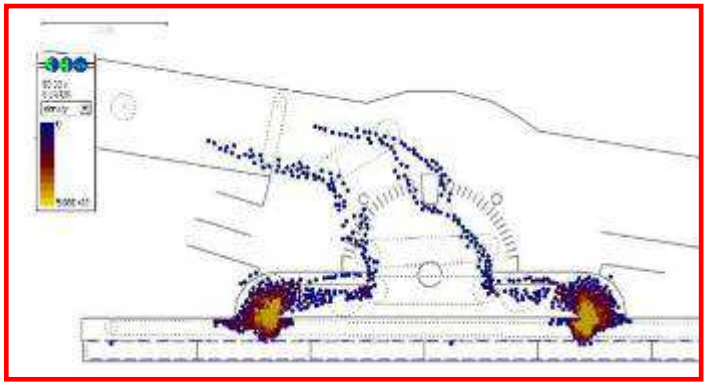
Comune di Venezia

Studio sull'accessibilità alla stazione di Venezia S. Lucia tramite simulazioni modellistiche

Progetto Comunitario "RAILHUC"
Programma CENTRAL EUROPE
Codice Progetto PE11003, CUP F77I11000110004

WP5 – Novembre 2014
Technical report



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COMUNE DI VENEZIA

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1. Methodology

Employed methodology is based on a sequence of operations traditionally used in the analysis of system of mobility. Among these, the most important step is the application of a quantitative model.

The main operations are:

- analysis of supply of transport and its representation within the model (topology of place, systems of transport facilities, signs);
- analysis of demand and its representation within the model (classes of demand, matrixes origin/destination, behaviour parameters);
- reproduction of balance between demand and supply in the actual state and analysis of existing critical issues;
- estimation of balance between demand and supply in the design scenarios and analysis of the results of proposed actions.

In the assessment of congestion of pedestrian places, particularly in this case, is much important to consider aleatory variables inside the system. The analysis refer to the sequent topics:

- variability of timetables of arrival/departure of water-buses, trains and buses that determine concentrations of demand in input or output from the system considered;
- variability of pedestrians' behaviours, particularly of tourist ones.

In the paragraphs that follow are illustrated:

- main methodological steps of the study;
- salient features of used microsimulation model;
- specifications of surveys about demand;
- actual demand estimation (origin/destination matrixes);
- reconstruction of the actual state in the simulation model (scenario 1);
- application of the model to the following design scenarios:
  - scenario 2, opening of a new pedestrian link between railroad station and San Giobbe’s quarter;
  - scenario 3 opening of a new pier in front of Parisi’s Palace;
  - scenario 4, start of a new water service towards the terminal cruises.

2. Characteristics of the simulation model

SimuGENS is a software tool for the simulation of the crowd dynamics, entirely developed by SHRAIL, capable of realistically simulate the behavior of individuals (up to thousands), wall constraints and other typical elements of crowd situations (signs, danger, information, ...).
SimuGENS features a user-friendly graphical interface, which allows a quick setup of the analysis case and offers an immediate visualization of the relevant parameters of the simulation.

SHRAIL.SIMUGENS – Example of simulation of crowd within a subway station

SimuGENS is based on a representation of the individuals of the crowd by means of agents with partial behavior motion model on continuous unstructured space. This approach allows the accurate representation of arbitrary environments, complex barriers and large spaces without the constraints imposed by grid or cells structures.

2.1 Model of representation of supply

The *Simu*GENS model describes spaces as a *continuum,* where pedestrians move cause to following factors:

- destination of trip;
- informations (signs) present/active;
- kinematic features;
- presence of conflictual pedestrians, which disturb the path of simulated walker with their trajectories.

The elements of the simulation are:

POPULATIONS
The crowd is represented by one or more populations of individuals with potentially different characteristics, behaviors, intentions and areas of origin / destination.

INDIVIDUALS
Any person (individual) is represented by a cylindrical volume characterized by mass, speed, handicap or loads moved. Each individual interacts with others by means of non-linear contact forces that are activated below a typical radius, generating a resistance to compression and contributing to the pressure on the individual itself.

WALLS
Individuals are constrained by barriers, which may represent ideal or yielding walls (walls, fences, ropes that can collapse due to pressure) as well as transparent walls (gates, windows, vegetation). Individuals change their behavior as they approach the walls. The walls can be activated / deactivated at arbitrary times during the simulation.

POLES
Individuals are also influenced by attractors or repulsive elements that determine the motion intention; the poles can represent visual cues (signs, lights emergencies, exists) or visible perceived dangers (fire, threats, signs); in this case, the poles are hidden by the walls. The poles can also represent generic goals or directions not directly hidden by the walls (destinations or recorded announcements). The poles can affect one or more populations of individuals. The poles can be permanent or can represent way-points, which become ineffective once reached or crossed by individuals. The poles can be switched on / off at arbitrary times of the simulation.

REGIONS
The regions are areas of the scene that change the behavior of individuals (slowdowns, low visibility etc.). Regions can be also used to assess the characteristics of individuals present during the simulation (number, flow, speed etc.).

CROWD DYNAMICS STUDY
Once the model representing a real situation is setup, SimuGENS evaluates for every time step the interaction between the various elements and calculates the dynamic of the individuals, determining the movement and updating positions.
At every moment, moreover, SimuGENS calculates the states of all the elements, allowing their monitoring and analysis during the simulation, storing them for later post-processing.

VISIBILITY STUDY
SimuGENS allows you to analyze symbols, signals, signs to determine the level of visibility or accessibility by individuals. This analysis can be an important decision support for safety concerns (placement of services, first aid etc..), placement of services (ticket machines, information kiosks etc..) and for the exploitation of commercial areas (lay-out of elements / exhibition areas, enhancement of levels of visibility, etc..).

DISPLAYING 1D (CHARTS)
During the simulation, various charts can display global quantities, such as people flow or presence of individuals within selected areas. This monitoring may also be performed in real time.
It is also possible to select an individual to display the value of its states during the simulation.

2D DISPLAY
The program allows also to display two-dimensional real time maps, with the representation of
- Velocity vectors of individuals
- Parameters of individuals such as pressure, density, speed, distance, travel time, etc
- Trace of the taken path

This representation allows an immediate understanding of the situation and in particular the identification of critical areas, bottlenecks or to highlight particular behaviors of individuals.
The 2D views can be exported in the form of images in the form of digital video.

3D VISUALIZATIONS
The program allows 3D view (virtual reality), rendering simple environments imported from CAD programs. 3D visualization can also run in real time (also based on the performance of the computer). The 3D visualizations can be exported in the form of images or as digital video.
It is also possible to setup a subjective view, following the behavior of a specific individual during the simulation.

IMPORTING CAD data
SimuGENS is able to import the geometry (walls, obstacles) from CAD drawings in DXF format. In addition, the program is able to import 3D data in 3DS format for simulations with 3D visualization.

2.2 Simulated area

The area of interest for this study spans from the San Giobbe university campus to piazzale Roma, with the Santa Lucia railway station in the center. The area includes approximately 50 possible origins/destinations, two main squares and 4000 m of pedestrian paths. These paths include typical Venice streets (i.e. calli, fondamenta, rii and of course bridges) characterized by narrow width and frequent presence of obstacles (for example shop desks and bar tables).

To the purposes of the simulation all the area is essentially plane, with no stacked floors or surfaces and has therefore been represented in SimuGENS in one single layer.

The area, object of simulation, is characterised by:

- access points to and from mainland:
    - gates of railroad station S. Lucia;
    - piazzale Roma including:
        - coach station
        - garage and kiss&ride facilities;
        - station of people mover, linking piazzale Roma with Port of Venice and Tronchetto's island;

- access points to and from old town through navigation services:
    - 3 piers in front of railroad station;
    - 2 piers in fondamenta S.Chiara;

- arteries of pedestrian access to and from old town:
    - arteries towards the quarters of S.Giobbe and Cannaregio;
    - paths towards the quarters of S.Polo and Rialto, using one of sequent bridges: "degli Scalzi", "S.Chiara", "del Prefetto" e "Tre Ponti";
    - artery towards le Zattere area.

- narrow streets ("fondamenta" and "calli") and small squares ("campi") linking mentioned notable points by walk.

Greater critical points for pedestrian outflow are:

- bridges, due the presence of persons with difficult in walking or with luggage, and of tourists that stop for watching urban landscape;

- fondamenta and calli more narrow, particularly in presence of retails;
- ACTV (Venice's operator of public transport) ticket offices and piers to water bus due the long queues of tourist and commuters.

Supply, formed by notable points, fondamenta, calli and campi, is represented within the *Simu*GENS model.

Reproduction of supply comprehends following items:

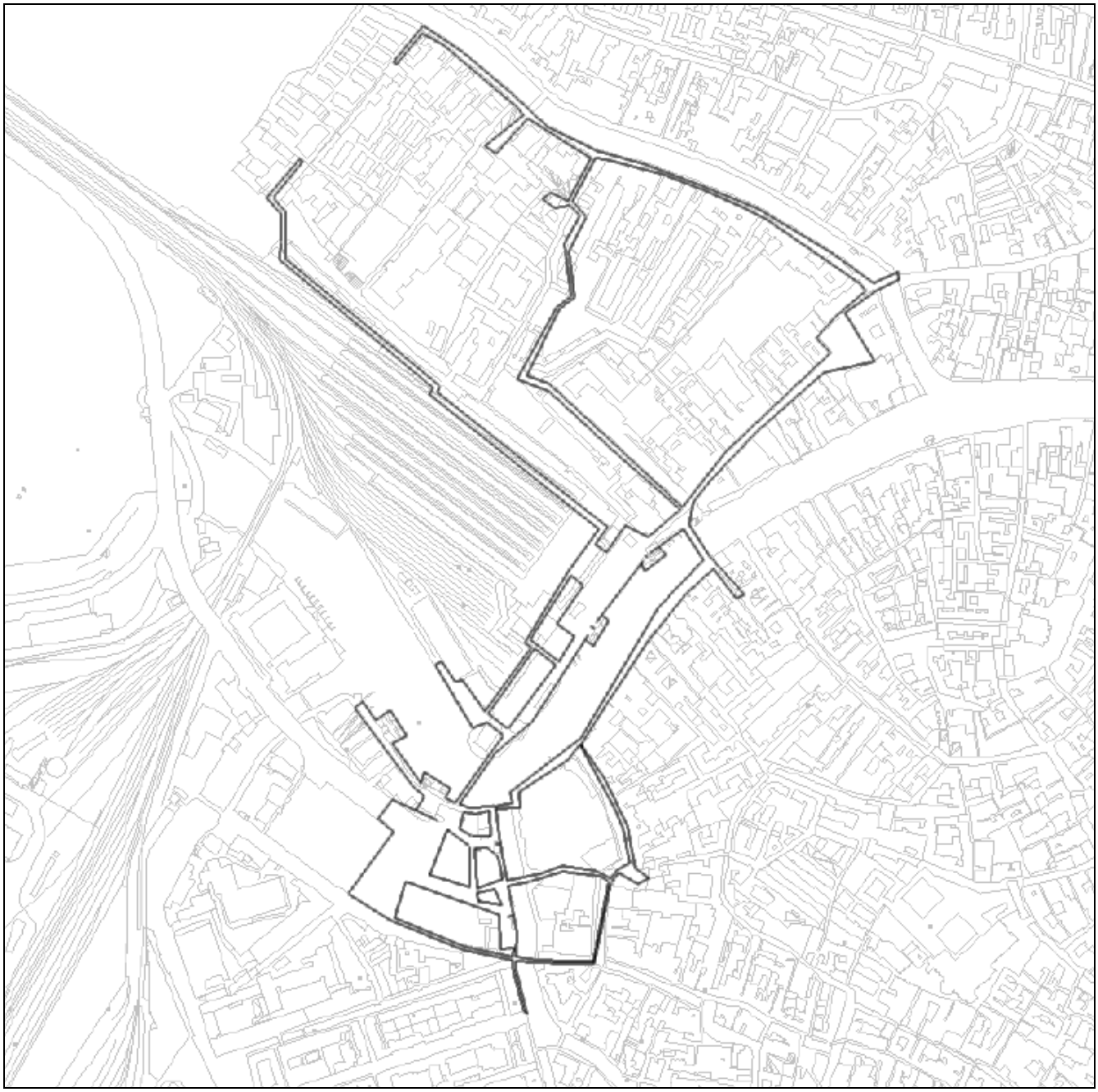
- geometry of pedestrian areas (sections of fondamenta, calli and bridges, extension of big squares and campi);
- obstacles to free outflow;
- level of service of ACTV ticket office (average times to dispose of users);
- timetables of water buses and average times to climb/descent of users.

This area is modeled in SimuGENS by a series of walls representing the physical limits of the streets. These include the contours of the buildings but also the edges of the canals, because the latter are often protected by railings or assumed as not-accessible to the individuals. This assumption is not valid in case of high crowd density: a verification a-posteriori based on the density results is therefore necessary to ensure the validity of the modeling.
The walls define therefore a closed domain which encloses all the individuals from the generation to the conclusion of their path.

Specific features have been considered for the modeling, in particular:

- building walls have been reproduced starting from official cartography, adapting the actual contours to the simulation needs, in particular removing unnecessary features such as small recesses or protrusions;
- canals and small docks have been reproduced as per cartography; smaller docks or basins have been simply represented by wall segments partially obstructing other areas;
- bridges have been represented as simple paths connecting two areas of the domain; on the bridges, a reduction in the maximum speed of the individuals has been considered;
- staircases of the Santa Lucia station have been ignored, as not relevant for the crowd flows.

The model geometry consists of a total of 240 walls, each one potentially affecting the behavior of each individual, if sufficiently close and mowing towards the wall itself.



Delineation of pedestrian areas as well as reproduced in the simulation model

OBSTACLES

A survey of obstacles present on the domain has been performed, collecting positions and dimensions of pillars, shops, working zones, bar tables and trash bins; smaller objects have been ignored whereas elements with dimensions capable to alter the crowd behaviors have been reproduced by means of wall segments or domain narrows.

The modeled obstacles include:

- dehors on fondamenta Tolentini 7.0 x 7.0 m
- kiosk on fondamenta Cossetti 4.5 x 4.5 m
- dehors on fondamenta San Simeone Piccolo 2.0 x 12.0 m
- kiosk on fondamenta San Simeone Piccolo 4.5 x 4.5 m
- kiosk on piazza della stazione 4.5 x 3.5 m
- kiosk on piazza della stazione 4.5 x 3.5 m

- tables on rio Tera' Lista di spagna 6.0 x 2.5 m
- shops displays on rio Tera' Lista di spagna, allowing 4 m
- dehors on campo San Geremia 7.5 x 7.5 m
- dehors on fondamenta Savorgnan 12.0 x 2.0 m
- dehors on fondamenta San Giobbe 10.0 x 3.0 m

2.3 Paths and demand

PATHS

Once created the geometry, the model has been completed by introducing the people.
Starting from a preliminary study of possible origins and destinations (OD), a series of distinct populations has been defined. For each population the model features:

- an origin area, where the individuals are created and introduced in the model;
- a series of spatial instructions, in fact virtual arrows, defining the path to be followed;
- a destination area, where the individuals complete their movement and are removed from the model.

In this way, individuals starting from the same origin can belong to different populations and, once started, will therefore split among different paths, reflecting the real surveys or the flow predictions elaborated for a specific simulation case.
The origins can also represent both constant and broken, periodic crowd flow, in order to simulate for example the arrival of trains or public transportation vehicles.

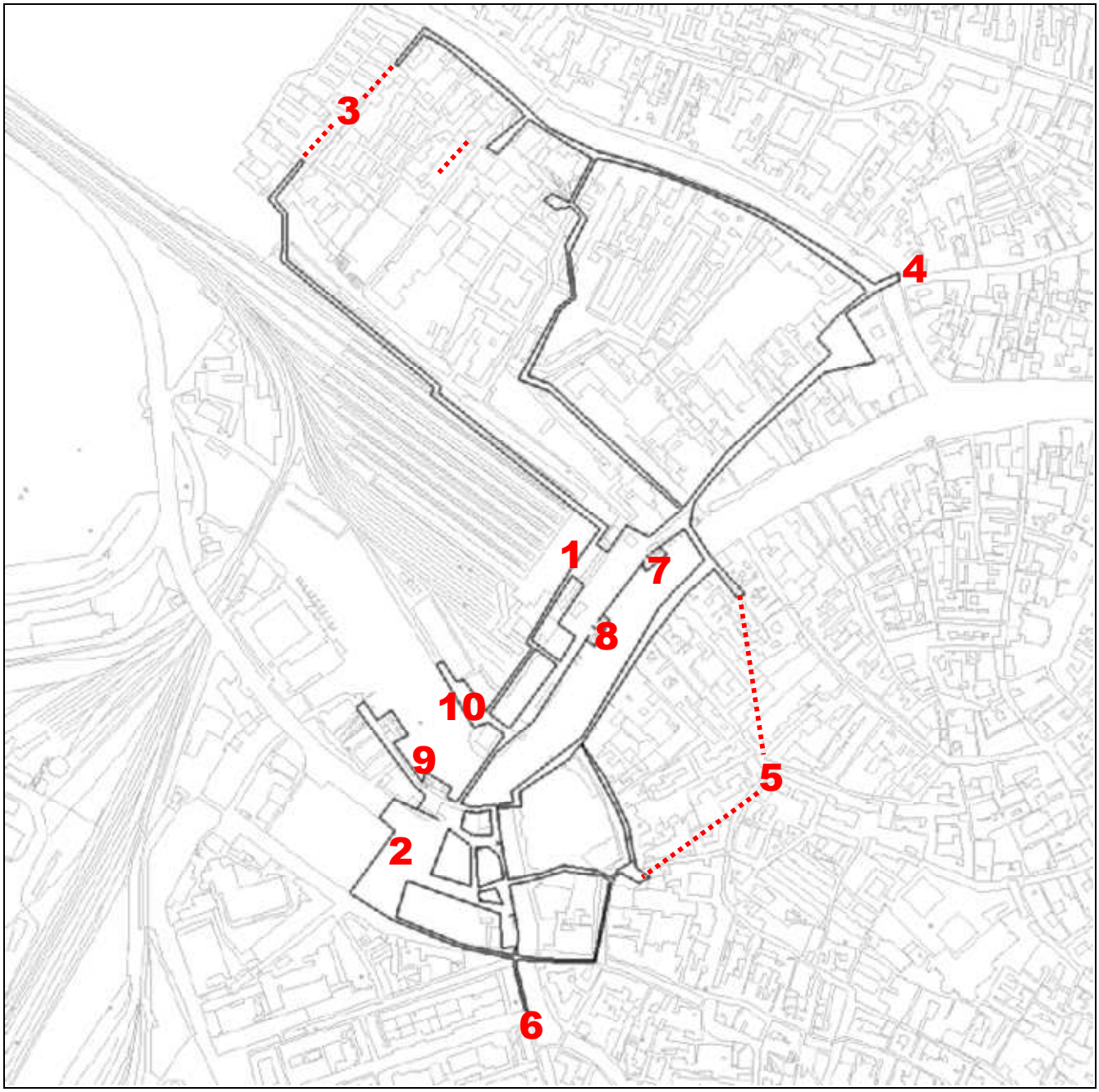
Note that the individuals are affected by the path prescriptions as well as by the other elements of the models like walls and other individuals, like in the reality, so the simulation result is the emerging behavior under this complex series of factors.

The model features approximately 40 populations.

ORIGIN/DESTINATION ZONES

In the model are defined 10 zone of trip's origin and/or destination :

1. railway station S. Lucia
2. Piazzale Roma
3. San Giobbe's quarter (University zone)
4. Cannareggio's quarter
5. San Polo's quarter
6. Le Zattere's quarter
7. piers in front of rail station near "ponte degli Scalzi"
8. piers in front of rail station near Region palace
9. piers in Fondamenta Santa Chiara
10. piers in front of Fondamenta Santa Chiara



Map of the areas of origin and / or destination of pedestrian movements

Obviously the routes to reach, for example, San Polo's (zone number 5) are several; in fact is possible to walk along the path through "Ponte degli Scalzi" (all the more so if you get at Venice by train) or those through "Ponte Santa Chiara" or "Ponte Prefetto" or "Tre Ponti".
Within the model is reproduced statistically distribution of pedestrians through several possible routes, that link the same origin/destination relationship.

DEMAND
The demand data are defined separately for each population.
For each population are indicated:

- the following typological variables
    - zone of origin
    - zone of destination
    - path from origin to destination
- the following quantity

- number of pedestrians generated per hour
- percentage of slow pedestrians
- the generation cycles (variables t1 and t2)

Demand of transport is layered in two main classes of pedestrians:

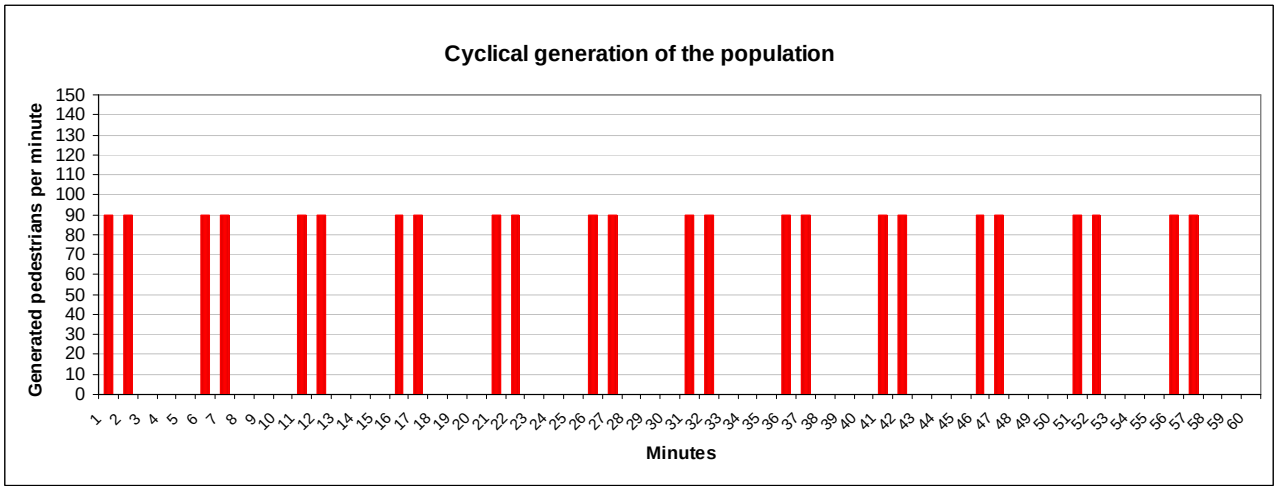
- residents/commuters;
- tourists/visitors or old people.

Residents usually walk faster than tourists and they know better the route to follow; while tourists walk uncertain while viewing urban landscape and reading maps or touristic signage.

The generation cycles are related to the populations which present discontinuities emission.
For example, in the case of the population of pedestrians getting off the trains, the variables t1 and t2 have the following meanings:

- t1 is the duration (in seconds) for the period of spillage of pedestrians from the station,
- t2 is the intermediate medium (in seconds) between the arrival of a train and the next.

In the event of a spill that lasts 2 minutes (t1=120") and intermediate time between arrival of two trains of 5 minutes (t2=300"), the generation of demand follows the trend shown in the graph.



Hourly flow of the population is given by:

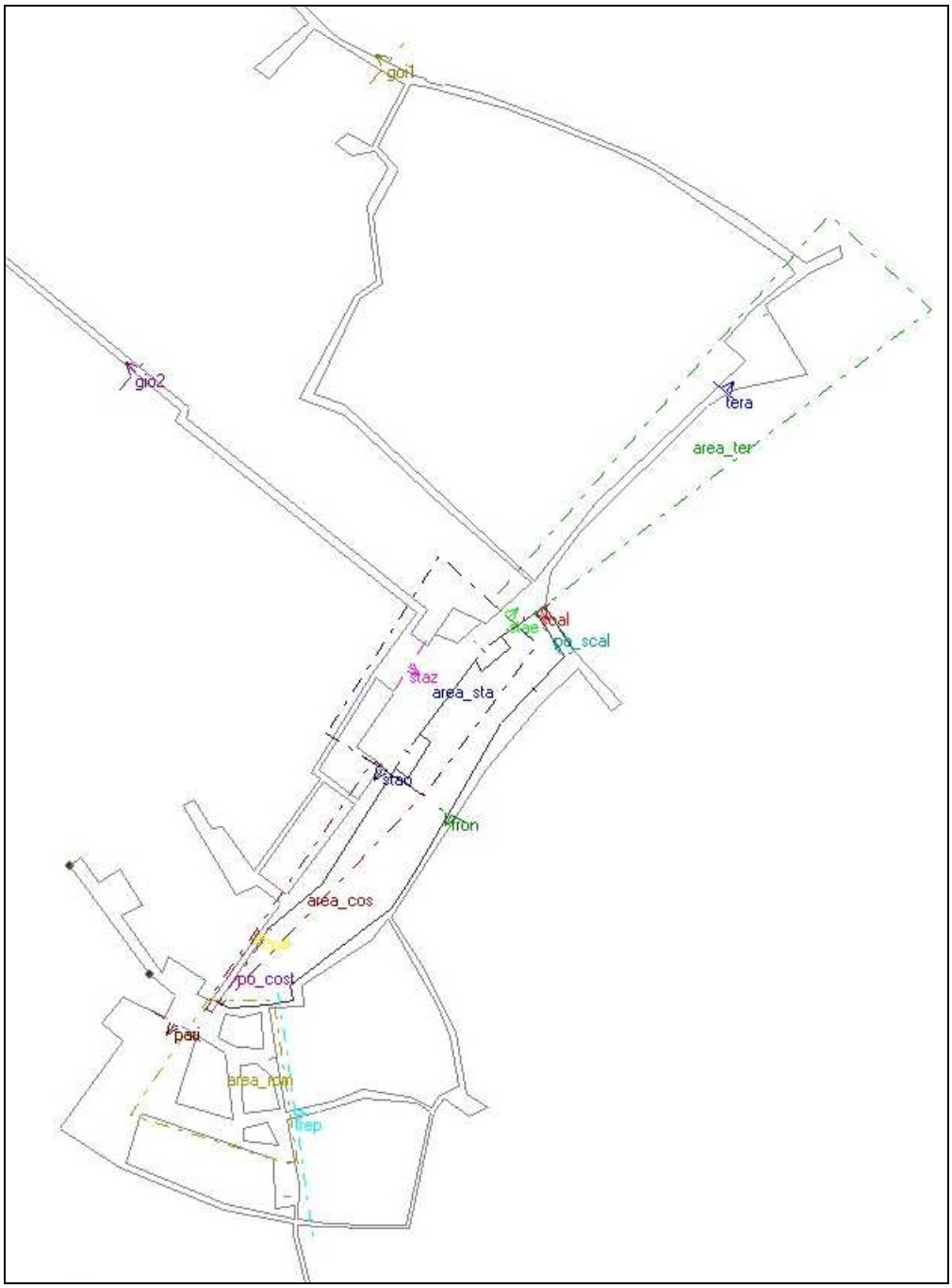
Hourly flow = flow generated per minute * 60 * (t1 / t2) = 90 * 60 * (120/300) = 2.160 p / h

Exceptions are two populations; it comes to pedestrians who are in the square in front of the station and Piazzale Roma and they appear stationary or aimlessly (then moving out only by inertia to make way for pedestrians in motion).
These pedestrians are generated at the beginning of the simulation.

REGIONS
The model has been also completed with a series of regions where, during the simulation, the number of individuals is continuously evaluated.
This evaluation is essential for validation purposes as well as for the extraction of the results.
These regions have been placed in key sections, to focus on flows, or on larger areas, to monitor their occupancy in the different scenarios.

The main regions are listed below:

- TERA section on rio Terà Lista di Spagna
- SCAL section on ponte degli Scalzi
- STAE section between S.Lucia station and ponte degli Scalzi
- STAZ section on S.Lucia station main gate
- STAO section between S.Lucia station and ponte della Costituzione
- COST section on ponte della Costituzione
- TREP section on Tre Ponti (together)
- AREA_TER area of rio Terà Lista di Spagna
- AREA_STA S.Lucia station square
- AREA_COS area between S.Lucia station square and ponte Costituzione
- AREA_ROM area of piazzale Roma



Map of regions

2.4 Performance specifications of the model

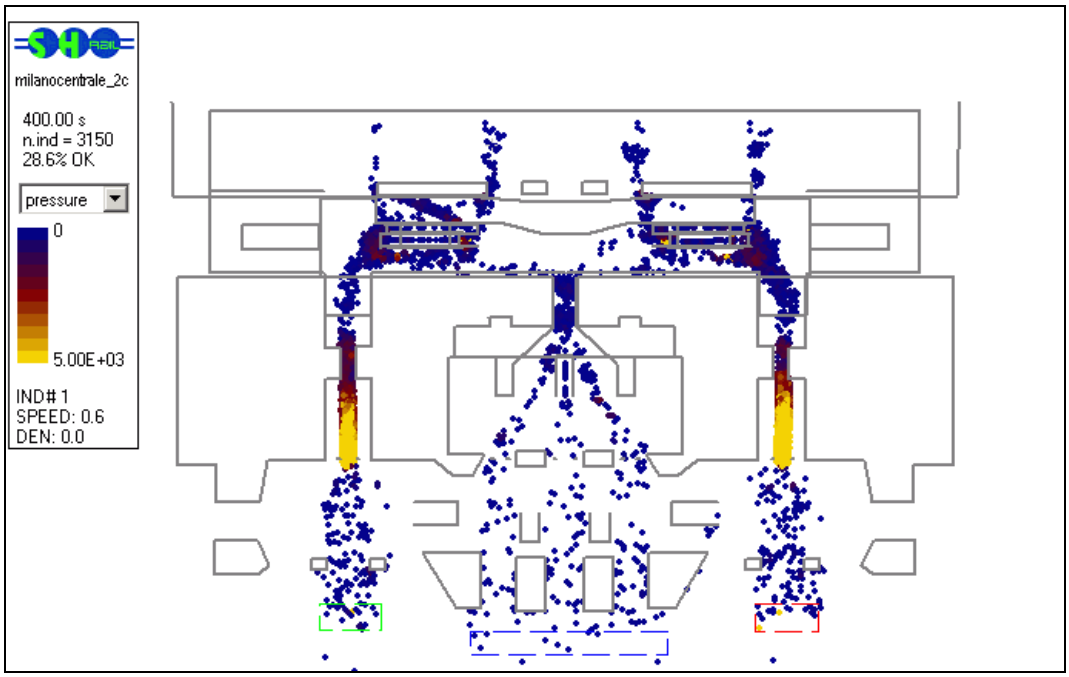
Simulation concerns a period of 2 thousand seconds (about half an hour) within the peak hour of the morning; in this situation the flow from mainland direct to old town is prevalent.
Because there are paths of the order of 1,500 meters of extension, a first period (of less than 1000 seconds) is used to charge the net and lead to regime the state of congestion of pedestrian areas.
For this reason, indicators are calculated as mean values within a subperiod from 1,000 to 2,000 seconds.
For each scenario, the indicators are the average estimates from two different versions of the model.

2.5 Evaluation of criticality

Analysis of planned simulations underlines possible problems of pedestrian access/movement within the interest area, as:

- zone of concentration of dangerous or not normal crowd;
- decay of level of service through paths and significant sections;
- rise of travel times.

These situations, in addition to indicators that represent crowd dynamics, let to evaluate several alternatives. Moreover these ratings may provide advices useful for improving pedestrian paths, services, signs.



SHRAIL.SIMUGENS – Simulation's example of crowd within Milan's main railroad station

3. Demand estimation

Demand is statistically rebuilt (origin/destination and class) based on available surveys and on those will be planned (as write on the technical supply report)

Available surveys will be processed as follow:

- an analysis of deseasonalization, since sources come from different periods of year;
- an analysis of time trends of demand, in order to find the peak range of the morning (time slot that will be surveyed and simulated).

Planned surveys will focus on follow aspects:

- update of oldest informations
- layering of demand into main classes mentioned above;
- queuing at ACTV ticket offices and at piers;
- rising of states of congestion along bridges and calli.

Demand, built as described, is included within the *SimuGENS model.*

The next step is the validation of the reference state of model. Particular attention will be paid at checking of probabilistic reproduction of queues and of congestion states of pedestrian flow.

3.1 Available data on pedestrian flows

Available datas about pedestrian flows are numerous and detailed.
Neverthless, it is appropriate to perform some additional surveys; such investigations focus on these aspects:

- update of oldest informations;
- layering of demand into main classes mentioned above;
- queuing at ACTV ticket offices and at piers;
- rising of states of congestion along bridges and calli.

3.2 Update of pedestrian's traffic demand based on new surveys

On 18th September 2014 a new surveying of pedestrian's traffic was carried out by Polinomia, during the period between 7:45 am and 9:15 am.

In particular the following surveys were carried out:

1. counting of pedestrian passages across sections located in the north side and south side of station's square (sections coded S1 and P1 in the drawing provided by City of Venice). This counting classifies pedestrians according to the following categories:
    a) residents/commuters;
    b) tourists/visitors, pedestrians with problems in moving and pedestrians with bulky loads or with baby carriage.

2. on the most frequented pier among those located in front of railroad station (coded as S4 in the drawing provided by City of Venice) counting of people that are climbing or descending from water buses and amount of person in queue;

3. survey of travel time by walk and of eventual states of slowing-down/stopping along the path between “Ponte delle Guglie” and “Ponte del Prefetto”.

Path surveyed

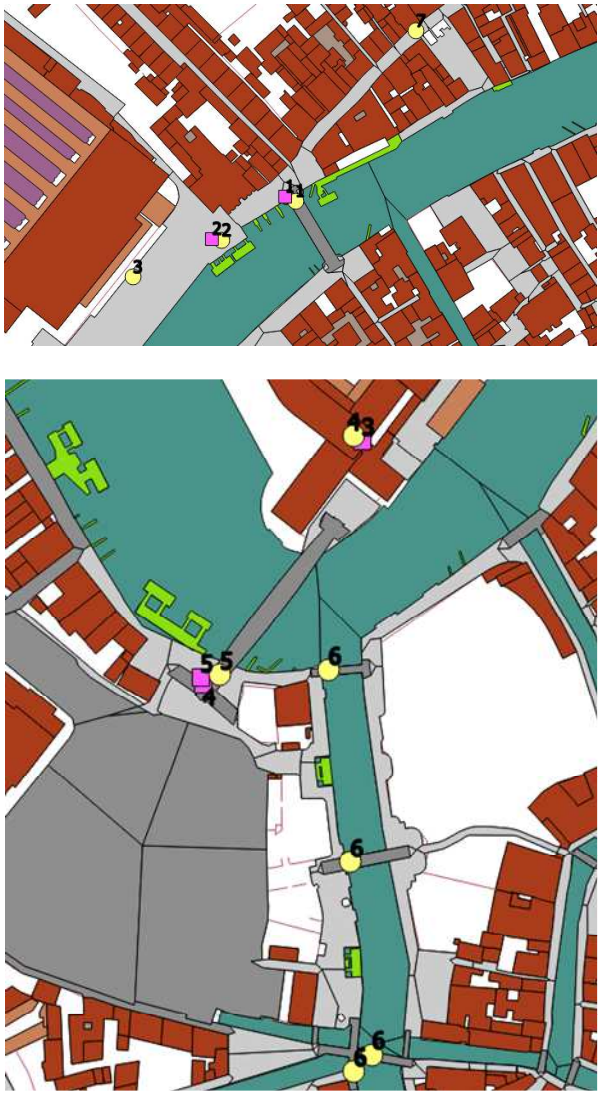
The survey was take:

- during a day with offices and schools open;
- during the peak range of morning (period of 90 minutes) detected on the base of available surveys;
- counting mentioned at point 1 will take place changing the direction of travel surveyed every 5 minutes;
- one person equipped with GPS recorder will perform the counting mentioned at point 3; these detectors severally and repeatedly will go across the route indicated.

SECTIONS

The sections controlled by an attendant and / or by a camera are the following:

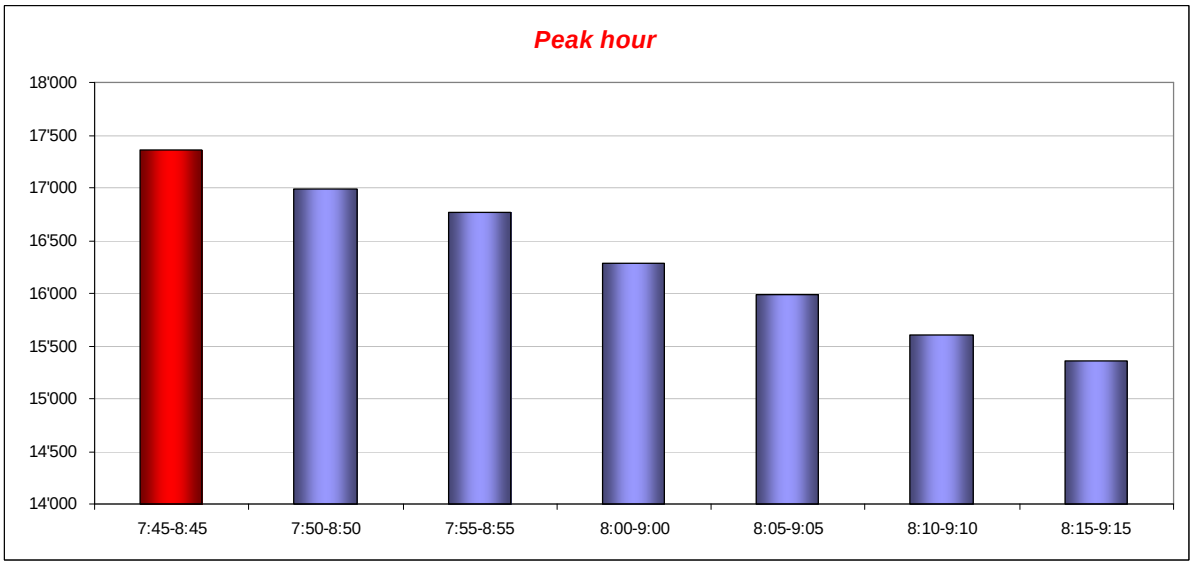
1) Ponte degli Scalzi, 1 man and 1 camera;
2) S. Lucia piers east, 1 man and 1 camera;
3) S.Lucia station main gate 1 man;
4) S. Lucia station secondary gate, 1 man and 1 camera;
5) Ponte della Costituzione, 1 man and 2 cameras;
6) Ponte S.Chiara, Ponte del Prefetto and Treponti,1 man.
7) Path between Ponte del Prefetto and Ponte delle Guglie, 1 man with gps.



Sections of surveying

3.3 Results of surveys

The analysis of the flows of pedestrians showed that the peak time is between 7:45 and 8:45.



The following tables show the results of the findings section by section.

Section 1 - Ponte degli Scalzi

From S.Lucia station										
To Ponte degli Scalzi			*To Lista di Spagna*			*To Cavalletti*			*S.Lucia station*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
902	98	1'000	not avab.	not avab.	1'931			1'568	4'499	981
From Scalzi's bridge										
To S.Lucia station			*To Lista di Spagna*			*To Cavalletti*			*Ponte degli Scalzi*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
109	60	169	132	134	266	0	0	0	435	1'197
From Lista di Spagna										
To S.Lucia station			*To Ponte degli Scalzi*			*To Cavalletti*			*Lista di Spagna*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
not avab.	not avab.	602	85	112	197	0	0	0	799	2'197
From Cavalletti										
To S.Lucia station			*To Ponte degli Scalzi*			*To Lista di Spagna*			*Cavalletti*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
not avab.	not avab.	210	0	0	0	0	0	0	210	1'568

Section 2 - S.Lucia piers east

From pier		
To S.Lucia station		
Fast	Slow	Tot
not avab.	not avab.	83

Section 3 - S. Lucia station main gate

From S.Lucia station						
West side			*East side*			*Main gate*
Fast	Slow	Tot	Fast	Slow	Tot	Outgoing
1'666	341	2'007	974	26	1'000	3'007
To S.Lucia station						
West side			*East side*			*Main gate*
Fast	Slow	Tot	Fast	Slow	Tot	Ingoing
170	219	389	293	120	413	802

Section 4 - S. Lucia station secondary gate

From Secondary gate							
To Ponte della Costituzione			*To Fondamenta S.Lucia*			*Secondary gate*	
Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
not avab.	not avab.	1'064	39	1	0	1'064	89
From Ponte della Costituzione							
To Secondary gate			*To Fondamenta S.Lucia*			*Ponte della Costituzione*	
Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
not avab.	not avab.	82	not avab.	not avab.	1'809	1'891	2'240
From Fondamenta S.Lucia							
To Ponte della Costituzione			*To Secondary gate*			*Fondamenta S.Lucia*	
Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
not avab.	not avab.	1'176	7	0	7	1'183	1'809

Section 5 - Ponte della Costituzione

From Ponte della Costituzione										
To Roma piers			*To Roma west side*			*To Roma south side*			*Ponte della Costituzione*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
65	12	77	1'005	195	1'200	921	217	1'138	2'415	1'855
From Roma piers										
To Ponte della Costituzione			*To Roma west side*			*To Roma south side*			*Roma piers*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
67	3	70	351	209	560	240	83	323	953	2'292
From Roma west side										
To Ponte della Costituzione			*To Roma piers*			*To Roma south side*			*Roma west side*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
365	140	505	1'400	74	1'474	not avab.	not avab.	not avab.	1'979	1'760
From Roma south side										
To Ponte della Costituzione			*To Roma piers*			*To Roma west side*			*Roma south side*	
Fast	Slow	Tot	Fast	Slow	Tot	Fast	Slow	Tot	Origins	Destinations
1'145	135	1'280	669	72	741	not avab.	not avab.	not avab.	2'021	1'461

Section 6 - Bridges between Roma and centre

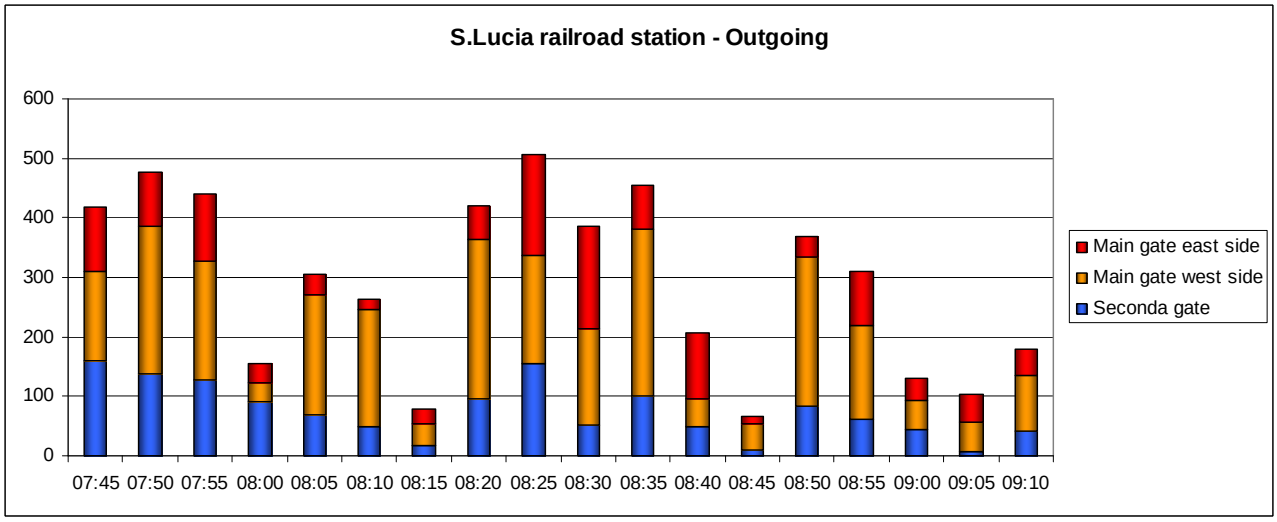
Ponte S.Chiara					
From Roma			*To Roma*		
Fast	Slow	Tot	Fast	Slow	Tot
131	10	141	84	52	136
Ponte del Prefetto					
From Roma			*To Roma*		
Fast	Slow	Tot	Fast	Slow	Tot
1'291	89	1'380	381	366	747
Treponti - S.Croce side					
From Roma			*To Roma*		
Fast	Slow	Tot	Fast	Slow	Tot
970	80	1'050	238	55	293
Treponti - Zattere side					
From Roma			*To Roma*		
Fast	Slow	Tot	Fast	Slow	Tot
1'936	427	2'363	613	476	1'089

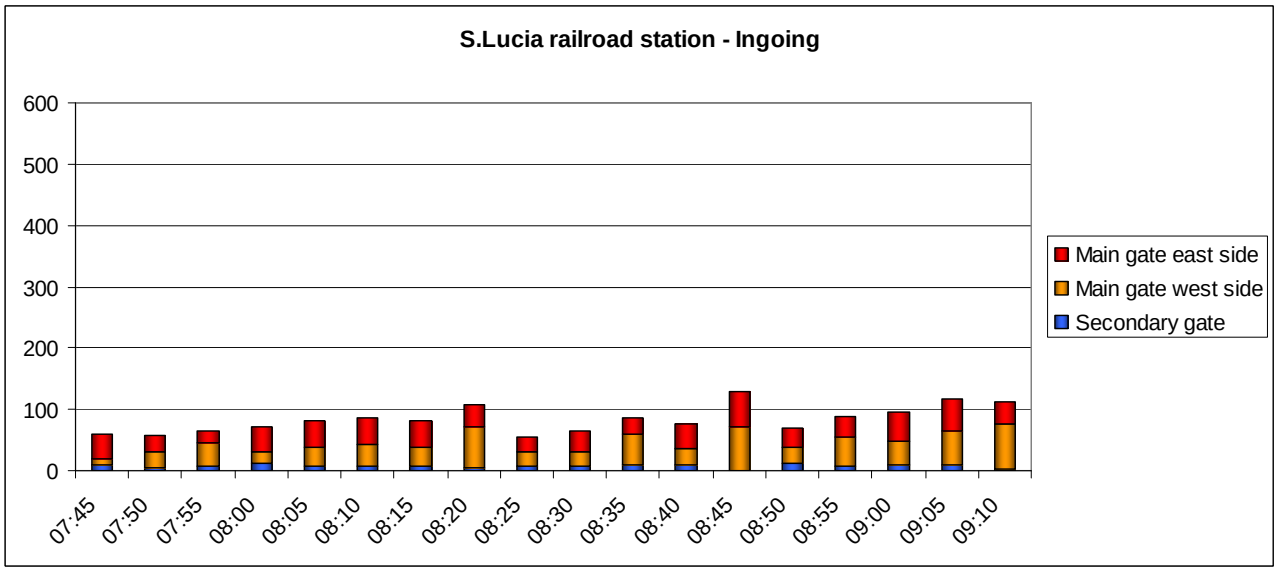
			1		3		5		AVG 1,3
From	*To*	*Dist (m)*	*Time*	*Speed (km/h)*	*Time*	*Speed (km/h)*	*Time*	*Speed (km/h)*	*Speed (km/h)*
Prefetto	Prefetto II	40	00:00:26	5,5	00:00:31	4,6	00:00:27	5,3	5,1
Prefetto II	Costitution	107	00:01:12	5,4	00:01:14	5,2	00:01:01	6,3	5,3
Costitution	Secondary entrance	120	00:01:32	4,7	00:01:42	4,2	00:01:25	5,1	4,5
Secondary en	S.Lucia station	202	00:02:02	6,0	00:01:49	6,7	00:01:41	7,2	6,3
S.Lucia statio	Scalzi	97	00:00:53	6,6	00:00:56	6,2	00:00:50	7,0	6,4
Scalzi	Guglie I	340	00:03:26	5,9	00:03:18	6,2	00:03:08	6,5	6,1
Guglie I	Guglie II	34	00:00:40	3,1	00:00:36	3,4	00:00:30	4,1	3,2
	Tot	**940**	**0:10:11**	**5,5**	**0:10:06**	**5,6**	**0:09:02**	**6,2**	**5,6**

			2		4		6		AVG 2,4
From	*To*	*Dist (m)*	*Time*	*Speed (km/h)*	*Time*	*Speed (km/h)*	*Time*	*Speed (km/h)*	*Speed (km/h)*
Guglie II	Guglie I	34	00:00:40	3,1	00:00:33	3,7	00:00:28	4,4	3,4
Guglie I	Scalzi	340	00:03:04	6,7	00:03:14	6,3	00:03:02	6,7	6,5
Scalzi	S.Lucia station	97	00:00:56	6,2	00:00:57	6,1	00:00:48	7,3	6,2
S.Lucia statio	Secondary entrance	202	00:02:05	5,8	00:02:01	6,0	00:01:50	6,6	5,9
Secondary en	Costitution	120	00:01:45	4,1	00:01:32	4,7	00:01:15	5,8	4,4
Costitution	Prefetto II	107	00:01:02	6,2	00:01:08	5,7	00:00:58	6,6	5,9
Prefetto II	Prefetto	40	00:00:32	4,5	00:00:31	4,6	00:00:25	5,8	4,6
	Tot	**940**	**0:10:04**	**5,6**	**0:09:56**	**5,7**	**0:08:46**	**6,4**	**5,6**

The following charts show the temporal trend of the inputs and outputs towards the railway station.

The secondary gate is used by 33% of travelers leaving the station and by 10% of travelers ingoing.

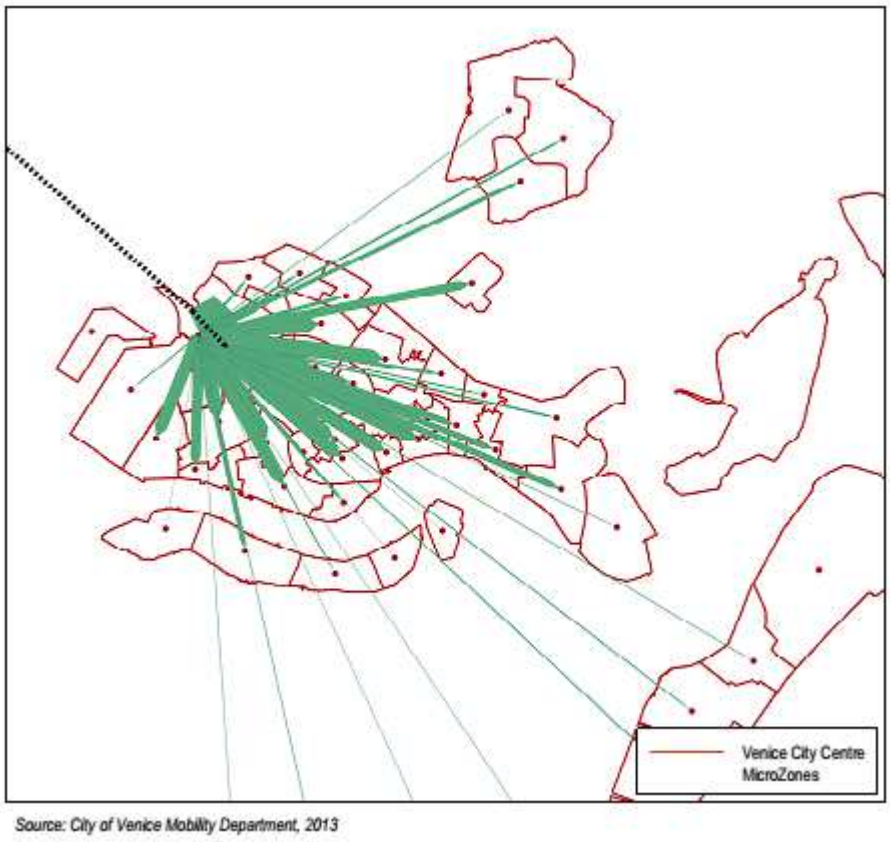




3.4 Pedestrian o/d matrix estimation

The demand of the actual state (peak hour in the morning 7:45-8:45) was estimated mainly based on direct surveys carried out on 18.09.2014.

Some relations have been enough data collected on 18/09, for others we proceeded to contrast with other available data. In particular, to distribute incoming travelers at the station was used the matrix of destinations within the city produced by the Mobility Department refers to a working day of February 2013.



Distribution of incoming travelers

The data provided by ACTV for two days on 18 and 19 September, were used to estimate the number of travelers from Roma and S.Lucia piers.

SCENARIO 1 – ACTUAL STATE

Scenario 1											
	1 S.Lucia station	2 Roma	3 S.Giobbe	4 Cannaregio	5 S.Polo	6 S.Croce	7 Zattere	8 S.Lucia piers west	9 S.Lucia piers east	10 Roma piers	Tot
1 S.Lucia station		209	863	897	1'000	1'050	406	99	220		**4'744**
2 Roma	10		705	1'034	141	1'380	1'861			1'993	**7'124**
3 S.Giobbe	27	183		30							**240**
4 Cannaregio	63	539	60		98	98					**858**
5 S.Polo	169	136		133							**438**
6 S.Croce	293	747		133							**1'173**
7 Zattere	79	788								222	**1'089**
8 S.Lucia piers west	167										**167**
9 S.Lucia piers east	83										**83**
10 Roma piers		787					96				**883**
Tot	**891**	**3'389**	**1'628**	**2'227**	**1'239**	**2'528**	**2'363**	**99**	**220**	**2'215**	**16'799**

The following table shows the percentage of each population for slow pedestrians calculated thanks to the surveys. Next to this data are the variables t1 and t2 that characterize the demand generation.

Origin	Destination	%slow	t1	t2	type
S.Giobbe	Cannaregio	15	0	0	urban
Cannaregio	S.Giobbe	10	0	0	urban
S.Giobbe	Roma	15	0	0	bus departures
Roma	S.Giobbe	5	0	0	bus arrival
S.Giobbe	S. Lucia station	42	0	0	train departures
S. Lucia station	S.Giobbe	12	90	240	train arrival/ commuters
S. Lucia station	Cannaregio	12	150	240	train arrival/ tourists
Cannaregio	S. Lucia station	42	0	0	train departures
Cannaregio	S.Polo	57	0	0	urban
S.Polo	Cannaregio	50	0	0	urban
Cannaregio	S.Croce	57	0	0	urban
S.Croce	Cannaregio	50	0	0	urban
S. Lucia station	S.Polo	12	150	240	train arrival/ tourists
S.Polo	S. Lucia station	42	0	0	train departures
Roma	S.Croce	6	0	0	bus arrival
S.Croce	Roma	49	0	0	bus departures
S. Lucia station	S.Croce	3	90	240	train arrival/ commuters
S.Croce	S. Lucia station	42	0	0	train departures
S. Lucia station	Zattere	12	90	240	train arrival/ commuters
Zattere	S. Lucia station	7	0	0	train departures
Roma piers	Zattere	19	60	600	waterbus arrival
Zattere	Roma piers	47	0	0	urban
Roma	Zattere	19	0	0	bus arrival
Zattere	Roma	47	0	0	bus departures
S. Lucia station	S.Lucia piers east	12	150	240	train arrival/ tourists
S.Lucia piers east	S. Lucia station	42	90	450	waterbus arrival
S. Lucia station	S.Lucia piers west	12	150	240	train arrival/ tourists
S.Lucia piers west	S. Lucia station	42	90	450	waterbus arrival
Roma	Roma piers	2	0	0	bus arrival
Roma piers	Roma	35	60	600	waterbus arrival
Roma	S. Lucia station	7	0	0	bus arrival
S. Lucia station	Roma	12	90	240	train arrival/ commuters
Roma	Cannaregio	3	0	0	bus arrival
Cannaregio	Roma	7	0	0	bus departures
Roma	S.Polo	7	0	0	bus arrival
S.Polo	Roma	38	0	0	bus departures

4. Simulation of the actual state (scenario 1)

4.1 Model validation

PATH CONSISTENCY

Once the model is set up each of the paths has been simulated in order to verify the adequateness of the path indications for the individuals.
This initial test has been performed with one intense single flow of individuals at a time, equal to 10000 pph, to avoid interference from other populations and to stress the capacity of the various paths capacity in terms of persons per hour.
Note that this does not represent a comprehensive evaluation of the capacity of one or more paths, which is out of the scope of this project, but it can be taken as a starting point for other dedicated investigations.

The consistency tests have initially highlighted some minor issues with the paths, in particular where multiple populations are crossing. The model has been therefore modified and the tests have been repeated, showing a correct behavior for all the origin-destination relationships of interest.

In some cases, these tests have produced critical behaviors in some crowded areas. Given the very high flow value that has been used for these tests, these criticalities do not necessary represent a real problem but can be useful to highlight potential issues to be verified in the subsequent analysis with realistic flows.

The results of the consistency tests are reported in annex A.

VALIDATION AGAINST FIELD SURVEY

Validation is based on comparison of the people flow on the 6 sections measured:

1. Ingoing/Outgoing S.Lucia station
2. S.Lucia station/Ponte degli Scalzi
3. Rio Terà Lista di Spagna
4. Ponte degli Scalzi
5. Ponte della Costituzione
6. Roma bridges (Ponte Santa Chiara, Ponte del Prefetto and Treponti)

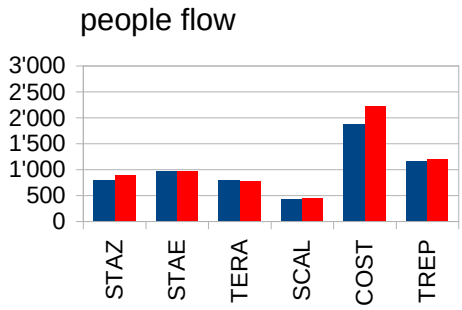
towards the station (ingoing) and towards the outside areas (outgoing)

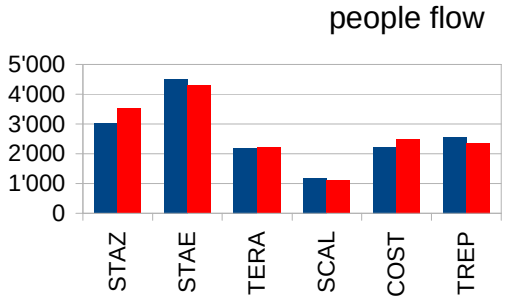
The model has been run with default parameters and also with modified parameters in order to verify if some characteristics need to be adapted for the particular conditions in Venice.
In fact a small reduction in the individuals ideal radius (i.e. a small reduction of the average dimension of an individual) showed to produce better matching of the simulation with the measured values and has therefore been adopted for the baseline model.

The flow results and the path time are showed below: survey is in blue, simulation is in red.

	code	direction	SURVEY	Actual State	direction	SURVEY	Actual State
Ingoing/Outgoing S.Lucia station	STAZ	Ingoing	**802**	**900**	Outgoing	**3'007**	**3'528**
S.Lucia station/Ponte degli Scalzi	STAE	Station	**981**	**976**	Centre	**4'499**	**4'288**
Rio Terà Lista di Spagna	TERA	Station	**799**	**792**	Centre	**2'197**	**2'203**
Ponte degli Scalzi	SCAL	Station	**435**	**446**	Centre	**1'197**	**1'112**
Ponte della Costituzione	COST	Station	**1'891**	**2'221**	Roma	**2'240**	**2'506**
Roma bridges	TREP	Roma	**1'176**	**1'199**	Centre	**2'571**	**2'369**

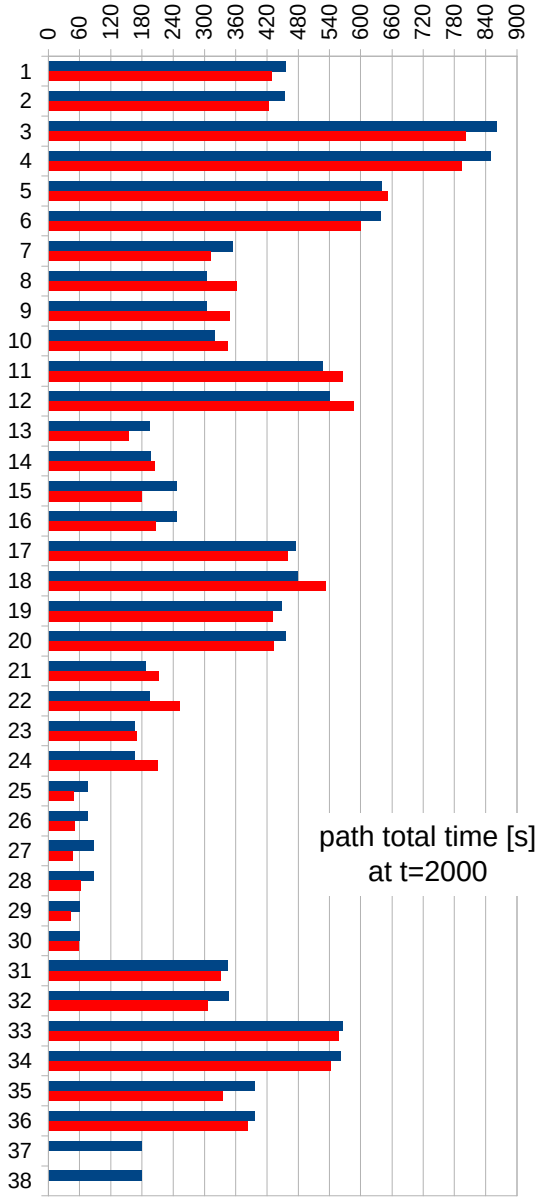
*survey in **blue**, simulation in **red***





	origin	destin.	SURV.	Actual State
1	S.Giobbe	Cannaregio	***457***	**429**
2	Cannaregio	S.Giobbe	***455***	**423**
3	S.Giobbe	Roma	***862***	**803**
4	Roma	S.Giobbe	***851***	**794**
5	S.Giobbe	S.Lucia station	***641***	**652**
6	S.Lucia station	S.Giobbe	***639***	**599**
7	S.Lucia station	Cannaregio	***354***	**312**
8	Cannaregio	S.Lucia station	***305***	**361**
9	Cannaregio	S.Polo	***305***	**348**
10	S.Polo	Cannaregio	***320***	**345**
11	Cannaregio	S.Croce	***527***	**566**
12	S.Croce	Cannaregio	***542***	**586**
13	S.Lucia station	S.Polo	***194***	**156**
14	S.Polo	S.Lucia station	***196***	**205**
15	Roma	S.Croce	***247***	**179**
16	S.Croce	Roma	***247***	**206**
17	S.Lucia station	S.Croce	***475***	**460**
18	S.Croce	S.Lucia station	***479***	**534**
19	S.Lucia station	Zattere	***450***	**430**
20	Zattere	S.Lucia station	***457***	**434**
21	Roma piers	Zattere	***187***	**212**
22	Zattere	Roma piers	***195***	**253**
23	Roma	Zattere	***167***	**171**
24	Zattere	Roma	***167***	**210**
25	S.Lucia station	S.Lucia piers E	***76***	**49**
26	S.Lucia piers E	S.Lucia station	***76***	**50**
27	S.Lucia station	S.Lucia piers W	***88***	**46**
28	S.Lucia piers W	S.Lucia station	***88***	**62**
29	Roma	Roma piers	***60***	**44**
30	Roma piers	Roma	***60***	**58**
31	Roma	S.Lucia station	***345***	**332**
32	S.Lucia station	Roma	***347***	**306**
33	Roma	Cannaregio	***566***	**559**
34	Cannaregio	Roma	***563***	**542**
35	Roma	S.Polo	***397***	**335**
36	S.Polo	Roma	***397***	**384**
37	S.Lucia station	Parisi pier	***180***	**0**
38	Parisi pier	S.Lucia station	***180***	**0**

*survey in **blue**, simulation in **red***



Results show that a general good agreement, with maximum difference of about 10% on flow and of 20% on total times.

Small differences in flow can be attributed to the sampling of the simulation, which has some fluctuations due to the periodic people flow coming from the railway station.

The most important differences on time are for paths 3, 4 and 8, discussed below.

The first two cases, in particular, show that the model people take approximately 100-150 s less than the real case to move from S.Giobbe to Ple Roma. This is in fact the longest path in the simulation, with over 10 minutes walk: while the simulation assumes the same maximum speed during the path, in reality people slow down during the path, taking 20-30% longer than the simulation to complete the path.

Finally, it must be observed that the time has been actually measured only on a part of the paths on a particular period of the survey, while the remaining times have been obtained by extending the measured speeds to the path distances. In the simulation, vice versa, the times are calculated considering all the individuals completing the transfer.

VALIDATION: FINAL REMARKS

The results obtained show that the model is capturing the performance of the crowd measured during the survey. Differences observed are limited to few situations and are explained.
The model can therefore be used for predictions on the analyzed domain.
Where a baseline situation is known, relative results (e.g. the deltas following the change of a constraint or an input) applied to the baseline situation can be used as they will be more reliable than absolute values produced by the simulation.

4.2 Indicators

The following results and indicators are useful to analyze the actual state and design scenarios:

- the transits (pedestrians / h) in seven sections of the pedestrian network;

Section	**Direction**	**Pedestrian flow per hour**	***% difference of flows compared to actual state***	**Direction**	**Pedestrian flow per hour**	***% difference of flows compared to actual state***
Rio Terà	S.Lucia station	792		Cannaregio	2'203	
Ponte degli Scalzi	S.Lucia station	446		San Polo	1'112	
S.Lucia station-Scalzi	S.Lucia station	976		Cannaregio/Scalzi	4'288	
Ingoing/Outgoing station	S.Lucia station	900		Cannaregio/Roma	3'528	
S.Lucia station-Costituzione	S.Lucia station	1'292		Roma	1'958	
Ponte della Costituzione	S.Lucia station	2'221		Roma	2'506	
Roma bridges	Roma	1'199		San Polo	2'369	

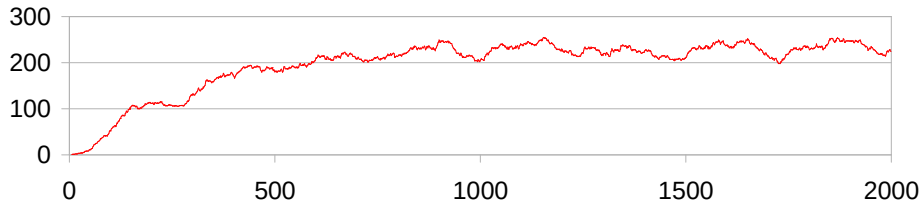
- the average attendant (pedestrians) crossing into four sub-areas;

Subarea	Average pedestrians in the subarea	Pedestrian area of the subarea (m2)	Average density (m2/pedestrian)	*Percentage difference of average density compared to actual state*
To the north of the station	232	5'069	21,8	-
In front of the station	164	6'664	40,6	-
To the south of the station	191	2'128	11,1	-
Roma square	243	5'608	23,1	-

Region:
area_ter

Average Presence:
232

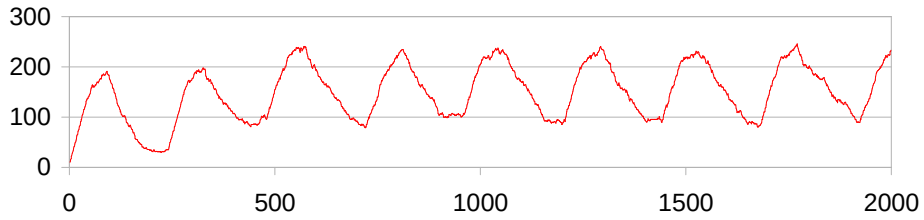
% wrt AS IS
98%



Region:
area_sta

Average Presence:
164

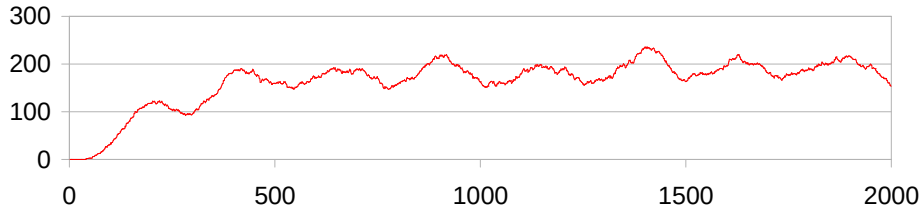
% wrt AS IS
116%



Region:
area_cos

Average Presence:
191

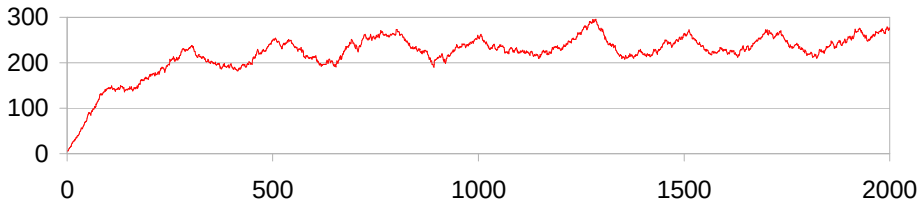
% wrt AS IS
90%



Region:
area_rom

Average Presence:
243

% wrt AS IS
99%

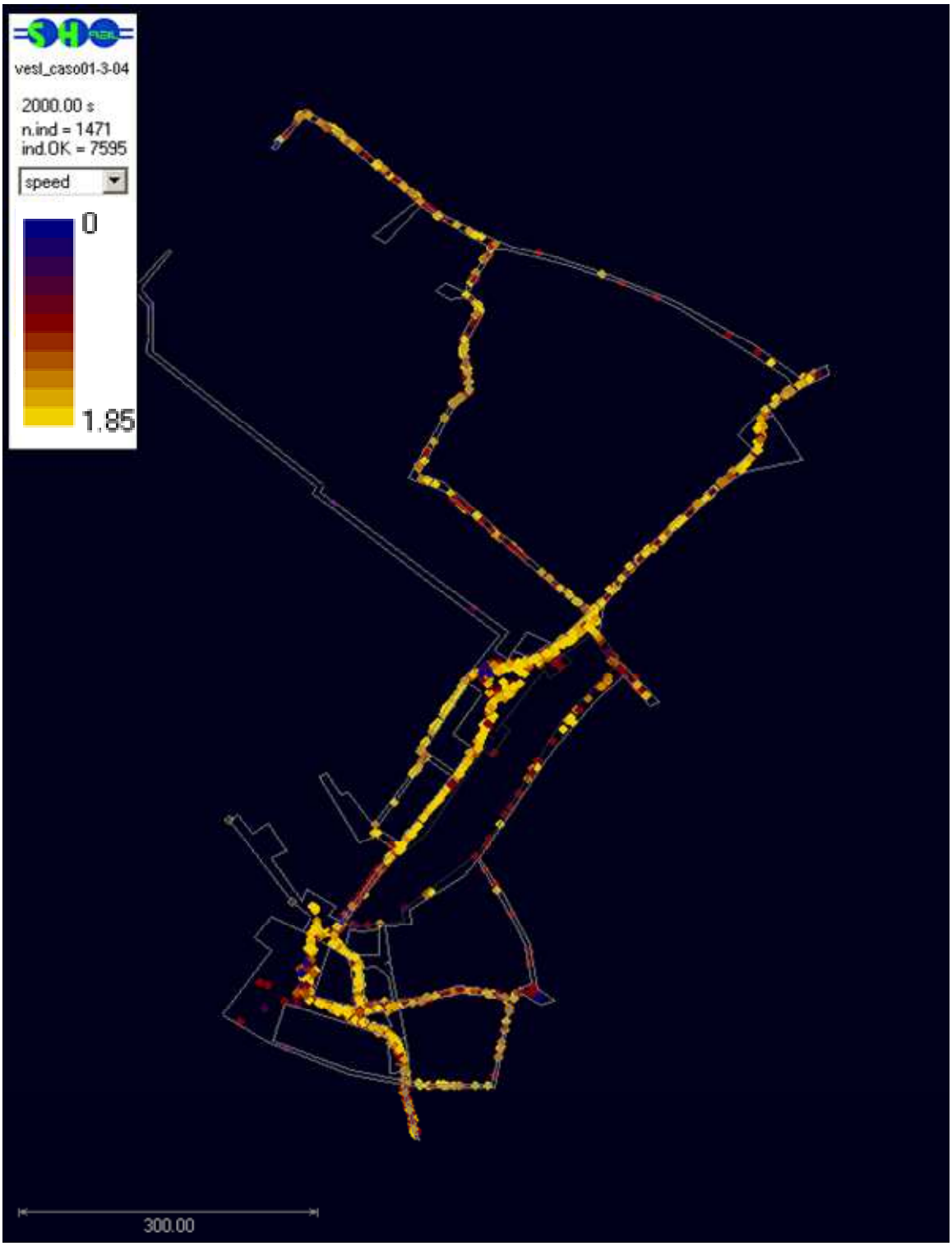


- Total and average journey time; in addtition to the overall values is interesting to read the journey times of the relations which engage most critical sectiocns, and in particolar the following:

    - O/D relations engaging the sub area located north/east of the S.Lucia station, i.e. the relations between piazzale Roma /Railway station and Cannaregio/S.Polo;
    - O/D relations engaging the sub area located south/west of the S.Lucia station, i.e. the relations between Cannaregio/Railway station and piazzale Roma /S.Croce.

Relations	Demand (pedestrians/h)	Total journey time (hh:mm)	Average journey time (mm:ss)	% difference of AJT compared to actual state
All O/D	16'799	1388:27	4:57	
S.Lucia station→Cannaregio	4'765	615:19	7:44	
S.Lucia station←Cannaregio	1'177	167:43	8:32	
S.Lucia station→S.Croce	2'485	337:49	8:09	
S.Lucia station←S.Croce	2'254	391:40	10:25	

- the maps showing speed values of pedestrians, ranged for color levels from 0 (blue) to 1,85 m/s (yellow). This speed is registered at the final moment of simulation (t=2.000 sec.).



5. Design scenarios

Different scenarios have been described and analyzed using the simulation tool.

5.1 Scenario 2 – Direct link between S.Lucia station and San Giobbe

A new direct pedestrian link has been added, along track 1 of railway station, linked to a new bridge on *Rio della Crea* between *Calle del la Beccarie* and *San Giobbe area*.
The new bridge on *Rio della Crea* rebuilds the destroyed *Ponte delle Vacche*.

New route S.Lucisa station-S.Giobbe and Ponte delle Vacche rebuilt

The train passengers direct to San Giobbe area (mostly composed by university students) come out from railway station through the main gate or Calle Carmelitani gate, then turn in *Rio Terrà Lista di Spagna* and in *Calle Priuli* to reach *Fondamenta San Giobbe* along the internal streets.

Scenario's new links reduce the distance between S.Lucia station and *San Giobbe* area. Furthermore reduce the pedestrian jam with link S.Lucia station-*Ponte degli Scalzi*.

The demand for this scenario consists of the same matrix of the actual case.

Section	Direction	Pedestrian flow per hour	*% difference of flows compared to actual state*	Direction	Pedestrian flow per hour	*% difference of flows compared to actual state*
Rio Terà	S.Lucia station	803	*1,4%*	Cannaregio	2'128	*-3,4%*
Ponte degli Scalzi	S.Lucia station	436	*-2,4%*	San Polo	1'116	*0,3%*
S.Lucia station-Scalzi	S.Lucia station	954	*-2,2%*	Cannaregio/Scalzi	3'438	*-19,8%*
Ingoing/Outgoing station	S.Lucia station	1'001	*11,2%*	Cannaregio/Roma	2'700	*-23,5%*
S.Lucia station-Costituzione	S.Lucia station	1'253	*-3,1%*	Roma	1'984	*1,3%*
Ponte della Costituzione	S.Lucia station	2'167	*-2,4%*	Roma	2'430	*-3,0%*
Roma bridges	Roma	1'206	*0,6%*	San Polo	2'477	*4,6%*

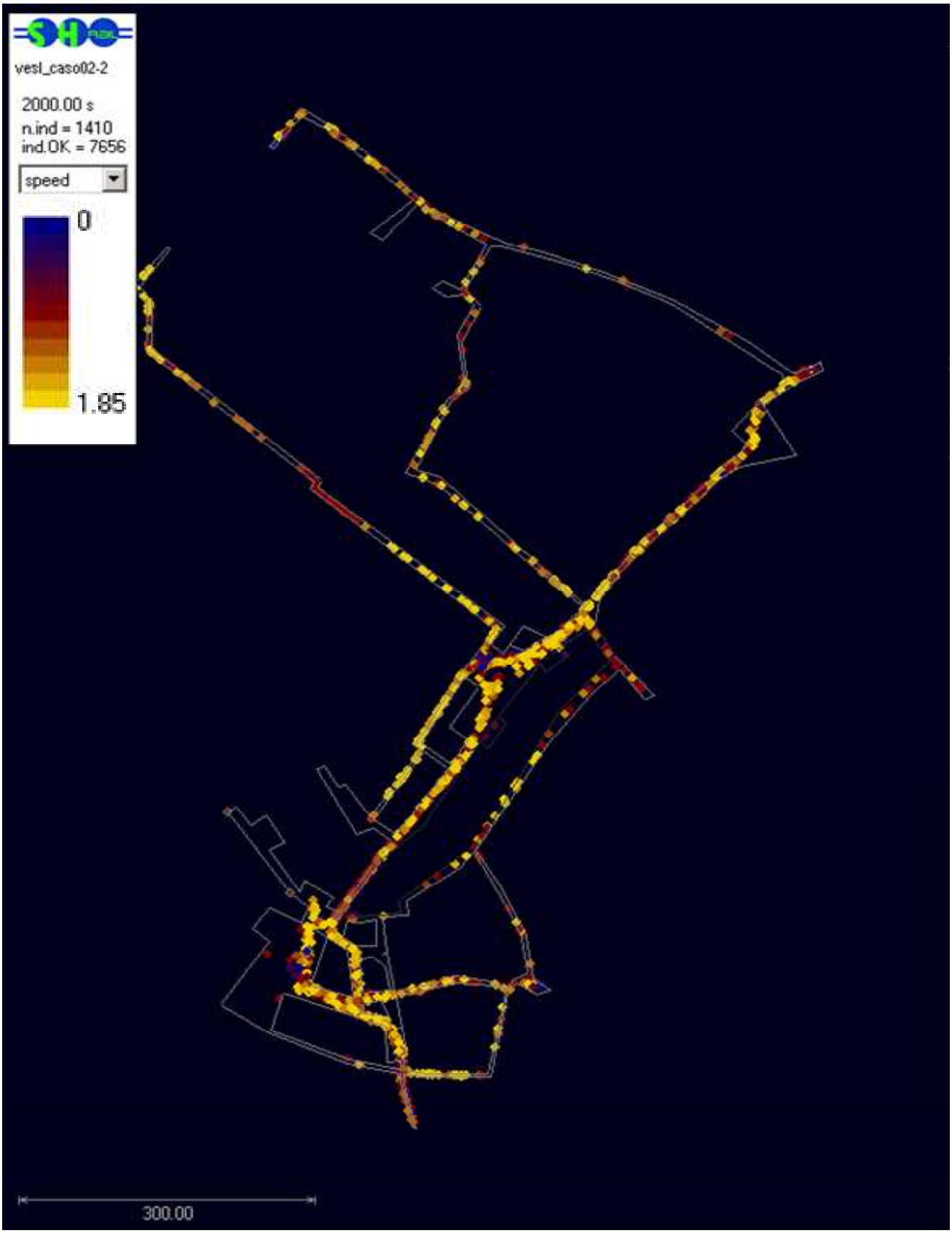
Subarea	Average pedestrians in the subarea	Pedestrian area of the subarea (m2)	Average density (m2/pedestrian)	*Percentage difference of average density compared to actual state*
To the north of the station	208	5'069	24,4	*11,7%*
In front of the station	156	6'664	42,8	*5,3%*
To the south of the station	186	2'128	11,4	*2,4%*
Roma square	236	5'608	23,7	*2,7%*

Relations	Demand (pedestrians/h)	Total journey time (hh:mm)	Average journey time (mm:ss)	% difference of AJT compared to actual state
All O/D	16'799	1345:09	4:48	-3,1%
S.Lucia station →Cannaregio	4'765	564:48	7:06	-8,2%
S.Lucia station ←Cannaregio	1'177	166:59	8:30	-0,4%
S.Lucia station →S.Croce	2'485	343:54	8:18	1,8%
S.Lucia station←*S.Croce*	2'254	392:39	10:27	0,3%

The new path S.Lucia station↔San Giobbe removes more than 800 pedestrians per hour from the main gate of railway station and from Rio Terrà Lista di Spagna.
Indeed we also observe a reduction of 800 people, compared to the actuale state,leaving the station (section STAZ) and in transit to Cannaregio (section STAE).

This reduction first of all improves journey times (-8%) on relations S.Lucia station→Cannaregio.
Furthermore it increases the average spaces available on the S.Lucia station square (+5%) and on Rio Terrà Lista di Spagna (+12%). At last this effect improves the outflow incoming in the railway station.

Overall the journey times in the entire area subject to simulation improve by 3%, demonstrating the positive impact of the opening of the new route.


vesl_caso02-2
2000.00 s
n.ind = 1410
ind.OK = 7656
speed
0
1.85
300.00

5.2 Scenario 3 – New Parisi pier

The scenario provides a shift of pier from Fondamenta Santa Maria (named Scomenzera) to ex Parisi factories front on the other side of Canal Grande.

Current (red continuos circle) and proposed (green hased circle) piers

Parisi pier provides *Murano* and *Lido* island links with waterbuses.
In addition this pier use a not long ago rebuild area between piazzale Roma and S.Lucia railway station, improving global accessibility.

In this scenario is added a new zone, the pier Parisi. The matrix used for this simulation is that of the actual state as amended. 10% of travelers with origin or destination of the piers Roma are transferred to the new zone.

Scenario 3												
	1 *S.Lucia station*	*2* *Roma*	*3* *S.Giobbe*	*4* *Cannaregio*	*5* *S.Polo*	*6* *S.Croce*	*7* *Zattere*	*8* *S.Lucia piers west*	*9* *S.Lucia piers east*	*10* *Roma piers*	*10* *Parisi pier*	***Tot***
1 S.Lucia station		209	863	897	1'000	1'050	406	99	220			**4'744**
2 Roma	10		705	1'034	141	1'380	1'861			1'797	195	**7'123**
3 S.Giobbe	27	183		30								**240**
4 Cannaregio	63	539	60		98	98						**858**
5 S.Polo	169	136		133								**438**
6 S.Croce	293	747		133								**1'173**
7 Zattere	79	788								222		**1'089**
8 S.Lucia piers west	167											**167**
9 S.Lucia piers east	83											**83**
10 Roma piers		709					96					**805**
11 Parisi pier	77											**77**
Tot	**968**	**3'311**	**1'628**	**2'227**	**1'239**	**2'528**	**2'363**	**99**	**220**	**2'019**	**195**	**16'525**

Section	Direction	Pedestrian flow per hour	*% difference of flows compared to actual state*	Direction	Pedestrian flow per hour	*% difference of flows compared to actual state*
Rio Terà	S.Lucia station	803	*1,4%*	Cannaregio	2.185	*-0,8%*
Ponte degli Scalzi	S.Lucia station	446	*0,0%*	San Polo	1.134	*1,9%*
S.Lucia station-Scalzi	S.Lucia station	972	*-0,4%*	Cannaregio/Scalzi	4.270	*-0,4%*
Ingoing/Outgoing station	S.Lucia station	904	*0,4%*	Cannaregio/Roma	3.438	*-2,6%*
S.Lucia station-Costituzione	S.Lucia station	1.282	*-0,8%*	Roma	2.016	*2,9%*
Ponte della Costituzione	S.Lucia station	2.254	*1,5%*	Roma	2.596	*3,6%*
Roma bridges	Roma	1.184	*-1,2%*	San Polo	2.423	*2,3%*

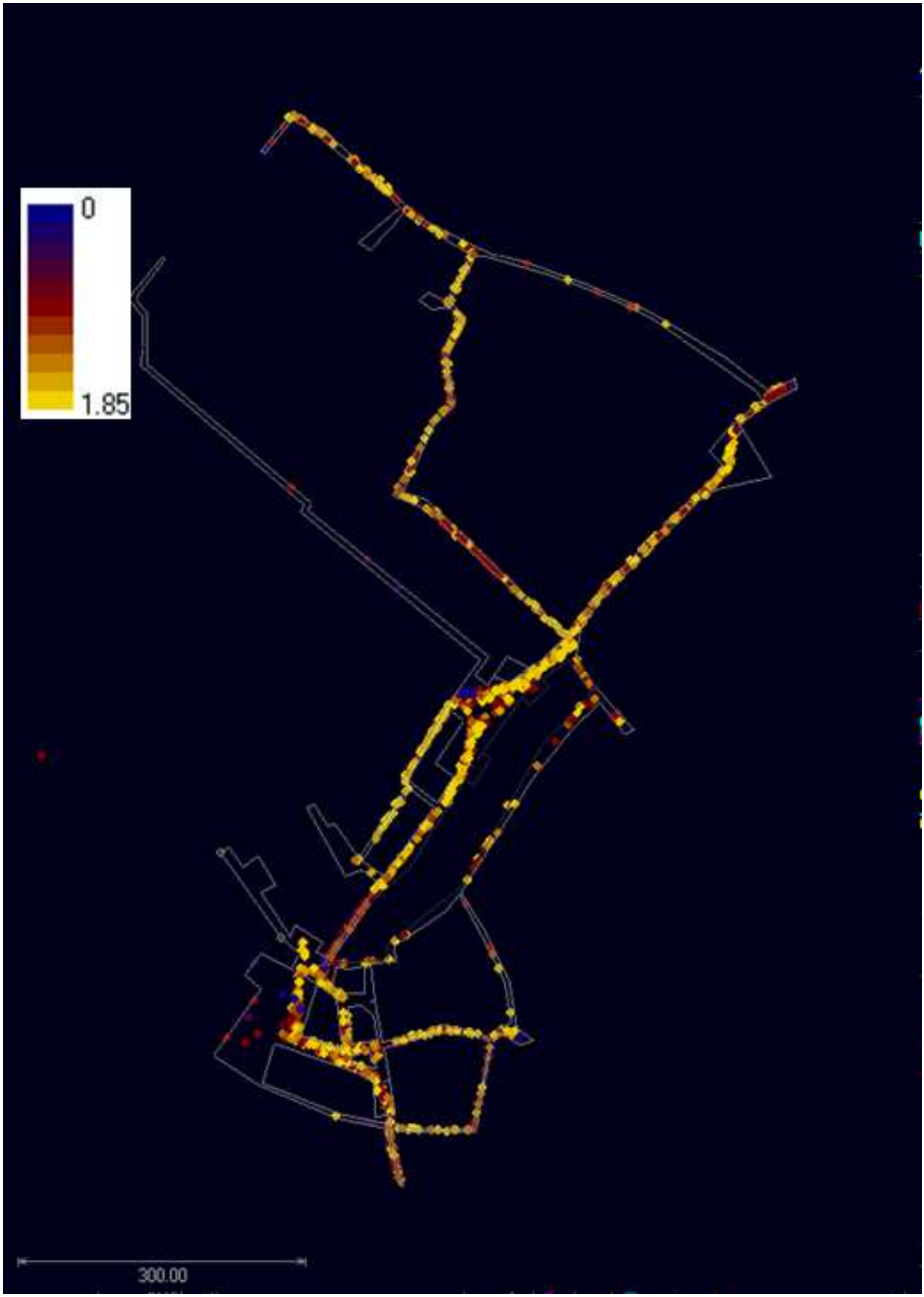
Subarea	Average pedestrians in the subarea	Pedestrian area of the subarea (m2)	Average density (m2/pedestrian)	*Percentage difference of average density*
To the north of the station	225	5.069	22,5	*-15,2%*
In front of the station	167	6.664	39,9	*39,1%*
To the south of the station	191	2.128	11,1	*-14,0%*
Roma square	236	5.608	23,7	*2,7%*

Relations	Demand (pedestrians/h)	Total journey time (hh:mm)	Average journey time (mm:ss)	% difference of AJT compared to actual state
All O/D	16'797	1408:49	5:01	1,5%
S.Lucia station →Cannaregio	4'765	610:56	7:41	-0,8%
S.Lucia station ←Cannaregio	1'177	169:27	8:38	0,7%
S.Lucia station →S.Croce	2'485	390:58	8:17	0,4%
S.Lucia station←S.Croce	2'254	343:37	10:24	-0,5%

The shifting of demand from S.Lucia station to the new Parisi piers, decreases the outputs from the main gate of railway station (-2,6%).

Instead the action doesn't' lighten flows passing on Ponte della Costituzione; on the contrary they increase about of 2,6% considering both directions of travel.

There is no observed benefits on travel times, in fact, the average time of journey increased in total by 1.5%; while the main benefit is the improvement of the indicator of density in front of the train station (+ 39%).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5.3 Scenario 4 - Added demand of cruise passengers (from/to Railway Station)

In this scenario has been added demand of cruise passengers between Marittima cruise terminal and Railway Station.

Cruise passengers leave the ship in the morning while new passengers board in the afternoon.

From Marittima cruise terminal the ship passengers usually reach railway station using people mover towards piazzale Roma or walking on Ponte della libertà. Once reached piazzale Roma they cross Ponte della Costituzione which is within the simulation area.
Scenario 4 provides a new bus line between *Marittima* cruise terminal and S.Lucia railway station, using a bridge currently only for train. The added demand is quantified according to bus line capacity. In case of 4 bus rides/hour and 100 passengers capacity of single bus, the bus line capacity per hour is 400 passengers. In the simulation period (morning peak hour), the added demand is 400 passengers from *Marittima* cruise terminal to S.Lucia station, and 100 passengers (lowest than capacity) in the opposite direction.

In this evaluation has been assumed:

- **Reference Solution** corresponding to Scenario 4, added cruise demand, without new bus line which correspond to added pedestrian in simulation area between *piazzale Roma* and *railway station;*
- **Project alternative**, corresponding to Scenario 1 and new bus line between *Marittima* cruise terminal and railway station (so the pedestrian demand in simulation area corresponds to actual demand)

Scenario 4											
	1 S.Lucia station	*2 Roma*	*3 S.Giobbe*	*4 Cannaregio*	*5 S.Polo*	*6 S.Croce*	*7 Zattere*	*8 S.Lucia piers west*	*9 S.Lucia piers east*	*10 Roma piers*	***Tot***
1 S.Lucia station		309	863	897	1'000	1'050	406	99	220		**4'844**
2 Roma	410		705	1'034	141	1'380	1'861			1'993	**7'524**
3 S.Giobbe	27	183		30							**240**
4 Cannaregio	63	539	60		98	98					**858**
5 S.Polo	169	136		133							**438**
6 S.Croce	293	747		133							**1'173**
7 Zattere	79	788								222	**1'089**
8 S.Lucia piers west	167										**167**
9 S.Lucia piers east	83										**83**
10 Roma piers		787					96				**883**
Tot	**1'291**	**3'489**	**1'628**	**2'227**	**1'239**	**2'528**	**2'363**	**99**	**220**	**2'215**	**17'299**

Section	**Direction**	**Pedestrian flow per hour**	***% difference of flows compared to actual state***	**Direction**	**Pedestrian flow per hour**	***% difference of flows compared to actual state***
Rio Terà	S.Lucia station	778	*-1,8%*	Cannaregio	2'153	*-2,3%*
Ponte degli Scalzi	S.Lucia station	457	*2,4%*	San Polo	1'138	*2,3%*
S.Lucia station-Scalzi	S.Lucia station	954	*-2,2%*	Cannaregio/Scalzi	4'266	*-0,5%*
Ingoing/Outgoing station	S.Lucia station	882	*-2,0%*	Cannaregio/Roma	3'539	*0,3%*
S.Lucia station-Costituzione	S.Lucia station	1'364	*5,6%*	Roma	1'940	*-0,9%*
Ponte della Costituzione	S.Lucia station	2'624	*18,2%*	Roma	2'671	*6,6%*
Roma bridges	Roma	1'199	*0,0%*	San Polo	2'466	*4,1%*

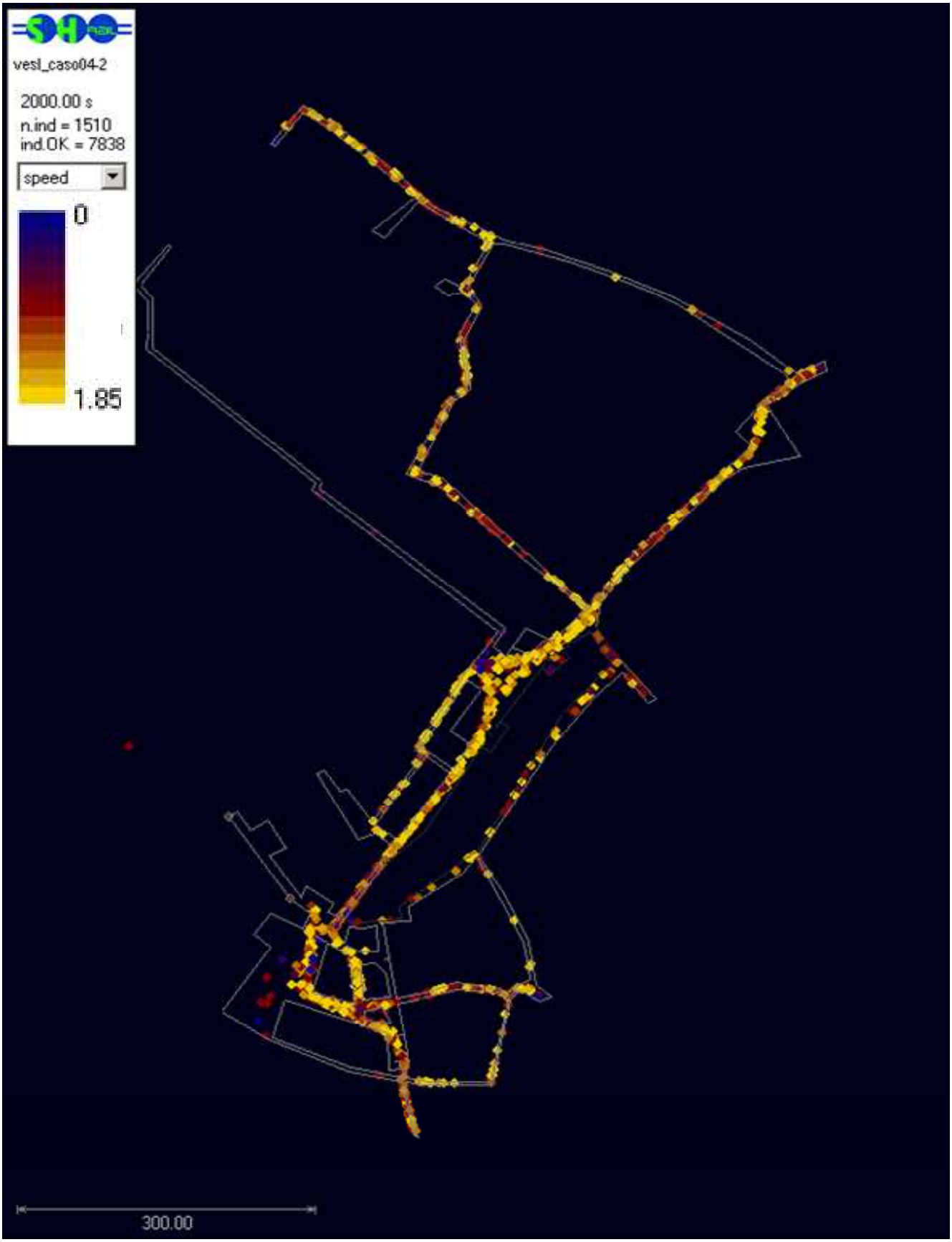
Subarea	Average pedestrians in the subarea	Pedestrian area of the subarea (m2)	Average density (m2/pedestrian)	*Percentage difference of average density compared to actual state*
To the north of the station	230	5'069	22,1	*1,1%*
In front of the station	166	6'664	40,2	*-1,0%*
To the south of the station	222	2'128	9,6	*-14,2%*
Roma square	256	5'608	21,9	*-5,2%*

Relations	Demand (pedestrians/h)	Total journey time (hh:mm)	Average journey time (mm:ss)	% difference of AJT compared to actual state
All O/D	17'299	1451:58	5:02	1,6%
S.Lucia station →Cannaregio	4'765	612:39	7:42	-0,4%
S.Lucia station ←Cannaregio	1'177	170:37	8:41	1,7%
S.Lucia station →S.Croce	2'585	356:50	8:16	1,5%
S.Lucia station←*S.Croce*	2'654	433:56	9:48	-5,9%

In this scenario, the increase of about 400 pedestrians (cruise passengers) from Roma square to S.Lucia railway station and of 100 pedestrians on the opposite direction produces a significative effect on outflow along Ponte della Costituzione. In fact, in this section the transits increase of about 700 pedestrians per hour compared to actual state.

The push of pedestrians belonging at Roma-S.Lucia station population could open more spaces for platoons headed towards S.Lucia station.
The pressure of pedestrians belonging at Roma-S.Lucia station population probably seems to increase spaces available for platoons headed towards station and consequently improves journey time(-6%).

All in all there are a strong reduction of available spaces per capita (14% into AREA_COS region, between railway station and Ponte della Costituzione) and an increment (+1,6%) of average journey times.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