday 25 October 2021 in the morning using Google Maps) by motorized vehicle the Polo Cravino area (authors selected a parking area used by users of the Faculties of Physics and Chemistry, Laboratories of Biotechnology and Physiology, the canteen and the CUS - University Sports Center). On the other hand, considering bicycles use (or other similar transport means), the Municipality are less than half an hour away. In example, Torre d'Isola – Pavia route (about 7 km) is covered in 10 minutes by motor vehicle and in 24 minutes by bicycle; Valle Salimbene – Pavia route (about 11 km) can be completed in 12 minutes by motor vehicle and in 29 minutes by bicycle; Travacò Siccomario – Pavia route (about 10 km) is completed in 13 minutes by car and in 23 minutes by bicycle.
Moreover, it is important to underline that many of the Municipalities have city-buses that connect them directly (without the need for changes) with the center of Pavia and with the university at Cravino pole.

6. Discussion

Despite the obvious interrelation between the transport system and the evolution of urban system, in everyday action, transport planning and urban planning often follow two distinct paths, at least in terms of timing.
For mobility infrastructures planning, the existing and planned territorial structure represents an input for the transport offer planning, as the quantity to be ensured to the territory in relation to urban functions. On the other hand, urban planning accepts the transport network project as an object existing in its own and not as a fundamental element to be included and organized with land use forecasts. The strategic role of mobility infrastructure planning is fundamental for achieving environmental quality, spatial equity and territorial efficiency objectives.
Consequently, the integration and coordination among the tools for mobility governance and for territorial transformations governance are equally fundamental: therefore, it is possible to reach a balance among the infrastructural system, the settlement system, the environmental system and therefore the urban/territorial system.
In Italy, modalities and rules of urban transformation were established already in 1942 with the National Urban Planning Law (ln 1150/1942), but it is only in the second half of the 1980s that arise attention towards the problems connected to the mobility system in urban areas. In the same period, the discussion on environmental and sustainable development issues re-emerged: it was clear the need to define policies,

strategies, actions, planning instruments and design tools to prevent and reduce the phenomenon of urban pollution.

Numerous studies, and not least the actual applications that are spreading in different countries, show how the spatial, environmental, functional and social implications of the "15-minute city" are indeed positive (Venco, 2021).

The emphasis on accessibility, especially on foot or by bicycle, and proximity is fundamental: the spatial distribution of origins/destinations, the ease of reaching them and the size, quality and character of the activities, determine the main characteristics of the infrastructural mobility system. The resulting mode of movement (micro-mobility) has numerous advantages from a social, economic and environmental point of view, facilitating communication and improving the planning process: the reduction of traffic congestion and pollution (noise and emissions) and the increase of green spaces, livable public areas and flexible and widespread collective facilities (Preston J., et al., 2007; Brussel M., et al., 2019). Citizens and city users benefit from health, economic, social, inclusion, time, safety and satisfaction benefits thanks to the quality of the new spaces (Min Weng, et al., 2019; Moreno C., et al., 2021).

Considering that most city trips are quite short (75% of them are approximately 16 km in total), and that the average citizen in the United States and Europe spends more than 200 hours a year commuting, entailing large expenditure of energy, the model of the "15-minutes city" would make cities more sustainable and convenient, directly improving mobility and welfare of residents by promoting accessibility to essential urban services (Earth.org).

Mobility safety, especially for pedestrian as the most vulnerable road users, is a key component of urban planning policies: the "15-minutes city" implementation implicates an increase in active mobility in complete safety and in favor of commercial, cultural and aggregative activities in the urban fabric (Pozoukidou G., et al., 2021).

As seen, these practices are widespread above all in high-dense urban settlements with a widespread functional mix, classic situations in all European cities and especially in medium-sized ones. Even at the territorial level, however, some considerations on the management of the "15-minutes city" may be interesting: here, the main element is not a single urban nucleus but different areas (municipalities, main independent settlements in the areas adjacent to more important cities, small hamlets scattered in the agricultural field) that come together, in an addition of services (among all university and healthcare facilities), relationships and physical and intangible connections to build a cohesive and inclusive community capable of restoring often marginal territories with respect to socio-economic aspects of the metropolitan areas. The "15-minutes city" concept will have to find different explanation, perhaps even different timings to be effectively realistic and useful to the population and to the social-working-economic system of each place, considering always the ideas expressed by Carlos Moreno.

Pavia and the first-tier of Municipality is a 15-minutes aggregation considering the small comprehensive dimensions of the settlement and the opportunity to connect all the centers in a very short time even with soft mobility devices.

7. Conclusion

Regarding Pavia context, as De Carlo (1968) said, the University must be related to the reticular motion of a continuous process of transformation in which it must assume a connective role of fundamental importance. The presence of an ancient University of international importance produces significant effects in the urban and territorial systems: with the University strongly involved in their development, territory and city growth becomes connected with the growth of the University itself. Moreover, the specific context of Pavia has various positive aspects: the small dimension of the city and that the whole city is a "15 minutes city"; the high ratio between students and inhabitants that makes Pavia a real University-City; the high quality and clear identity

of the different parts of the city (above all: the historical city center and the recent scientific pole at north-west of the city); the relevance of the University in all the major urban development phases.
About the general relation between city and University, according to some authors (i.e. Benneworth et al., 2010), the implementation of shared urban projects brings the University closer to the city, fostering the involvement of the local community in the use of university open spaces because it is no more a separate entity but a living body strictly connected with urban spaces and dynamics. University becomes a strategic factor for the development, modernization and renovation of both urban fabric and territorial areas. Di Leo (2015) underlines how a renewed role of the University in close collaboration with local institutions (such as municipalities and associations) could be an ideal driving force for a renewal process of the entire city and of the relations among them. Since that university activities cannot exist if isolated, the territory must be enforced with a strong infrastructure system and strategy linked to the University itself. Therefore, the level of integration of the environment, the quantity and quality of the physical and intangible interrelations that it can guarantee becomes fundamental. Among all the possible typologies of links, the one related to soft mobility assumes an interesting role because it permits to face different issues: 1) the physical network (connected with the spatial shape of the city); 2) the role of urban functions depending on their multimodal accessibility; 3) the diverse use of the same spaces among the various users (citizen, students, professors, researchers, doctors, etc.); 4) the improvement of the shareable events between city and University systems; 5) the favorable and healthy behaviors related to bicycle and pedestrian mobility.
Medium-distance cycle and cycle/pedestrian paths (between the poles, city districts and identified socio-economic-infrastructural-cultural emergencies) are essential elements for the development and the sustainable renewal of urban fabric with the necessity to trigger more and more participatory processes and share projects between the different city realities. University, as attraction pole for a very large number of users (with the related demand for services and the need for expansion), and as an economic driving force, is able to trigger continuous physical and social changes in urban spaces. The structural project presented here fits perfectly into this cultural context and aims to respond to road safety needs clearly expressed by citizens. The project responds with a single uniform and organic development of the university-city system to the needs expressed by the municipality and the university governance. The use of a Collaborative Planning tool helps in sharing the planning process and therefore helps all the involved stakeholders in accepting the technical and political choices. Many mobile apps are nowadays developing very fast (i.e. Moovit, https://moovit.com/it/features-it/) and the behavior and decisions of users are taken into account in the decision making algorithms. These apps have data of users' movements and they optimize travel proposals according with users' choices; they are an almost real bottom-up Decision Support System. Collaborative instruments, such as the one proposed in this paper, try to shorten the distance from the top-down side.
In Pavia history De Carlo proposal has been a milestone for at least three reasons: 1) it proposed a common view for the future of the city between the two main subject who governed the city: Municipality and University; 2) it was based on the strong relation between settlement system and mobility system with reference to the specificity of the city as a forerunner of the 15-minutes city; 3) the idea was governed as a process, proposing a society involvement in decision making; nowadays this way of planning compares in the legislative framework and it is compulsory so that modern IT instruments are extremely useful to manage the whole planners-citizen relation.

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