



SAPIENZA
UNIVERSITÀ DI ROMA

***“IMPLEMENTATION OF CYCLE PATH
IN URBAN AREA”***

*Faculty Of Civil And Environmental Engineering
Course Of Transport System Engineering*

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INTRODUCTION

The concept of road safety is very complex. It provides for precautionary measures depending on the type of transport involved. Therefore, both private and public motor vehicles will be considered, as well as bikes. In the following table four different European Capitals are taken as examples. Each one is characterized by a different extension and the population varies with it. Data refer to year 2007.

<i>Cities</i>	<i>Rome</i>	<i>London</i>	<i>Paris</i>	<i>Barcelona</i>
Population	2,718,770	7,557,000	2,153,600	1,595,110
Area [Km ²]	1,285	1,570	105.4	101
Road Network [Km]	5,000	14,926	1,644	1,281
Motorized Vehicle	2,660,202	3,010,000	893,300	991,151
Freight Vehicles	182,397	21,000	117,700	73,491
Cars	1,897,672	2,497,000	673,600	617,022
Moped and motorcycles	535,997	116,000	102,000	278,671
Other Vehicles	44,294	376,000	-	278,671
Motorization rate [x1000 inh.]	978	398	415	621
N° of accidents	19,960	23,210	8,019	9,834
N° of deaths	201	222	35	43
N° of injuries	26,299	28,361	9,205	12,824
Mortality rate	74	29	16	27

The city of Rome is the second in terms of extension and number of motorized vehicles. The percentage of moped and motorcycle is the highest among the cities analyzed: 20.15%

It is a high value, considering that there is no mobility plan in Italy that involves PTW (Powered two-wheelers) between the dominant units. It is estimated that 1 to 5 people has a motorbike or a moped. The rate of accidents involving these users is 19.0, when the European average is 12.9.

The category “other vehicles” shows how the use of bicycles is a marginal component, but no one must forget this detail, especially in the urban environment where numerous conflict points are generated. For this reason that thesis represents an incentive for urban metamorphosis projected to the systematic decline of private cars that generate congestion, in particular the city of Rome.

A protected cycle path can represent that impulse lacking in change, which has forced the majority of users to use motorized vehicles for short trip in urban environment. Obviously, if roadblocks allow, the continuity of the cycle track must be guaranteed, otherwise promiscuous routes for cyclists and pedestrians will be used; always in compliance with current regulation. The daily use of bicycle allows to combine different aspects. First of all the health-related one: continuous and regular use of the bicycle favors daily exercise. Economic aspect: It reduces the part of family-budget allocated to car, but also the hours lost in traffic, especially city traffic. Ecological: less environmental impact, zero pollution, both atmospheric and acoustic. Political: reduction of energy dependence and saving of non-renewable resources. Mobility: the systematic reduction of motor vehicle makes it easier, in favour of public transport. In this perspective, the benefits of MODAL SPLIT can be fully exploited, resulting from the decrease in the number of cars in circulation. Social: linked to increased autonomy of young and elderly people. Psychic: resulting from the reduction of stress. Therefore, infrastructure plays a significant role, because:

- conflicts with other road users must be minimized,
- paths must be both secure and direct as much as possible, as well as improving the quality of the urban environment.

This organization is important from International to national and local levels, differentiating tourist purposes and local users puposes. The policies listed above are a guide to create a functional and modern cycling network. However, it must be accompanied by detailed information on the territorial reality where the network is to be implemented.

In the following pages, three different realitis will be analyzed:

- American regulation
- Italian regulation
- Spanish regulation
- Danish regularion

CHAPTER 1

"Critical analysis of cycling infrastructures
regulations."

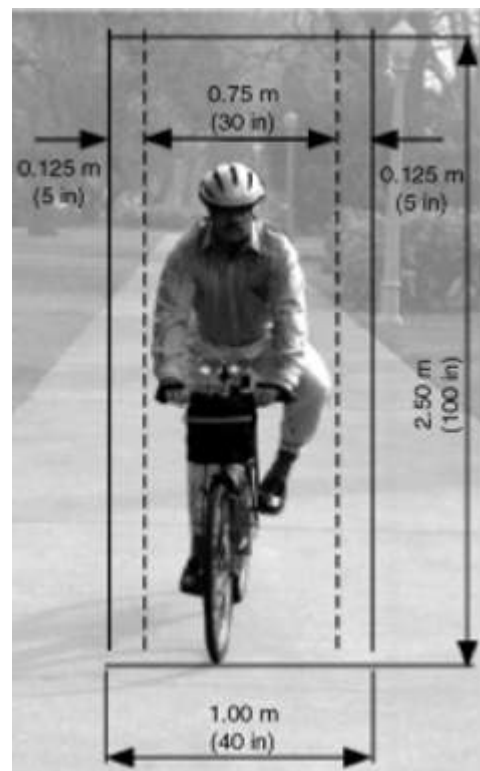
Here, for different regulation are reported: American, Spanish, Danish and Italian regulation. The first three are carried out as example, in order to provide a starting point for the expansion and evolution of Italian regulation, which has been in place since 1999.

AMERICAN REGULATION

The average American user uses bicycle the most during leisure time. Its exploitation in the Modal Split model has began to emerge from the second half of the 70's. Nationwide, people are recognizing the energy efficiency, cost effectiveness, health benefits and environmental advantages of bicycling. According to *AASHTO Guide for the development of bicycle facilities*: **“All highways, except those where cyclists are legally prohibited, should be designed and constructed under the assumption that they will be used by cyclists. Therefore, bicycles should be considered in all phases of transportation planning, new roadway design, roadway reconstruction, and capacity improvement and transit projects”**.

Cyclists require at least 1.0 m (40 inches) of essential operating space based solely on their profile. An operating space of 1.2 m (4 feet) is assumed as the minimum width for any facility designed for exclusive or preferential use by bicyclists. Where traffic parameter are greater, a more comfortable operating space of 1.5 m (5 feet) or more is desirable. A 1994 report by the Federal Highway Administration used the following general categories of bicycle user types (A, B and C) to assist highway designers in determining the impact of different facility types and roadway conditions on bicyclists:

- ❖ **Advanced or experienced riders**; they are the kind of users that use bike as they would a motor vehicle. They are very confident with road traffic.
- ❖ **Basic or less confident adult riders**; that kind of user prefers riding bike along neighborhood street, where traffic is few. Sometimes they use bicycle to get work, but primary use is to visiting friends or going to the store.



- ❖ **Children;** they use bike on their own or with their parents. They use bike to go to school or to reach some recreational center. Designers are involved into realizing new bicycle paths, with protected lanes, which could entice children to move along busier roads.

It is also important the facility type, which is chosen by the user according to his degree of confidence. From the point of view of design, the realization of a bicycle facility has to be an ongoing process that should be consistent with a comprehensive plan considering the different bicycle users, existing conditions and community goals. In the following pages are reported the four different type of facilities with explanatory photos:

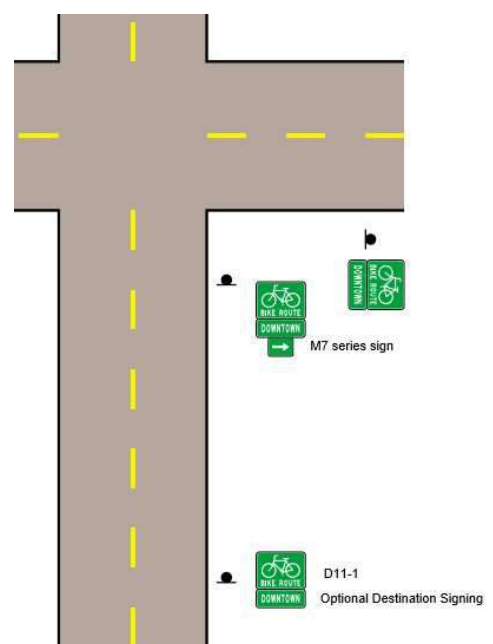
Shared Roadway (No Bikeway Designation). Most bicycle travel in the United States now occurs on streets and highways without bikeway designations. Width is the most critical variable affecting the ability of a roadway to accommodate bicycle traffic. In order for bicycles and motor vehicles to share the use of a roadway without compromising the level of service and safety for either, the facility should provide sufficient paved width to accommodate both modes. I.e, using paved shoulders or increasing lane width.



Signed Shared Roadway. Signed shared roadways are designated by bike route signs, and serve either to:

- Provide continuity to other bicycle facilities (usually Bike Lanes); or
- Designate preferred routes through high-demand corridors.

Regardless of the type of facility or roadway where they are used, it is recommended that bike route signs include destination information. In urban areas, signs typically would be placed every 500 m (approximately every 1/4 mile), at all turns, and at major signalized intersections.

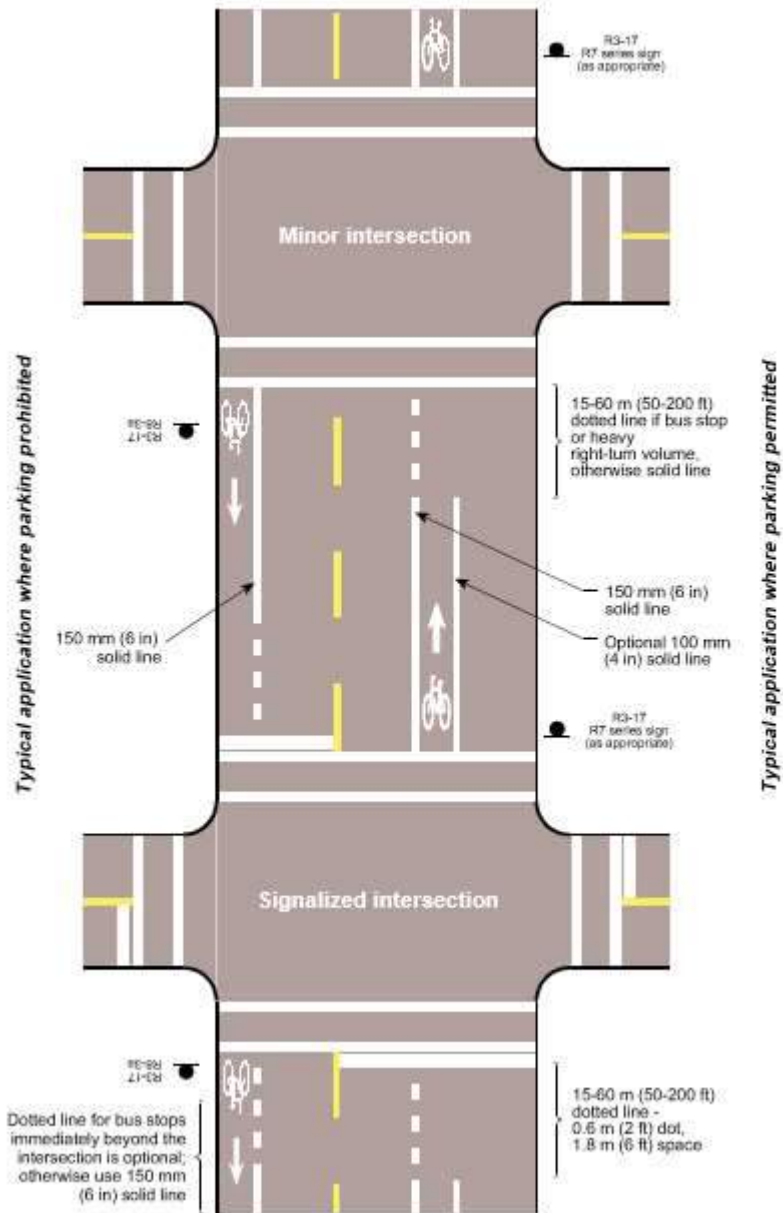


Bike Lane or Bicycle Lane. Bike lanes are established with appropriate pavement markings and signing along streets in corridors where there is significant bicycle demand. They can be incorporated into a roadway when it is desirable to delineate available road space for preferential use by cyclists and motorists and to provide for more predictable movements by each. Bike lane markings, as exemplified in the following picture, can increase a bicyclist's confidence. Bike lanes should be one-way facilities and carry bike traffic in the same direction as adjacent motor vehicle traffic. Two-way bike lanes on one side of the roadway are not recommended when they result in bicycles riding against the flow of motor vehicle traffic. For roadways with no curb and gutter, the minimum width of a bike lane should be 1.2 m (4 feet). If parking is permitted, the bike lane should be placed between the parking area and the travel lane having a minimum width of 1.5 m (5 feet). Where parking is permitted but a parking stripe or stalls are not utilized, the shared area should be a minimum of 3.3 m (11 feet) without a curb face and 3.6 m (12 feet) adjacent to a curb face . If the parking volume is substantial or turnover is high, an additional 0.3 to 0.6 m (1 to 2 feet) of width is desirable.

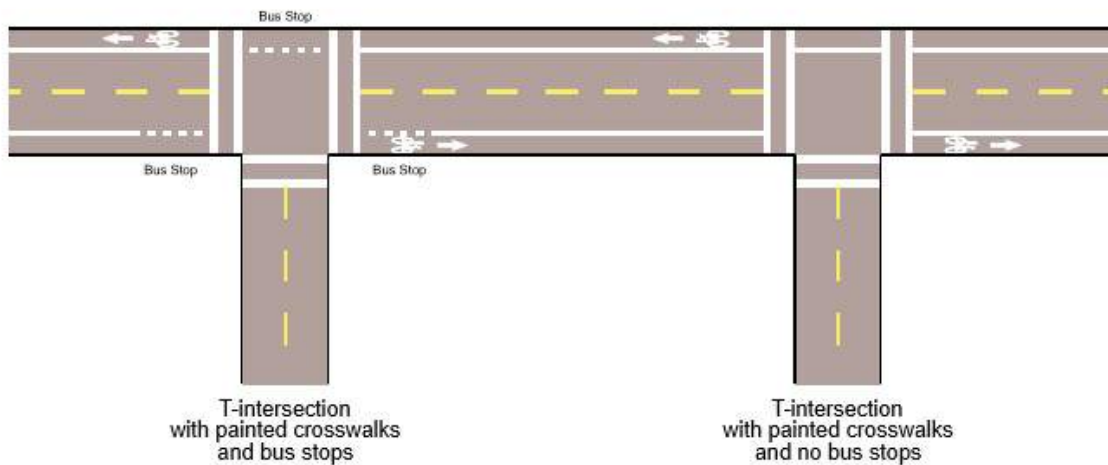


About road intersection, it is important to establish the precedence and the right of turning. When the right turn is allowed, the continuous line defining bike lane is interrupted. It should be replaced with a broken line with 0.6-m (2-foot) dots and 1.8-m (6-foot) spaces. The length of the broken line section is usually 15 m to 60 m (50 feet to 200 feet). At minor intersection, since there are usually small volumes of right-turning motor vehicles, the bike line striping can continue without interruption. If there is a bus stop near the secondary intersection, the following design method is applied: the 150-mm (6-inch) stripe is replaced by a broken line with 0.6-m (2-foot) dots and 1.8-

m (6-foot) spaces, for the entire length of the bus stop. If a bus stop is located on a far side of the intersection rather than on a near side approach, the solid white line can also be replaced with a broken line for a distance of at least 24 m (80 feet) from the crosswalk on the far side of the intersection.



The picture above show the cases of signalized intersection and secondary intersection, when parking is allowed and, on the left, when parking is not allowed. The following picture shows the differences with bus stop and without it.



Shared Use Path. Generally, shared use paths should be used to serve corridors not served by streets and highways or where wide utility or former railroad right-of-way exists, permitting such facilities to be constructed away from the influence of parallel streets. Shared use paths should offer opportunities not provided by the road system.



Shared use path.

The paved width and the operating width required for a shared use path are primary design considerations. Figure 17 depicts a shared use path on a separated right of way. Under most conditions, a recommended paved width for a two-directional shared use path is 3.0 m (10 feet). In rare instances, a reduced width of 2.4m (8feet) can be adequate. This reduced width should be used only where the following conditions prevail:

- bicycle traffic is expected to be low, even on peak days or during peak hours,
- pedestrian use of the facility is not expected to be more than occasional,
- there will be good horizontal and vertical alignment providing safe and frequent passing opportunities,d
- during normal maintenance activities the path will not be subjected to maintenance vehicle loading conditions that would cause pavement edge damage.

Under certain conditions it may be necessary or desirable to increase the width of a shared use path to 3.6 m (12 feet), or even 4.2 m (14 feet), due to substantial use by bicycles, joggers, skaters and pedestrians, use by large maintenance vehicles, and/or steep grades.

The minimum width of a one-directional shared use path is 1.8 m (6 feet). It should be recognized, however, that one-way paths often will be used as two-way facilities unless effective measures are taken to assure one-way operation.

About the design speed, it is used a minimum design speed equal to 30 km/h (20 mph). Although cyclists can travel faster than this. When a downgrade exceeds 4 percent, or where strong prevailing tailwinds exist, a design speed of 50 km/h (30 mph) or more is advisable. On unpaved paths, where cyclists tend to ride more slowly, a lower design speed of 25 km/h (15 mph) can be used. Similarly, where the grades or the prevailing winds dictate, a higher design speed of 40 km/h (25 mph) can be used.

In order to define the horizontal alignment, it is considered the lean angle, that is the minimum angle until the pedal strikes the ground. If $15^\circ < \alpha < 20^\circ$, the horizontal alignment has the following formula:

For Metric Units:

$$R = \frac{0.0079 V^2}{\tan \theta}$$

Where:

R = Minimum radius of curvature (m)

V = Design Speed (km/h)

θ = Lean angle from the vertical (degrees)

When the lean angle approaches 20°, the formula becomes:

For Metric Units:

$$R = \frac{V^2}{127 \left(\frac{e}{100} + f \right)}$$

Where:

R = Minimum radius of curvature (m)

V = Design Speed (km/h)

e = Rate of bikeway superelevation (percent)

f = Coefficient of friction

To provide bicyclists with an opportunity to see and react to the unexpected, a shared use path should be designed with adequate stopping sight distances.

$$S = \frac{V^2}{254 (f \pm G)} + \frac{V}{1.4}$$

Where: S = stopping sight distance (m)
V = velocity (km/h)
f = coefficient of friction (use 0.25)
G = grade (m/m) (rise/run)

Reaction time is assumed equal to 2.5s.

SPANISH REGULATION

According to the technical book “La bicicleta en la ciudad”, drafted by Ministerio de Fomento, a bicycle path has to be the right compromise between:

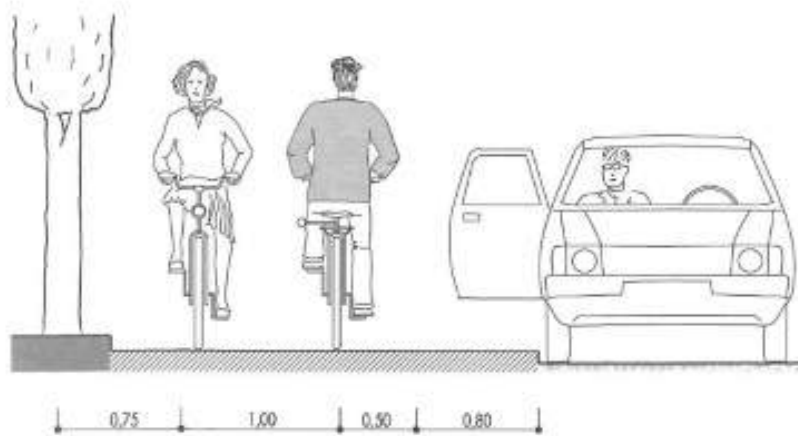
- Shortest path;
- Panoramic view;
- Connection with other ways of transport;

Moreover, the design of a cycle track keeps the cyclist at the center of attention. In this way designers can satisfy the needs of various users: workers, children, elderly and tourists. The following points are the most important:

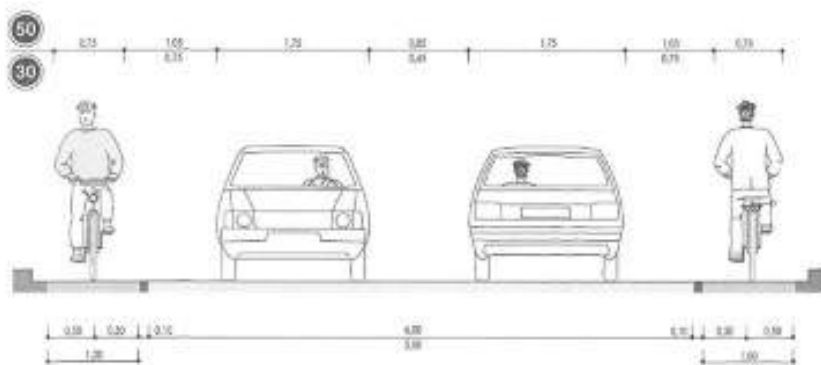
- Avoiding excessive slopes;
- Avoiding interferences with motorized vehicles and pedestrians;
- Design project must consider the maximum and minimum flow: number of bicycles;
- When protected path cannot be ensured, the designer must ensure that any intersections do not endanger cyclists;
- In the urban environment, signalized intersections are recommended;
- It needs to be protected from especially adverse weather conditions;
- Lighting systems, which allow the use even at night;

All this provided that ordinary maintenance is carried out.

About cross section, in order to define safe circulation for cyclists, designers compute the following measurements: a cyclist occupies a street section of 0.75 m and a planner must guarantee at least 1.00 m to allow displacements. Between two bicycles moving in the opposite direction, a minimum clearance of 1.00 m must be ensured. The distance between the wheel of the bicycle and the curb varies between 0.25 and 0.50 m.



The picture above shows the case in which parking is allowed alongside the sidewalk/bicycle path. A distance of 0.8 m must be ensured because of people getting down the car. In major streets, bicycles could run on different lane according to direction. The picture below shows that situation.



The width is the same for each lane: 1.00 m, assuming that cyclists run on the center line. The distance between cars and bicycle varying from 0.75 to 1.05 m.

Planing elements with constant curvature are characterized by the following formula:

$$R = 0.24V + 0.42$$

R is Radius, while V is speed. Speed range varying from 12 Km/h to 30 Km/h. In the following table is shown the corresponding value of radius for speed one.

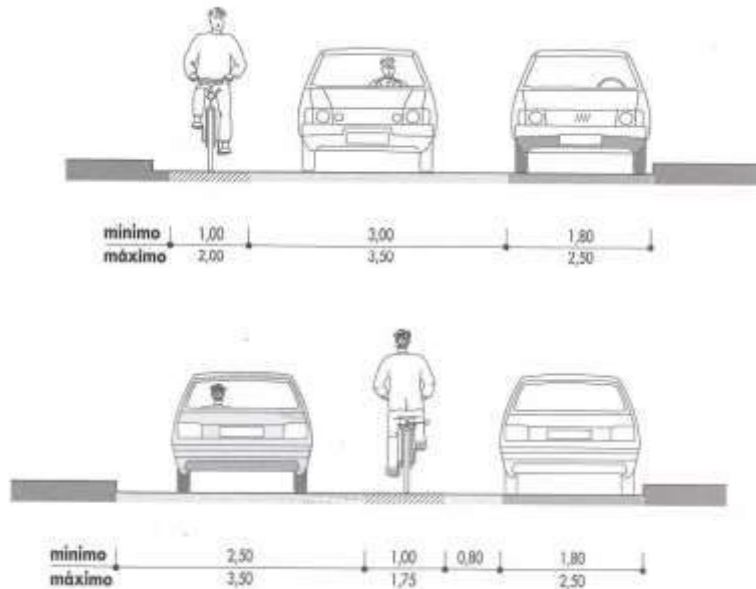
Speed				Radius	
12	[Km/h]	3.3	[m/s]	3.3	[m]
15	[Km/h]	4.2	[m/s]	4	[m]
20	[Km/h]	5.6	[m/s]	5.2	[m]
30	[Km/h]	8.3	[m/s]	7.6	[m]

About Altimetric technical characteristics:

<i>Transversal Slope</i>	$X \geq 2\%$
<i>Longitudinal Slope</i>	$X \leq 5\%$
<i>Longitudinal Slope per Km</i>	2% (Max Length: 4,0 km) (Speed Max: 15 km/h) 4% (Max Length: 2,0 km) (Speed Max: 15 km/h)
<i>Longitudinal Slope on ramps or to get different levels</i>	$X \leq 20 \div 25\%$

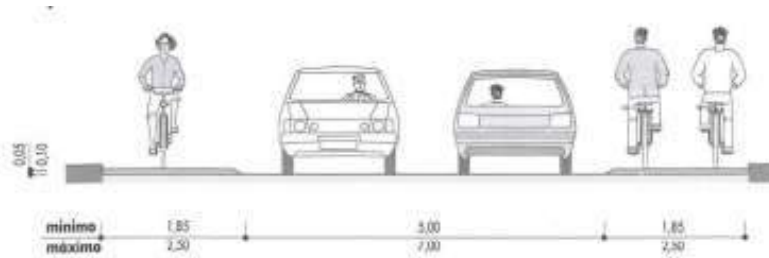
According to Spanish regulation, there are different definitions of bicycle path, which depend on the typology:

- CARRIL – BICI: bicycles and cars move on the same lane. Designers must consider space proportional to speed. For unidirectional way, with bicycles adjacent to sidewalk, space goes from 1.00 m to 2.00 meters. When bicycles run between moving and stopped vehicles, lane width goes from 1.00 m to 1.75 meters.



Single direction traffic

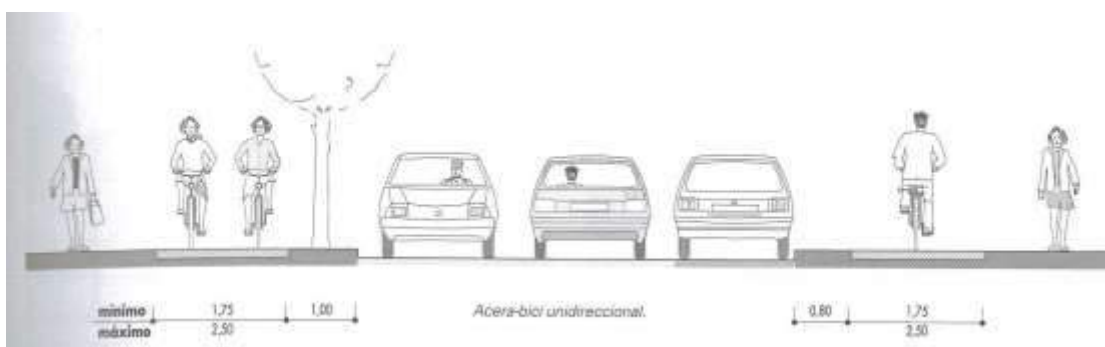
In the case of bidirectional way, spanish regulation provides a semi-protected route for bicycles. For each direction two bicycles are allowed to run parallel. About measures, each lane width goes from 1.85 m to 2.50 meters, as shown in the figure.



Bidirectional traffic

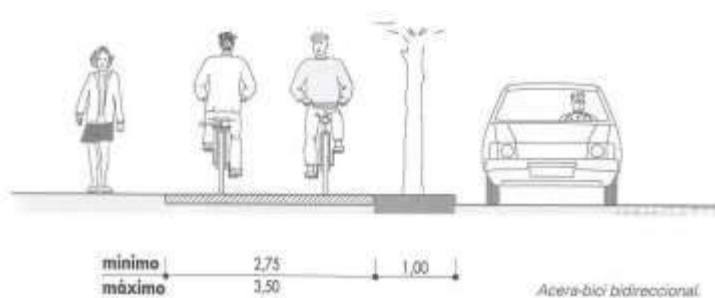
- ACERAS – BICI: this typology provides the passage of pedestrians and cyclists on the same portion of road. More precisely, sidewalk is divided into two parts: one referred to pedestrian, the other one to cyclists. There are two different case: the first one is related to unidirectional bike traffic, the latter to bidirectional bike traffic.

- 1. Unidirectional bike traffic



Lane width has a minimum value of 1.75 m. and a maximum one of 2.50 meters.

- 2. Bidirectional bike traffic



Lane width has a minimum value of 2.75 m. and a maximum one of 3.50 meters.

- PISTAS – BICI: When the bicycle lane is independent of the roadway, it is called PISTA BICI. The footprints remain quite the same, both for single-directional and bi-directional circulation:
 - Unidirectional: from a minimum of 1.75 m. to a maximum of 2.00 meters
 - Bidirectional: from a minimum of 1.75 m. to a maximum of 2.50 meters

DANISH REGULATION

In Denmark there are about 7000 Km of segregated dedicated bicycle paths. The four main cities are crossed by approximately 1350 km of bicycle paths, respectively: Aalborg (609 Km), Odense (510 Km), Aarhus (450 Km) and Copenhagen (412 Km). Danish regulation considers bike path divided into the following typologies:

- cycle lane;
- paved shoulder;
- cycle path;
- cycle track.

Generally, bicycle path are realized above the shoulder of the road, but in the previous years they were separated by motorvehicle lanes by a thick whit lane. Many investments have been done in order to create more cycle ways and to improve safety.

The Danish Roads Directorate acknowledges that the Danish cycle track system "functions best when cyclists travel at relatively low speeds"(The Danish Road Directorate. 2000). Infact, bicycle lanes are ideal for urban areas, with low traffic speed [≤ 50 km/h] and moderate traffic. Lane dimensions are:

- lane width = $1,2 \div 1,5$ m
- median line thickness = 0,3 m

Paved shoulders are used in small town, where there is few cycle traffic and along major corridors with low traffic.

- Width:
 - 1,2 m (extaurban areas)
 - 1,5 m (urban areas)
- median line thickness = 0,3 m

Cycle paths are used in recreational areas or along the large road arteries (with few crossings). Down there, it is possible to find their characteristics:

- Width:
 - $1,7 \div 2,5$ m (it is a cycle protected route, flanked by a pedestrian lane)
una corsia pedonale)
 - 3,0 m (pista ciclopedonale)
- Distance by the road:

- $\geq 1,0$ m (urban areas)
- $\geq 1,5$ m (on highways)
- 3,0 m (on major roads)

Cycle tracks are used along roads with high speed [≥ 50 km/h] and intense traffic. Their dimensions are the following:

- Width:
 - 1,7 ÷ 2,2 m (one lane)
 - 1,5 ÷ 1,7 m (promiscuous passage: cycle and pedestrian)
- Flooring:
 - 7 ÷ 12 cm (cycle track – roads)
 - 5 ÷ 9 cm (cycle track – pedestrian area)
- Square width:
 - $\geq 2,0$ m (highway)
 - 1,0 ÷ 1,5 m (with trees; 2,0 m in the city)
 - 0,6 m (with lawn partition)

About slopes, danish regulation follows the table below:

Slopes	Max Lenght
50‰	50 m
45‰	100 m
40‰	200 m
35‰	300 m
30‰	500 m

According to this value, it is important to define the correct values of design speed related to slope ‰.

Slope	Design Speed
50‰	40 km/h
45‰	38 km/h
40‰	36 km/h
35‰	34 km/h
30‰	32 km/h



(Bike bridge Copenhagen)

ITALIAN REGULATION

In Italy, the bodies responsible for the construction, maintenance and design of cycle paths are:

- Ministry of Public Works
- Ministry of Transport and Navigation

It should be noted, however, that the legislation is not updated since 1999, when the Ministerial Decree No. 557 was issued, laying down rules for the definition of the technical characteristics of the cycle lanes. As the previous case of American regulation, it is possible to observe in Italy the following cases:

- bicycle path on its own infrastructure;
- bicycle path on a protected lane;
- promiscuous itineraries (pedestrian/ cyclist);
- promiscuous itineraries (moter vehicle/ cyclist).

However there is no systematic detection of the interventions carried out in favor of cycling, both on local and national scale. For this reason the project FIAB (Federazione Italiana Amici della Bicicletta) was developed. It wants to promote the diffusion of bicycle as an ecological way of transport, in an environmental re-qualification framework. It gathers more than 130 local associations which act for a better cycling in Italy. More in dept, FIAB project has the following aims:

1. it wants to build and to get available an updated framework of the state of development of tourists cycle paths, represented by regional and national cycling routes (basic, secondary, cycling access systems and panoramic routes inside Regional parks),
2. moreover, defining bike no more as a complementary way of transport, but a primary one. (dutch and danish model).

Technical Regulation

The following part regard the technical regulation. The last achievement dates back to 1999. MINISTERIAL DECREE 30/11/1999, n. 557. "Regulation collecting normatives which defines technical characteristics of bicycle path".

It is divided into three parts:

- CAPO 1: Guidelines for the design of cycling routes; it is subdivided into 5 articles which are organized in this way:
 - Art.1, introduction;
 - Art.2, purpose and design criteria;
 - Art.3, planning tools;
 - Art.4, additional elements for design;
 - Art.5, technical-economic feasibility.
- CAPO 2: Main standards design for bike lanes:
 - Art.6, definitions, typology and location;
 - Art.7, width of lanes and slats;
 - Art.8, design speed and plano-altimetric features;
 - Art.9, bicycle crossing;
 - Art.10, road signs;
 - Art.11, parking lots;
 - Art.12, cycle surfaces.

<i>Width [m]</i>	One lane: 1.50 [m]
	Two lanes: 1.25 [m] + 1.25 [m] = 2.50 [m]
	Short stretches: 1.00 [m]
<i>Slats [m]</i>	$X > 0.50$ [m]
<i>Design Speed [km/h]</i>	20 [km/h] ÷ 25 [km/h] on flat
	40 [km/h] downhill $i = 5\%$
<i>Perception and Decision Time [s]</i>	1.0 [s] urban environment
	2.5 [s] extraurban environment
<i>Longitudinal adhesion coefficient</i>	$X < 0.35$
<i>Slope</i>	$X \leq 5\%$
<i>Long. Slope offset crossing ramps</i>	$X \leq 10\%$
<i>Average longitudinal inclination per Km</i>	$X \leq 2\%$
<i>Horizontal Radius [m]</i>	5.0 [m] measured from internal eyelash
	3.0 [m] in intersection areas
<i>Transversal slope</i>	$X \geq 2\%$
<i>Protective barriers for bicycle overlays</i>	$X \geq 1.50$ m

- CAPO 3: Transitional provisions:
 - Art.13, scope of application.

Each regulation takes into account the characteristics of national road network, regarding both urban roads and extraurban roads. For each typology traffic volumes have to be measured. By proceeding in order, the American one is surely the most comprehensive regulation. Unlike the Europeans, it divides the cycling user into 3 different categories, identifying for each one the most appropriate itinerary or path. The footprints vary depending on the type of route, but a minimum space for the cyclist is required, ranging from 1.20 to 1.50 meters. AASHTO regulation also provides the type of crossing, depending on whether it is a road with high traffic volume or a secondary road. About Europe, there is a close connection between Danish and Italian regulations. Both countries adopt a maximum width of 2.50 meter, for bidirectional cycle path (the Danish one extends up to 3.00 meters in the case of cyclopedonal path). Spanish regulation predicts that, in the case of a double-lane cycling track, the width increases to a maximum of 3.50 meters. Regarding the maintenance status of cycle paths, the Italian situation, especially the Roman one, is extremely weak.

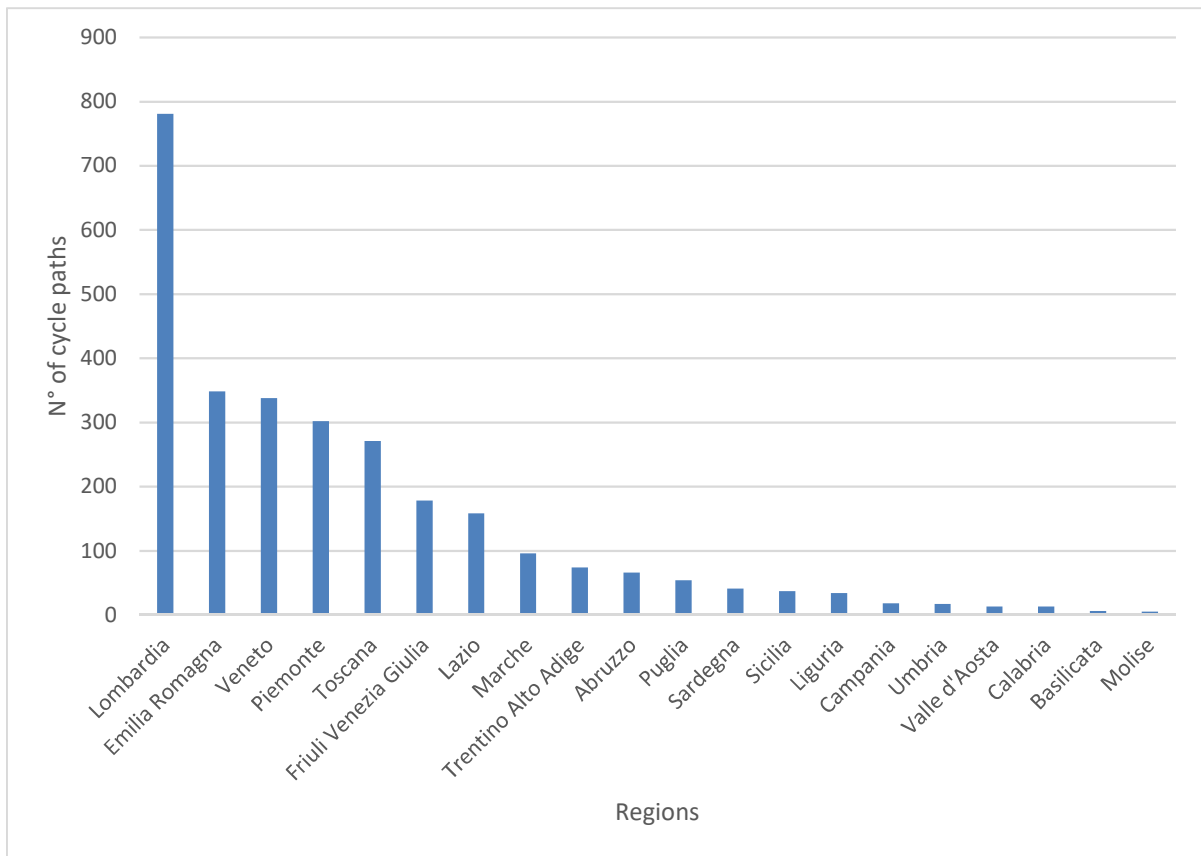
For example, In Denmark bicycle transport plays a central role, just think about the Bike Bridge in Copenhagen. The “Bicycle Snake” connects the city and transports cyclists across the harbour on an aesthetic ride above the harbour basin. The Bridge is 4 metres wide, with a length of 190 meters and 30 meters of ramps. Ponte della Musica is the only example of cycling infrastructure in Rome, but realized to ensure the passage of a future tram.

CHAPTER 2

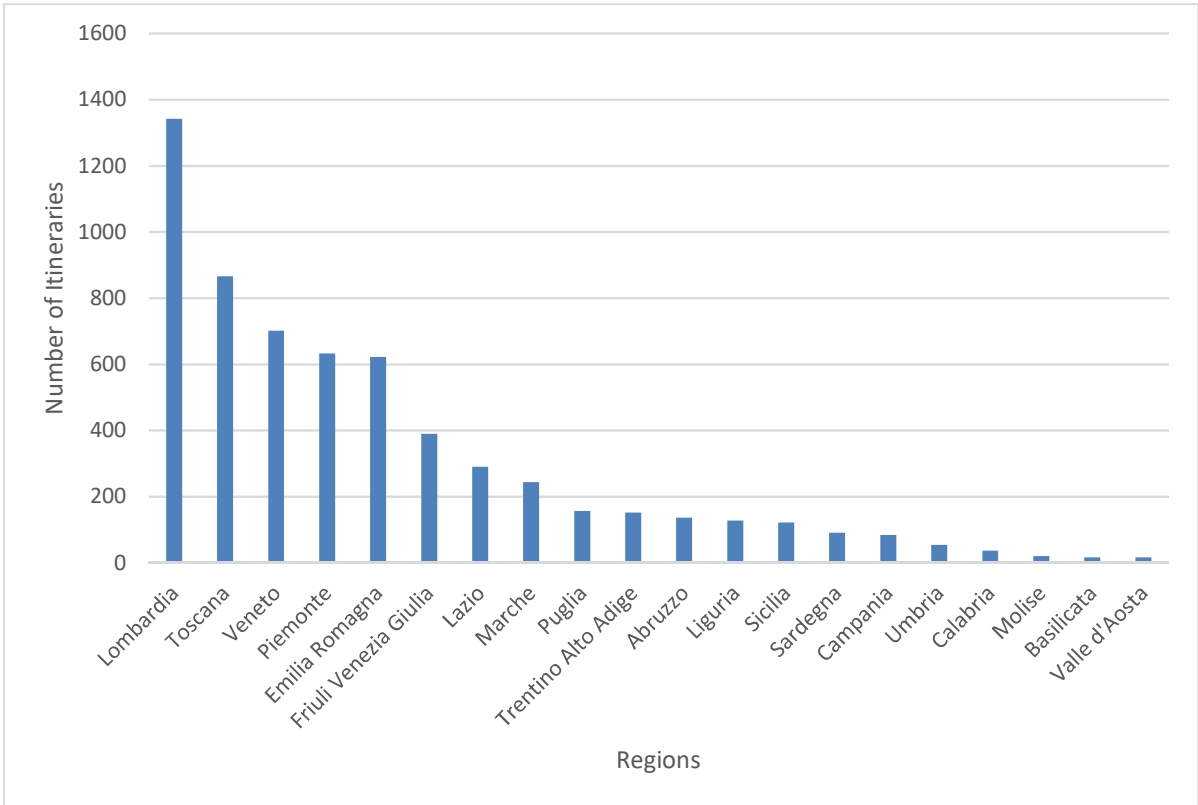
"Italian Cycling network classification."

In Italy, each region has to lead districts in the way to model cycling network. Then each district do the same with local communities. The latter are responsible of the interventions on cycling in their territory. In the following table is shown the number of cycle path for each Region. Each value is expressed in Kilometres.

Regions	Paths
Lombardia	781
Emilia Romagna	348
Veneto	338
Piemonte	302
Toscana	271
Friuli Venezia Giulia	178
Lazio	158
Marche	96
Trentino Alto Adige	74
Abruzzo	66
Puglia	54
Sardegna	41
Sicilia	37
Liguria	34
Campania	18
Umbria	17
Valle d'Aosta	13
Calabria	13
Basilicata	6
Molise	5



Regions	N° of itineraries
Lombardia	1342
Toscana	866
Veneto	701
Piemonte	633
Emilia Romagna	622
Friuli Venezia Giulia	390
Lazio	290
Marche	244
Puglia	157
Trentino Alto Adige	152
Abruzzo	136
Liguria	128
Sicilia	122
Sardegna	91
Campania	84
Umbria	54
Calabria	37
Molise	20
Basilicata	16
Valle d'Aosta	16



The previous two tables, with outlined charts, show an updated rank number of paths and itineraries. Lombardia is ranked first in both rankings. This is due to its strategic position, which includes, in its orography, flat territories (Pianura Padana), hilly territories, and finally mountainous. Among the main routes, it is important to identify the one who run along Adda Valley, the Bergamasche Hills and all the itineraries that overlook Lake Garda, Lake of Como and Lake Maggiore.



Adda Valley



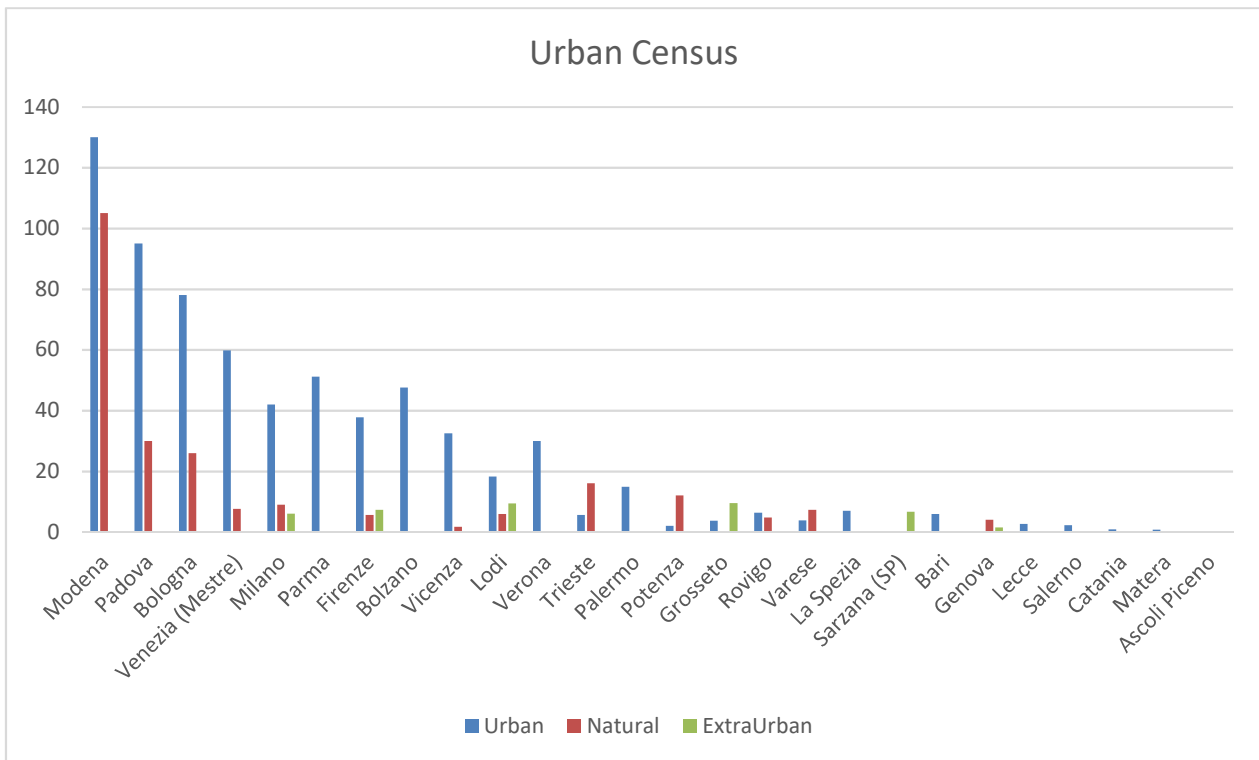
Valtellina (Lago di Como)

However, attention must be paid to the urban environment, as the Cycle Path Project concerns city background. The FIAB provides a municipal-level extension in [Km] of the bicycle network. For the following survey, conducted in 2009, 25 municipalities were considered. This investigation is called “FIAB's first national census on cycling in chief town districts”. Different cycle paths are considered from various aspects:

- Typology: protected or promiscuous
- Quantitative data: length and width
- Directions: monodirectional or bidirectional
- Security level: path or lane
- Destination: urban, natural or extraurban
- Status of signage: in compliance or not in compliance

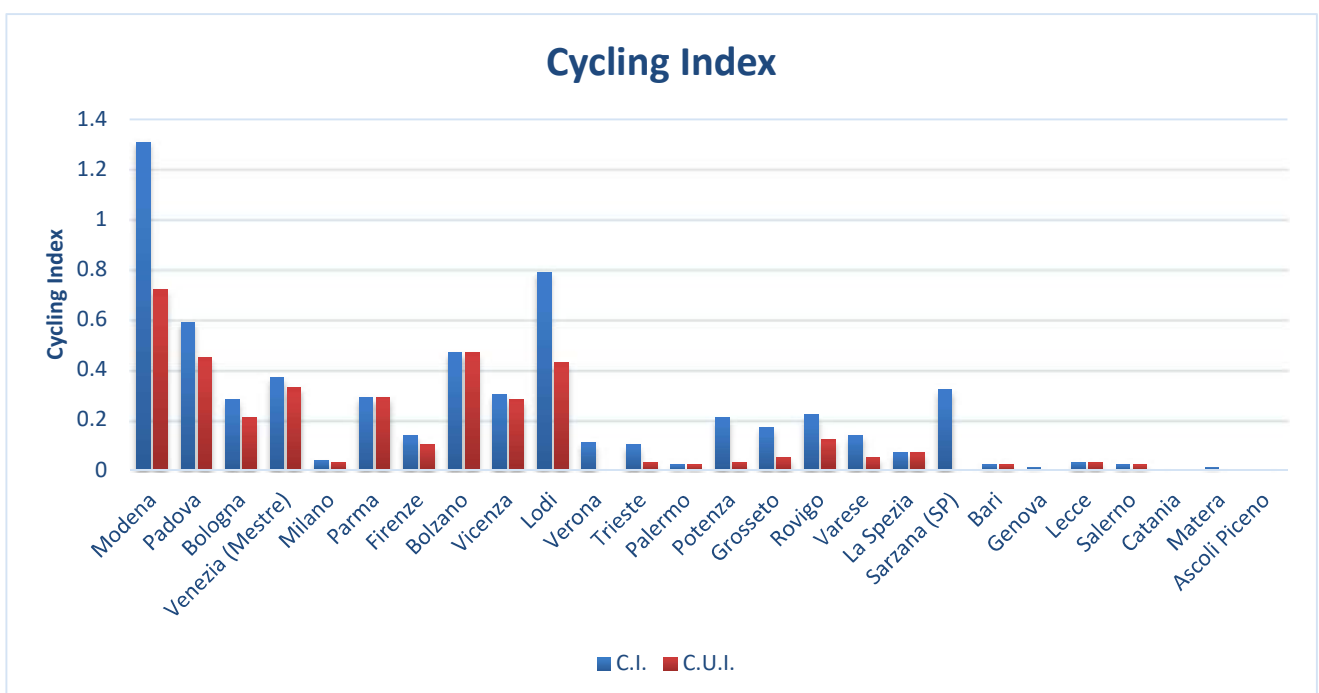
Of 71 contacted organizations, only 25 provided the above data. The cities concerned are those listed in the table below.

<i>Cities</i>	<i>Urban</i>	<i>Natural</i>	<i>ExtraUrban</i>	
Modena	130	105	0	[Km]
Padova	95	30	0	[Km]
Bologna	78	26	0	[Km]
Venezia(Mestre)	59.8	7.6	0	[Km]
Milano	42	9	6	[Km]
Parma	51.2	0	0	[Km]
Firenze	37.8	5.6	7.25	[Km]
Bolzano	47.6	0	0	[Km]
Vicenza	32.5	1.7	0	[Km]
Lodi	18.3	5.9	9.45	[Km]
Verona	30	0	0	[Km]
Trieste	5.6	16	0	[Km]
Palermo	14.9	0	0	[Km]
Potenza	2	12	0	[Km]
Grosseto	3.7	0	9.5	[Km]
Rovigo	6.4	4.8	0	[Km]
Varese	3.8	7.3	0	[Km]
La Spezia	7	0	0	[Km]
Sarzana (SP)	0	0	6.7	[Km]
Bari	5.9	0	0	[Km]
Genova	0	4	1.5	[Km]
Lecce	2.7	0	0	[Km]
Salerno	2.2	0	0	[Km]
Catania	0.9	0	0	[Km]
Matera	0.8	0	0	[Km]
Ascoli Piceno	0	0	0	[Km]



The number of meters per track per inhabitant is defined as the *Cycling Index*, while the *Urban Cycling Index* has the same value but exclusively in the urban environment. 1.5 is the maximum achievable value. The cycling index is used in order to provide a parameter that really takes into account the potential of the bicycle path. The kilometers of bike paths provide only a quantity that does not represent the requirements for good cycling mobility.

Cities	C.I.	C.U.I.
Modena	1.31	0.72
Padova	0.59	0.45
Bologna	0.28	0.21
Venezia (Mestre)	0.37	0.33
Milano	0.04	0.03
Parma	0.29	0.29
Firenze	0.14	0.1
Bolzano	0.47	0.47
Vicenza	0.3	0.28
Lodi	0.79	0.43
Verona	0.11	N.C
Trieste	0.1	0.03
Palermo	0.02	0.02
Potenza	0.21	0.03
Grosseto	0.17	0.05
Rovigo	0.22	0.12
Varese	0.14	0.05
La Spezia	0.07	0.07
Sarzana (SP)	0.32	N.C
Bari	0.02	0.02
Genova	0.01	0
Lecce	0.03	0.03
Salerno	0.02	0.02
Catania	0	0
Matera	0.01	0
Ascoli Piceno	0	0

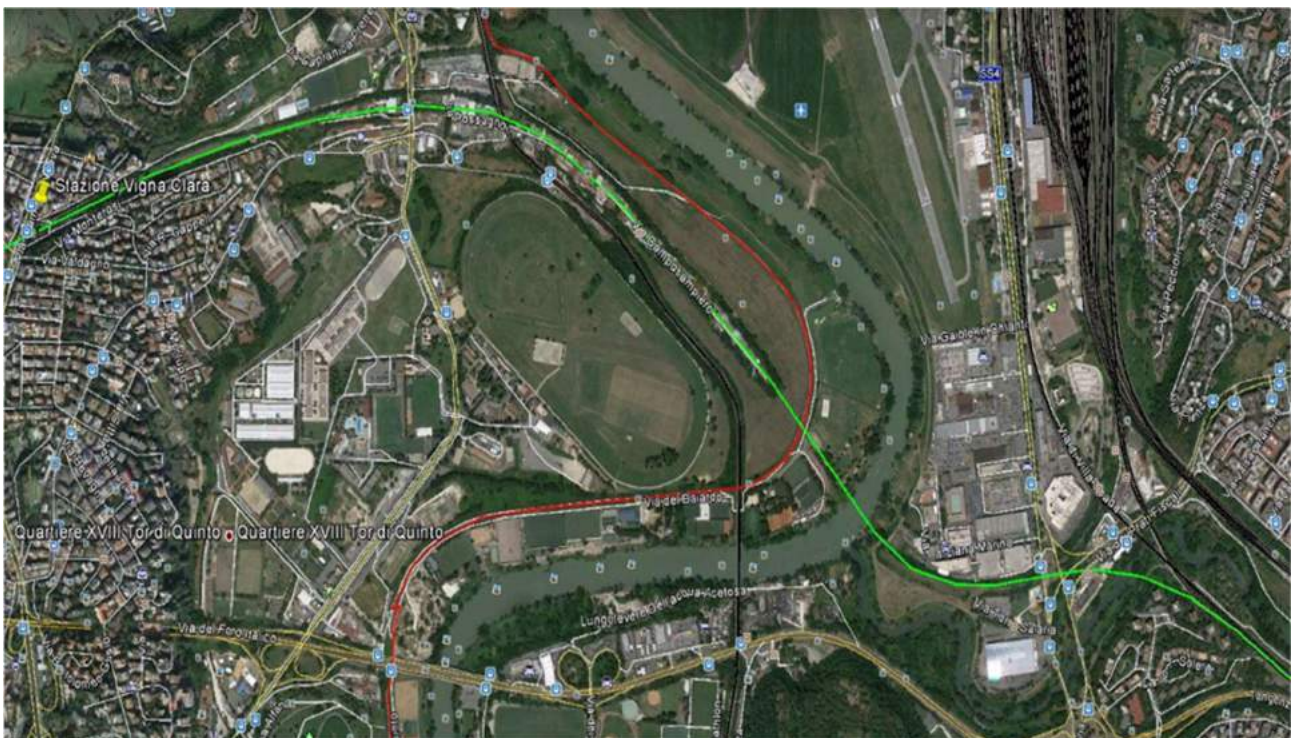


City of Rome

Today, the city of Rome has about 240 km of bike paths (110 of which are in green areas). There are 31 cycle corridors crossing the capital for a total of 360.71 km; Most of these, are not reported and force users to drive their bicycles on the lanes where motorized vehicles move.

ID	DENOMINATION	KM	
1	Corridoio Litoranea	9.55	[Km]
2	Corridoio Colombo	24.81	[Km]
3	Corridoio Ostiense	16.90	[Km]
4	Corridoio Tevere	41.97	[Km]
5	Corridoio Laurentina	11.14	[Km]
6	Corridoio Tuscolano	11.13	[Km]
7	Corridoio Roma Sud	9.93	[Km]
8	Corr. Anagnina - Tor Vergata	7.10	[Km]
9	Corr. Prenestina - Casilina	17.30	[Km]
10	Corr. AV Roma - Napoli	2.63	[Km]
11	Tangenziale Aniene	30.95	[Km]
12	Corridoio Nomentano	6.25	[Km]
13	Corr. Ponte Mammolo - Tiburtina	5.74	[Km]
14	Corr. Parco Aniene - S.Lorenzo	4.46	[Km]
15	Corr. Monte Sacro Alto - Aniene	6.82	[Km]
16	Corr. Marcigliana - Porta Pia	11.49	[Km]
17	Corr. Parco di Veio - Corso Francia	8.35	[Km]
18	Corr. Giustiniana - Aurelio	18.01	[Km]
19	Tangenziale Esterna	32.20	[Km]
20	Corr. Villa Pamphili - Tevere	10.86	[Km]
21	Tangenziale Interna	10.62	[Km]
22	Corr. Eur - Marconi	4.75	[Km]
23	Tangenziale Roma Est	11.61	[Km]
24	Corr. Interno Ostiense	4.06	[Km]
25	Corridoio Aurelia	8.67	[Km]
26	Corridoio Appia Nuova	6.79	[Km]
27	Corridoio Casilina	6.50	[Km]
28	Corridoio Nord Est	11.02	[Km]
29	Tang. - T. Bella Monaca - T.Vergata	3.55	[Km]
30	Corr. Anagnina - Tuscolana	3.70	[Km]
31	Corr. Aurelia - Villa Pamphili	1.85	[Km]
	TOTALE	360.71	[Km]

Regarding new possible projects, it is important to underline the one provided by RFI, about the realization of the new railway line that will connect Vigna Clara station with Rome Tiburtina one. Nowadays this area is occupied by the craftsmanship of "Consorzio Roma Due Ponti", but as soon as they are displaced in a new area, a new bike path will be realized along the train route. Currently, Mario Elia, CEO of Ferrovie dello Stato, said that to complete the whole infrastructure, about 500 million of euro are needed and all this money should be financed by Ministry of Environment and the Ministry of Infrastructure, after the approbation of the final project. A small part of this sum will be used to realize the bicycle infrastructure.



This aerial view shows in green the new railway track while the red curve defines the local train from Roma Piazzale Flaminio to Viterbo, served by ATAC.

About existing routes, two cycle paths are taken for example. The first crosses the city center, starting from Ponte Milvio and arriving at Villa Ada. It belongs to the Tiber Cycle Path. The other leaves Villa Ada and arrives at Ponte Nomentano and is part of the Aniene Cycle Route.

Cycle path from Ponte Milvio to Villa Ada

This route was designed in order to realize a link between Tevere River and Aniene River. It offers a very panoramic view, from the point of view of natural environment. It snaps inside Rome's second

district and runs across Villa Glori and Monte Antenne, where there are leisure and sport facilities. Moving along that path it is possible to reach the Auditorium

Technical Data

Access Points: Ponte Milvio, Viale Tiziano, Viale De Coubertin, Piazza Euclide, Viale Pilsudski, Viale della Moschea, Via Salaria

Total length: Km 5,56, mostly flat

The route

Starting from Piazza Cardinal Consalvi (Ponte Milvio), it continues on Viale Tiziano, moving on sidewalk. At the height of Piazza Apollodoro it moves on the left, reaching the pedestrian area in front of Auditorium. Then it continues on Viale De Coubertin until it reach Viale Pilsudski. Along the avenue that runs along Villa Glori, there is the first entrance to the park. It continues for a hundred meters on a false flat floor until the second entrance, located at Piazzale del Parco della Rimembranza. Here cyclists can continue on Viale della Moschea or moving to Piazza Euclide.

Within the square there is the Train Stop Euclide of the Roma Nord line. Continuing on Viale della Moschea, cyclist get to Ponte Salario, where it is recommended to get off the bike. It thus reaches the area of Monte Antenne. Using the sidewalk of the deceleration lane of the Olympic Tangenziale, it joins the Aniene ridge: the track linking Villa Ada to Ponte Nomentano.

Cycle Path from Villa Ada to Ponte Nomentano

This promiscuous track was open on 29 September 2005. It allows pedestrian and bicycle to pass. It runs along Aniene River, starting from Villa Ada to Ponte Nomentano; mainly along the left bank. It includes two important branches: the first to the neighborhood of Prato della Signora, the latter to Nomentana station of the Rome - Florence railway line. The first branch allows neighboring districts to get easily the itinerary along the river. The second one permits the use of the same itinerary by people alighting trains; in that way is realized a good example of modal split.

Technical Data

Access Points: Via Salaria, Via Val d'Aosta, Ponte Tazio

Total length: 4.1 Km mostly flat

The route

The route starts from Villa Ada going down to Prato della Signora. It runs on the left sidewalk of Via Ponte Salaria and then it goes to Via Salaria using a special ramp. At the height of the intersection with Viale Somalia, the path crosses that junction remaining on Via Salaria for 30 meters until it reaches the turning point with Via Catalani. Now it heads to Prato della Signora district crossing the subway of Salaria ring road in the direction to Via Fioravanti. Here starts the connection with Aniene river, which allows people living in Nuovo Salaria and Prato della Signora districts to use bike path.

Here, the path starts its natural itinerary, entering in the Aniene Valley. After Piazza Raffaele Casimiri it goes under the train subway and right here begins to run along the train infrastructure. After the ACEA plant, the track follows the Aniene course and then passes over the Roma-Orte subway railway line and the Delle Valli viaduct reaching Via del Fosso di Sant'Agnesa and Via dei Campi Flegrei, at the height of Via Val di Fossa. From Via del Fosso di Sant'Agnesa it is possible to get to Nomentana railway station, ensuring train/bike modal split. The station has an appropriate subway, which connects it with Viale Ethiopia (on the other side of Aniene Valley). Considering the opposite side, the cycle path crosses Val di Fossa garden and then ends near Ponte Tazio with an equipped area. Using a semaphorized crossing it is possible to reach the gardens of Ponte Tazio and Ponte Nomentano.



Ponte Milvio (start of Cycle Path from Ponte Milvio to Villa Ada)

Auditorium Pedestrian/Cycle square



Viale Parioli

Via della Moschea, nearby via di Monte Antenne





“Percorso Aniene” at the height of Via del Prato della Signora

Cycle Path “Percorso Aniene” at the height of Via di Val Trompia



Nowadays the situation is different. “Percorso Aniene” lacks in ordinary maintenance, especially in off-shore areas. An example is the access nearby Via del Prato della Signora, adjacent to Via Salaria. Branches, pits, and garbage invade the path, making it untranslatable. In addition, the area was deliberately ignited and the burnt trees are still observable. Moreover, in many part of the track, both vertical and horizontal signs are missing. When it was realized in 2005, ACEA provided the rail subway with photovoltaic lighting, nowadays it lacks both the panels and the electrical system. The state of the verse of the infrastructure is highlighted by the following photos.



Via del Prato della Signora at the height of Via Salaria.

Along Aniene Valley, no maintenance.



Entrance of the path, completely blocked by a bar.

Despite Italian regulation is stopped since 1999, there are many initiatives regarding cyclists. For example, ATAC (Azienda tramvie e autobus del Comune) allows free bicycle transport for those who own the annual membership fee. On metro lines A, B, C and Roma-Lido train, bike transport is only permitted on special carriages. For those who don't own the annual membership fee, The cost of the transport is valid for a second ticket (1,50 €), in addition to the user one. Foldable bicycles do not require additional tickets. Different situation for Tram lines and Bus lines, for which "Linee bike Friendly" is realized. The following bus lines allow bikes onboard:

- 83, 118, 412, 673, 715, 772, 791, 911

For buses serving only on public holidays:

- 120F e 180F

All Roma tram lines adhere to the on-board transportation service. Bicycle transport is permitted on all 31 km of the network; the lines are:

- 2, 3, 5, 8, 14, 19



The picture above shows the service logo "Bike Friendly Lines"

CHAPTER 3

"Pre-feasibility study of a cycle Path in Rome."

BICYCLE PATH



This work regards the realization of a bicycle path, inside Rome's Municipality (Second district). The analysis regards a L-shaped route, which is provided by the cycling framework of Roma Capitale administration. The map above offers a more complete view, defining the local network (light blue). This one is composed by routes which are not defined as cycle path, but courses that are used to link different corridors. The aim of the work is to provide a new piece of bicycle corridor in order to increase bike mobility. Black colour defined districts among them, while violet colour stands for financed route, not yet realized. The red one characterized existing routes. Green stars represents Bike-Sharing points co-operated by Atac, while orange and blue stars symbolized parking lots, respectively universities and high schools. Looking at the small map it is possible to see various red lines that embrace Guido Reni district, circled in green. By surveys on field, it was possible to observe an intense bicycle traffic. That's because, it directly connects two existing corridor: Corridoio Tevere and Tangenziale Aniene (at the end of violet line). Lungotevere, especially on weekends is crossed by cyclists, who want to reach natural paths. During working days is possible to observe a discrete number of cyclists which move along Lungotevere: it was asked to 20 cyclists, observed in



one hour, if a new bicycle path can improve their movements during the day. 13 people use bike to go work, others use bike during leisure time. All of them are agree with the new bicycle path, but this must be safe from traffic road. Hence the decision to realize an entire protected route (promiscuous parts will be minimized). Piazza Gentile da Fabriano is the starting point of the new cycle track. As soon as cyclists arrive at the end of Ponte della Musica, they have to cross Lungotevere Flaminio in

order to get Piazza Gentile da Fabriano. it is necessary to realize a new bike (and pedestrian) crossing, directly connected to the square. Such achievement provides a displacement of the existing traffic light of about 32 metres back. So, cars coming from Piazza Gentile da Fabriano, which turn left, must pay attention to cyclists and pedestrian. Moreover, to solve this problem, a repeater could be installed after the turn.

It is now important to decide the way out from the square, ensuring the shortest and the safest route possible. One of the worst problem, regarding the realization of the bike lane, is parking lots. In order to remove the least number of parking spaces, a bidirectional flow passage is intended to be realized adjacent to sidewalk. According to the map below, Viale del Vignola turns out to be the shortest passage to get Piazzale Manila; infact the whole street has a length of 777 metres that becomes 935.34 metres joining Maresciallo Pilsudsky intersection. In this way there would be no connection to "Tangenziale Aniene" Corridor, at the height of Sports Hall "PalaTiziano". Moreover, Viale del Vignola, like Viale Pinturicchio, is characterized by a complex layout: parking lots are both on side and on central and trees cover the horizontal alignment of the road, outlining useful spaces for cars. The best possible solution is Via Guido Reni, the widest among the three streets. Moving the attention to the center of Piazza Gentile da Fabriano, the entrance of underground car parks represents an obastacle to the bicycle path and for that reason is needed to realize a new bike crossing adjacent to the pedestrian one.



The Olimpico theatre is another disadvantage because, during the performances, crowd lurking on the sidewalk could hinder the passage of bicycles invading their lane. For that reason bike path cannot run along Via del Vignola, because is nearby the theatre.



Underground car parks entrance



Teatro Olimpico, Piazza Gentile da Fabriano



Guido Reni's side

In the picture above is shown the side of Piazza Gentile da Fabriano overlooking Via Guido Reni. The white van and the grey car occupy the useful space for bike crossing.



Lungotevere Flaminio's side



Intersection between Piazza Gentile da Fabriano and Lungotevere Flaminio



Lungoteve Flaminio



Viale Pinturicchio



Viale del Vignola

Resuming the speech about the cycle path, according to surveys on field, Via Guido Reni's left side is the best one. This choice is linked to the need of parking lots. By analyzing the route, it was possible to count the number of parking lots, both on the left side and the right side. The latter is the least appropriate given the presence of the local market (Mercato Flaminio II), which could cause problems on circulation in the morning hours.

So on the left side there are 42 parking spaces. This number is high, therefore there may be protests from citizens, who would have fewer lots for their cars. There are two different possibilities:

1. From the beginning of Via Guido Reni to the civic number 22 of the same street, the track changes into a promiscuous lane both for cyclists and pedestrian. This choice is linked to sidewalk width, which is 4 meters long.
2. The latter choice provides a protected path for bicycle until they reach the intersection of Piazza Apollodoro. This one is more oriented to a north European model, which places cycle mobility at the center of the public interest.

Moreover, after the crossroad with Via Giovanni Pannini, there are two gates (belonging to Reparto Volanti of Polizia Statale). Here, police cars, crossing high-speed entrances, could pose a danger to cyclists. It's nice to set up a traffic light that only switches over to the police cars, giving the red signal to bicycles. On that way, there is MAXXI museum and the cycle path will run parallel to the museum, ensuring the passage in front of the main entrance, in order to be considered as a path of cultural interest. No more problems affect the bicycle path until the crossroad with Piazza Apollodoro. Here it has to face with a double intersection: cars and trams. Tram tracks run on two streets: Via Flaminia and Viale Tiziano. Bicycles follow the first pedestrian crossing, reaching a green area. Subsequently, they cross Viale Tiziano joining the bicycle corridor n°11. At this point cyclists can choose either to continue along the new route, or move to the Auditorium.

The choice could fall on Viale Flaminia, but this turns out to be particularly narrow due to:

- Tramway
- Two avenues, each one characterized by a single lane
- The realization of a cycle track could cause inconvenience to the owners of the houses in front of the road
- The smaller avenue can not be turned into a bike path, as there are roads connecting Viale Tiziano with Via Flaminia



So the passage on Viale Tiziano turns out to be the only acceptable alternative, especially because it is wider and more exploitable than Via Flaminia. Crossing twice Piazza Apollodoro, the bicycle path follows Viale Tiziano passing on the left side, particularly wide. Nowadays it is characterized by very large parking lots, which can be arranged in the following way:

- Sidewalk, which permits people to enter inside Paolo Rosi Sporting Center.
- Bicycle path
- Parking lots

After the intersection with Via Dorando Pietri, a gap is needed to realize, due to the bus stop of 910 and N25. Moreover it is important to consider two accesses located along the boulevard that allow car entering inside Flaminio Stadium. The traffic on that road is very few, so it is enough to install pedestrian crossing without traffic lights. From that point, two possibilities are provided about the realization of the path.

The first one need an important implementation: a new traffic light on the intersection between the turning point from Viale Maresciallo Pilsudski and Viale Tiziano, regarding cars which arrive from Parioli district turning on Viale Tiziano. Right now, cars must stop at the intersection without any traffic light. In the future, the bicycle path will need a traffic light with the same cycle of the adjacent one, in order to allow a safe crossing of bicycles. From that point, cyclists can move alongside Collina Parioli, before reaching Via delle Belle Arti.

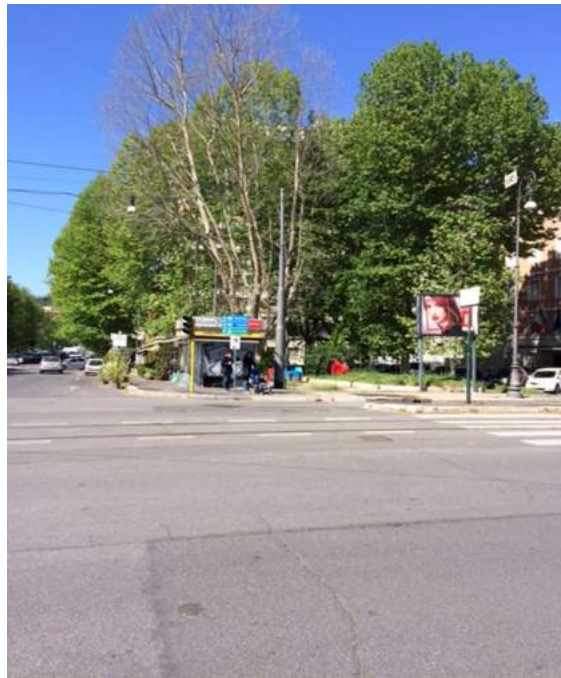


Photo 1°: Piazza Apollodoro, in front of the small green area in which bicycle path will be realized.



Photos 2° and 3°: Piazza Apollodoro, pedestrian crossing on Via Pietro de Coubertein. Connection to Corridor n°11



Photos 4° and 5°: Viale Tiziano nowadays. Parking lots and footwalk.



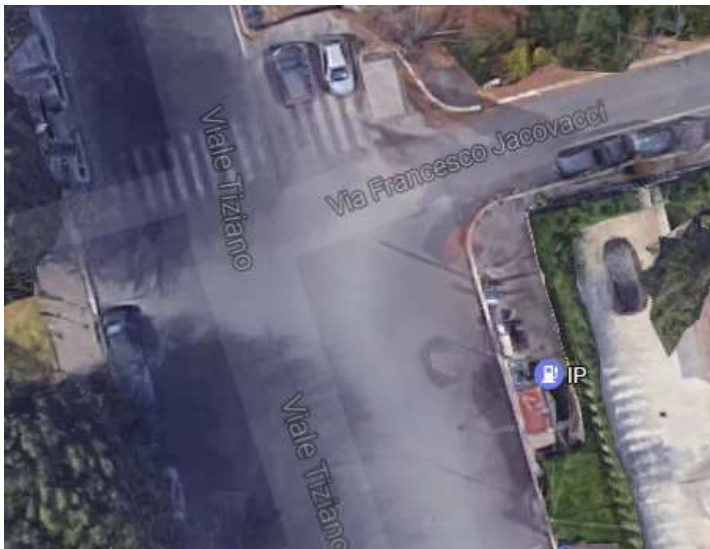
Photos 6°: intersection Viale Maresciallo Pilsudski/Piazzale Manila



In order to get Via delle Belle Arti in the shortest way possible, cyclists have to follow Viale Tiziano on the right side. Containment walls were made provisionally, to limit the dangers of landslides. When such problems are solved, the carriageway will be enlarged. In this way the implementation of the bicycle path will be easier. About the roadway, nowadays a petrol pump is an obstacle to the circulation of bicycles. Inbound cars and outbound cars pose dangers to cyclists. For this reason it is expected to be removed. The same for gas pump located at the beginning of Viale Tiziano nearby the intersection with Via delle Belle Arti.



This part of the route has a length of about 560 m. It joins the existing cycle path through Villa Borghese. The first corner of that portion is 7.20 m wide. By this length 2.5 m has to be removed, in



order to provide two lanes for bicycles. 4.7 metres are more than enough to ensure traffic movements. Immediately afterwards is located the entrance of Salita Parioli, so is needed a crossing. After 38.60 metres, there is an abandoned car gate, which will not affect bicycle path realization, in fact it protects a unused area of about 355 sq, characterized by 7.43 and 47.8 metres sides. After the fuel pump

(for a total length of 82 metres), there is a 3.90 m wide corridor between the road and Collina Parioli.

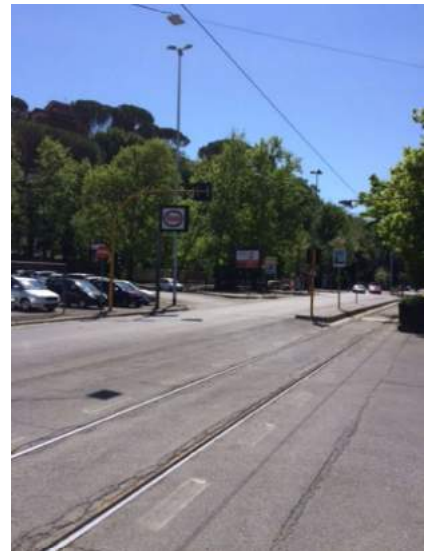
It was realized in order to prevent landslides on the road. As soon as geotechnical problems are resolved, it could be used as a byke corridor. It's width is more than enough, according to technical



legislation, but it's reduction is necessary, in order to avoid bottlenecks. At the intersection with Via Enrico Chiarada and Viale Tiziano carriageway width is 6.9 metres, while the existing corridor occupies 3.90 metres, for a total width of 10.8 metres. Carriageway will improve to 8.3 metres if bicycle path is realized. The wall runs for 199 metres until it reaches Via Francesco Jacobacci, where bicycle and pedestrian crossings are needed. After the junction there is a gas pump and a car gate. Parking is forbidden along this stretch of road. The

sidewalk is 4.7 metres wide. Bicycle path runs adjacent to it. Turning on Via delle Belle Arti, it is necessary a promiscuous pathway both for pedestrians and cyclists. This promiscuous passage is needed for 14.1 metres, until it reaches pedestrian crossing on Via delle Belle Arti. In that way a link is created with the already existing bicycle path which runs across Villa Borghese. This alternative is the fastest but most expensive as it requires the removal of two gas pumps.

The second alternative involves the passage of the cycle path within the green areas that are located between Viale Tiziano and Via Flaminia. Photos below show the crucial design nodes related to the installation of a traffic light for bicycles between Via Maresciallo Pilsudski and Viale Tiziano. In order to not mix different flows (pedestrians and cyclists), the street parallel to Viale Tiziano nearby the fuel pump, could be transformed into a cycle path. Traffic is very few and this would ensure a direct passage to Piazzale Manila park. Obviously, it needs a special crossing only for bicycles.



Photos 6° and 7°: intersection Viale Maresciallo Pilsudski/Piazzale Manila

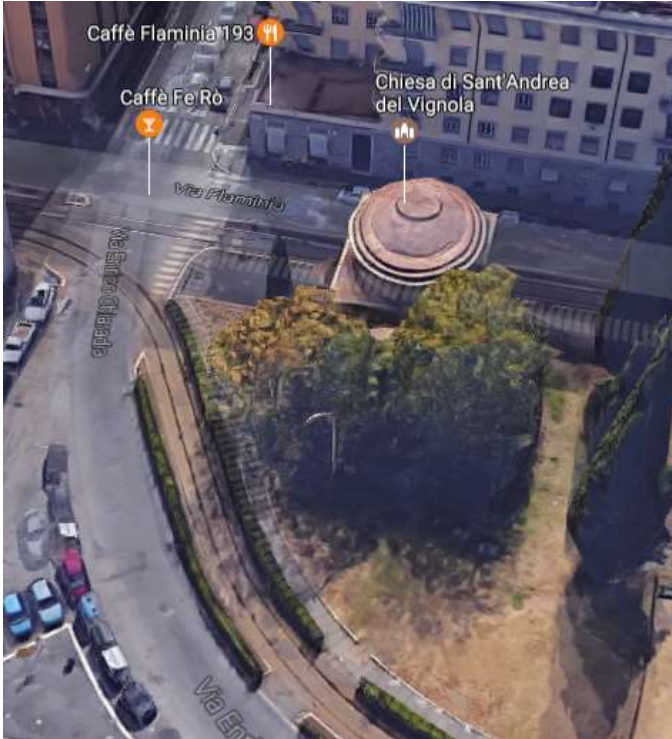
The corridor inside the bigger green area has a total length of 327 metres ca. Pavement and its materials will be deepened.



The idea regards the realization of a corridor inside this green area, in order to ensure a retraining of the concerned area. Unfortunately, there is no ordinary green maintenance, which is less noticeable near the "Tribar", located at the far end of the pitch. The photo, taken from Google Earth,

shows the passage that bicycles have to cross. Tramways represent two big obstacles that the route has to avoid and for that reason it must be moved opposite.

Crossing tram track and Via Enrico Chiaradia, bicycles move to traffic island on a protected route,



that run along the street (Viale Tiziano). On that part of the road there are few parking lots, so they can be removed. After this devolution the path continues on the green area ending with Via delle Belle Arti.



In the picture above it is possible to see the planimetry of the path until it reaches Via delle Belle Arti. It has a total length of 286.5 m.

The final part of the bicycle path runs from Via delle Belle Arti (Junction with Via Flaminia) to Piazzale Flaminio. This is a historical district and precisely for this reason streets are particularly narrow. As the previous section, here two alternatives are given.

In the first one, from Piazzale Flaminio, bicycle path cross Via Luisa di Savoia reaching Via Giambattista Vico. Then, it turns on Via Cesare Beccaria. At the end of the street it reaches Via Flaminia. It travels it all until it gets to Via delle Belle Arti. The proposed choice must guarantee:

- Encourage and promote a high degree of cycling and pedestrian mobility, ensuring the safety of those who travel from vehicular traffic.
- The route must ensure the shortest possible link between different points of interest; In this way it can be a good alternative to the car.
- Some paths have been selected on field observations. Cyclists travel on the motorway lanes, taking advantage of internal roads where public transport is also circulating (i.e flow of cyclists driving on the preferred tram lane of Via Flaminia shortly after the terminus of tram line 2). It was necessary to remodel the road, in order to ensure protected cycle tracks.
- Last but not least, the reduction of carbon monoxide and particulate pollution.

This choice was made according to surveys on field. Nowadays Cyclists prefer passing through Via Flaminia, which is not equipped with bicycle facilities. In this way any cyclist can be tempted to ride this new track, which is a good alternative to the bicycle passage on the tram rails.



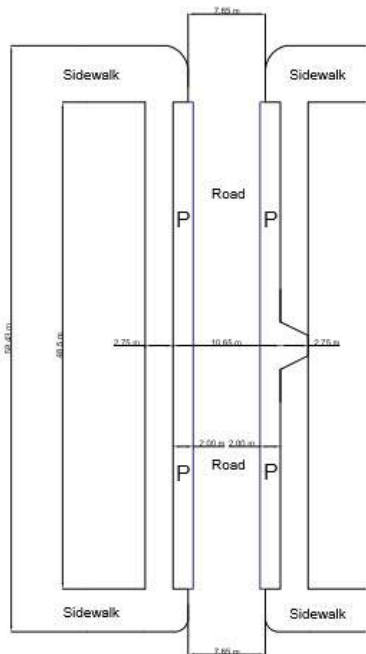
This can be considered as the shortest route from Piazzale Flaminio to Via delle Belle Arti. The idea is to use the traffic light in front of the entrance of Piazza del Popolo. Then bikes reach the pitch that divides Piazzale Flaminio from Via Luisa of Savoia. So cyclists can reach Via Giambattista Vico. Initially, the route would have to follow via Luisa of Savoia, up to Giambattista Vico intersection. The problem is Flaminio's subway entrance, which represents an obstacle that can only be circumvented by reducing the useful road carriageway. After Crossing Piazzale Flaminio, cyclists have to cover a distance of 118 metres ca. before reaching Via Cesare Beccaria, which allow the connection with Via Flaminia. Both on Via Vico and Via Beccaria, parking lots represent obstacles for bicycles. The nominal width is 2.1 m, which is not enough for the bidirectional circulation; The occupation of both sides of the road can not be contemplated, as too many parking lots would be removed. So it is preferable to decrease the width of the sidewalk (3.1 m), in order to ensure the streams. On Via Flaminia, the circulation is organized in the following way:

- Pedestrian, on two sidewalks.
- Cars, moving from Piazza della Marina to Piazzale Flaminio
- Trams, moving in two directions (Piazza Mancini – Piazzale Flaminio)

The project does not envisage the use of promiscuous cycle lanes, therefore, again, it is needed the removal of parking lots, located between tramway and road. Their width is 3.00 meters, so it is possible to create a bicycle corridor up to Piazza della Marina. Cars coming from Via Domenico Azuni, which turn on left to Piazza della Marina, must turn on Via Filangeri after 169 metres. According to this path, bicycles are allowed to run on Via Flaminia using today's car lane which connects Piazza della Marina with Via delle Belle Arti. Despite being the shortest alternative, with 988m of development, it requires more intervention on the circulation. In that way, only cars coming from Via delle Belle Arti are allowed to run on Via Flaminia.



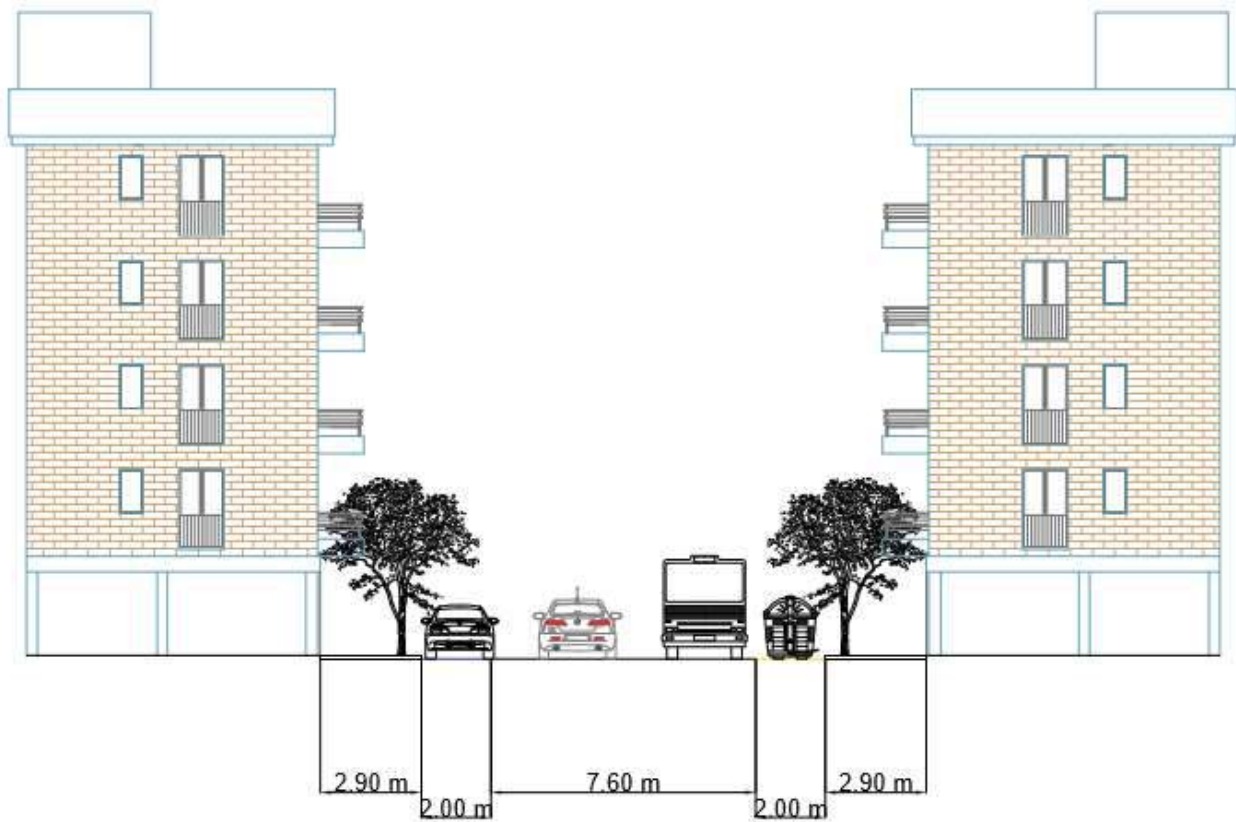
The right lane involves only the passage of bicycles, which can count on a protected path. It is adjacent to the car lane, which move in the opposite direction. A bicycle crossing must be realized at the height of Via Flaminia 158, because of cars moving through the private road. Afterwards the bicycles move uninterrupted up to the crossroad with Via di Villa Giulia, then arrive at the intersection with Via delle Belle Arti, where the path leads to corridor No. 4. Here cyclists can decide whether to continue in the direction of Villa Borghese or take the cycle path inside the green area in front of the traffic light.



In order to get unanimous consensus, last alternative provides zero removal of parking lots. As the planimetry shows, to allow bicycles moving along Via Beccaria, all parking lots on the right side have to be removed, resulting in disadvantage for residents of the neighborhood. Moreover, the transversal section of Via Giambattista Vico permits to observe that a reduction in space, to get cycle path, could cause a reduction in terms of mobility for motorized vehicles. Moreover, the street is crossed by a considerable number of coaches and buses and this would greatly undermine the maneuvers.

The last 360 meters of cycle path will run on the sidewalk, with a promiscuous lane. Infact it has a width of 3.80 meters, which allows to realize a bidirectional lane. After passing the "Ministero Marina" stop of tram no. 2, the cycle track deviates along the right sidewalk of Via Flaminia. The goal is to maintain a double circulation; for this reason it takes a minimum space of 2.50 meters. Such space is missing on the left sidewalk. Once reached Piazzale

Flaminio, bicycles cross the pedestrian area in front of Piazza del Popolo's entrance. After crossing the pedestrian strip, cyclists can enter the square.



Total amount of space of the carriageway is 7.60 meters. Realizing the cycle track, the whole space would be reduced to 7.1 meters: too little to allow the transit of heavy vehicles in both directions. reducing the width of the sidewalk, costs would be excessive.

CHAPTER 4

"Technical Characteristics of the path."

In the following pages road intersections are showed, highlighting crucial and dangerous conflict points. The aim of the work is to define a continuous path from Piazza Gentile da Fabriano to Piazza del Popolo, in which cyclists can sit on their bikes without ever having to go down, except for some unforeseen events.

Obviously, the survey should not only concern cyclists. Road vehicles are an obstacle to the circulation of bicycles, both in terms of size and conflict at intersections. As we have seen before, the traffic light of Piazza Gentile da Fabriano is located near the intersection. This choice is useful for drivers, but not for cyclists. Infact, bikers who are crossing Lungotevere are not protected by cars which turn on left. For that reason the traffic light is moved 30 m back and a repeater is installed for turning cars.

This project has the task of modernizing the Roman cycling network. Choices were made to bring Rome closer to European capitals where traffic is hierarchical:

- TPL (Tram and Bus)
- Bike
- Cars



The most powerful example is the city of Amsterdam. As it is possible to see, tram track run along the centerline, while cars have to share bike lane and tram lane giving them precedence. Central roads are shared by TPL and bike, while cars have to move in nearby streets.

The dutch example is full of interesting cases, that allow bikers to move around the whole city. The exchange nodes are characterized by special racks, arranged on multiple levels if the volume of bicycles is high. Moreover, each intersection is regularized both for pedestrians and cyclists. In this way it is possible to clear conflicts between different users, leaving each one with its own

lane. The picture below show an intersection in Southern part of Amsterdam.



It is possible to see how the circulation is subdivided according to the user. Pedestrians, cyclists and drivers run on different lanes. Pedestrians and cyclists share the same portion of sidewalk, but nearby the intersection each of them runs on a different part. The pic above shows two pedestrians moving on zebra crossing, while a cyclist is going to engage the intersection. Minutes ago, they were moving on different lanes, but on the same portion of sidewalk. This scheme is made in order to get continuity. Cyclists can move on the zebra crossing getting on their bike.

By the way, each intersection of the project is analyzed into two different ways: first one, the planimetry of the existing case, then the modified planimetry, with the new cycle path.

The analysis regards the following junctions:

1. Piazza Gentile da Fabriano/ Lungotevere
2. Piazza Gentile da Fabriano/ Via Guido Reni
3. Via Guido Reni/ Via Pannini
4. Via Guido Reni/ Via Flaminia
5. Piazza Apollodoro/ Viale Tiziano
6. Piazza Apollodoro/ Via de Coubertin
7. Viale Tiziano/ Viale Pilsudski
8. Viale Tiziano/ Via delle Belle Arti
9. Via delle Belle Arti/ Via Flaminia

10. Via Flaminia/ Piazza della Marina

11. Via Giambattista Vico/ Piazzale Flaminio

In order to get the best possible result, PTV Vissim 8 is used to simulate traffic flow on the most complex intersection: Piazza Gentile da Fabriano, Piazza Apollodoro, Piazzale Manila, Via delle Belle Arti/Via Flaminia and Piazzale Flaminio.

PVT Vissim allows designers to simulate traffic patterns exactly. Starting from the background maps, designer can draw each road or street in order to define traffic streams. After that it is necessary to compute the exact value of traffic volume and its composition (cars, moped, vans and HCV). The “Highway capacity manual” suggest to make surveys on field of 15 minutes each. For each analysis, designer must enumerate the number of cars which run along a defined road track. After that it is possible to “move” the value inside the simulator. All the surveys were conducted in the month of May, before summer periodo. This choice was due to the fact of traffic volume, reduced during this time of year. The work has to be equipped with traffic signal, like: traffic lights, priorities, parking lots and preferential lanes. Finally node detection is required, ie the area designer wants to evaluate during the simulation. Different voices are reported in the final table, but the most indicative about congestion degree is “MAX queue length”. This value allows to choose the best alternative, among the proposed choices.

Piazza Gentile da Fabriano/ Lungotevere

Lungotevere Flaminio		Piazza G. da Fabriano		[along Lungotevere]		
G		Y		R		
48.49		5.83		34.03	[s]	C 88.35

Lungotevere Flaminio		Piazza G. da Fabriano		from P.G. da F.		
G		Y		R		
27.12		3.57		57.66	[s]	C 88.35

Pedestrian Crossing [On P.da Gentile]		
G	40.14	[s]
Y	11.96	[s]
R	36.25	[s]
C	88.35	[s]

Pedestrian Crossing [On Lungotevere]		
G	9.82	[s]
Y	21.61	[s]
R	56.92	[s]
C	88.35	[s]

These tables concern value of Cycle length relative to Piazza Gentile da Fabriano junction. The following vehicles were observed along Lungotevere. This survey was conducted for 15 minutes according the HCM method.

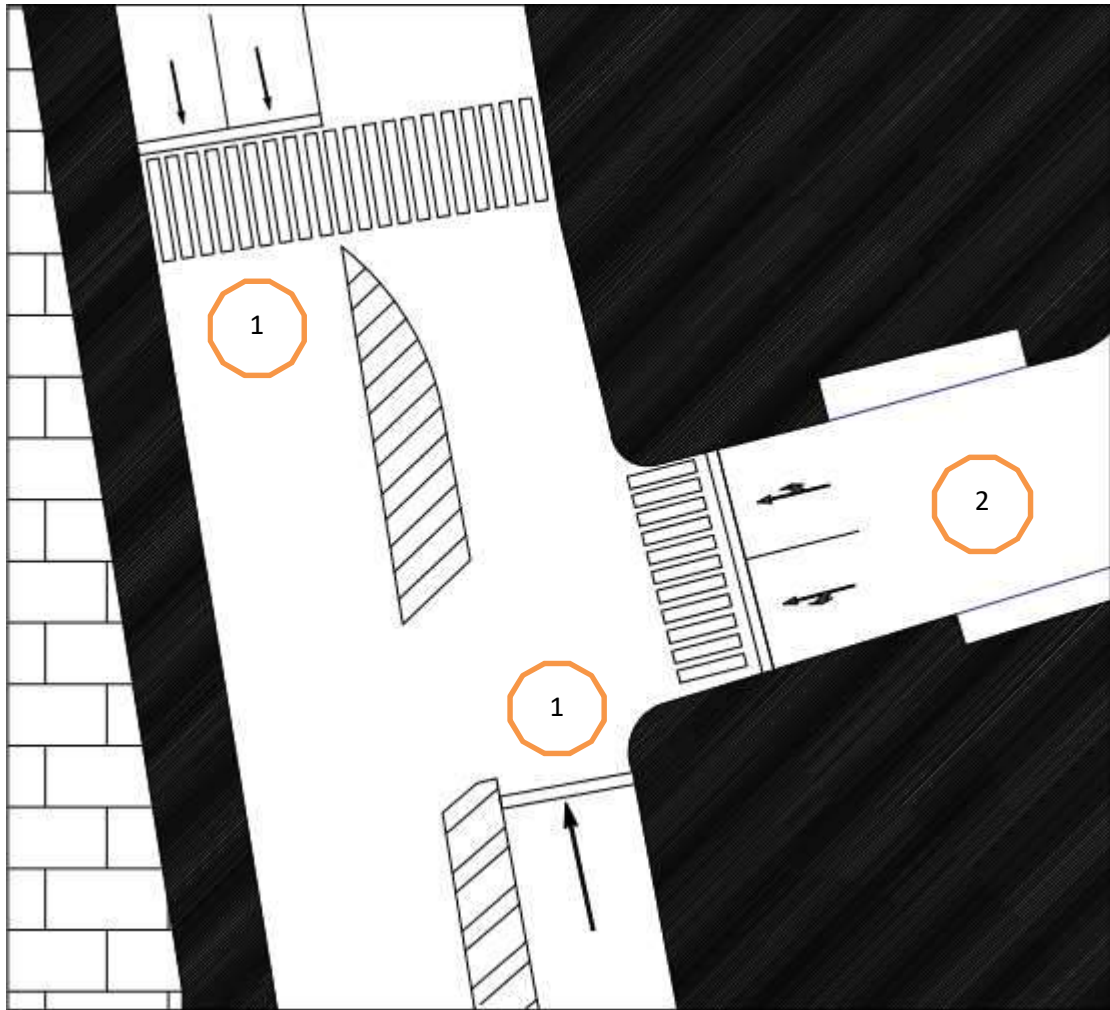
Car	612	[VeH]
Van	15	[VeH]
Moped	240	[VeH]
Heavy V.	12	[VeH]

Car	596	[VeH]
Van	15	[VeH]
Moped	200	[VeH]
Heavy V.	16	[VeH]

One the left table, cars moving from Southbound to Northbound are reported, while the right table regards cars moving from Northbound to Southbound. The same observation for cars arriving at Piazza Gentile da Fabriano traffic light. Here drivers can turn on two different directions.

Left	Car	96	[VeH]
	Van	3	[VeH]
	Moped	12	[VeH]
	Heavy V.	0	[VeH]

Right	Car	252	[VeH]
	Van	3	[VeH]
	Moped	36	[VeH]
	Heavy V.	0	[VeH]



1. Phase n°1: Cars move along Lungotevere.
2. Phase n°2: Coming from Piazza Gentile da Fabriano, cars move either on Lungotevere North (to Ponte Milvio) or to Lungotevere South (to Belle Arti).



The above picture shows a rough planimetry of Piazza Gentile da Fabriano. Here it is possible to observe Vissim application; circled one stands for traffic light, while circled two regards priority of people coming from south in respect of cars turning left, inside Piazza Gentile da Fabriano. This is the real situation, without any improvement concerning cycle mobility. According to the aim of the work, two different alternatives are proposed:

1. Coming from the right sidewalk of Via Guido Reni, the cycle path will move inside the square with a first zebra crossing (only for bicycles). Then it runs parallel to pedestrian flow, reaching the sidewalk adjacent to the river railing.
2. This case provides a continuous and direct link to Ponte della Musica: bicycles coming from Via Guido Reni move inside the square using the already existing zebra crossing. After that they have to cross a new zebra crossing, realized only for cyclists. The design model is organized into two similar alternatives:
 - a. Northbound traffic light is moved 30 meters back in order to guarantee a safe crossing for bicycles. Obviously cars coming from westbound have to pay attention to cyclist.
 - b. Northbound traffic light is moved 30 meters back, but zebra crossing is both protected from northbound and westbound cars using a repeater light.

<i>SIMRUN</i>	<i>TIMEINT</i>	<i>MOVEMENT</i>	<i>QLENMAX</i>	<i>VEHS(ALL)</i>	<i>EMISSIONSCO</i>	<i>EMISSIONSNOX</i>	<i>EMISSIONSVOC</i>	<i>FUELCONSUMPTION</i>
1	0-100	1-1@68.6-1@119.5	33.53	7	4.076	0.793	0.945	0.058
1	0-100	1-2@7.5-2@56.9	33.44	12	4.435	0.863	1.028	0.063
1	0-100	1-5@20.2-1@119.5	17.99	3	1.883	0.366	0.437	0.027
1	0-100	1-5@20.2-2@56.9	17.99	2	1.074	0.209	0.249	0.015
1	0-100	1	33.53	24	11.424	2.223	2.648	0.163
1	100-200	1-1@68.6-1@119.5	25.88	21	13.069	2.543	3.029	0.187
1	100-200	1-2@7.5-2@56.9	46.21	30	15.382	2.993	3.565	0.22
1	100-200	1-5@20.2-1@119.5	12.45	4	2.306	0.449	0.535	0.033
1	100-200	1-5@20.2-2@56.9	12.45	3	1.528	0.297	0.354	0.022
1	100-200	1	46.21	58	32.207	6.266	7.464	0.461
1	200-300	1-1@68.6-1@119.5	6.73	11	4.192	0.816	0.972	0.06
1	200-300	1-2@7.5-2@56.9	46.34	29	14.931	2.905	3.46	0.214
1	200-300	1-5@20.2-1@119.5	34.13	4	2.295	0.447	0.532	0.033
1	200-300	1-5@20.2-2@56.9	34.13	4	2.769	0.539	0.642	0.04
1	200-300	1	46.34	48	24.273	4.723	5.626	0.347
1	300-400	1-1@68.6-1@119.5	45.71	19	10.926	2.126	2.532	0.156
1	300-400	1-2@7.5-2@56.9	33.22	16	8.461	1.646	1.961	0.121
1	300-400	1-5@20.2-1@119.5	24.74	7	4.364	0.849	1.011	0.062
1	300-400	1-5@20.2-2@56.9	24.74	1	0.913	0.178	0.212	0.013
1	300-400	1	45.71	43	24.644	4.795	5.712	0.353
1	400-500	1-1@68.6-1@119.5	19.08	14	6.745	1.312	1.563	0.096
1	400-500	1-2@7.5-2@56.9	20.14	21	9.097	1.77	2.108	0.13
1	400-500	1-5@20.2-1@119.5	17.9	6	2.932	0.571	0.68	0.042
1	400-500	1-5@20.2-2@56.9	17.9	2	1.17	0.228	0.271	0.017
1	400-500	1	20.14	43	19.962	3.884	4.626	0.286
1	500-600	1-1@68.6-1@119.5	24.77	15	8.368	1.628	1.939	0.12
1	500-600	1-2@7.5-2@56.9	26.7	11	4.215	0.82	0.977	0.06
1	500-600	1-5@20.2-1@119.5	25.16	6	5.428	1.056	1.258	0.078
1	500-600	1-5@20.2-2@56.9	25.16	3	2.6	0.506	0.602	0.037
1	500-600	1	26.7	35	20.622	4.012	4.779	0.295

TIMEINT: it consists in the time interval, 100 s for each one.

MOVEMENT: the first number stands for the whole node (in this case there is only one node), the second number (before @) identifies the incoming arc, while the third one represents the outgoing arc. More in depth, it is possible to observe that from 1@68.6 to 1@119.5 are cars from southbound to northbound are represented; from 2@7.5 to 2@56.9, cars from northbound to southbound. Finally 5@20.2 and 1@119.5 represents cars turning on left from westbound, while from 5@20.2 to 2@56.9 represents cars turning on right from westbound. The fifth point define the MAXIMUM value of QLENMAX and the total amount of vehicles, emissions and fuel consumption.

QLENMAX and VEHS (ALL): the first measured total length of the queue, the latter defines total number of cars waiting in queue.

EMISSIONS and FUEL CONSUMPTION describe the level of pollution.

Focus the attention on QLENMAX it is possible to detect the worst case for the node:

1	200-300	1-2@7.5-2@56.9	46.34	29	14.931	2.905	3.46	0.214
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1.

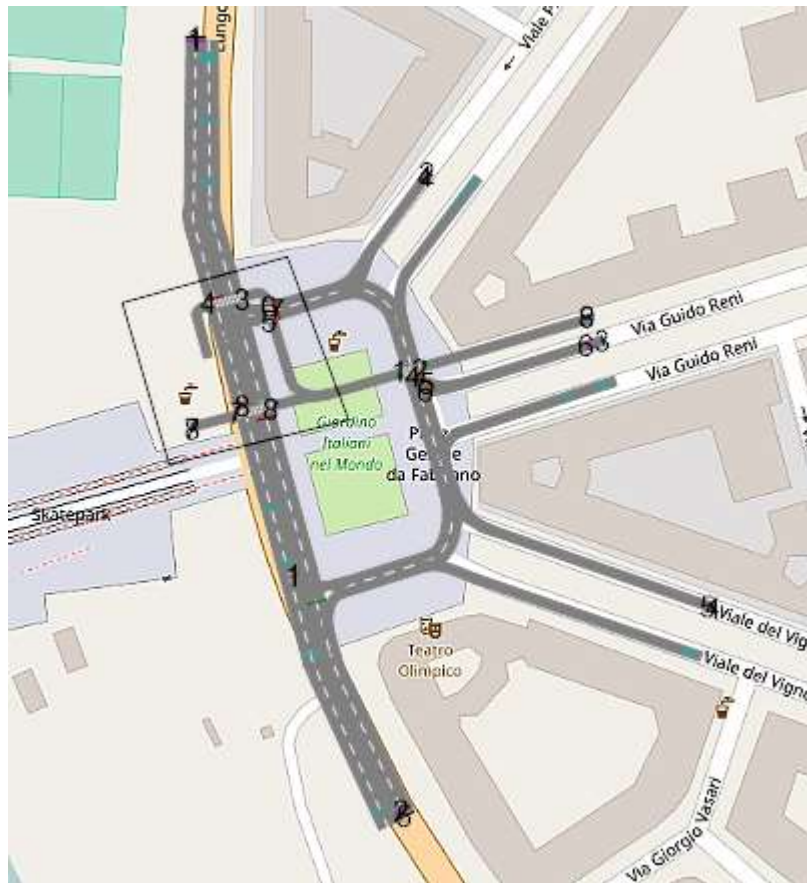


SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EMISSIONSCO	EMISSIONSNOX	EMISSIONSVOC	FUELCONSUMPTION
2	0-100	1-1@71.5-1@114.6	33.47	8	4.961	0.965	1.15	0.071
2	0-100	1-2@12.5-2@55.3	33.34	13	5.012	0.975	1.162	0.072
2	0-100	1-5@12.5-1@114.6	17.36	3	2.438	0.474	0.565	0.035
2	0-100	1-5@12.5-2@55.3	17.36	2	1.215	0.236	0.282	0.017
2	0-100	1	33.47	26	13.527	2.632	3.135	0.194
2	100-200	1-1@71.5-1@114.6	31.03	20	13.248	2.578	3.07	0.19
2	100-200	1-2@12.5-2@55.3	26.34	31	15.162	2.95	3.514	0.217
2	100-200	1-5@12.5-1@114.6	24.79	4	3.022	0.588	0.7	0.043
2	100-200	1-5@12.5-2@55.3	24.79	3	1.723	0.335	0.399	0.025
2	100-200	1	31.03	58	33.049	6.43	7.66	0.473
2	200-300	1-1@71.5-1@114.6	13.03	10	3.946	0.768	0.915	0.056
2	200-300	1-2@12.5-2@55.3	46.4	26	14.776	2.875	3.424	0.211
2	200-300	1-5@12.5-1@114.6	38.87	1	1.401	0.273	0.325	0.02
2	200-300	1-5@12.5-2@55.3	38.87	1	1	0.195	0.232	0.014
2	200-300	1	46.4	38	21.093	4.104	4.888	0.302
2	300-400	1-1@71.5-1@114.6	52.27	21	11.826	2.301	2.741	0.169
2	300-400	1-2@12.5-2@55.3	33.09	16	8.472	1.648	1.964	0.121
2	300-400	1-5@12.5-1@114.6	46.07	7	11.124	2.164	2.578	0.159
2	300-400	1-5@12.5-2@55.3	46.07	1	1.904	0.371	0.441	0.027
2	300-400	1	52.27	45	33.017	6.424	7.652	0.472
2	400-500	1-1@71.5-1@114.6	19.73	14	6.456	1.256	1.496	0.092
2	400-500	1-2@12.5-2@55.3	26.66	21	9.981	1.942	2.313	0.143
2	400-500	1-5@12.5-1@114.6	69.05	5	8.341	1.623	1.933	0.119
2	400-500	1-5@12.5-2@55.3	69.05	0	0	0	0	0
2	400-500	1	69.05	40	24.083	4.686	5.581	0.345
2	500-600	1-1@71.5-1@114.6	26.85	14	8.254	1.606	1.913	0.118
2	500-600	1-2@12.5-2@55.3	20.21	9	3.388	0.659	0.785	0.048
2	500-600	1-5@12.5-1@114.6	65.63	3	6.172	1.201	1.43	0.088
2	500-600	1-5@12.5-2@55.3	65.63	3	4.677	0.91	1.084	0.067
2	500-600	1	65.63	29	22.891	4.454	5.305	0.327

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EMISSIONSCO	EMISSIONSNOX	EMISSIONSVOC	FUELCONSUMPTION
2	400-500	1-5@12.5-1@114.6	69.05	5	8.341	1.623	1.933	0.119

Here, in the table above is represented the worst case regarding cars moving from westbound turning both on left and on right.

2a.



The expected situation provides for a lower degree of congestion as the bicycles move on a straight path, unlike the previous case, where they moved parallel to the existing pedestrian pathway (longer). Cars that turn left are fewer than those that turn right. Right now no bicycles move on the previous path and so there is a lower delay, because none car waits for crossing cyclists.

For this reason it is expected that there will be an increase in the queue along the two North-South arcs, rather than trasversal one.

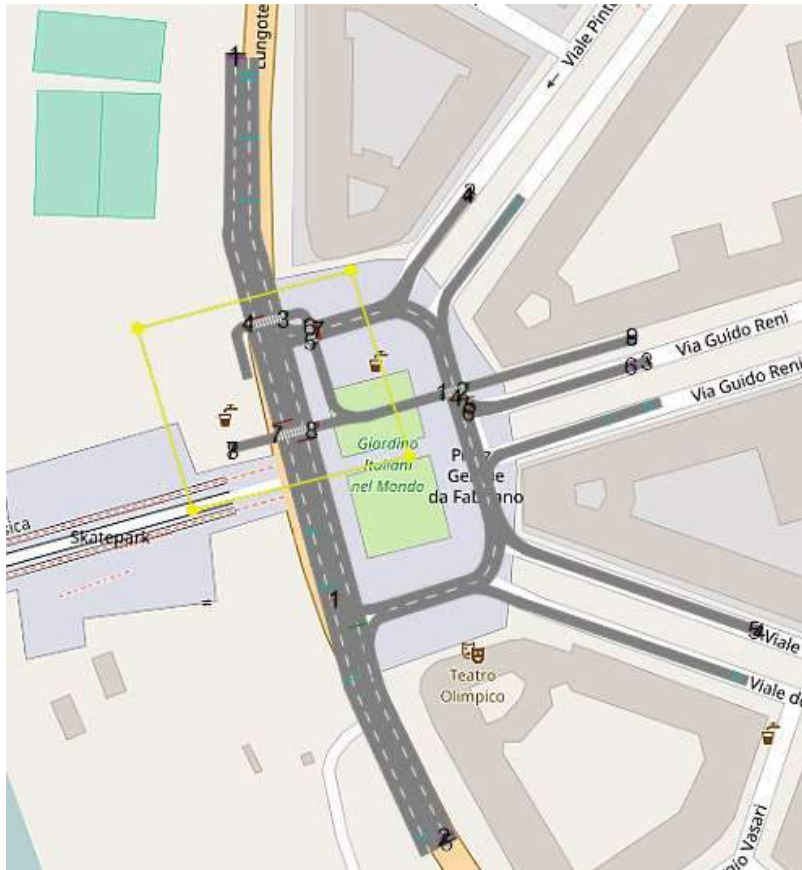
SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EMISSIONSCO	EMISSIONSNOX	EMISSIONSVOC	FUELCONSUMPTION
3	0-100	1-1@66.4-1@116.1	32.46	7	3.611	0.703	0.837	0.052
3	0-100	1-2@10.9-2@60.5	33.34	12	4.454	0.867	1.032	0.064
3	0-100	1-5@13.7-1@116.1	17.36	3	2.327	0.453	0.539	0.033
3	0-100	1-5@13.7-2@60.5	17.36	2	1.22	0.237	0.283	0.017
3	0-100	1	33.34	24	11.401	2.218	2.642	0.163
3	100-200	1-1@66.4-1@116.1	30.93	20	14.654	2.851	3.396	0.21
3	100-200	1-2@10.9-2@60.5	38.81	30	16.609	3.232	3.849	0.238
3	100-200	1-5@13.7-1@116.1	11.93	4	2.471	0.481	0.573	0.035
3	100-200	1-5@13.7-2@60.5	11.93	3	1.629	0.317	0.377	0.023
3	100-200	1	38.81	57	35.204	6.849	8.159	0.504
3	200-300	1-1@66.4-1@116.1	12.99	11	5.135	0.999	1.19	0.073
3	200-300	1-2@10.9-2@60.5	47.24	28	16.565	3.223	3.839	0.237
3	200-300	1-5@13.7-1@116.1	26.64	4	2.504	0.487	0.58	0.036
3	200-300	1-5@13.7-2@60.5	26.64	3	2.991	0.582	0.693	0.043
3	200-300	1	47.24	46	27.35	5.321	6.339	0.391
3	300-400	1-1@66.4-1@116.1	46.39	21	13.165	2.561	3.051	0.188
3	300-400	1-2@10.9-2@60.5	33.09	16	8.7	1.693	2.016	0.124
3	300-400	1-5@13.7-1@116.1	24.22	8	5.167	1.005	1.197	0.074
3	300-400	1-5@13.7-2@60.5	24.22	0	0	0	0	0
3	300-400	1	46.39	45	26.966	5.247	6.25	0.386
3	400-500	1-1@66.4-1@116.1	19.75	14	7.082	1.378	1.641	0.101
3	400-500	1-2@10.9-2@60.5	26.66	20	10.022	1.95	2.323	0.143
3	400-500	1-5@13.7-1@116.1	14.01	5	1.756	0.342	0.407	0.025
3	400-500	1-5@13.7-2@60.5	14.01	1	0.781	0.152	0.181	0.011
3	400-500	1	26.66	40	19.542	3.802	4.529	0.28
3	500-600	1-1@66.4-1@116.1	18.95	14	7.851	1.527	1.819	0.112
3	500-600	1-2@10.9-2@60.5	20.21	9	3.503	0.682	0.812	0.05
3	500-600	1-5@13.7-1@116.1	25.4	6	5.721	1.113	1.326	0.082
3	500-600	1-5@13.7-2@60.5	25.4	4	4.065	0.791	0.942	0.058
3	500-600	1	25.4	33	21.149	4.115	4.902	0.303

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EMISSIONSCO	EMISSIONSNOX	EMISSIONSVOC	FUELCONSUMPTION
3	200-300	1-2@10.9-2@60.5	47.24	28	16.565	3.223	3.839	0.237
3	300-400	1-1@66.4-1@116.1	46.39	21	13.165	2.561	3.051	0.188

As expected, the North - South arches are the most congested. First row stands for South – North direction, while second row represents the North – South direction. Time interval is different for each direction. The higher value is the worst of the whole simulation.

2b.

The final simulation is the safest case. The satin intersection is protected by a further traffic light which replicates the cycle of Southbound one. Values are very similar to the previous case, but from a design point of view this is the best of the two. Reason, as stated, is in the highest degree of security.



SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	STOPS(ALL)	EMISSIONSCO	EMISSIONSNOX	EMISSIONSVOC	FUELCONSUMPTION
4	0-100	1-1@61.0-1@116.1	32.46	7	0.29	3.701	0.72	0.858	0.053
4	0-100	1-2@10.9-2@65.9	33.34	11	0.18	4.339	0.844	1.006	0.062
4	0-100	1-5@7.7-1@116.1	17.36	3	1	2.351	0.457	0.545	0.034
4	0-100	1-5@7.7-2@65.9	17.36	2	1.5	2.423	0.471	0.561	0.035
4	0-100	1	33.34	23	0.43	12.434	2.419	2.882	0.178
4	100-200	1-1@61.0-1@116.1	30.93	20	0.7	14.912	2.901	3.456	0.213
4	100-200	1-2@10.9-2@65.9	38.81	27	0.63	17.116	3.33	3.967	0.245
4	100-200	1-5@7.7-1@116.1	11.93	4	0.5	2.525	0.491	0.585	0.036
4	100-200	1-5@7.7-2@65.9	11.93	3	1.33	2.772	0.539	0.642	0.04
4	100-200	1	38.81	54	0.69	37.45	7.286	8.679	0.536
4	200-300	1-1@61.0-1@116.1	12.99	11	0.36	5.267	1.025	1.221	0.075
4	200-300	1-2@10.9-2@65.9	47.24	31	0.71	20.342	3.958	4.715	0.291
4	200-300	1-5@7.7-1@116.1	40.32	4	0.75	2.647	0.515	0.613	0.038
4	200-300	1-5@7.7-2@65.9	40.32	3	1.67	2.971	0.578	0.689	0.043
4	200-300	1	47.24	49	0.69	31.487	6.126	7.297	0.45
4	300-400	1-1@61.0-1@116.1	46.39	21	0.57	13.443	2.615	3.115	0.192
4	300-400	1-2@10.9-2@65.9	33.09	17	0.53	9.672	1.882	2.242	0.138
4	300-400	1-5@7.7-1@116.1	24.22	8	0.5	5.255	1.022	1.218	0.075
4	300-400	1-5@7.7-2@65.9	24.22	0		0	0	0	0
4	300-400	1	46.39	46	0.54	28.301	5.506	6.559	0.405
4	400-500	1-1@61.0-1@116.1	19.75	14	0.36	7.261	1.413	1.683	0.104
4	400-500	1-2@10.9-2@65.9	26.65	20	0.5	10.797	2.101	2.502	0.154
4	400-500	1-5@7.7-1@116.1	14.02	5	0.4	1.771	0.344	0.41	0.025
4	400-500	1-5@7.7-2@65.9	14.02	1	1	0.799	0.156	0.185	0.011
4	400-500	1	26.65	40	0.45	20.532	3.995	4.758	0.294
4	500-600	1-1@61.0-1@116.1	18.95	14	0.43	8.024	1.561	1.86	0.115
4	500-600	1-2@10.9-2@65.9	20.21	8	0.25	3.406	0.663	0.789	0.049
4	500-600	1-5@7.7-1@116.1	25.37	6	1	5.949	1.157	1.379	0.085
4	500-600	1-5@7.7-2@65.9	25.37	3	1.33	3.668	0.714	0.85	0.052
4	500-600	1	25.37	31	0.58	21.154	4.116	4.903	0.303

<i>SIMRUN</i>	<i>TIMEINT</i>	<i>MOVEMENT</i>	<i>QLENMAX</i>	<i>VEHS(ALL)</i>	<i>EMISSIONSCO</i>	<i>EMISSIONSNOX</i>	<i>EMISSIONSVOC</i>	<i>FUELCONSUMPTION</i>
3	200-300	1-2@10.9-2@60.5	47.24	28	16.565	3.223	3.839	0.237
3	300-400	1-1@66.4-1@116.1	46.39	21	13.165	2.561	3.051	0.188

In conclusion it is possible to observe that the last case is not so far from the initial one and for that reason is chosen according to the level of safety and for economical cost. First alternative forces to realize a parallel path to the pedestrian one with a significant increase in costs due to the construction of two more traffic light, in order to ensure the continuity of the cycle track. It has also been noted that cyclists prefer direct routes; many of them, once they reach the center of the square, may cross the Lungotevere where there is no zebra crossing, resultin in mortale accidents.

Observing the emission table and highlighting the 3 alternatives it can be deduced that:

	<i>EMISSIONSCO</i>	<i>EMISSIONSNOX</i>	<i>EMISSIONSVOC</i>
1° alternative	147.66	28.73	34.221
2° alternative	141.612	27.552	32.821
3° alternative	151.358	29.448	35.078

Despite the fact that the third alternative is the best from the design point of view, it involves the worst situation from the point of view of pollutant emissions.

According to American regulation, intersections represent the most difficult component to handle. From a design point of view, all this results in effective management of useful spaces. First of all, the two-way route would not have been chosen. A one-way route is preferable, because bike user can count on a proper space from 1.2 meters to 1.5 meters, depending on traffic volume.

Piazza Apollodoro

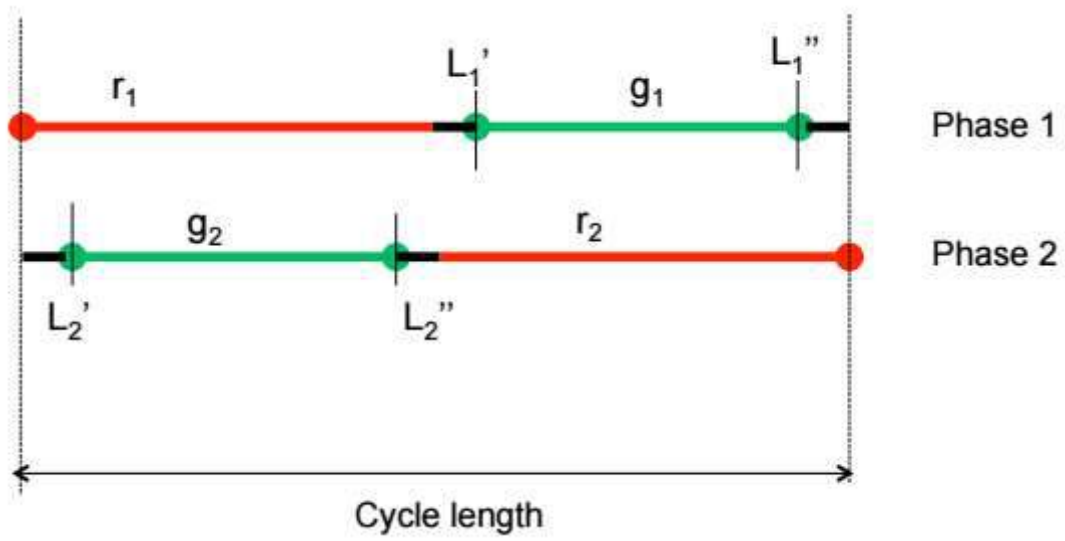
Piazza Apollodoro intersection is divided into two junction. The first is relative to Via Guido Reni and Via Flaminia, the latter is composed by Via de Coubertin and Viale Tiziano. From a design point of view, the path run along Via Guido Reni, parallel to the left sidewalk. As soon as it reaches the first junction it moves on the first car lane, which is nowadays occupied by the flowers of the florist in front of the road. This is the situation right now:

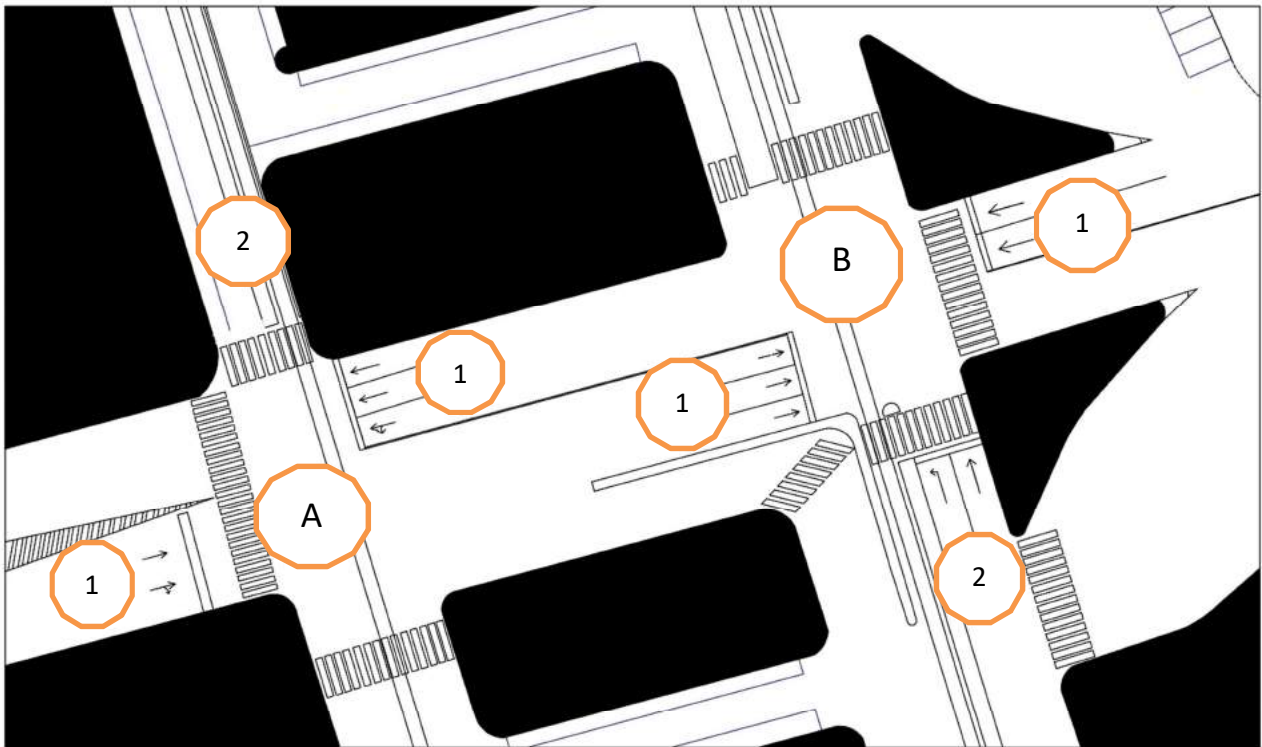


After that, bicycles run parallel to the existing zebra crossing on Viale Tiziano junction (a dedicated zebra crossing for cyclists will be realized). As stated before, at this point of the path, cyclists can decide to move either on the Auditorium corridor or on the new one, that move parallel to Viale Tiziano. The only problem is the tram, which is protected by intelligent traffic control. PTV Vissim is unable to make such a simulation, since there is a dynamic traffic signal control. While cars pass through the intersection, tram traffic light is always red, but as soon as it closes the doors at the stop before the traffic light, the light automatically turns green, giving the red signal to both vehicle flows. According to these consideration, if the traffic light cycle was kept constant, the following equation would be used in the simulator.

$$C \min = \frac{L}{1 - \sum_{i=n}^n y_n}$$

L is the total lost time, while y_n represents the single yellow light time for each phase. C_{min} is the minimum Cycle.





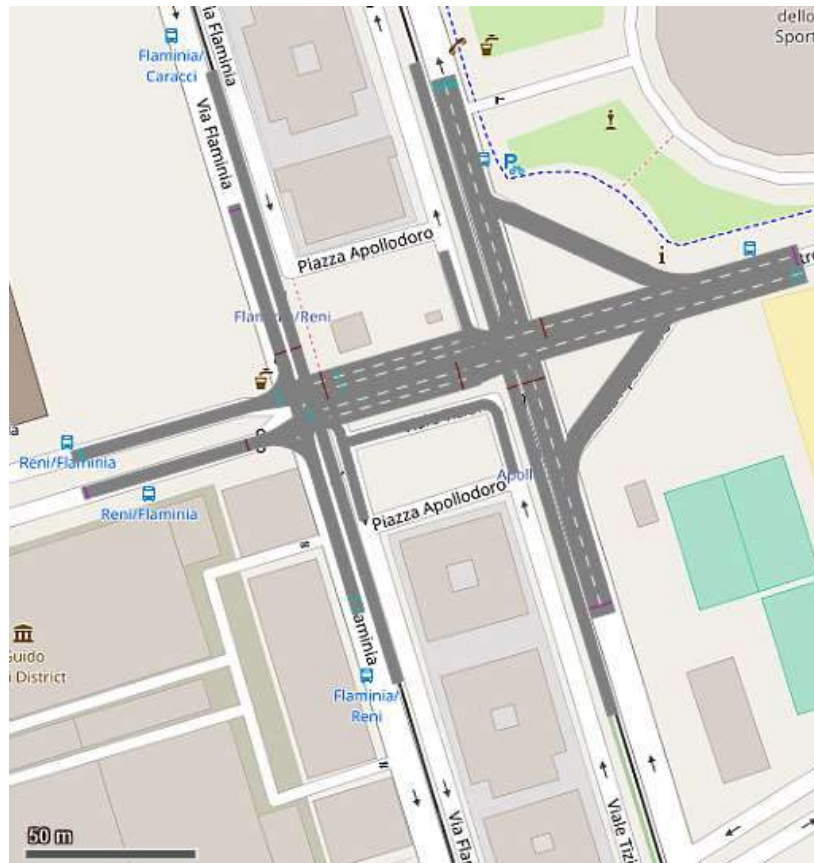
Two different intersection:

A. Via Flaminia crossing Via Guido Reni:

1. 1° Phase: Cars coming from Via Guido Reni, which can move to Piazza Apollodoro or turn on Via Flaminia. Cars which approach Piazza Apollodoro can decide to continue along Via Guido Reni or to turn on Via Flaminia, giving priority to car coming from Via Guido Reni.
2. 2° Phase: Cars moving along Via Flaminia

B. Viale Tiziano crossing Via De Coubertin:

1. 1°Phase: Cars moving along Via De Coubertin can only go straight. Cars coming from Piazza Apollodoro can continue along Via De Coubertin or turn on Viale Tiziano, giving priority to cars coming from Via de Coubertin.
2. 2°Phase: Cars moving along Viale Tiziano



Linear process is introduced in order to overcome the problem of the variable cycle. Each simulation lasts 600s. If it is assumed that the tram frequency is $\frac{1 \text{ tram}}{10 \text{ min}}$, 500s will be conducted without trams; the remaining 100s will be considered with a new traffic light cycle and consequently tram passage.

1.

This case refers to the first time interval of 500s, in which there is no tram passage. The following tables refers to traffic light phases and relative times.

Via Guido Reni		Via Flaminia		[from Ponte Milvio]		
G	Y		R			
20	4		42	[s]	C	66 [s]

Via Guido Reni		Via Flaminia		[from Ponte della Musica]		
G	Y		R			
20	4		42	[s]	C	66 [s]

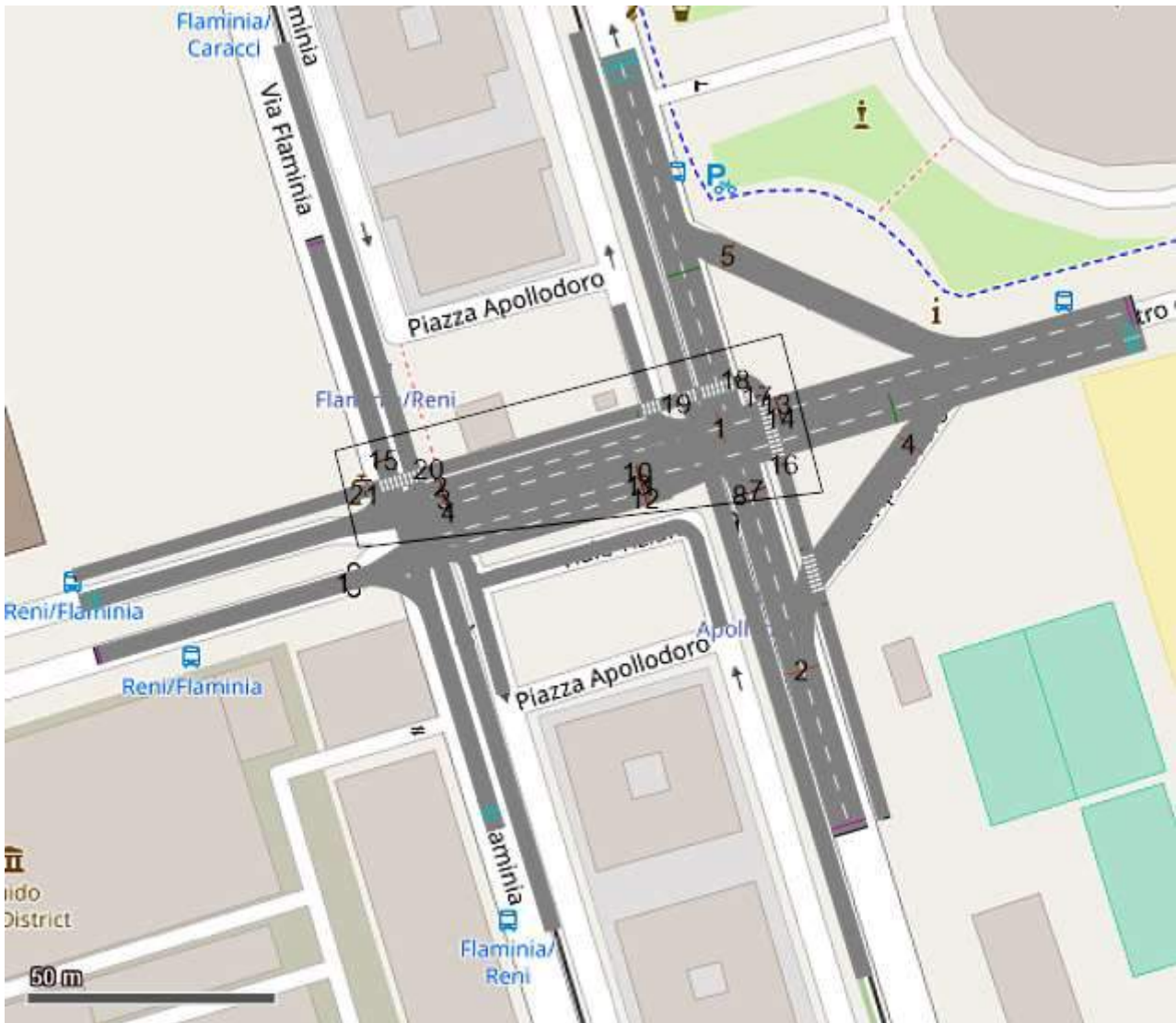
Piazza Apollodoro		Viale Tiziano		[from Via Guido Reni]		
G	Y		R			
20	4		42	[s]	C	66 [s]

Piazza Apollodoro		Viale Tiziano		[from Piazzale Manila]		
G	Y	R				
20	4	42	[s]	C	66	[s]

	Along Viale Tiziano	From Via de Coubertin	From Piazza Apollodoro	
Car	96	128	176	veh/h
Moped	36	64	76	veh/h
Van	12	20	32	veh/h
Heavy V.	20	24	24	veh/h

	Along Via Flaminia	From Via Guido Reni	From Piazza Apollodoro	
Car	156	144	240	veh/h
Moped	60	24	24	veh/h
Van	25	2	10	veh/h
Heavy V.	0	5	2	veh/h

The two tables above show traffic volumes recorded in one hour. Surveys on field was conducted for 15 minutes; each result was multiplied 4 times in order to get the hourly value.



Via Flaminia						
G	Y	R		C		
8	16	42	[s]		66	[s]

Viale Tiziano						
G	Y	R		C		
8	16	42	[s]		66	[s]

Via de Coubertin						
G	Y	R		C		
25	13	28	[s]		66	[s]

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EM. CO	EM. NOX	EM. VOC	FUEL CONS
1	0-100	1-From Piazza Apollodoro to Via de Coubertin	0	0	0	0	0	0
1	0-100	1-From Piazza Apollodoro to Viale Tiziano	0	1	0.123	0.024	0.029	0.002
1	0-100	1-From Via de Coubertin to Viale Tiziano parallel	18.87	0	0	0	0	0
1	0-100	1-From Via de Coubertin to Via Guido Reni	18.87	0	0	0	0	0
1	0-100	1-From Via de Coubertin to Via Guido Reni	18.87	3	6.55	1.274	1.518	0.094
1	0-100	1-From Via de Coubertin to Via Guido Reni	18.87	0	0	0	0	0
1	0-100	1-From Via de Coubertin to Via Flaminia	18.87	0	0	0	0	0
1	0-100	1-From Via Flaminia to Via Guido Reni	18.02	0	0	0	0	0
1	0-100	1-Along Via Flaminia	18.02	2	2.07	0.403	0.48	0.03
1	0-100	1-From Via Flaminia to Piazza Apollodoro	13.74	1	1.236	0.24	0.286	0.018
1	0-100	1-Along Viale Tiziano	11.94	2	2.113	0.411	0.49	0.03
1	0-100	1-From Viale Tiziano to Via Guido Reni	11.94	0	0	0	0	0
1	0-100	1-From Viale Tiziano to Via Guido Reni	11.94	2	1.261	0.245	0.292	0.018
1	0-100	1-From Viale Tiziano to Via Guido Reni	11.94	0	0	0	0	0
1	0-100	1-From Viale Tiziano to Via Flaminia	11.94	0	0	0	0	0
1	0-100	1-Tramline n°2	0	0	0	0	0	0
1	0-100	1-Tramline n°2	0	0	0	0	0	0
1	0-100	1-Cycle Path to Piazzale Manila	22.96	0	0	0	0	0
1	0-100	1-Cycle Path to Ponte della Musica	21.62	0	0	0	0	0
1	0-100	1-From Via Guido Reni to Piazza Apollodoro	42.51	0	0	0	0	0
1	0-100	1	42.51	11	13.382	2.604	3.101	0.191
1	100-200	1-From Piazza Apollodoro to Via de Coubertin	24.36	7	5.401	1.051	1.252	0.077
1	100-200	1-From Piazza Apollodoro to Viale Tiziano	24.36	3	1.16	0.226	0.269	0.017
1	100-200	1-From Via de Coubertin to Viale Tiziano parallel	6.52	0	0	0	0	0
1	100-200	1-From Via de Coubertin to Via Guido Reni	6.52	0	0	0	0	0
1	100-200	1-From Via de Coubertin to Via Guido Reni	6.52	0	0	0	0	0
1	100-200	1-From Via de Coubertin to Via Guido Reni	6.52	0	0	0	0	0
1	100-200	1-From Via de Coubertin to Via Flaminia	6.52	1	2.049	0.399	0.475	0.029
1	100-200	1-From Via Flaminia to Via Guido Reni	18.78	2	1.198	0.233	0.278	0.017
1	100-200	1-Along Via Flaminia	18.78	2	2.438	0.474	0.565	0.035
1	100-200	1-From Via Flaminia to Piazza Apollodoro	14.5	2	1.84	0.358	0.426	0.026
1	100-200	1-Along Viale Tiziano	6.88	2	1.385	0.269	0.321	0.02
1	100-200	1-From Viale Tiziano to Via Guido Reni	6.88	0	0	0	0	0
1	100-200	1-From Viale Tiziano to Via Guido Reni	6.88	0	0	0	0	0
1	100-200	1-From Viale Tiziano to Via Guido Reni	6.88	0	0	0	0	0
1	100-200	1-From Viale Tiziano to Via Flaminia	6.88	1	0.877	0.171	0.203	0.013
1	100-200	1-Tramline n°2	0	0	0	0	0	0
1	100-200	1-Tramline n°2	0	0	0	0	0	0
1	100-200	1-Cycle Path to Piazzale Manila	45.23	0	0	0	0	0
1	100-200	1-Cycle Path to Ponte della Musica	36.13	1	1.321	0.257	0.306	0.019
1	100-200	1-From Via Guido Reni to Piazza Apollodoro	42.46	0	0	0	0	0
1	100-200	1	45.23	21	18.158	3.533	4.208	0.26
1	200-300	1-From Piazza Apollodoro to Via de Coubertin	13.28	0	0	0	0	0
1	200-300	1-From Piazza Apollodoro to Viale Tiziano	13.28	2	1.632	0.318	0.378	0.023
1	200-300	1-From Via de Coubertin to Viale Tiziano parallel	31.35	0	0	0	0	0
1	200-300	1-From Via de Coubertin to Via Guido Reni	31.35	0	0	0	0	0
1	200-300	1-From Via de Coubertin to Via Guido Reni	31.35	4	9.501	1.849	2.202	0.136
1	200-300	1-From Via de Coubertin to Via Guido Reni	31.35	0	0	0	0	0
1	200-300	1-From Via de Coubertin to Via Flaminia	31.35	1	2.034	0.396	0.471	0.029
1	200-300	1-From Via Flaminia to Via Guido Reni	6.25	0	0	0	0	0
1	200-300	1-Along Via Flaminia	6.25	1	0.126	0.025	0.029	0.002
1	200-300	1-From Via Flaminia to Piazza Apollodoro	0	1	0.131	0.025	0.03	0.002
1	200-300	1-Along Viale Tiziano	12.17	1	1.258	0.245	0.292	0.018
1	200-300	1-From Viale Tiziano to Via Guido Reni	12.17	0	0	0	0	0
1	200-300	1-From Viale Tiziano to Via Guido Reni	12.17	1	1.713	0.333	0.397	0.025
1	200-300	1-From Viale Tiziano to Via Guido Reni	12.17	0	0	0	0	0
1	200-300	1-From Viale Tiziano to Via Flaminia	12.17	1	1.22	0.237	0.283	0.017
1	200-300	1-Tramline n°2	0	0	0	0	0	0
1	200-300	1-Tramline n°2	0	0	0	0	0	0
1	200-300	1-Cycle Path to Piazzale Manila	50.85	4	7.032	1.368	1.63	0.101
1	200-300	1-Cycle Path to Ponte della Musica	21.75	1	0.653	0.127	0.151	0.009
1	200-300	1-From Via Guido Reni to Piazza Apollodoro	31.74	0	0	0	0	0
1	200-300	1	50.85	17	24.499	4.767	5.678	0.35

1	300-400	1-From Piazza Apollodoro to Via de Coubertin	13.23	4	4.302	0.837	0.997	0.062
1	300-400	1-From Piazza Apollodoro to Viale Tiziano	13.23	2	1.428	0.278	0.331	0.02
1	300-400	1-From Via de Coubertin to Viale Tiziano parallel	11.49	0	0	0	0	0
1	300-400	1-From Via de Coubertin to Via Guido Reni	11.49	0	0	0	0	0
1	300-400	1-From Via de Coubertin to Via Guido Reni	11.49	2	3.507	0.682	0.813	0.05
1	300-400	1-From Via de Coubertin to Via Guido Reni	11.49	0	0	0	0	0
1	300-400	1-From Via de Coubertin to Via Flaminia	11.49	4	7.272	1.415	1.685	0.104
1	300-400	1-From Via Flaminia to Via Guido Reni	18.54	3	2.809	0.547	0.651	0.04
1	300-400	1-Along Via Flaminia	18.54	1	0.11	0.021	0.025	0.002
1	300-400	1-From Via Flaminia to Piazza Apollodoro	17.84	5	1.957	0.381	0.454	0.028
1	300-400	1-Along Viale Tiziano	6.71	0	0	0	0	0
1	300-400	1-From Viale Tiziano to Via Guido Reni	6.71	0	0	0	0	0
1	300-400	1-From Viale Tiziano to Via Guido Reni	6.71	1	1.648	0.321	0.382	0.024
1	300-400	1-From Viale Tiziano to Via Guido Reni	6.71	0	0	0	0	0
1	300-400	1-From Viale Tiziano to Via Flaminia	6.71	1	0.918	0.179	0.213	0.013
1	300-400	1-Tramline n°2	0	0	0	0	0	0
1	300-400	1-Tramline n°2	0	0	0	0	0	0
1	300-400	1-Cycle Path to Piazzale Manila	24.46	1	1.815	0.353	0.421	0.026
1	300-400	1-Cycle Path to Ponte della Musica	21.68	3	3.564	0.693	0.826	0.051
1	300-400	1-From Via Guido Reni to Piazza Apollodoro	30.38	0	0	0	0	0
1	300-400	1	30.38	27	29.699	5.778	6.883	0.425
1	400-500	1-From Piazza Apollodoro to Via de Coubertin	20.14	2	2.184	0.425	0.506	0.031
1	400-500	1-From Piazza Apollodoro to Viale Tiziano	20.14	3	4.148	0.807	0.961	0.059
1	400-500	1-From Via de Coubertin to Viale Tiziano parallel	13.9	0	0	0	0	0
1	400-500	1-From Via de Coubertin to Via Guido Reni	13.9	0	0	0	0	0
1	400-500	1-From Via de Coubertin to Via Guido Reni	13.9	1	1.218	0.237	0.282	0.017
1	400-500	1-From Via de Coubertin to Via Guido Reni	13.9	0	0	0	0	0
1	400-500	1-From Via de Coubertin to Via Flaminia	13.9	2	4.386	0.853	1.016	0.063
1	400-500	1-From Via Flaminia to Via Guido Reni	11.73	1	0.106	0.021	0.025	0.002
1	400-500	1-Along Via Flaminia	11.73	0	0	0	0	0
1	400-500	1-From Via Flaminia to Piazza Apollodoro	7.45	4	0.517	0.101	0.12	0.007
1	400-500	1-Along Viale Tiziano	10.61	0	0	0	0	0
1	400-500	1-From Viale Tiziano to Via Guido Reni	10.61	0	0	0	0	0
1	400-500	1-From Viale Tiziano to Via Guido Reni	10.61	4	5.29	1.029	1.226	0.076
1	400-500	1-From Viale Tiziano to Via Guido Reni	10.61	0	0	0	0	0
1	400-500	1-From Viale Tiziano to Via Flaminia	10.61	0	0	0	0	0
1	400-500	1-Tramline n°2	0	0	0	0	0	0
1	400-500	1-Tramline n°2	0	0	0	0	0	0
1	400-500	1-Cycle Path to Piazzale Manila	57.85	5	8.49	1.652	1.968	0.121
1	400-500	1-Cycle Path to Ponte della Musica	42.2	0	0	0	0	0
1	400-500	1-From Via Guido Reni to Piazza Apollodoro	45.04	0	0	0	0	0
1	400-500	1	57.85	22	27.515	5.353	6.377	0.394

2.

The last scenery provides the worst case: tram across the intersection. Obviously, cycle time increases. The table clearly shows how this does not enhance congestion. Traffic volume is not high, so traffic light cycle increase does not compromise the equilibrium.

Via Guido Reni		Via Flaminia		[from Ponte Milvio]			
G	Y	R					
20	4	65		[s]	C	89	[s]

Via Guido Reni		Via Flaminia		[from Ponte della Musica]			
G	Y	R					
20	4	65		[s]	C	89	[s]

Piazza Apollodoro		Viale Tiziano		[from Via Guido Reni]			
G	Y	R					
20	4	65		[s]	C	89	[s]

Piazza Apollodoro		Viale Tiziano		[from Piazzale Manila]			
G	Y	R					
20	4	65		[s]	C	89	[s]

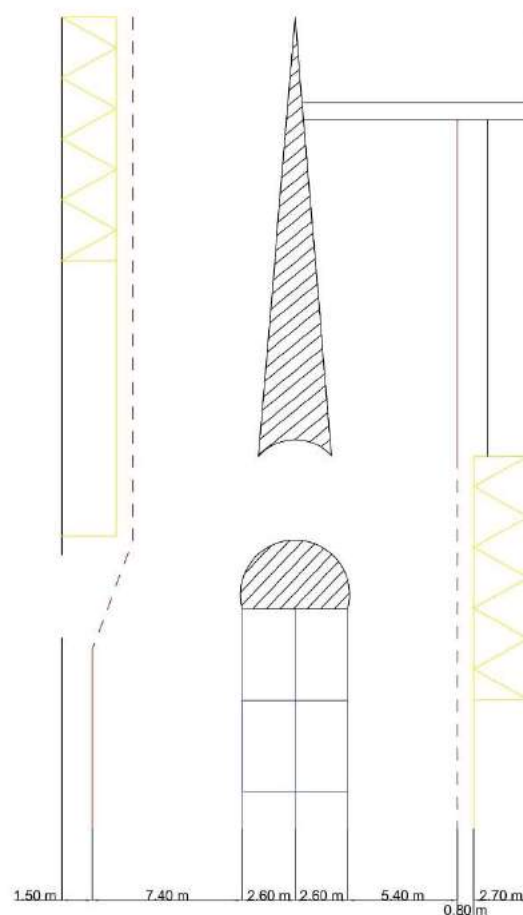
<i>Tram traffic light</i>			
G	Y	R	
20	3	66	
			[s]

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EM. CO	EM. NOX	EM. VOC	FUEL CONS.
2	0-100	1-From Piazza Apollodoro to Via de Coubertin	0	0	0	0	0	0
2	0-100	1-From Piazza Apollodoro to Viale Tiziano	0	1	0.123	0.024	0.029	0.002
2	0-100	1-From Via de Coubertin to Viale Tiziano parallel	18.87	0	0	0	0	0
2	0-100	1-From Via de Coubertin to Via Guido Reni	18.87	0	0	0	0	0
2	0-100	1-From Via de Coubertin to Via Guido Reni	18.87	0	0	0	0	0
2	0-100	1-From Via de Coubertin to Via Guido Reni	18.87	0	0	0	0	0
2	0-100	1-From Via de Coubertin to Via Flaminia	18.87	0	0	0	0	0
2	0-100	1-From Via Flaminia to Via Guido Reni	18.02	0	0	0	0	0
2	0-100	1-Along Via Flaminia	18.02	2	2.07	0.403	0.48	0.03
2	0-100	1-From Via Flaminia to Piazza Apollodoro	13.74	1	1.236	0.24	0.286	0.018
2	0-100	1-Along Viale Tiziano	11.94	0	0	0	0	0
2	0-100	1-From Viale Tiziano to Via Guido Reni	11.94	0	0	0	0	0
2	0-100	1-From Viale Tiziano to Via Guido Reni	11.94	2	1.261	0.245	0.292	0.018
2	0-100	1-From Viale Tiziano to Via Guido Reni	11.94	0	0	0	0	0
2	0-100	1-From Viale Tiziano to Via Flaminia	11.94	0	0	0	0	0
2	0-100	1-Tramline n°2	0	0	0	0	0	0
2	0-100	1-Tramline n°2	0	0	0	0	0	0
2	0-100	1-Cycle Path to Piazzale Manila	22.96	0	0	0	0	0
2	0-100	1-Cycle Path to Ponte della Musica	21.62	0	0	0	0	0
2	0-100	1-From Via Guido Reni to Piazza Apollodoro	48.75	0	0	0	0	0
2	0-100	1	48.75	6	4.708	0.916	1.091	0.067

MAX					
QLENMAX	QLENMAX	QLENMAX	QLENMAX	QLENMAX	
42.51	45.23	50.85	30.38	57.85	[m]
0-100	100-200	200-300	300-400	400-500	[s]

Last table allows to compare the results; 48.75 m is in line with those obtained in the first simulation. It is possible to conclude that the increase of traffic light cycle due to the passing of the tram does not increase the level of congestion. Moreover, the small number of vehicles that circulate on Piazza Apollodoro allows to reduce the number of lanes from 3 to 2, along the direction to Piazza Gentile da Fabriano. The lane adjacent to the sidewalk is nowadays occupied by a florist. Taking advantage from this opportunity, a promiscuous path on the sidewalk could be avoided, giving continuity to the cycle track.

The continuity factor is guaranteed. Users crosses the intersection in his bicycle seat. Nothing has been done to improve the intersection's traffic. AASHTO regulation provides a guideline for defining horizontal marking in crossings. First of all, the flow of cyclists must be differentiated. Bicycles must follow the vehicular flow and obviously the bicycle lane must adapt to the presence of parking lots and preferential lanes.



This is a hypothetical transformation of the intersection, according to American regulation. Obviously, Italian parameters are respected. The portion of bicycle lane adjacent to the bus stop is 0.80 meter wide, too small compared to 1.50 meter of the single lane. This is not prohibited by regulation, which allows narrowing of the bicycle lane, only for short stretches. Moreover, AASHTO guide book provides suggestions to designer, who has to separate, when it is possible, different flows: cars, pedestrians and bicycles have to run on different path.

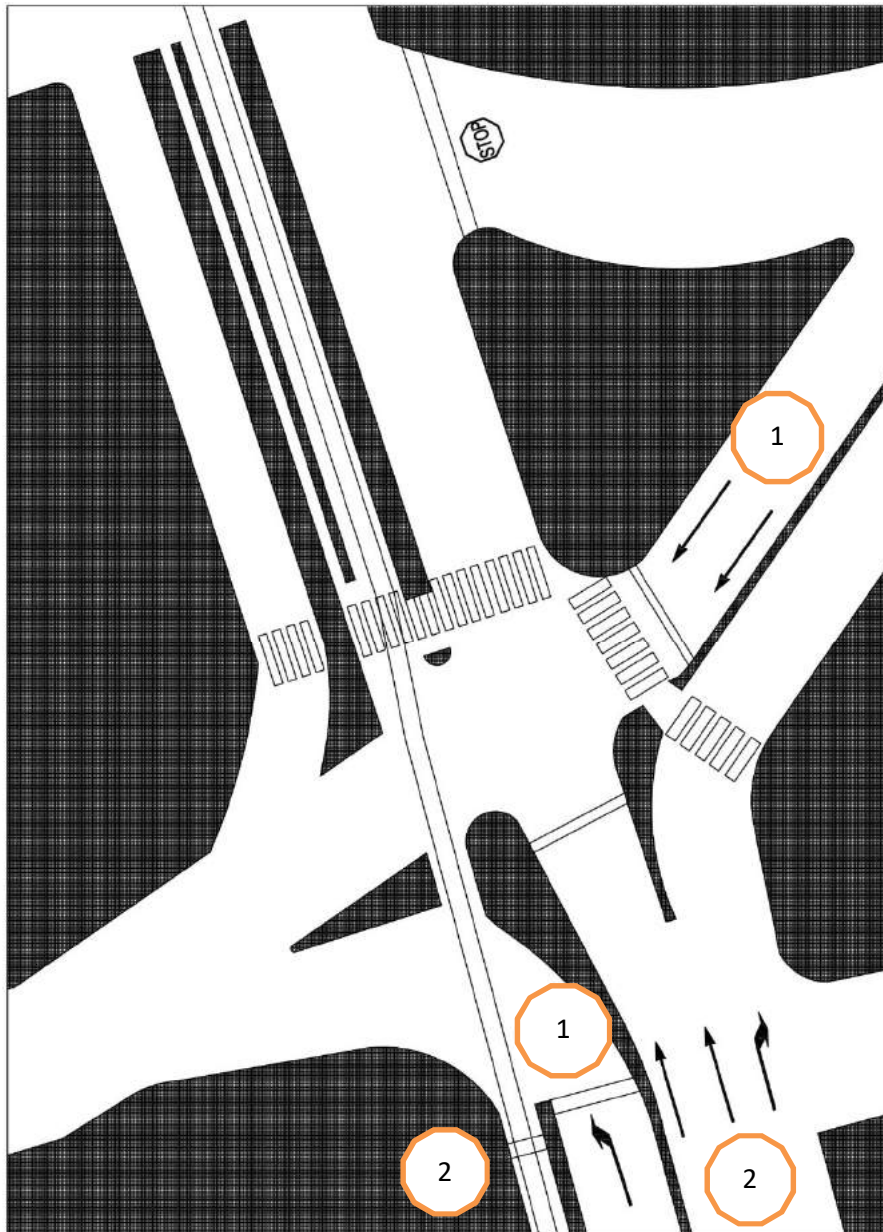
Piazzale Manila



The above planimetry shows Piazzale Manila node. It is a very complex one, like Piazza Apollodoro intersection. In this case, no intelligent traffic light system is adopted. As the whole junction is very congested, only Viale Tiziano and Viale Pilsudski intersection is analysed. Traffic volume is very high, so it must balance vehicular and cycling traffic, taking into account that the latter is 100 veh/h. The proposed alternatives are the following:

1. Moving on the left side of Viale Tiziano, cyclists join the zebra crossing transversal to Viale Pilsudski. Here they move on a proper zebra crossing until they reach “Salita dei Parioli”. Obviously the second traffic light, that nowadays is one request, will be regularized by a traffic light system with the same cycle of the previous one.

2. At the height of Esso EXXON gas station, a new traffic light is implemented. It allows cyclist to move on the small parallel road to Viale Tiziano. This one becomes transitable only for bikes.



1. Phase n°1: Cars turning on Piazzale Manila and cars moving along Viale Maresciallo Pilsudski. First group of cars have to give priority to the second one.
2. Phase n°2: Cars moving on Viale Tiziano and Tramway n°2.

The planimetry below shows the correct scheme of the intersection: the same used for simulation. Second junction is deleted in order only to show the most significant traffic light useful for the purpose. The gas station is schematized in a very simple way, using only input and output arches. A third traffic light has been inserted only to be able to define an alternative subsequently.



Down below the results are shown. The most congested part of the junction is Viale Tiziano, because on only one trunk there are three vehicular currents, sometimes in conflict with each other. Traffic light times, traffic volumes and their partitions are reported in the following pages.

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EM.CO	EM.NOX	EM.VOC	FUEL CONS.
1	0-100	1-Along Viale Tiziano	33.03	1	0.348	0.068	0.081	0.005
1	0-100	1-Along Viale Pilsudski	32.2	15	8.335	1.622	1.932	0.119
1	0-100	1-From Viale Tiziano to Piazzale Manila	0	3	0.958	0.186	0.222	0.014
1	0-100	1-Tramline n°2	0	0	0	0	0	0
1	0-100	1-Sidewalk	0	0	0	0	0	0
1	0-100	1-Sidewalk	21.72	0	0	0	0	0
1	0-100	1-Sidewalk	21.72	0	0	0	0	0
1	0-100	-Parallel to Viale Tiziano on Piazzale Manila	0	0	0	0	0	0
1	0-100	1-From Viale Tiziano to Viale Pilsudski	0	24	8.328	1.62	1.93	0.119
1	0-100	1	33.03	43	18.044	3.511	4.182	0.258
1	100-200	1-Along Viale Tiziano	141.08	14	16.072	3.127	3.725	0.23
1	100-200	1-Along Viale Pilsudski	49.95	22	13.87	2.699	3.215	0.198
1	100-200	1-From Viale Tiziano to Piazzale Manila	25.46	7	5.595	1.089	1.297	0.08
1	100-200	1-Tramline n°2	0	0	0	0	0	0
1	100-200	1-Sidewalk	39.81	0	0	0	0	0
1	100-200	1-Sidewalk	20.83	0	0	0	0	0
1	100-200	1-Sidewalk	20.83	0	0	0	0	0
1	100-200	-Parallel to Viale Tiziano on Piazzale Manila	12.11	0	0	0	0	0
1	100-200	1-From Viale Tiziano to Viale Pilsudski	5.1	39	21.551	4.193	4.995	0.308
1	100-200	1	141.08	82	57.047	11.099	13.221	0.816
1	200-300	1-Along Viale Tiziano	31.35	10	10.419	2.027	2.415	0.149
1	200-300	1-Along Viale Pilsudski	48.39	24	18.413	3.583	4.267	0.263
1	200-300	1-From Viale Tiziano to Piazzale Manila	0	2	1.792	0.349	0.415	0.026
1	200-300	1-Tramline n°2	0	1	0.435	0.085	0.101	0.006
1	200-300	1-Sidewalk	30.21	0	0	0	0	0
1	200-300	1-Sidewalk	20.32	0	0	0	0	0
1	200-300	1-Sidewalk	20.32	0	0	0	0	0
1	200-300	-Parallel to Viale Tiziano on Piazzale Manila	11.06	3	5.265	1.024	1.22	0.075
1	200-300	1-From Viale Tiziano to Viale Pilsudski	12.27	34	12.499	2.432	2.897	0.179
1	200-300	1	48.39	74	48.988	9.531	11.353	0.701
1	300-400	1-Along Viale Tiziano	42.03	12	10.754	2.092	2.492	0.154
1	300-400	1-Along Viale Pilsudski	26.53	18	6.496	1.264	1.506	0.093
1	300-400	1-From Viale Tiziano to Piazzale Manila	25.07	5	5.726	1.114	1.327	0.082
1	300-400	1-Tramline n°2	0	0	0	0	0	0
1	300-400	1-Sidewalk	25.67	0	0	0	0	0
1	300-400	1-Sidewalk	39.8	1	4.065	0.791	0.942	0.058
1	300-400	1-Sidewalk	39.8	0	0	0	0	0
1	300-400	-Parallel to Viale Tiziano on Piazzale Manila	12.67	0	0	0	0	0
1	300-400	1-From Viale Tiziano to Viale Pilsudski	24.97	37	16.814	3.271	3.897	0.241
1	300-400	1	42.03	73	44.13	8.586	10.227	0.631
1	400-500	1-Along Viale Tiziano	180.33	10	9.971	1.94	2.311	0.143
1	400-500	1-Along Viale Pilsudski	24.53	23	13.799	2.685	3.198	0.197
1	400-500	1-From Viale Tiziano to Piazzale Manila	16.09	8	11.379	2.214	2.637	0.163
1	400-500	1-Tramline n°2	0	0	0	0	0	0
1	400-500	1-Sidewalk	0	0	0	0	0	0
1	400-500	1-Sidewalk	31.34	0	0	0	0	0
1	400-500	1-Sidewalk	31.34	0	0	0	0	0
1	400-500	-Parallel to Viale Tiziano on Piazzale Manila	0	2	3.899	0.759	0.904	0.056
1	400-500	1-From Viale Tiziano to Viale Pilsudski	175.86	43	22.499	4.378	5.214	0.322
1	400-500	1	180.33	86	61.441	11.954	14.24	0.879
1	500-600	1-Along Viale Tiziano	179.39	9	10.5	2.043	2.434	0.15
1	500-600	1-Along Viale Pilsudski	30.34	17	10.435	2.03	2.419	0.149
1	500-600	1-From Viale Tiziano to Piazzale Manila	12.34	6	4.235	0.824	0.982	0.061
1	500-600	1-Tramline n°2	40.27	1	0.849	0.165	0.197	0.012
1	500-600	1-Sidewalk	20.36	0	0	0	0	0
1	500-600	1-Sidewalk	0	0	0	0	0	0
1	500-600	1-Sidewalk	0	0	0	0	0	0
1	500-600	-Parallel to Viale Tiziano on Piazzale Manila	6.71	2	1.013	0.197	0.235	0.014
1	500-600	1-From Viale Tiziano to Viale Pilsudski	174.92	45	22.255	4.33	5.158	0.318
1	500-600	1	179.39	80	49.331	9.598	11.433	0.706

Viale Tiziano/ Viale Pilsudski intersection

Viale Tiziano		Viale M. Pilsudski		[Coming from Parioli]		
G	Y	R				
73	4	37		[s]	C	114 [s]

Viale Tiziano		Viale M. Pilsudski		[Coming from Belle Arti]		
G	Y	R				
29	4	81		[s]	C	114 [s]

Viale Tiziano		Viale M. Pilsudski		[Coming from Parioli]		[Pedestrian]	
G	Y	R					
23	10	81		[s]	C	114	[s]

Viale Tiziano		Viale M. Pilsudski		[Coming from Belle Arti]		[Pedestrian]	
G	Y	R					
8	24	82		[s]	C	114	[s]

[Passing along Viale Tiziano]		
Car	276	[VeH]
Moped	48	[VeH]
Van	36	[VeH]
Heavy V.	12	[VeH]
Tram	14	[VeH]
[Turning on Viale M. Pilsudski]		
Car	1188	[VeH]
Moped	384	[VeH]
Van	24	[VeH]
Heavy V.	0	[VeH]
[Turning on P.Manila]		
Car	252	[VeH]
Moped	36	[VeH]
Van	24	[VeH]
Heavy V.	7	[VeH]
Bus	12	[VeH]

[Passing through P. Manila]		
Car	756	[VeH]
Moped	132	[VeH]
Van	36	[VeH]
Heavy V.	12	[VeH]
[Turning on Viale Tiziano]		
Car	84	[VeH]
Moped	12	[VeH]
Van	0	[VeH]
Heavy V.	0	[VeH]

Piazzale Manila/ Via Flaminia

Piazzale Manila		Via Flaminia	
G	Y	R	
4	56	69	[s]

C	129	[s]
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Piazzale Manila		Via Flaminia		[Pedestrian]
G	Y	R		
4	56	69	[s]	

C	129	[s]
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Turning Point Esso gas station

Going Ahead			
G	Y	R	
4	78	32	[s]

C	114	[s]
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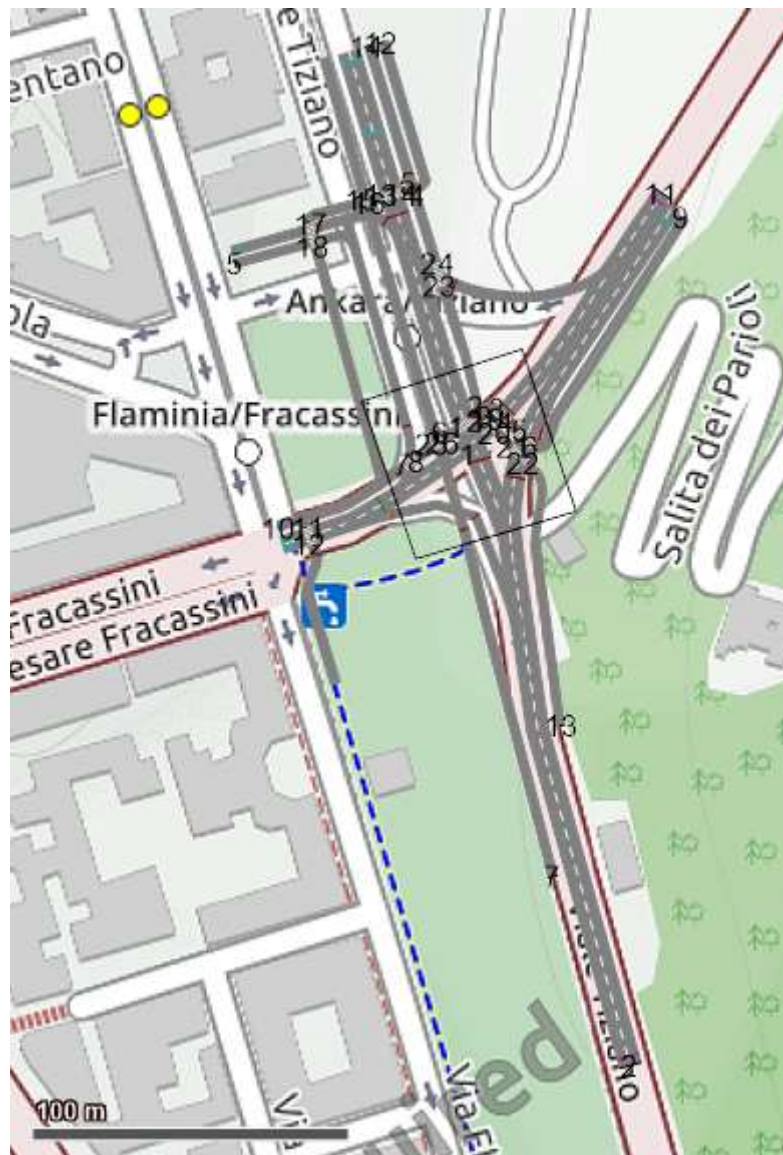
Turning Left			
G	Y	R	
4	28	82	[s]

C	114	[s]
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Pedestrian Crossing			
G	Y	R	
24	8	82	[s]

C	114	[s]
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1.



Planimetry of first alternative. Arch 13 and arch 12, respectively at the bottom and at the top of the map, stand for cycle path. Arch 13 runs parallel to the first trunk of Viale Tiziano, adjacent to Collina Parioli. Arch 12 moves adjacent to the upper part of the street; here, pedestrians and cyclists run parallel on two different itineraries. The used space for cycle path is get from parking lots. The way it does is explained in the transversal section of the road.

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EM.CO	EM.NOX	EM.VOC	FUEL CONS.
2	0-100	1-Along Viale Tiziano	129.53	1	0.348	0.068	0.081	0.005
2	0-100	1-Along Viale Pilsudski	29.97	15	8.432	1.64	1.954	0.121
2	0-100	1-From Viale Pilsudski to Viale Tiziano	6.47	3	1.042	0.203	0.241	0.015
2	0-100	1-Tramline n°2	0	0	0	0	0	0
2	0-100	1-Sidewalk	0	0	0	0	0	0
2	0-100	1-Sidewalk	0	0	0	0	0	0
2	0-100	1-Sidewalk	0	0	0	0	0	0
2	0-100	1-From Viale Tiziano to Piazzale Manila	0	0	0	0	0	0
2	0-100	1-Cycle Path [from North to South]	0	0	0	0	0	0
2	0-100	1-From Viale Tiziano to Viale Pilsudski	122.35	4	1.306	0.254	0.303	0.019
2	0-100	1-Cycle Path [from South to North]	0	0	0	0	0	0
2	0-100	1	129.53	23	11.183	2.176	2.592	0.16
2	100-200	1-Along Viale Tiziano	203.66	8	11.959	2.327	2.772	0.171
2	100-200	1-Along Viale Pilsudski	51.22	22	14.088	2.741	3.265	0.202
2	100-200	1-From Viale Pilsudski to Viale Tiziano	0	2	0.822	0.16	0.19	0.012
2	100-200	1-Tramline n°2	0	0	0	0	0	0
2	100-200	1-Sidewalk	0	0	0	0	0	0
2	100-200	1-Sidewalk	21.72	0	0	0	0	0
2	100-200	1-Sidewalk	21.72	0	0	0	0	0
2	100-200	1-From Viale Tiziano to Piazzale Manila	11.99	0	0	0	0	0
2	100-200	1-Cycle Path [from North to South]	0	0	0	0	0	0
2	100-200	1-From Viale Tiziano to Viale Pilsudski	196.47	22	30.839	6	7.147	0.441
2	100-200	1-Cycle Path [from South to North]	38.25	1	0.476	0.093	0.11	0.007
2	100-200	1	203.66	55	58.253	11.334	13.501	0.833
2	200-300	1-Along Viale Tiziano	198.02	7	13.784	2.682	3.195	0.197
2	200-300	1-Along Viale Pilsudski	44.61	28	18.22	3.545	4.223	0.261
2	200-300	1-From Viale Pilsudski to Viale Tiziano	13.48	1	1.743	0.339	0.404	0.025
2	200-300	1-Tramline n°2	0	1	0.435	0.085	0.101	0.006
2	200-300	1-Sidewalk	31.52	0	0	0	0	0
2	200-300	1-Sidewalk	20.33	0	0	0	0	0
2	200-300	1-Sidewalk	20.33	0	0	0	0	0
2	200-300	1-From Viale Tiziano to Piazzale Manila	11.06	3	5.25	1.021	1.217	0.075
2	200-300	1-Cycle Path [from North to South]	77.8	0	0	0	0	0
2	200-300	1-From Viale Tiziano to Viale Pilsudski	190.84	23	41.227	8.021	9.555	0.59
2	200-300	1-Cycle Path [from South to North]	1.4	0	0	0	0	0
2	200-300	1	198.02	63	80.642	15.69	18.69	1.154
2	300-400	1-Along Viale Tiziano	203.28	4	7.35	1.43	1.703	0.105
2	300-400	1-Along Viale Pilsudski	30.85	15	5.193	1.01	1.203	0.074
2	300-400	1-From Viale Pilsudski to Viale Tiziano	37.54	3	5.21	1.014	1.208	0.075
2	300-400	1-Tramline n°2	0	0	0	0	0	0
2	300-400	1-Sidewalk	29.08	0	0	0	0	0
2	300-400	1-Sidewalk	11.26	1	3.647	0.71	0.845	0.052
2	300-400	1-Sidewalk	11.26	0	0	0	0	0
2	300-400	1-From Viale Tiziano to Piazzale Manila	12.67	1	1.429	0.278	0.331	0.02
2	300-400	1-Cycle Path [from North to South]	83.5	1	0.513	0.1	0.119	0.007
2	300-400	1-From Viale Tiziano to Viale Pilsudski	196.09	21	41.646	8.103	9.652	0.596
2	300-400	1-Cycle Path [from South to North]	87.77	0	0	0	0	0
2	300-400	1	203.28	46	65.332	12.711	15.141	0.935
2	400-500	1-Along Viale Tiziano	203.62	6	12.638	2.459	2.929	0.181
2	400-500	1-Along Viale Pilsudski	25.14	22	11.797	2.295	2.734	0.169
2	400-500	1-From Viale Pilsudski to Viale Tiziano	9.85	5	12.498	2.432	2.896	0.179
2	400-500	1-Tramline n°2	0	0	0	0	0	0
2	400-500	1-Sidewalk	18.27	0	0	0	0	0
2	400-500	1-Sidewalk	33.09	0	0	0	0	0
2	400-500	1-Sidewalk	33.09	0	0	0	0	0
2	400-500	1-From Viale Tiziano to Piazzale Manila	0	1	1.469	0.286	0.34	0.021
2	400-500	1-Cycle Path [from North to South]	125.53	0	0	0	0	0
2	400-500	1-From Viale Tiziano to Viale Pilsudski	196.44	23	38.451	7.481	8.911	0.55
2	400-500	1-Cycle Path [from South to North]	60.25	1	2.448	0.476	0.567	0.035
2	400-500	1	203.62	58	79.412	15.451	18.404	1.136
2	500-600	1-Along Viale Tiziano	199.76	4	8.6	1.673	1.993	0.123
2	500-600	1-Along Viale Pilsudski	31.02	17	9.764	1.9	2.263	0.14
2	500-600	1-From Viale Pilsudski to Viale Tiziano	0	1	1.418	0.276	0.329	0.02
2	500-600	1-Tramline n°2	40.27	1	0.849	0.165	0.197	0.012
2	500-600	1-Sidewalk	24.15	0	0	0	0	0
2	500-600	1-Sidewalk	20.28	0	0	0	0	0
2	500-600	1-Sidewalk	20.28	0	0	0	0	0
2	500-600	1-From Viale Tiziano to Piazzale Manila	6.71	2	1.013	0.197	0.235	0.014
2	500-600	1-Cycle Path [from North to South]	125.19	1	0.518	0.101	0.12	0.007
2	500-600	1-From Viale Tiziano to Viale Pilsudski	202.01	11	22.596	4.396	5.237	0.323
2	500-600	1-Cycle Path [from South to North]	26.09	1	1.214	0.236	0.281	0.017
2	500-600	1	202.01	38	46.323	9.013	10.736	0.663

This case could be the most critical. From design point of view it is the simplest, but he forces to remove all the parking lots along Viale Tiziano, up to Via delle Belle Arti. Moreover, conflict points are defined at the height of ERG gas station and IP fuel station. Congestion may be crucial: a new traffic light is needed to allow cyclists to cross intersection. Nowadays this traffic light is on request, because pedestrian volume is very low. If the latter were to take the phase of the previous pedestrian traffic light, a long queue of cars could originate during the peak period. The following table data demonstrates this drawback, making this alternative not good for the studied case. In the page down below it is possible to observe the planimetry of the analyzed alternative. The cycle path runs along Viale Tiziano up to the turning arch of Viale Pilsudski; here a new traffic light is installed with a cycle time of 60 s. then it move to the intersection with Viale Pilsudski. Here it has to stop because of pedestrian flow. The space is enough to admit both the pedestrian arch and cycle path to cross the intersection without moving the traffic light back.

Along Viale Tiziano, queue length computation gives very high values. Starting from 129.53 meters, it reaches the MAXIMUM value at 203.66 meter during 100-200 time interval.

Cars		
G	Y	R
36	4	20

C	60	[s]
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Bicycles		
G	Y	R
5	15	40

C	60	[s]
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Tables above show traffic light new implementation on turning point arch from Viale Pilsudski to Viale Tiziano. It is used only in that alternative.

2.



This choice provides a new destination for road trunk called “controviale Tiziano”. Right now a small percentage of cars use it to do reverse or to exit from Esso gas station. So, with this alteration, drivers are forced to move on Viale Tiziano, using a cross street to return on Via Flaminia. When they move out they find a new traffic light with the same cycle and phases of the one used for turning inside of the service station square.

Esso Traffic Light [cars]		
G	28	[s]
Y	4	[s]
R	82	[s]
Esso Traffic Light [bicycles]		
G	50	[s]
Y	32	[s]
R	32	[s]

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EM.CO	EM.NOX	EM.VOC	FUEL CO.
3	0-100	1-Along Viale Tiziano	33.04	1	0.348	0.068	0.081	0.005
3	0-100	1-Along Viale Pilsudski	31.4	21	9.846	1.916	2.282	0.141
3	0-100	1-From Viale Tiziano to Piazzale Manila	0	3	1.31	0.255	0.304	0.019
3	0-100	1-Tramline n°2	0	0	0	0	0	0
3	0-100	1-Sidewalk	0	0	0	0	0	0
3	0-100	1-Sidewalk	21.77	0	0	0	0	0
3	0-100	1-Sidewalk	21.77	0	0	0	0	0
3	0-100	1-Bicycle path [From North to South]	0	0	0	0	0	0
3	0-100	1-Bicycle path [From South to North]	21.69	1	0.257	0.05	0.06	0.004
3	0-100	1-From Viale Tiziano to Viale Pilsudski	0	24	8.298	1.615	1.923	0.119
3	0-100	1	33.04	50	20.042	3.899	4.645	0.287
3	100-200	1-Along Viale Tiziano	141.08	14	15.93	3.099	3.692	0.228
3	100-200	1-Along Viale Pilsudski	38.89	22	14.828	2.885	3.437	0.212
3	100-200	1-From Viale Tiziano to Piazzale Manila	25.46	5	4.908	0.955	1.137	0.07
3	100-200	1-Tramline n°2	0	0	0	0	0	0
3	100-200	1-Sidewalk	0	0	0	0	0	0
3	100-200	1-Sidewalk	19.69	0	0	0	0	0
3	100-200	1-Sidewalk	19.69	0	0	0	0	0
3	100-200	1-Bicycle path [From North to South]	30.06	0	0	0	0	0
3	100-200	1-Bicycle path [From South to North]	33.99	2	1.019	0.198	0.236	0.015
3	100-200	1-From Viale Tiziano to Viale Pilsudski	0	39	21.277	4.14	4.931	0.304
3	100-200	1	141.08	82	57.746	11.235	13.383	0.826
3	200-300	1-Along Viale Tiziano	31.75	10	10.365	2.017	2.402	0.148
3	200-300	1-Along Viale Pilsudski	58.25	24	14.551	2.831	3.372	0.208
3	200-300	1-From Viale Tiziano to Piazzale Manila	5.36	2	1.324	0.258	0.307	0.019
3	200-300	1-Tramline n°2	0	1	0.435	0.085	0.101	0.006
3	200-300	1-Sidewalk	39.53	0	0	0	0	0
3	200-300	1-Sidewalk	20.31	1	2.553	0.497	0.592	0.037
3	200-300	1-Sidewalk	20.31	0	0	0	0	0
3	200-300	1-Bicycle path [From North to South]	32.19	2	4.043	0.787	0.937	0.058
3	200-300	1-Bicycle path [From South to North]	24.4	4	4.357	0.848	1.01	0.062
3	200-300	1-From Viale Tiziano to Viale Pilsudski	12.4	34	13.09	2.547	3.034	0.187
3	200-300	1	58.25	78	51.689	10.057	11.979	0.739
3	300-400	1-Along Viale Tiziano	25.47	12	10.636	2.069	2.465	0.152
3	300-400	1-Along Viale Pilsudski	25.59	13	5.561	1.082	1.289	0.08
3	300-400	1-From Viale Tiziano to Piazzale Manila	25.05	8	9.911	1.928	2.297	0.142
3	300-400	1-Tramline n°2	0	0	0	0	0	0
3	300-400	1-Sidewalk	31.34	0	0	0	0	0
3	300-400	1-Sidewalk	38.65	0	0	0	0	0
3	300-400	1-Sidewalk	38.65	0	0	0	0	0
3	300-400	1-Bicycle path [From North to South]	44.06	4	11.107	2.161	2.574	0.159
3	300-400	1-Bicycle path [From South to North]	41.98	5	3.588	0.698	0.832	0.051
3	300-400	1-From Viale Tiziano to Viale Pilsudski	19.7	39	18.368	3.574	4.257	0.263
3	300-400	1	44.06	81	62.63	12.186	14.515	0.896
3	400-500	1-Along Viale Tiziano	203.1	8	9.468	1.842	2.194	0.135
3	400-500	1-Along Viale Pilsudski	45.52	18	8.874	1.727	2.057	0.127
3	400-500	1-From Viale Tiziano to Piazzale Manila	8.9	7	10.418	2.027	2.414	0.149
3	400-500	1-Tramline n°2	0	0	0	0	0	0
3	400-500	1-Sidewalk	10.01	1	2.049	0.399	0.475	0.029
3	400-500	1-Sidewalk	30.19	0	0	0	0	0
3	400-500	1-Sidewalk	30.19	0	0	0	0	0
3	400-500	1-Bicycle path [From North to South]	29.32	4	8.901	1.732	2.063	0.127
3	400-500	1-Bicycle path [From South to North]	24.24	2	1.532	0.298	0.355	0.022
3	400-500	1-From Viale Tiziano to Viale Pilsudski	198.63	35	23.687	4.609	5.49	0.339
3	400-500	1	203.1	75	65.815	12.805	15.253	0.942
3	500-600	1-Along Viale Tiziano	191.69	11	12.234	2.38	2.835	0.175
3	500-600	1-Along Viale Pilsudski	44.57	26	17.239	3.354	3.995	0.247
3	500-600	1-From Viale Tiziano to Piazzale Manila	17.99	5	4.143	0.806	0.96	0.059
3	500-600	1-Tramline n°2	40.27	1	0.849	0.165	0.197	0.012
3	500-600	1-Sidewalk	20.37	2	3.469	0.675	0.804	0.05
3	500-600	1-Sidewalk	0	1	2.651	0.516	0.614	0.038
3	500-600	1-Sidewalk	0	0	0	0	0	0
3	500-600	1-Bicycle path [From North to South]	26.15	0	0	0	0	0
3	500-600	1-Bicycle path [From South to North]	26.71	0	0	0	0	0
3	500-600	1-From Viale Tiziano to Viale Pilsudski	187.22	51	30.922	6.016	7.167	0.442
3	500-600	1	191.69	97	71.685	13.947	16.614	1.026

Compared to the previous case, it is possible to observe lower values for QLENMAX. It is due to maintaining the standard configuration for the traffic light scheme at node 1. Higher values are motivated by a possible queue on the Viale Tiziano corridor, which causes congestion for cars that want to turn on Viale Pilsudski.

<i>SIMRUN</i>	<i>TIMEINT</i>	<i>MOVEMENT</i>	<i>QLENMAX</i>	<i>VEHS(ALL)</i>
3	400-500	1-Along Viale Tiziano	203.1	8
3	400-500	1-From Viale Tiziano to Viale Pilsudski	198.63	35
3	500-600	1-Along Viale Tiziano	191.69	11
3	500-600	1-From Viale Tiziano to Viale Pilsudski	187.22	51

The best alternative is the second. First of all, the queue parameters are lower. At a cost level, it reduces those related to the implementation of a new traffic light system, which is present in the first case. This alternative also allows to take advantage from a nearly unused road trunk (controviale Tiziano). It might be though that new bike crosswalk should be realized at the end of Piazzale Manila, where the pedestrian one already exist. From this point of view, cost-benefit analysis could give a better result, but cyclists could reduce the route crossing the road where horizontal marking does not allow it, resulting in risks.

Via delle Belle Arti/ Via Flaminia intersection

The following picture shows Belle Arti intersection planimetry made by PTV Vissim simulator. Just a quick overview over the the intersection:



The archs named 1,2 and 3 represent tramlines. Arch number 1 stands for tramline n°2 coming from Piazza Mancini; arch number 2 defines tramline n°19 coming from Piazza Thorvaldsen. Finally, on arch 3, pass tramline n°2, coming from Piazzale Flaminio and tramline n°19 coming from Piazza Risorgimento. The arrival of trams is stochastic. So, Intelligent traffic light system is installed.

The are three different cycles:

1. None tram arrives at the junction: cars traffic light has the following cycle and phases:

Via delle Belle Arti [coming from Lungotevere]		
G	Y	R
42	4	55

C	101	[s]
---	-----	-----

Along Via Flaminia		
G	Y	R
45	4	52

C	101	[s]
---	-----	-----

2. One tram is approaching the junction:

Via delle Belle Arti [coming from Lungotevere]		
G	Y	R
44	4	80

C	128	[s]
---	-----	-----

Along Via Flaminia		
G	Y	R
41	4	83

C	128	[s]
---	-----	-----

1 Tram		
G	Y	R
26	4	98

C	128	[s]
---	-----	-----

3. Two trams approach the intersection

Via delle Belle Arti [coming from Lungotevere]		
G	Y	R
44	4	80

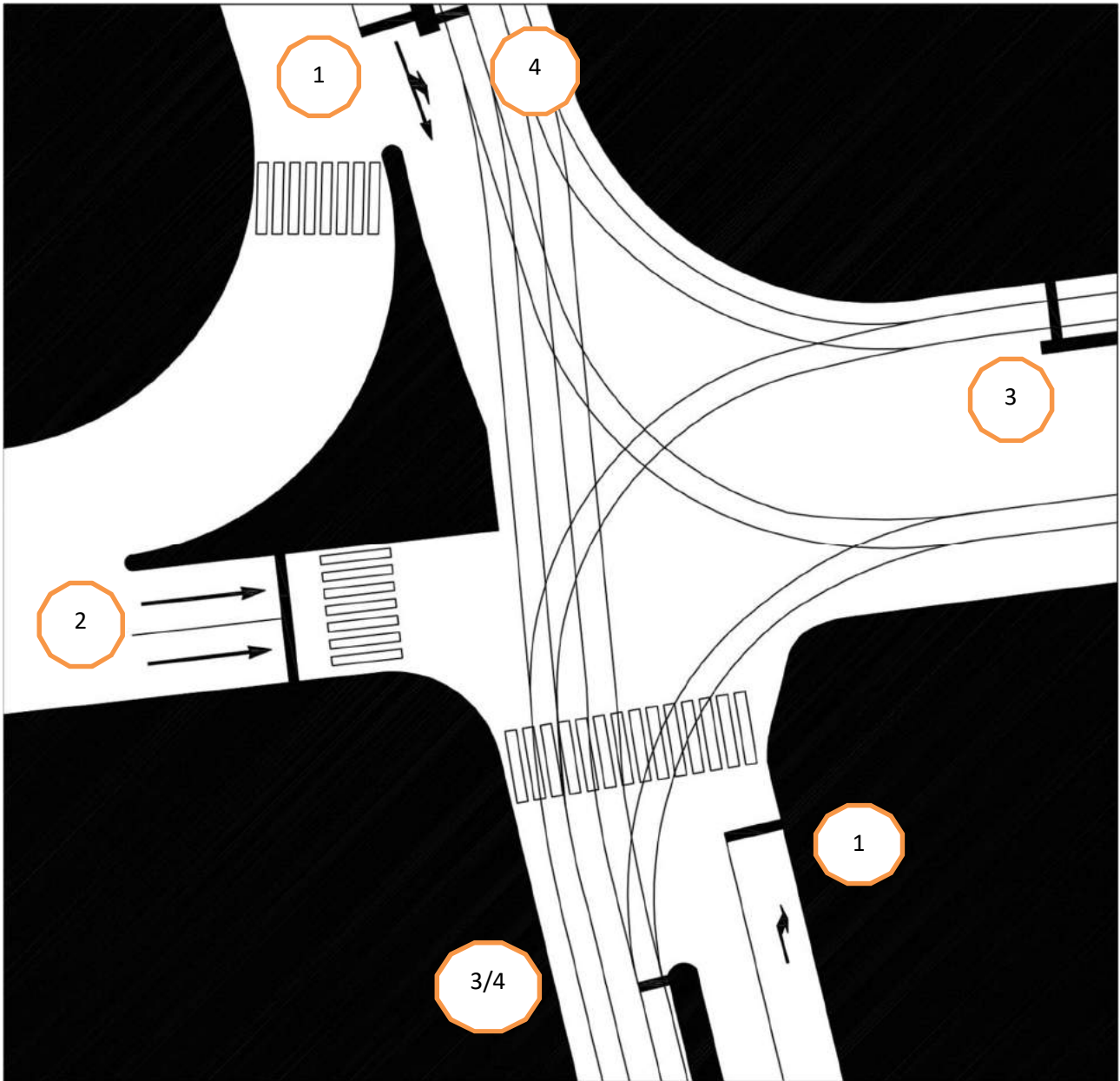
C	128	[s]
---	-----	-----

Along Via Flaminia		
G	Y	R
41	4	83

C	128	[s]
---	-----	-----

2 Trams		
G	Y	R
13	4	111

C	128	[s]
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Belle Arti intersection is divided into four different phases: two relative to cars and remaining two to trams.

1. Phase n°1: Cars coming from the lower side of Via Flaminia and Cars coming from the upper side of Via Flaminia, which can continue along via Flaminia or turn on Via delle Belle Arti giving priority to the first group of cars.
2. Phase n°2: Cars Coming from Lungotevere.
3. Phase n°3: Tramline 19
4. Phase n°4: Tramline 2

Tram lines n°2 and n°19 share the same trunk of Via Flaminia up to Piazza della Marina. Dead times, especially for line n°19, can produce high waiting car for cars. In that way disutility is reduced for cars. As Piazza Apollodoro intersection, PTV Vissim cannot simulate that kind of junction, because of varying cycle times. In this case, mediating three results would not lead to an exact picture of the situation. The project wants to make a significant change to the neighborhood viability and for that reason a hypothetical scenario is excluded as it does not faithfully respect the reality. For this reason it was decided to opt for the most critical situation: the third one.

SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EM. CO	EM. NOX	EM. VOC	FUEL CONS.
1	0-100	1-Tramline 19 to Piazza della Marina	0	0	0	0	0	0
1	0-100	1-From Via Flaminia to Via delle Belle Arti	18.57	0	0	0	0	0
1	0-100	1-From Via Flaminia to Viale Tiziano	18.57	2	0.686	0.134	0.159	0.01
1	0-100	1-Tramline 19 to Via delle Belle Arti	40.25	0	0	0	0	0
1	0-100	1-Tramline 2 to Piazzale Manila	0	0	0	0	0	0
1	0-100	1-Tramline 2 to Piazza della Marina	0	0	0	0	0	0
1	0-100	1-From Via Flaminia to Via delle Belle Arti	48.41	0	0	0	0	0
1	0-100	1-Along Via Flaminia	48.39	0	0	0	0	0
1	0-100	1-From Via Flaminia to Piazzale Belle Arti	37.34	23	5.711	1.111	1.323	0.082
1	0-100	1-From Piazzale Belle Arti to Via delle Belle Arti	136.01	4	5.936	1.155	1.376	0.085
1	0-100	1-From Piazzale Belle Arti to Viale Tiziano	136.01	10	15.453	3.007	3.581	0.221
1	0-100	1-From Piazzale Belle Arti to Via Flaminia	136.01	0	0	0	0	0
1	0-100	1	136.01	39	27.751	5.399	6.432	0.397
1	100-200	1-Tramline 19 to Piazza della Marina	0	0	0	0	0	0
1	100-200	1-From Via Flaminia to Via delle Belle Arti	17.64	4	2.829	0.55	0.656	0.04
1	100-200	1-From Via Flaminia to Viale Tiziano	17.64	3	3.632	0.707	0.842	0.052
1	100-200	1-Tramline 19 to Via delle Belle Arti	38.66	1	2.174	0.423	0.504	0.031
1	100-200	1-Tramline 2 to Piazzale Manila	0	0	0	0	0	0
1	100-200	1-Tramline 2 to Piazza della Marina	0	0	0	0	0	0
1	100-200	1-From Via Flaminia to Via delle Belle Arti	71.95	17	28.857	5.615	6.688	0.413
1	100-200	1-Along Via Flaminia	71.94	4	3.601	0.701	0.834	0.052
1	100-200	1-From Via Flaminia to Piazzale Belle Arti	60.89	32	9.868	1.92	2.287	0.141
1	100-200	1-From Piazzale Belle Arti to Via delle Belle Arti	134.88	10	11.269	2.193	2.612	0.161
1	100-200	1-From Piazzale Belle Arti to Viale Tiziano	134.88	19	14.244	2.771	3.301	0.204
1	100-200	1-From Piazzale Belle Arti to Via Flaminia	134.88	2	2.004	0.39	0.465	0.029
1	100-200	1	134.88	92	78.623	15.297	18.222	1.125
1	200-300	1-Tramline 19 to Piazza della Marina	0	0	0	0	0	0
1	200-300	1-From Via Flaminia to Via delle Belle Arti	20.13	2	1.949	0.379	0.452	0.028
1	200-300	1-From Via Flaminia to Viale Tiziano	20.13	4	2.781	0.541	0.645	0.04
1	200-300	1-Tramline 19 to Via delle Belle Arti	0	0	0	0	0	0
1	200-300	1-Tramline 2 to Piazzale Manila	0	0	0	0	0	0
1	200-300	1-Tramline 2 to Piazza della Marina	0	0	0	0	0	0
1	200-300	1-From Via Flaminia to Via delle Belle Arti	126.08	12	22.197	4.319	5.144	0.318
1	200-300	1-Along Via Flaminia	126.07	6	10.751	2.092	2.492	0.154
1	200-300	1-From Via Flaminia to Piazzale Belle Arti	115.01	22	7.323	1.425	1.697	0.105
1	200-300	1-From Piazzale Belle Arti to Via delle Belle Arti	175.99	10	11.539	2.245	2.674	0.165
1	200-300	1-From Piazzale Belle Arti to Viale Tiziano	175.99	36	44.878	8.732	10.401	0.642
1	200-300	1-From Piazzale Belle Arti to Via Flaminia	175.99	2	1.394	0.271	0.323	0.02
1	200-300	1	175.99	94	102.881	20.017	23.844	1.472

1	300-400	1-Tramline 19 to Piazza della Marina	0	0	0	0	0	0
1	300-400	1-From Via Flaminia to Via delle Belle Arti	0	2	0.678	0.132	0.157	0.01
1	300-400	1-From Via Flaminia to Viale Tiziano	0	1	0.319	0.062	0.074	0.005
1	300-400	1-Tramline 19 to Via delle Belle Arti	40.42	0	0	0	0	0
1	300-400	1-Tramline 2 to Piazzale Manila	0	0	0	0	0	0
1	300-400	1-Tramline 2 to Piazza della Marina	0	0	0	0	0	0
1	300-400	1-From Via Flaminia to Via delle Belle Arti	109.47	4	7.417	1.443	1.719	0.106
1	300-400	1-Along Via Flaminia	109.46	0	0	0	0	0
1	300-400	1-From Via Flaminia to Piazzale Belle Arti	98.41	16	11.978	2.331	2.776	0.171
1	300-400	1-From Piazzale Belle Arti to Via delle Belle Arti	171.28	17	22.261	4.331	5.159	0.318
1	300-400	1-From Piazzale Belle Arti to Viale Tiziano	171.28	29	37.783	7.351	8.757	0.541
1	300-400	1-From Piazzale Belle Arti to Via Flaminia	171.28	1	1.655	0.322	0.383	0.024
1	300-400	1	171.28	70	82.164	15.986	19.042	1.175
1	400-500	1-Tramline 19 to Piazza della Marina	0	0	0	0	0	0
1	400-500	1-From Via Flaminia to Via delle Belle Arti	26.81	0	0	0	0	0
1	400-500	1-From Via Flaminia to Viale Tiziano	26.81	0	0	0	0	0
1	400-500	1-Tramline 19 to Via delle Belle Arti	38.73	1	1.434	0.279	0.332	0.021
1	400-500	1-Tramline 2 to Piazzale Manila	0	0	0	0	0	0
1	400-500	1-Tramline 2 to Piazza della Marina	40.23	0	0	0	0	0
1	400-500	1-From Via Flaminia to Via delle Belle Arti	128.43	10	24.783	4.822	5.744	0.355
1	400-500	1-Along Via Flaminia	128.42	3	8.845	1.721	2.05	0.127
1	400-500	1-From Via Flaminia to Piazzale Belle Arti	117.36	41	50.07	9.742	11.604	0.716
1	400-500	1-From Piazzale Belle Arti to Via delle Belle Arti	197.33	13	25.05	4.874	5.806	0.358
1	400-500	1-From Piazzale Belle Arti to Viale Tiziano	197.33	17	30.781	5.989	7.134	0.44
1	400-500	1-From Piazzale Belle Arti to Via Flaminia	197.33	0	0	0	0	0
1	400-500	1	197.33	85	140.541	27.344	32.572	2.011
1	500-600	1-Tramline 19 to Piazza della Marina	0	0	0	0	0	0
1	500-600	1-From Via Flaminia to Via delle Belle Arti	33	4	3.908	0.76	0.906	0.056
1	500-600	1-From Via Flaminia to Viale Tiziano	33	4	4.27	0.831	0.99	0.061
1	500-600	1-Tramline 19 to Via delle Belle Arti	0	0	0	0	0	0
1	500-600	1-Tramline 2 to Piazzale Manila	0	1	0.466	0.091	0.108	0.007
1	500-600	1-Tramline 2 to Piazza della Marina	38.61	1	2.093	0.407	0.485	0.03
1	500-600	1-From Via Flaminia to Via delle Belle Arti	82.89	15	32.397	6.303	7.508	0.463
1	500-600	1-Along Via Flaminia	82.88	3	3.255	0.633	0.754	0.047
1	500-600	1-From Via Flaminia to Piazzale Belle Arti	71.82	33	8.667	1.686	2.009	0.124
1	500-600	1-From Piazzale Belle Arti to Via delle Belle Arti	193.89	5	1.804	0.351	0.418	0.026
1	500-600	1-From Piazzale Belle Arti to Viale Tiziano	193.89	13	10.416	2.026	2.414	0.149
1	500-600	1-From Piazzale Belle Arti to Via Flaminia	193.89	0	0	0	0	0
1	500-600	1	193.89	79	67.173	13.069	15.568	0.961

Queues are long enough and their increase is expected if the number of traffic light phases enhances. In the previous chapter was defined the route of the cycle path: the circulation between Via delle Belle Arti and Piazza della Marina denies cars to move on Via Flaminia on South to North direction. On that lane only bicycles are allowed to move, in both direction. In this way a direct corridor can be made up into the green area. The only way to accomplish this corridor is to change traffic light phases.

- First phase: cars moving along Via delle Belle Arti, coming from Lungotevere.
- Second phase: cars coming from the upper part of Via Flaminia. They can decide to keep on Via Flaminia or to move on Via delle Belle Arti or to get back to Piazzale Flaminia moving on Viale Tiziano.

- Third phase: Bicycle. With a proper and protected phase, cyclists can move safely inside green area, ensuring art.2 of Italian bike regulation.

The illustrative example on page shows the modified planimetry of the intersection. Three dotted lines define the path. This is done according to American regulation.

<i>SIMRUN</i>	<i>TIMEINT</i>	<i>MOVEMENT</i>	<i>QLENMAX</i>	<i>VEHS(ALL)</i>	<i>EM. CO</i>	<i>EM. NOX</i>	<i>EM. VOC</i>	<i>FUEL CONS.</i>
2	0-100	1-Tramline 19 From Via Belle Arti	0	0	0	0	0	0
2	0-100	1-Cycle Path from Piazza della Marina	0	1	0.488	0.095	0.113	0.007
2	0-100	1-Tramline 19 from Piazza della Marina	40.25	0	0	0	0	0
2	0-100	1-Tramline 2 from Piazza della Marina	0	0	0	0	0	0
2	0-100	1-Tramline 2 from Piazza Mancini	0	0	0	0	0	0
2	0-100	1-From Via Flaminia to Via delle Belle Arti	48.34	0	0	0	0	0
2	0-100	1-Along Via Flaminia	48.35	0	0	0	0	0
2	0-100	1-From Via Flaminia to Piazzale Belle Arti	37.59	24	5.949	1.157	1.379	0.085
2	0-100	1-From Piazzale Belle Arti to Via delle Belle Arti	131.27	4	6.176	1.202	1.431	0.088
2	0-100	1-From Piazzale Belle Arti to Viale Tiziano	131.27	9	15.961	3.106	3.699	0.228
2	0-100	1-From Piazzale Belle Arti to Via Flaminia	131.27	0	0	0	0	0
2	0-100	1-Cycle Path from Piazza Apollodoro	0	0	0	0	0	0
2	0-100	1	131.27	38	28.268	5.5	6.551	0.404
2	100-200	1-Tramline 19 From Via Belle Arti	0	0	0	0	0	0
2	100-200	1-Cycle Path from Piazza della Marina	10.82	0	0	0	0	0
2	100-200	1-Tramline 19 from Piazza della Marina	38.66	1	2.174	0.423	0.504	0.031
2	100-200	1-Tramline 2 from Piazza della Marina	0	0	0	0	0	0
2	100-200	1-Tramline 2 from Piazza Mancini	0	0	0	0	0	0
2	100-200	1-From Via Flaminia to Via delle Belle Arti	61.45	19	24.887	4.842	5.768	0.356
2	100-200	1-Along Via Flaminia	61.46	4	4.199	0.817	0.973	0.06
2	100-200	1-From Via Flaminia to Piazzale Belle Arti	50.7	31	8.259	1.607	1.914	0.118
2	100-200	1-From Piazzale Belle Arti to Via delle Belle Arti	134.98	11	12.65	2.461	2.932	0.181
2	100-200	1-From Piazzale Belle Arti to Viale Tiziano	134.98	21	17.632	3.43	4.086	0.252
2	100-200	1-From Piazzale Belle Arti to Via Flaminia	134.98	2	2.263	0.44	0.525	0.032
2	100-200	1-Cycle Path from Piazza Apollodoro	3.97	0	0	0	0	0
2	100-200	1	134.98	89	72.268	14.061	16.749	1.034
2	200-300	1-Tramline 19 From Via Belle Arti	0	0	0	0	0	0
2	200-300	1-Cycle Path from Piazza della Marina	8.53	4	5.923	1.152	1.373	0.085
2	200-300	1-Tramline 19 from Piazza della Marina	0	0	0	0	0	0
2	200-300	1-Tramline 2 from Piazza della Marina	0	0	0	0	0	0
2	200-300	1-Tramline 2 from Piazza Mancini	0	0	0	0	0	0
2	200-300	1-From Via Flaminia to Via delle Belle Arti	101.73	13	18.8	3.658	4.357	0.269
2	200-300	1-Along Via Flaminia	101.74	5	9.632	1.874	2.232	0.138
2	200-300	1-From Via Flaminia to Piazzale Belle Arti	90.98	28	8.984	1.748	2.082	0.129
2	200-300	1-From Piazzale Belle Arti to Via delle Belle Arti	209.37	11	11.811	2.298	2.737	0.169
2	200-300	1-From Piazzale Belle Arti to Viale Tiziano	209.37	34	49.895	9.708	11.564	0.714
2	200-300	1-From Piazzale Belle Arti to Via Flaminia	209.37	2	2.609	0.508	0.605	0.037
2	200-300	1-Cycle Path from Piazza Apollodoro	3.87	2	1.274	0.248	0.295	0.018
2	200-300	1	209.37	99	109.951	21.393	25.482	1.573

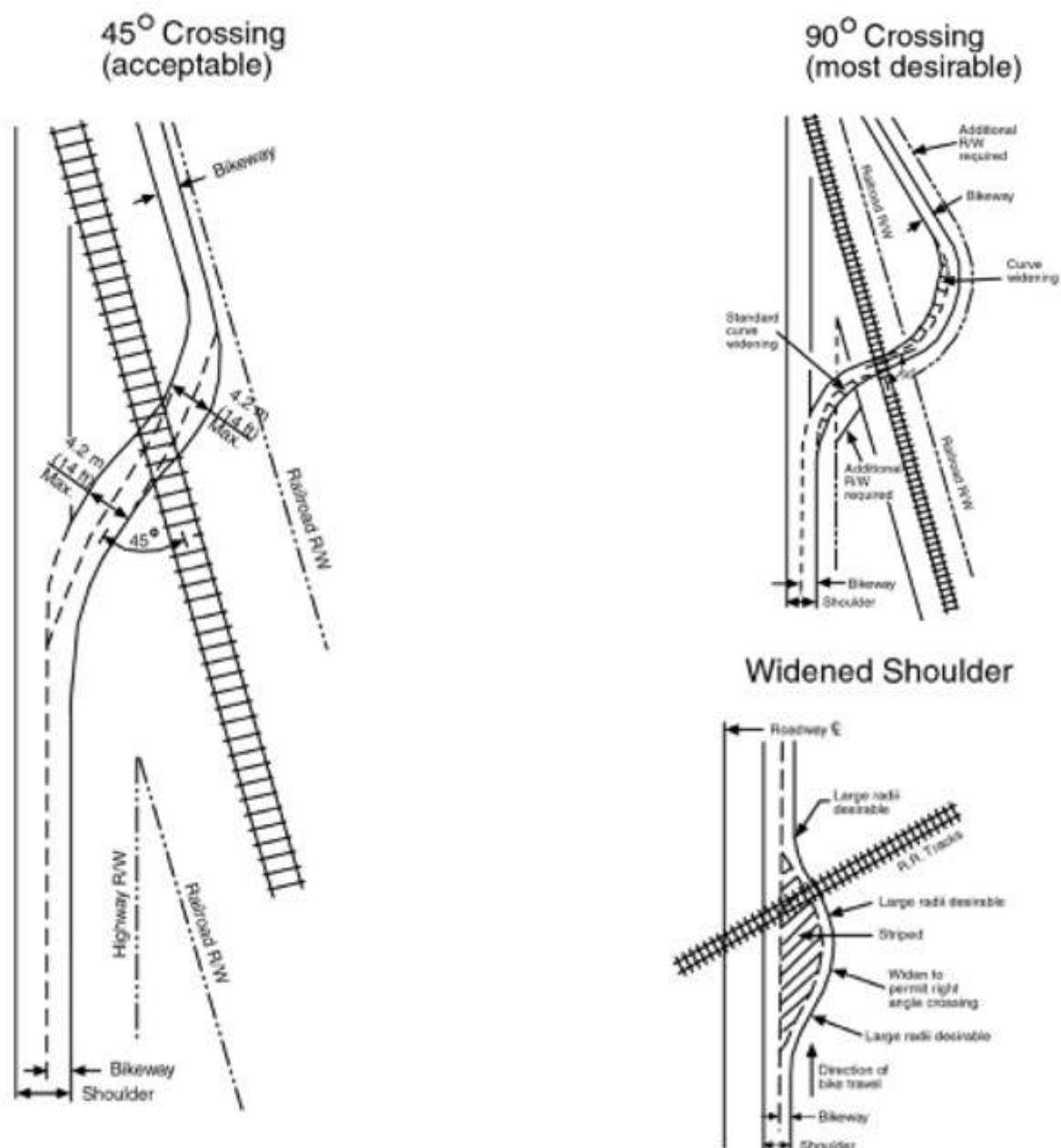
2	300-400	1-Tramline 19 From Via Belle Arti	0	0	0	0	0	0
2	300-400	1-Cycle Path from Piazza della Marina	10.89	4	4.362	0.849	1.011	0.062
2	300-400	1-Tramline 19 from Piazza della Marina	40.42	0	0	0	0	0
2	300-400	1-Tramline 2 from Piazza della Marina	0	0	0	0	0	0
2	300-400	1-Tramline 2 from Piazza Mancini	0	0	0	0	0	0
2	300-400	1-From Via Flaminia to Via delle Belle Arti	57.66	5	10.698	2.081	2.479	0.153
2	300-400	1-Along Via Flaminia	57.67	3	9.089	1.768	2.106	0.13
2	300-400	1-From Via Flaminia to Piazzale Belle Arti	46.91	35	8.965	1.744	2.078	0.128
2	300-400	1-From Piazzale Belle Arti to Via delle Belle Arti	207.42	16	21.072	4.1	4.884	0.301
2	300-400	1-From Piazzale Belle Arti to Viale Tiziano	207.42	28	44.418	8.642	10.294	0.635
2	300-400	1-From Piazzale Belle Arti to Via Flaminia	207.42	1	1.841	0.358	0.427	0.026
2	300-400	1-Cycle Path from Piazza Apollodoro	3.39	2	1.628	0.317	0.377	0.023
2	300-400	1	207.42	94	101.336	19.716	23.486	1.45
2	400-500	1-Tramline 19 From Via Belle Arti	0	0	0	0	0	0
2	400-500	1-Cycle Path from Piazza della Marina	9.74	4	6.126	1.192	1.42	0.088
2	400-500	1-Tramline 19 from Piazza della Marina	38.73	1	1.434	0.279	0.332	0.021
2	400-500	1-Tramline 2 from Piazza della Marina	0	0	0	0	0	0
2	400-500	1-Tramline 2 from Piazza Mancini	40.23	0	0	0	0	0
2	400-500	1-From Via Flaminia to Via delle Belle Arti	43.85	12	13.425	2.612	3.111	0.192
2	400-500	1-Along Via Flaminia	43.86	1	1.059	0.206	0.245	0.015
2	400-500	1-From Via Flaminia to Piazzale Belle Arti	33.1	16	3.841	0.747	0.89	0.055
2	400-500	1-From Piazzale Belle Arti to Via delle Belle Arti	207.65	11	26.133	5.085	6.057	0.374
2	400-500	1-From Piazzale Belle Arti to Viale Tiziano	207.65	21	39.014	7.591	9.042	0.558
2	400-500	1-From Piazzale Belle Arti to Via Flaminia	207.65	0	0	0	0	0
2	400-500	1-Cycle Path from Piazza Apollodoro	10.73	4	4.307	0.838	0.998	0.062
2	400-500	1	207.65	70	95.619	18.604	22.161	1.368
2	500-600	1-Tramline 19 From Via Belle Arti	0	0	0	0	0	0
2	500-600	1-Cycle Path from Piazza della Marina	8.25	3	5.373	1.045	1.245	0.077
2	500-600	1-Tramline 19 from Piazza della Marina	0	0	0	0	0	0
2	500-600	1-Tramline 2 from Piazza della Marina	0	1	0.466	0.091	0.108	0.007
2	500-600	1-Tramline 2 from Piazza Mancini	38.61	1	2.093	0.407	0.485	0.03
2	500-600	1-From Via Flaminia to Via delle Belle Arti	75.3	10	11.335	2.205	2.627	0.162
2	500-600	1-Along Via Flaminia	75.31	3	1.746	0.34	0.405	0.025
2	500-600	1-From Via Flaminia to Piazzale Belle Arti	64.55	33	8.036	1.564	1.863	0.115
2	500-600	1-From Piazzale Belle Arti to Via delle Belle Arti	202.28	4	5.24	1.019	1.214	0.075
2	500-600	1-From Piazzale Belle Arti to Viale Tiziano	202.28	10	8.432	1.641	1.954	0.121
2	500-600	1-From Piazzale Belle Arti to Via Flaminia	202.28	0	0	0	0	0
2	500-600	1-Cycle Path from Piazza Apollodoro	8.39	3	4.302	0.837	0.997	0.062
2	500-600	1	202.28	68	48.098	9.358	11.147	0.688

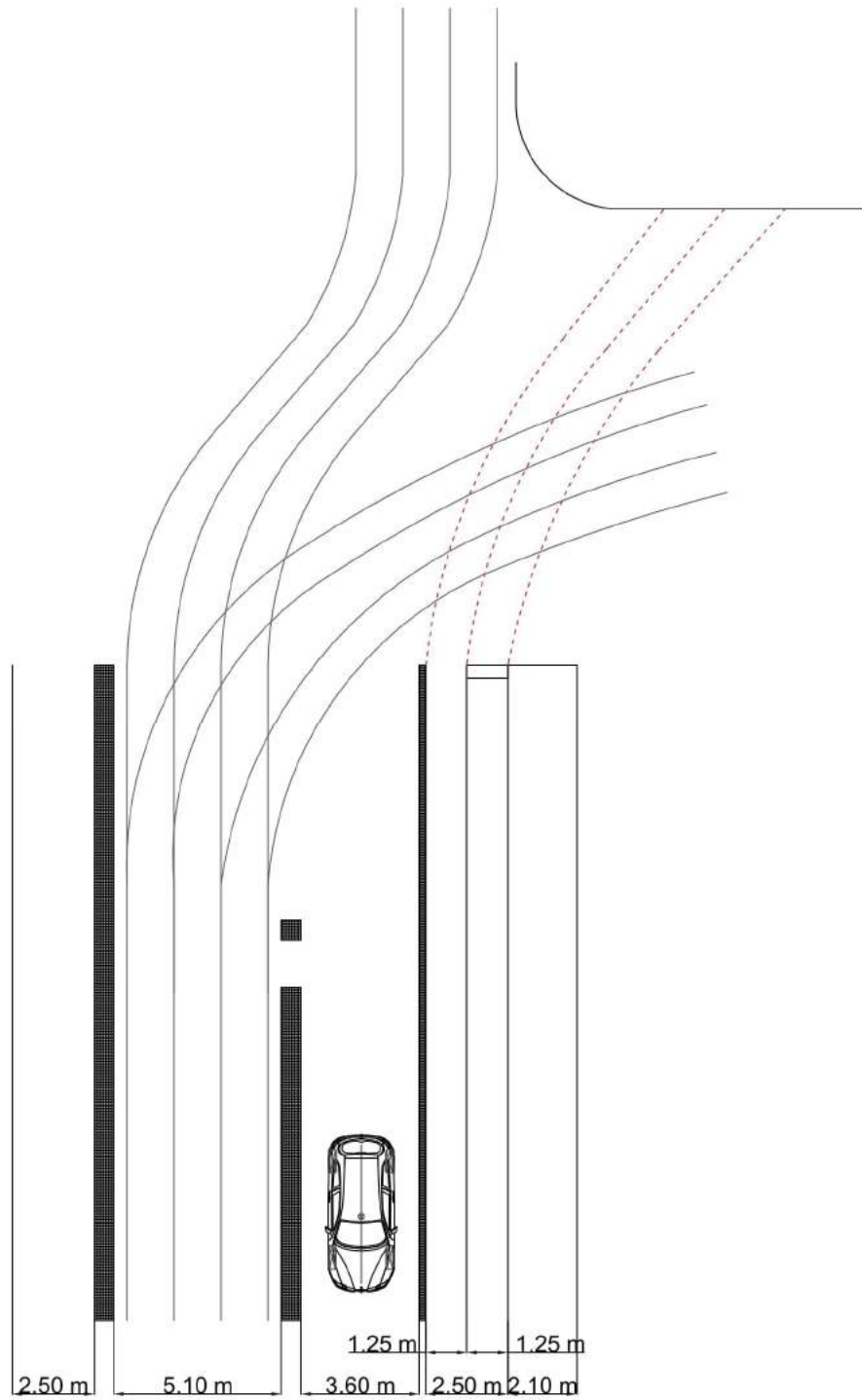
From the comparison between the two tables it is clear that the second alternative increases the degree of congestion along the itinerary passing through Piazzale delle Belle Arti. This is due to the fact that road traffic has changed, because people who wants to get Via delle Belle Arti cannot move along Via Flaminia, moving on Piazzale delle Belle Arti. Respectively:

2	200-300	1-From Piazzale Belle Arti to Via delle Belle Arti	209.37	11	11.811	2.298	2.737	0.169
2	200-300	1-From Piazzale Belle Arti to Viale Tiziano	209.37	34	49.895	9.708	11.564	0.714
2	200-300	1-From Piazzale Belle Arti to Via Flaminia	209.37	2	2.609	0.508	0.605	0.037
1	400-500	1-From Piazzale Belle Arti to Via delle Belle Arti	197.33	13	25.05	4.874	5.806	0.358
1	400-500	1-From Piazzale Belle Arti to Viale Tiziano	197.33	17	30.781	5.989	7.134	0.44
1	400-500	1-From Piazzale Belle Arti to Via Flaminia	197.33	0	0	0	0	0

The increase of traffic is equal to 5.75%; so this choice could be perfectly implemented without significantly increasing traffic congestion.

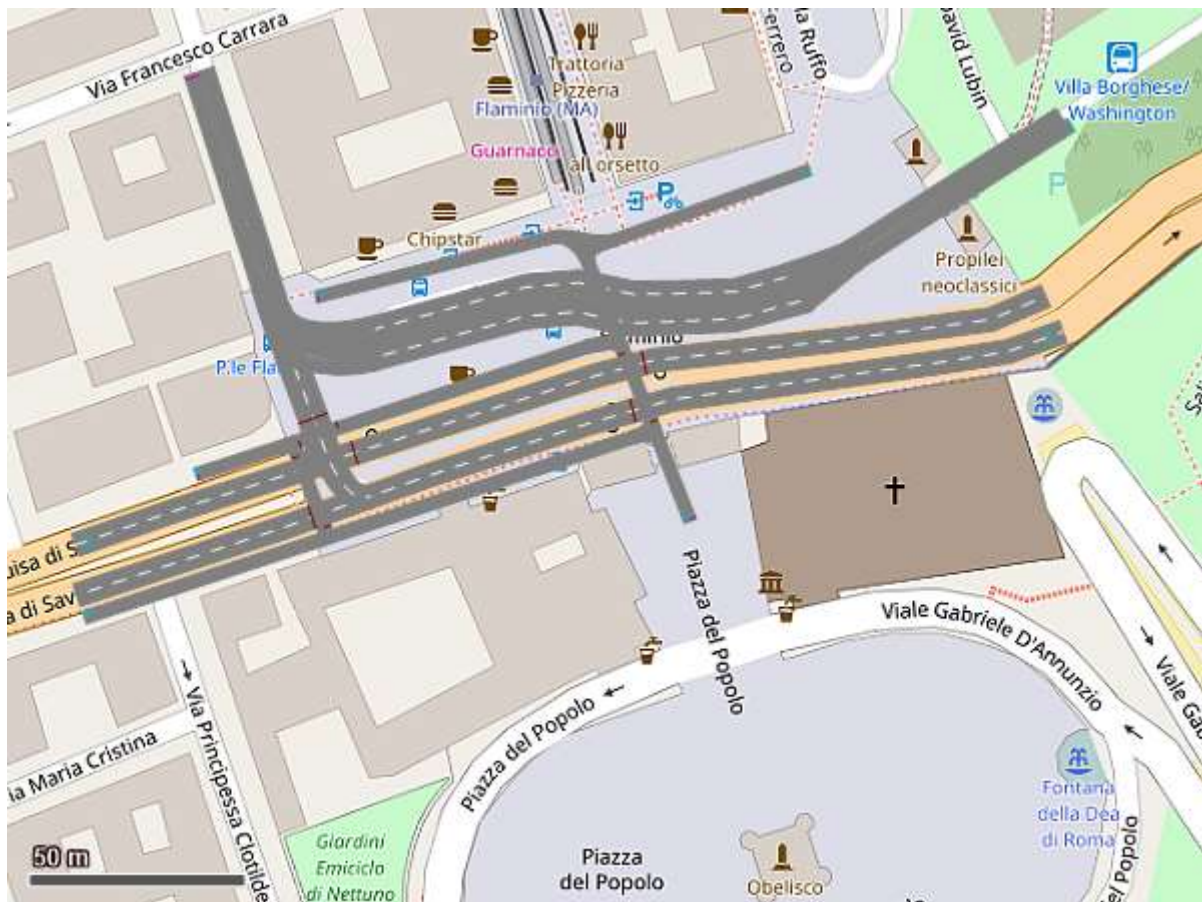
This intersection represents a good possibility to show how bicycle paths should cross tramlines. Italian regulation doesn't provide any guidance for rail crossing. This lack is particularly important. In the urban environment there are numerous trams and LRT trains, which passage can be a danger to users who are cycling. AASHTO guide book spends more than a page to describe how cycle path has to cross railroads. It is important to define the angle of intersection. It varies from 45° to 90° degrees. The first is acceptable, the latter is the most desirable. In this way it is possible to avoid that the wheels of bike slip into the rails. If α is less than 45° an additional paved shoulder of sufficient width should be provided to permit the bicyclist to cross the track at a safer angle, preferably perpendicularly.





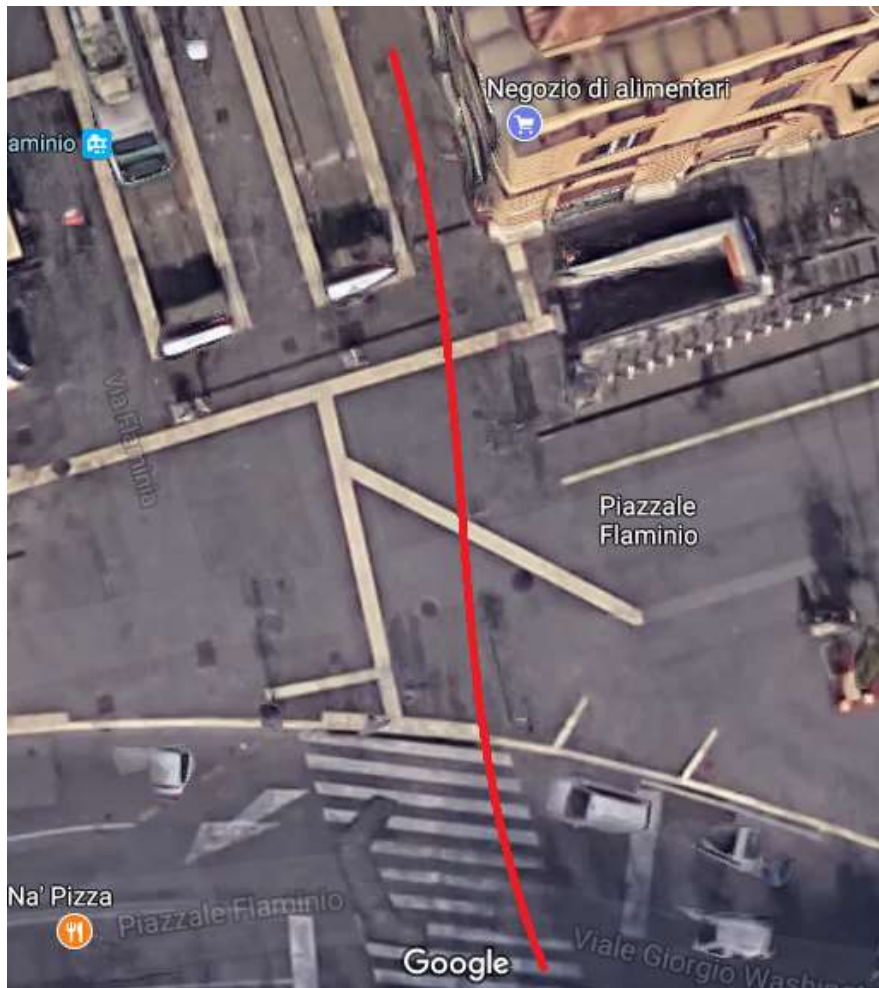
This planimetry represents Northbound of Via Flaminia/Via Belle Arti intersection. The red hat identifies the crossing area of the bicycles. It has been made with an angle of attack greater than 45 ° in such a way as to prevent the wheels of the bike from slipping into the rails.

Piazzale Flaminio intersection



This is the last intersection analysed with PTV Vissim simulator. Right now, only pedestrian and vehicles archs are shows in the planimetry. Simulation is simple because routes are very well defined and conflicts points are reduced to a very low value. As soon as cyclists arrive in Piazzale Flaminio, they fall within a large pedestrian area, which will be provided with a specific lane for bicycles. Surveys on field revealed that cyclists prefer direct link instead of bypass the whole area moving inside the small streets near Piazzale Flaminio. In order to get Piazza della Marina from Piazzale Flaminio cyclists run on the tramway. This is particularly dangerous. For this reason, a bicycle lane on the right sidewalk it is considered as the best possible choice. As the area is particularly congested by pedestrians, it is necessary to define a direct passage for bicycles.

In the picture below, red polyline shows the hypothetical route of cycle lane. This route has been chosen in such a way as not to interfere with alighting and boarding flows of Tram terminus.



Traffic light cycles are defined in the following way:

Via Luisa di Savoia [cars]				
G	Y	R	C	
80	4	42	126	[s]

Via Luisa di Savoia [pedestrian]				
G	Y	R	C	
18	22	86	126	[s]

Viale Giorgio Washington [cars]				
G	Y	R	C	
80	4	42	126	[s]

Viale Giorgio Washington [pedestrian]				
G	Y	R	C	
18	22	86	126	[s]

This set of phases regards the first node directly connected with Piazza del Popolo gate.

Via Luisa di Savoia [cars]			
G	Y	R	C
80	4	42	126

[s]

Via Luisa di Savoia [pedestrian]			
G	Y	R	C
18	22	86	126

[s]

Via Giambattista Vico [cars]			
G	Y	R	C
36	4	86	126

[s]

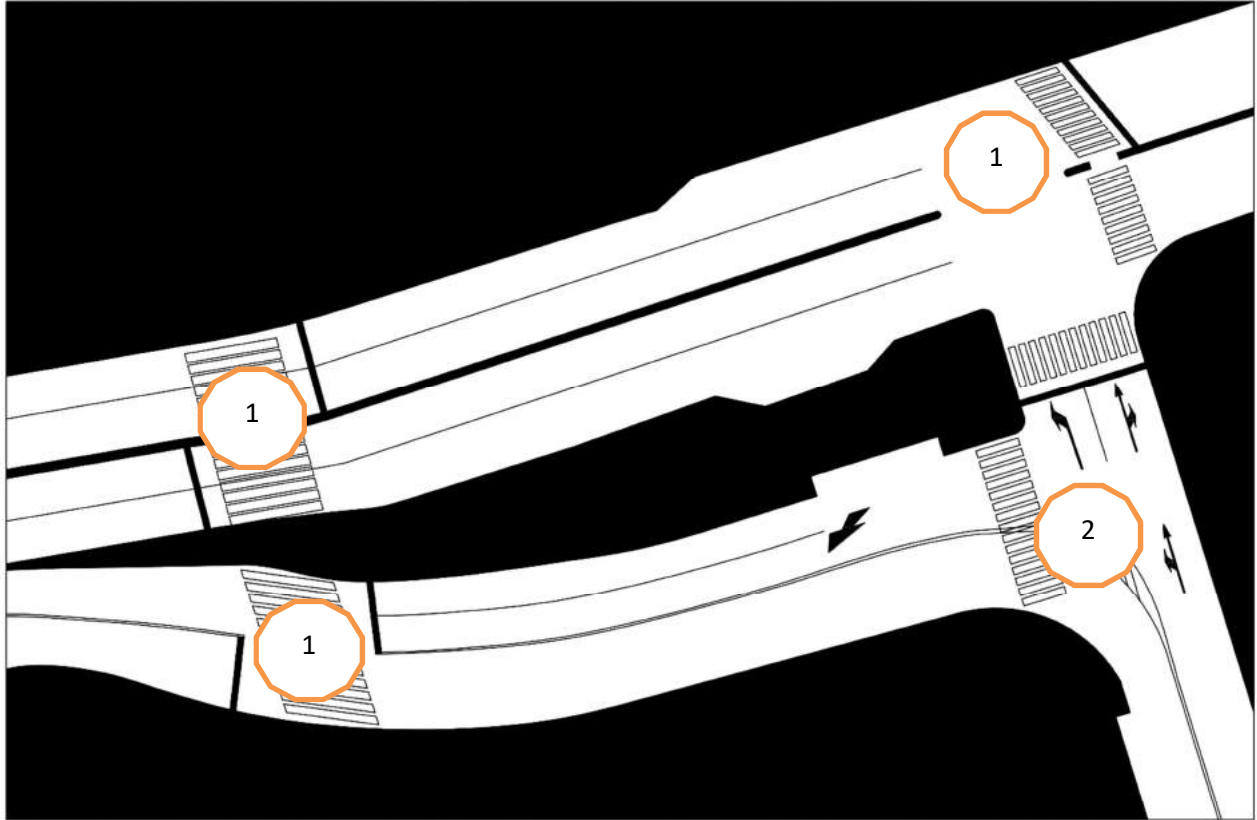
Via Giambattista Vico [pedestrian]			
G	Y	R	C
73	12	41	126

[s]

Via Giambattista Vico			
	Turning left	Turning right	
Cars	312	168	Veh/h
Moped	96	84	Veh/h
Vans	7	8	Veh/h
Heavy V.	12	15	Veh/h

Via Luisa di Savoia [from Piazza Fiume]			Via Luisa di Savoia (fast-track)[from Piazza Fiume]		
Cars	1260	Veh/h	Cars	180	Veh/h
Moped	660	Veh/h	Moped	0	Veh/h
Vans	24	Veh/h	Vans	0	Veh/h
Heavy V	11	Veh/h	HCV	132	Veh/h

Via Luisa di Savoia [from LungoTevere]			Via Luisa di Savoia (fast-track)[from Piazza Fiume]		
Cars	1452	Veh/h	Cars	132	Veh/h
Moped	756	Veh/h	Moped	0	Veh/h
Vans	72	Veh/h	Vans	0	Veh/h
Heavy V	20	Veh/h	HCV	156	Veh/h



This intersection is particularly simple. It is divided into two phases:

1. Phase n°1: Cars running along Via Luisa di Savoia in both direction and Bus running on the protected lane.
2. Phase n°2: Cars coming from Via Giambattista Vico can only turn on Via Luisa di Savoia (both direction)

<i>SIMRUN</i>	<i>TIMEINT</i>	<i>MOVEMENT</i>	<i>QLENMAX</i>	<i>VEHS(ALL)</i>	<i>EM. CO</i>	<i>EM. NOX</i>	<i>EM. VOC</i>	<i>FUEL CONS</i>
1	0-100	1-Along Via Luisa di Savoia to Piazza Fiume	33.07	34	8.526	1.659	1.976	0.122
1	0-100	1-Along Via Luisa di Savoia to LungoTevere	12.47	33	10.72	2.086	2.485	0.153
1	0-100	1-From Via G.Vico to Piazza Fiume	83.03	0	0	0	0	0
1	0-100	1-From Via G.Vico to LungoTevere	83.03	1	1.826	0.355	0.423	0.026
1	0-100	1	83.03	68	21.041	4.094	4.876	0.301
1	100-200	1-Along Via Luisa di Savoia to Piazza Fiume	62.22	60	35.533	6.913	8.235	0.508
1	100-200	1-Along Via Luisa di Savoia to LungoTevere	80.84	45	35.248	6.858	8.169	0.504
1	100-200	1-From Via G.Vico to Piazza Fiume	89.48	10	19.817	3.856	4.593	0.284
1	100-200	1-From Via G.Vico to LungoTevere	89.48	8	4.243	0.825	0.983	0.061
1	100-200	1	89.48	123	94.957	18.475	22.007	1.358
1	200-300	1-Along Via Luisa di Savoia to Piazza Fiume	62.25	40	33.353	6.489	7.73	0.477
1	200-300	1-Along Via Luisa di Savoia to LungoTevere	99.26	45	40.22	7.825	9.321	0.575
1	200-300	1-From Via G.Vico to Piazza Fiume	83.57	15	27.908	5.43	6.468	0.399
1	200-300	1-From Via G.Vico to LungoTevere	83.57	7	8.049	1.566	1.865	0.115
1	200-300	1	99.26	107	109.626	21.329	25.407	1.568
1	300-400	1-Along Via Luisa di Savoia to Piazza Fiume	62.16	36	17.284	3.363	4.006	0.247
1	300-400	1-Along Via Luisa di Savoia to LungoTevere	52.42	30	18.574	3.614	4.305	0.266
1	300-400	1-From Via G.Vico to Piazza Fiume	81.89	15	30.841	6.001	7.148	0.441
1	300-400	1-From Via G.Vico to LungoTevere	81.89	5	5.974	1.162	1.385	0.085
1	300-400	1	81.89	86	72.684	14.142	16.845	1.04
1	400-500	1-Along Via Luisa di Savoia to Piazza Fiume	58.27	36	28.155	5.478	6.525	0.403
1	400-500	1-Along Via Luisa di Savoia to LungoTevere	44.5	26	9.558	1.86	2.215	0.137
1	400-500	1-From Via G.Vico to Piazza Fiume	89.69	0	0	0	0	0
1	400-500	1-From Via G.Vico to LungoTevere	89.69	5	8.155	1.587	1.89	0.117
1	400-500	1	89.69	67	45.785	8.908	10.611	0.655
1	500-600	1-Along Via Luisa di Savoia to Piazza Fiume	57.05	72	45.098	8.774	10.452	0.645
1	500-600	1-Along Via Luisa di Savoia to LungoTevere	68.72	56	35.52	6.911	8.232	0.508
1	500-600	1-From Via G.Vico to Piazza Fiume	84.86	12	24.342	4.736	5.642	0.348
1	500-600	1-From Via G.Vico to LungoTevere	84.86	3	2.254	0.439	0.522	0.032
1	500-600	1	84.86	143	106.843	20.788	24.762	1.529

As it is possible to observe in the table above, the situation is a bit congested, especially for cars and heavy vehicles coming from Via G.Vico. Users who want to move on the fast track of Piazzale Flaminio have to wait for queue dissolving. The next scenario involves the passage of the bicycle lane. In order to get understandable results, pedestrian flow and cyclist flow are separated. Bicycle traffic is set on 100 veh/h. Even if there is a fair amount of bicycle traffic within the area, it is not possible to determine the exact destination of each user. For this reason it is considered only the flow of users that moves along Via Flaminia. This volume is less than 100 veh/h, but in the near future, following the completion of the route, an increase in traffic is expected. The planimetry below shows the possible itinerary of cycle lane inside Piazzale Flaminio. Only this case is shown because no other alternative can be analysed in order to get the shortest route.



SIMRUN	TIMEINT	MOVEMENT	QLENMAX	VEHS(ALL)	EM. CO	EM. NOX	EM. VOC	FUEL CONS.
2	0-100	1-Along Via Luisa di Savoia to Piazza Fiume	33.07	34	9.075	1.766	2.103	0.13
2	0-100	1-Along Via Luisa di Savoia to LungoTevere	18.63	34	10.918	2.124	2.53	0.156
2	0-100	1-From Via G.Vico to Piazza Fiume	89.09	0	0	0	0	0
2	0-100	1-From Via G.Vico to LungoTevere	89.09	1	1.607	0.313	0.372	0.023
2	0-100	1	89.09	69	23.433	4.559	5.431	0.335
2	100-200	1-Along Via Luisa di Savoia to Piazza Fiume	62.22	60	35.812	6.968	8.3	0.512
2	100-200	1-Along Via Luisa di Savoia to LungoTevere	82.24	45	31.29	6.088	7.252	0.448
2	100-200	1-From Via G.Vico to Piazza Fiume	88.93	9	19.352	3.765	4.485	0.277
2	100-200	1-From Via G.Vico to LungoTevere	88.93	7	3.972	0.773	0.921	0.057
2	100-200	1	88.93	121	118.819	23.118	27.537	1.7
2	200-300	1-Along Via Luisa di Savoia to Piazza Fiume	62.25	47	31.112	6.053	7.211	0.445
2	200-300	1-Along Via Luisa di Savoia to LungoTevere	76.21	44	37.924	7.379	8.789	0.543
2	200-300	1-From Via G.Vico to Piazza Fiume	86.36	7	17.461	3.397	4.047	0.25
2	200-300	1-From Via G.Vico to LungoTevere	86.36	4	8.638	1.681	2.002	0.124
2	200-300	1	86.36	102	154.323	30.026	35.766	2.208
2	300-400	1-Along Via Luisa di Savoia to Piazza Fiume	62.16	34	23.7	4.611	5.493	0.339
2	300-400	1-Along Via Luisa di Savoia to LungoTevere	94.89	36	24.832	4.831	5.755	0.355
2	300-400	1-From Via G.Vico to Piazza Fiume	84.13	9	37.719	7.339	8.742	0.54
2	300-400	1-From Via G.Vico to LungoTevere	84.13	3	12.357	2.404	2.864	0.177
2	300-400	1	94.89	82	160.518	31.231	37.202	2.296
2	400-500	1-Along Via Luisa di Savoia to Piazza Fiume	60.03	27	12.324	2.398	2.856	0.176
2	400-500	1-Along Via Luisa di Savoia to LungoTevere	44.13	44	23.8	4.631	5.516	0.34
2	400-500	1-From Via G.Vico to Piazza Fiume	83.26	0	0	0	0	0
2	400-500	1-From Via G.Vico to LungoTevere	83.26	6	16.715	3.252	3.874	0.239
2	400-500	1	83.26	77	111.512	21.696	25.844	1.595
2	500-600	1-Along Via Luisa di Savoia to Piazza Fiume	57.85	72	47.741	9.289	11.064	0.683
2	500-600	1-Along Via Luisa di Savoia to LungoTevere	75.84	49	32.649	6.352	7.567	0.467
2	500-600	1-From Via G.Vico to Piazza Fiume	85.09	14	31.801	6.187	7.37	0.455
2	500-600	1-From Via G.Vico to LungoTevere	85.09	1	1.923	0.374	0.446	0.028
2	500-600	1	85.09	136	148.557	28.904	34.43	2.125

Final results are very similar to the previous simulation. This scenario does not seem to be more congested than the previous one. Minimal variations are due to the stochastic behavior of cars.

CHAPTER 5

"CONCLUSIONS"

This thesis work is aimed at improving the Italian technical regulation for building cycle lanes, as has been emphasized several times. The Spanish, Danish and American regulations are accompanied by a lot of technical details that suit the cycle path to any kind of need, defining the dimensions for the different types of itinerary: lane, shared lane and protected route.

There is no such approach in Italy. This lack makes designer work difficult, forcing him not to rely on a single and complete document, such as their Europeans and overseas.

Rome, Capital of Italy, is not equipped with a functional bicycle network. Part of the difficulties are due to its great superficial extension, but above all, lack of maintenance has forced bicycle users to move on alternative routes, sometimes dangerous. For this reason, this work has partially been adapted to international standards. In particular, American legislation spans a wide range of topics, paying attention to flat junctions. The two illustrative examples in the previous chapter allow to guide the designer in defining the route and how it should move among the urban obstacles.

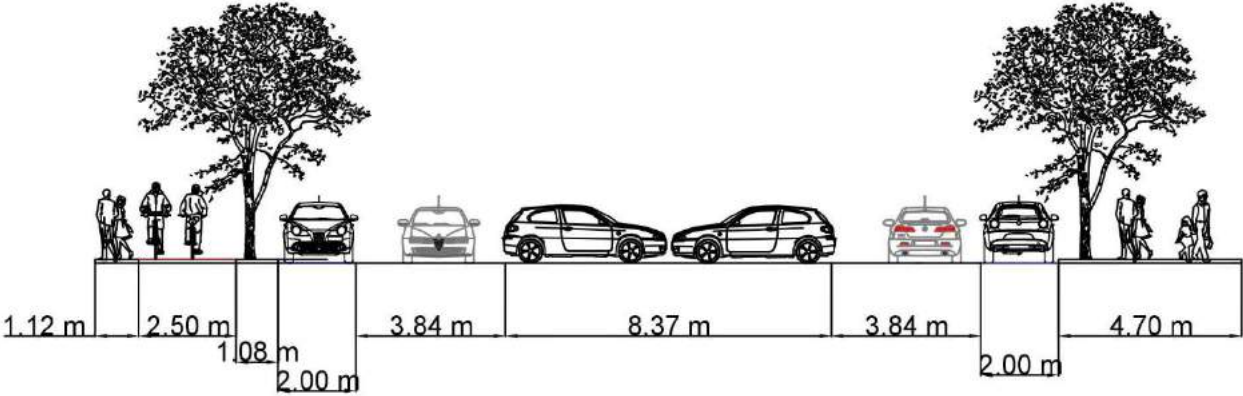
Trams, buses, cars and pedestrians are the obstacles to be avoided and if it is not possible, there must be a certain space margin that allows each type of user to move in total safety. This path has the characteristic of maintaining the bond of continuity. The cyclist may not descend from his saddle, throughout the whole trail. Obviously, the value of $\frac{100 \text{ bicycles}}{\text{hou}}$ is hypothetical and precisely for this reason the balance between the flow of bicycles and the flow of motor vehicles, clearly superior, is maintained.

However, this choice should not mislead the reader, as a substantial reduction in vehicular traffic would bring significant benefits, both economically (lower costs for the private vehicle) and environmental (consequent reduction of pollution). Combining measures for bicycles and public transport can reduce the use of private vehicles. The city of Amsterdam demonstrates how this joint venture is particularly effective: good air quality, reduced traffic congestion rate and punctuality of public transport.

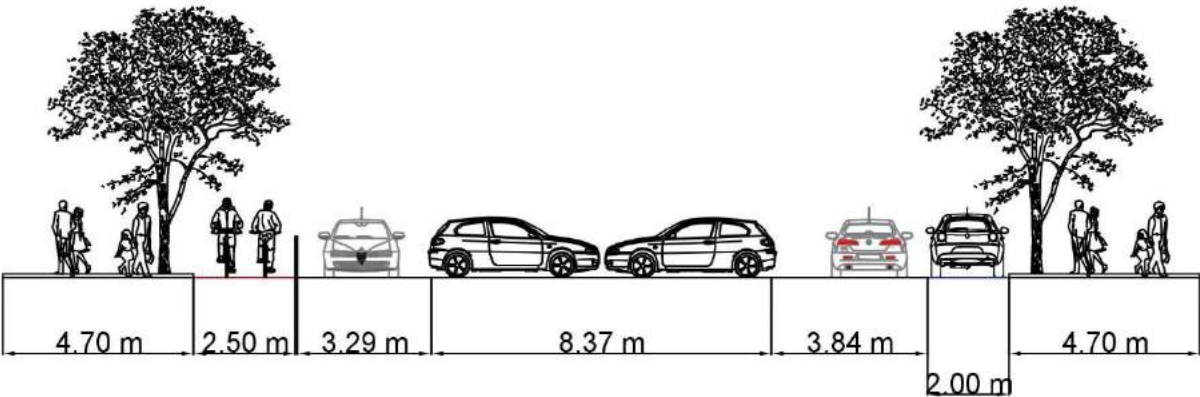
Finally, the whole itinerary is set in the picture below, taken from GOOGLE EARTH. For each number is associated the correct transversal section, realized by AUTODESK AUTOCAD. Each measurement is done with TACKLIFE telemeter up to 40 m.



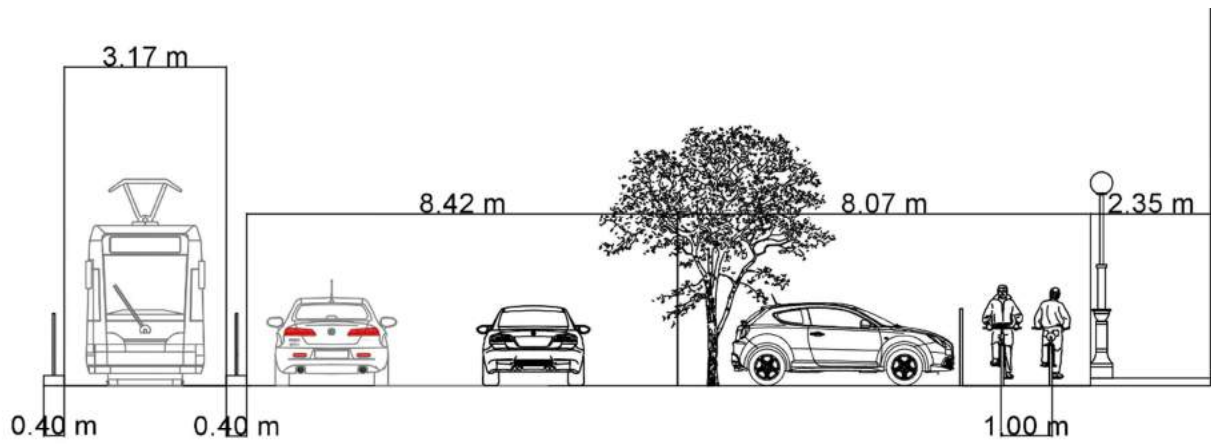
1. Via Guido Reni, upper side.



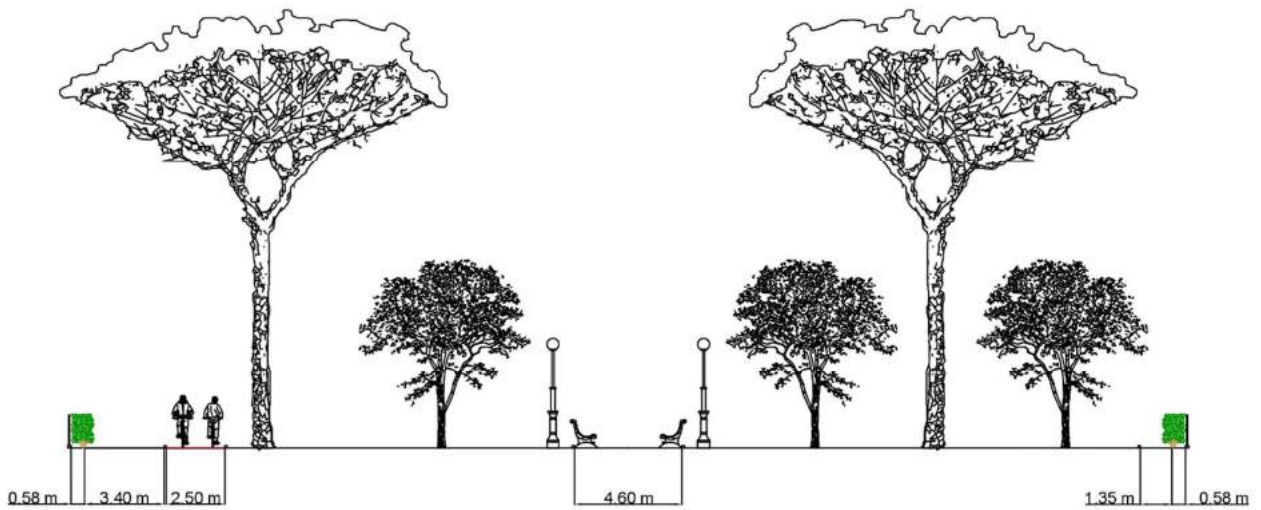
2. Via Guido Reni lower side



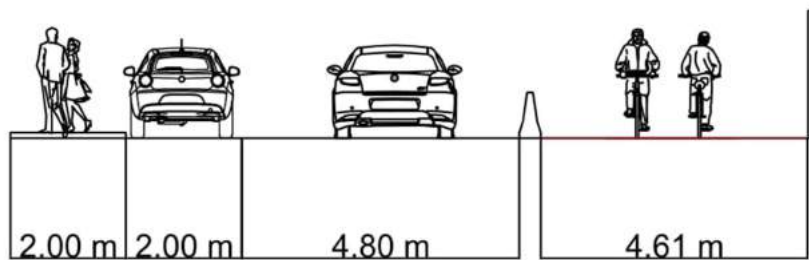
3. Viale Tiziano upper side



4. Parco delle Crocerossine

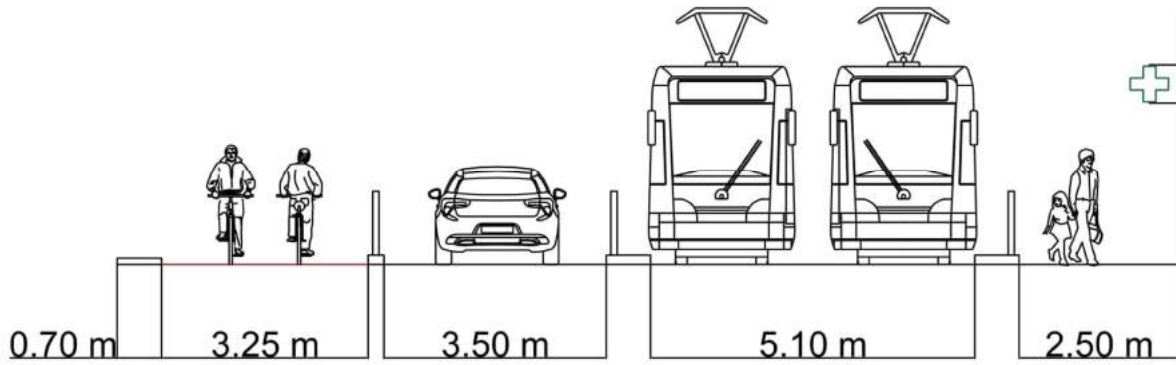


5. Viale Tiziano lower side

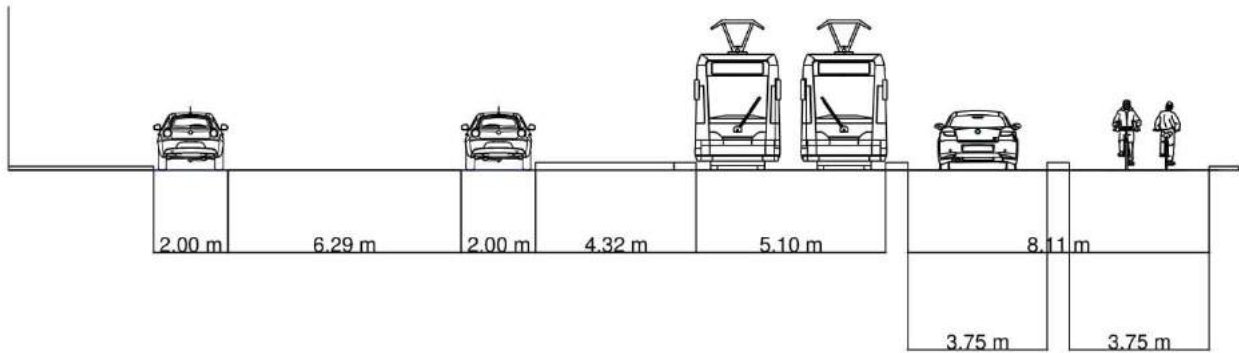


Parco Delle Crocerossine

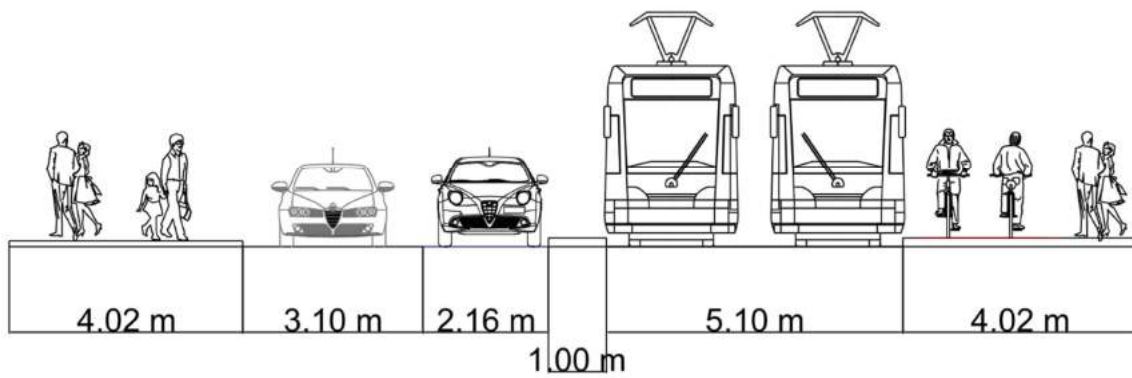
6. Via Flaminia upper side



7. Piazza della Marina



8. Via Flaminia lower side



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