Politecnico di Torino

Master of Science in Civil Engineering

Master's Degree Thesis

Updating Travel Demand O/D Matrices from Old Travel Surveys through More Recent Traffic Counts: a case study in Turin

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Abstract

In order to effectively implement any transport policy, it is essential to study the traffic demand and consequently to have the appropriate movements or trips information, expressed as origin-destination matrices. It is possible to say then, that the generation of origin-destination matrices is crucial for transport planning. Such matrices represent the amount of people travelling or the amount of goods being transported between different zones of an area.

There are several ways to obtain origin-destination matrices. Traditional methods like surveys are generally expensive and time-consuming and that is why they are generally implemented only every 5-10 years. As a consequence, decision makers and analysts are often relying on old O/D matrices that need to be updated. This is a difficult and challenging task, especially when unforeseen conditions (e.g. pandemics or economic shocks) trigger an unforeseen and abrupt change in travel demand levels and patterns, compared to the latest available information.

This thesis analyses to which extent the matrix estimation model based on the OmniTRANS software can help in achieving such goal. The tool is originally intended to estimate a matrix, based on a prior matrix and a set of constraints represented for example by traffic counts. We use it to update origin-destination matrices for car trips where the prior matrix is from an old survey whereas traffic counts are more recent.

The performance of the developed method is tested in the city of Turin (Italy) and its surroundings. The matrices used in the estimation are obtained from the IMQ 2013 raw data, IMQ being the series of travel surveys performed in the region of Piedmont whose latest dataset dates back 2013. The traffic counts included in the estimation are located all over the city of Turin and belong to year 2019. The results obtained in the thesis allowed estimating an update of origin-destination matrices of car trips from year 2013 to year 2019 in the study area.

Aggiornamento delle matrici O/D della domanda di mobilità da vecchie indagini sugli spostamenti attraverso conteggi di traffico più recenti: un caso di studio a Torino.

Sommario

Per implementare efficacemente qualsiasi politica dei trasporti, è fondamentale studiare la domanda di traffico e di conseguenza disporre di adeguate informazioni sugli spostamenti, espresse come matrici origine-destinazione. Si può quindi affermare che la disponibilità delle matrici origine-destinazione è fondamentale per la pianificazione dei trasporti. Tali matrici rappresentano il numero di persone che si spostano o le quantità di merci trasportate tra diverse zone di un'area.

Esistono diversi modi per ottenere matrici origine-destinazione. I metodi tradizionali come le indagini sono generalmente costosi e richiedono molto tempo ed è per questo che vengono generalmente implementati solo ogni 5-10 anni. Di conseguenza, i decisori e gli analisti si affidano spesso a matrici O/D che sono datate e che devono essere aggiornate. Si tratta di un compito difficile e impegnativo, soprattutto quando condizioni impreviste (pandemie o shock economici) innescano un cambiamento imprevisto e improvviso nei livelli e nelle caratteristiche della domanda di mobilità, rispetto alle ultime informazioni disponibili.

Questa tesi analizza in che misura il modello di stima della matrice basato sul software OmniTRANS può aiutare a raggiungere tale obiettivo. Lo strumento ha originariamente lo scopo di stimare una matrice, basata su una matrice precedente e su un

insieme di vincoli rappresentati ad esempio dai conteggi del traffico. Tale strumento sarà invece usato per aggiornare le matrici origine-destinazione degli spostamenti in auto, in cui la matrice precedente proviene da un vecchio sondaggio mentre i conteggi del traffico sono più recenti.

Le prestazioni del metodo sviluppato sono testate nella città di Torino e cintura (Italia). Le matrici utilizzate nella stima sono ricavate dai dati IMQ 2013, essendo l'IMQ la serie di indagini di mobilità effettuate nella regione Piemonte il cui ultimo dataset risale al 2013. I conteggi del traffico inclusi nella stima sono localizzati in tutta la città di Torino e risalgono invece all'anno 2019. I risultati ottenuti nella tesi hanno consentito di stimare un aggiornamento delle matrici origine-destinazione degli spostamenti in auto dall'anno 2013 all'anno 2019 nell'area di studio.

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Chapter I

Introduction

The study of the traffic demand is essential for the implementation of transport polices. The traffic demand includes the movements or trips information, expressed as origin-destination matrices. Such matrices are obtained by the summation of all trips performed in a particular area so that individuals can complete their daily activities. In other words, origin-destination matrices represent the amount of people travelling or the amount of goods being transported between different zones of an area. It is possible to say then, that the generation of origin-destination matrices is crucial for transport planning.

Obtaining origin-destination matrices with traditional methods like surveys is a costly and time-consuming activity, and that is why they are generally implemented only every 5-10 years. In addition, although having accurate origin-destination matrices is essential to perform a traffic analysis, sometimes the budget and/or time to do it is scarce. Under this panorama, the need to find new ways to obtain origin-destination matrices is born. Moreover, Bera and Rao (2011) agree that "But in situations of financial constraints these surveys become impossible to conduct. And by the time the survey data are collected and processed, the O-D obtained become obsolete" (p. 3).

As a consequence of the explanation made above, sometimes decision makers and analysist have to rely on outdated information in order to apply transport policies. This thesis analyses to which extent the matrix estimation model based on the OmniTRANS software can help in the obtainment of valid and updated origin-destination matrices. In other words, the mentioned software is used to update origin-destination matrices for car trips, using a prior matrix from an old survey, traffic counts and trip end information from a more recent year.

The analysed approach is tested in the city of Turin (Italy) and its surroundings. The matrices used in the estimation are obtained from the IMQ 2013 raw data, IMQ being the series of travel surveys performed in the region of Piedmont whose latest dataset dates back 2013. The traffic counts included in the estimation are located in main roads all over the city of Turin and belong to year 2019. Also, some trip end information is used in the model. This is obtained by computing some matrices for the same year 2019 that are available through technical annexes of the Sustainable Urban Mobility Plan (PUMS) of the Turin Metropolitan Area that was published in May 2021. This work aims to optimize and economize the obtainment of updated origin-destination matrices through the development of a method based in the OmniTRANS software.

In Chapter I, the context of the thesis has been introduced. The objectives have been identified, and the value of such work argued. The remaining parts of this thesis are organized as follows. In Chapter II, the existing literature is reviewed. Chapter III contains an overview of the different software and tools used for the creation of the model in which the work is based. In Chapter IV, the main data used in the model is examined (IMQ survey from which matrices are derived, traffic counts and PUMS matrices from which trip end information is estimated). In Chapter V, the creation of the model is explained in detail. Finally, Chapter VI is where conclusions are drawn.

Chapter II

State of the Art

In this chapter, the literature review carried out for the development of this thesis is explained. First, some papers regarding the different mathematical methods for the estimation of matrices are analysed. Then, some interesting case studies where matrix estimation using different input information are discussed. Finally, an important comment on the thesis developed by Smits in the year 2010 in the Netherlands is made.

2.1. Earlier studies

In order to write the first part of this literature review, papers mentioning different methods in order to estimate matrices were searched. During this first recollection of material, the selected papers were those that included matrix estimation with traffic counts and the use of a prior matrix. In order to describe some of the existing mathematical methods to estimate OD matrices, from a large sample of papers, five main approaches were chosen.

The issue of matrix estimation is being studied since 1970s. During this years, many mathematical methods have been developed in order to solve it. According to Abrahamsson (1998):

Virtually all models for OD matrix estimation use prior information on the OD matrix. The prior information might be expressed in terms of a "target" OD *matrix and/or the number of travellers attracted to/originating in different zones. The target OD matrix can be obtained by a sample survey or from an old (probably outdated) matrix. The existence and typology of a target OD matrix is thus a second important characteristic distinguishing various models for OD matrix estimation. (p. 2)*

In 1982, LeBlanc and Farhangian reviewed the Nguyen model (1977) and developed an algorithm in order to estimate OD matrices and determined the so called *trip table* which specifies the number of travellers driving between each origin-destination pair. This method generates a multiplicity of solutions, so the question of which one to use is also addressed in the study by using the Lagrangian technique. This method was used in a rather small-scale problem including 24 nodes and 76 links.

Maher (1983) proposed a new method based on Bayesian statistical interference, in which it is possible to assign different weight values to the prior information in the trip matrix. Maher assumes that prior information and observed traffic follow a multivariate Poisson distribution (multivariate normal, MVN, provides an accurate approximation when the means of the traffic counts are not too small). As a consequence, the estimated matrix also becomes MVN distributed. Maher highlights that the minimum information approach is an extreme case from a continuum of possibilities.

In 1987, Spiess develops a maximum likelihood model in order to estimate OD matrices. With this method, the author obtains the estimated matrix "by sampling, for each O-D pair, a Poisson distributed random variable with unknown mean" (p.2). The advantage of maximum likelihood models is the possibility to analyse its effectiveness by using the likelihood ratio test. It is important to highlight that in order to use this method, elements must be independently Poisson distributed.

The Spiess gradient based model, also called method of steepest descent (1990), is a bi-level structure method formulated as an optimization problem which aim is to minimize the distance between observed and assigned volumes. This methodology considers congestion in the network. The adjustment procedure consists of two equilibrium assignments on the network. The model has been successfully applied in different large-scale projects.

In 1992, Yang et al. published a paper discussing a new method using *Generalized Least Square* and equilibrium traffic assignment in the form of an optimization problem used for the estimation of origin-destination matrices. The authors in this paper, formulate the problem as a bi-level program and introduce *User Equilibrium Assignment* in the lower level.

2.2. More recent applications

The methods mentioned above are some of the several existing methodologies used in the estimation of origin-destination matrix using a prior OD matrix and traffic counts.

Thereupon, some case studies were analysed. In all of the following papers, the estimation of origin-destination matrices is carried out with different methods and different input information. At the end, in most cases, the effectiveness of the method is determined by the author, stating in this way if the model used is reliable or not. In order to perform the second part of this literature review, papers including real data cases in different countries were chosen. Anyway, in order to consider the latest and most modern techniques, only papers written in the last ten years were included.

In Table 9 located in Appendix A, a comparison between the different case studies is performed. All of these use different input in order to perform the origin-destination matrix estimation. Anyways, it is necessary to understand that some of the case studies use complex models that required precise information. In some cases, the input data has to be thoroughly obtained beforehand using a long and arduous methodology. It is a must, then, to conduct a cost analysis of these innovative methods given that in many occasions it doesn't differ so much from the costs of traditional methods such as surveys. The advantages and disadvantages of the methods and results and the main findings of the case studies, considering the point of view of this thesis, are illustrated in Table 1.

Table 1

Advantages and Disadvantages of the analysed case studies

	Advantages	Disadvantages	Main Findings
Gonzalez et al. (2020)	Good estimations. Applicable for large-scale problems	Maximum entropy problems do not consider the uncertainty of traffic counts and prior matrix information	The paper reveals that the trips are an exponential function of the Lagrange multipliers related to the trip cost, the observed traffic counts in the links, and the total number of passenger cars trips in the transportation network. The estimations obtained are considered as reliable
Toledo and Kolechkina (2013)	Applicable for large and complex networks. According to Burghout (2006) "MEZZO supports an iterative process for the estimation of travel times that represents a “learning” mechanism" (p.3)	Traffic counts were not available and were estimated with the assignment of an old available matrix. The prior OD matrix was obtained as a product of the available one	The paper demonstrated the applicability of the developed algorithms to large-scale complex networks and their computational efficiency compared to current state-of-the-art approaches
Savrasovs and Pticina (2017)	According to the analysis of effectiveness, it shows a low error and R-square near to one. Good approximations. The matrix estimation was done quickly	High number of resources given that video recordings are analysed manually	This paper shows the obtainment of accurate estimations of traffic demand in Riga city
Moghadam et al. (2015)	Useful methodology to extract patterns on the selection of routes	The paper suggest the fact that the methodology should be tested with a larger set of origin-destination pairs	Small average error is achieved for traffic assignment on routes that have an end to end delay in the range of the shortest path route. “The split of traffic happens in a way that in general the paths with the shorter delay takes the higher portion of the traffic for a given OD pair. However an interesting observation is that the set of chosen routes by drivers not only have delays in the range of the shortest path but also have low correlations with each others”

Larijani et al. (2015)	Possible to detect different transport modes. Using GPS location gives a very accurate location of origin and destinations of each trip	No effectiveness measure. Car flows are only possible to analyse in long and continuous distances and when the mean speed is relatively high. Walking and bike transportation modes are difficult to recognize	There is rather no specific concentration of the flow around any group of zones. The data is rather dispersed in the whole region without an interesting source of clue to conclude a consistent manner of demand. Nevertheless, moving from border to the centre, the flow has an increasing trend. Lack of the public transport in suburb, urbanization issues and socio-economic aspects could cause this phenomenon. There are some continuous behaviors detected by the highest range of flow. This is likely caused by the transit routes, mostly commuter trains, linking the airports from the suburb to the city center, besides some touristic attractions in suburban area
Basso et al. (2022)	Using GPS location gives a very accurate location of origin and destinations of each trip	Applicable only for heavy traffic. Method highly associated to the location of the study. Need of expert's criteria as part of the methodology. Time-consuming method	Distribution maps of origins and destinations per each municipality. Realizing most trips start on the outskirts consequence of the suburbanization of warehouses which is an increasing phenomenon in most countries
Hora et al. (2017)	Accurate due to calculations at stop level. Fast computations using C++ (less than 60 seconds) which results in the system analysing 500 thousand daily records	Only applicable for public transport. Not possible to correlate with real disaggregate information in order to verify the effectiveness of the estimation	Number of transactions done in the city differentiating those performed on weekdays and during the weekend. Also, the walking distances between the estimated exit stops and the real boarding stops is recovered.

Regarding the analysed case studies, it is noticeable that the last three (Larijani et al., Basso et al. and Hora et al.) consider the estimation of origin-destination matrices but using other modes of transportation such as public transport and heavy vehicles. These cases are related to the work performed in this thesis because they all include matrix estimation. Anyways, in this work the estimation of the demand matrices is performed by using passenger cars.

The study carried out by Gonzalez et al. in Medellin has similar aims to this thesis, even if the methodology used to obtain the results is different. Gonzalez et al. obtained good estimations anyways they considered the paper to be until in the experimental phases and propose testing the methodology disaggregating the zones and using a more detailed network. Moreover, the paper written by Savrasovs and Pticina also consider the updating of O/D matrices using traffic counts. In the case presented in such paper, the initial matrix is constructed using video recordings. This procedure implicates the use of recording devices and a big staff to analyse the material which result in high costs. It is important to consider this, because even if the estimations can be performed in shorter times (two weeks for the case study in the paper), the high costs are a big disadvantage. This is due to the fact that one of the main reasons to avoid performing surveys so often, are the costs.

On the other hand, in the study by Toledo and Kolechkina a methodology which is applicable for large networks is introduced, contrary to the first analysed paper by Gonzalez et al. At the end of this study it is argued that "… the gain in terms of run times obtained by the linear assignment matrix approximation is even larger compared to the gain in terms of number of iterations". Anyways, in this paper the prior matrix used was obtained by multiplying what they call *true matrix* by 0,6 and the traffic count data was estimated by applying this same *true matrix* and using the Mezzo. Having all input information derived from the same data can result in estimations which are misleading. It is my belief and also that of the authors of the paper, that the methodology should also be tested with prior matrices generated from other sources.

Also, the case study developed by Moghadam et al., consider real-time speed information which results in quite different results. One of the main findings in this paper is the possibility to acknowledge the chosen routes by drivers and the correlations between them.

Finally, it can be said that all of the analysed papers consider that the obtained estimations of origin-destination matrices are acceptable and quite accurate. Anyways, an analysis on the costs of obtainment and the quality of input information used in some of the studies should be revised and considered before validating them for a more universal use.

2.3. A focus on OmniTRANS procedures

As mentioned at the beginning, it is important to make a special reference to the master's degree thesis written by Smits (2010) developed as part of an internship in OmniTRANS International, since the same software will be used in the present work. In this thesis, an analysis of the algorithm to estimate matrices used by the OmniTRANS software is done. When doing so, the author explains the method used and lists its disadvantages. In addition, two alternative methods are presented. The main problem detected in the algorithm according to the author is that the results depend on the order of the input so, corrections made by the first restrictions[1] can be overruled by later restrictions and as a result the OD estimated matrix will better represent the restrictions treated later. Another drawback mentioned in thesis done by Smits is the fact that because the algorithm does not use the prior matrix actively, the difference between such matrix and the estimated one can become substantial. Although from a mathematical point of view, this disadvantage can be fundamental, it is not said that from an engineering analysis the results obtained by the methodology used should be overruled. In other words, the aim of this thesis is to update origin-destination matrices using an old survey, traffic counts and trip ends from a more recent year. When achieving this, it is possible to consider an error margin that is acceptable for the estimations and therefore the results should still be useful for the decision makers.

As a consequence of the literature research conducted and explained above, this thesis will be centred in analysing the estimation procedures used by OmniTRANS in a practical case application using the city of Turin (in Piedmont) and its surroundings as the study area. Testing the method on a real case and analysing its reliability is useful in order to determine if such method, and as a consequence if such application, can be used for a real-life O/D matrix updating.

As mentioned at the beginning, having accurate origin-destination matrices is fundamental for transport planners. Economizing the procedures used for the generation of this matrices signifies having up to date matrices which, consequently, improves the

[1] The restrictions in OmniTRANS are defined as the block data, trip end information, counts and screenlines. These are explained in Chapter III of this thesis.

precision and the quality of the information from which decisions are made. On the other hand, the procedures presented by OmniTRANS in order to estimate OD matrices are straightforward. This thesis will try to determine if such methodology is reliable in order to be used in real-life cases.

Chapter III

Software and Tools used in the Estimation of Origin-Destination Matrices

3.1. An introduction to origin-destination matrices

A matrix is “an arrangement of numbers, symbols, etc. in rows and columns, treated as a single quantity” (Oxford English Dictionary, n.d., definition 1). According to Ortúzar and Willumsen (2011, p.35) “any variable with two subscripts can be called a matrix”. In this thesis, origin-destination matrices will be used. As mentioned in the introduction, this kind of matrices represents the travel demand, which is the summation of all trips done in a particular area so that individuals can complete their daily activities. The travel demand is, then, a consequence of individuals doing different activities in different locations.

In order to have an origin-destination matrix, it is necessary to divide the study area in different sample zones[2]. Mathematically speaking, origin-destination matrices are an array of numbers containing the amount of trips that begin in one sample zone and end in the same and in other zones. Following this logic, the main diagonal of the O/D matrices always contain the internal trips[3] done in each zone. So, the main diagonal represents trips performed without crossing the zone’s limits (see Matrix 1).

[2] Sample zones are, mainly, the result of dividing the study area in homogeneous smaller zones in order to analyse them.

[3] Internal trips are defined as trips that begin and finish in the same zone.

As an example, consider a study area divided in 5 sample zones. All trips have to be generated and ended somewhere, this location can be the same zone (in the study area) or not. The origin, is then, the zone where the trip has started and the destination is the zone where the trip has ended. Another possibility is having a trip that starts outside the study area and ends in the study area or vice versa (a trip that starts in the study area and ends outside the study area). In this last two cases an *external* area is considered and trip's extremes outside the main study area are considered external. Overall, zones can be set as origins and destinations of different trips.

In transport planning it is considered that in each zone, trips begin and end in the same point (centroid of the zone). This is a way of simplifying the traffic modelling given that it would be very time consuming to do it otherwise. It is a good practice to do a thorough zoning in order to minimize at the most the trips in the diagonal of the matrix. According to the aggregated model which considers the existence of centroids, trips in the diagonal of the matrix start and end in the same point so they are not considered.

Following with the example, origin-destination Matrix 1 will be used to illustrate some exemplifications.

Matrix 1

Example Matrix

	1	**2**	**3**	**4**	**5**
1	150	60	180	50	201
2	30	70	200	30	35
3	100	30	40	170	40
4	40	25	23	20	30
5	55	160	10	35	20

In Matrix 1, the sample zones are numbered from 1 to 5 and the numbers inside the matrix indicate the amount of trips that were done between the two centroids. Following each row, the numbers indicated are trips originated in the zone and following each column the numbers are the amount of trips ended in that zone. For instance, in the row of zone number 2, the number *'200'* indicates the amount of trips that started in the centroid of zone 2 and finished in zone 3.

In a general origin-destination matrix, trips are represented as t_{ij} and the addition of trips are represented by o_i in rows and d_j in columns. Furthermore, as shown in Matrix 2 and Equation (1), the summation of all trips in rows should be equal to the summation of all trips in columns because both calculations represent what is called the Grand Total (GT) of the matrix. Depending on the precision of the method used to model or estimate the origin-destination matrices, Equation (1) can be totally fulfilled or not. It is possible that the summation of o_i and d_j are not exactly equal and in this cases it is necessary to analyse the confidence level of each total result and use the one that can be trusted the most (or has the higher confidence level). Anyways, only a small error can be accepted given that results should be very similar (if they are not exactly the same).

$$GT = \sum_j o_i = \sum_i d_j \qquad (1)$$

Matrix 2

General Representation of an O/D matrix

	1	**2**	**3**	**4**	**5**	**Total**
1	t_{11}	t_{12}	t_{13}	t_{14}	t_{15}	o_1
2	t_{21}	t_{22}	t_{23}	t_{24}	t_{25}	o_2
3	t_{31}	t_{32}	t_{33}	t_{34}	t_{35}	o_3
4	t_{41}	t_{42}	t_{43}	t_{44}	t_{45}	o_4
5	t_{51}	t_{52}	t_{53}	t_{54}	t_{55}	o_5
Total	d_1	d_2	d_3	d_4	d_5	**GT**

Origin-destination matrices will be one of the key points of this dissertation. The procedures followed in order to estimate them are fully explained in Chapter V.

3.2. The use of QGIS to determine the centroid’s location

QGIS, also called Quantum GIS, is an Open Source Geographic Information System developed since 2002 use to observe, edit and analyse geospatial information. This application provides many different features that can be added with *plug-ins*. Some of the main highlights of QGIS are:

- The possibility to see vectors and/or raster data in different formats without doing a conversion to another format.
- The opportunity to create maps and analyse them.
- The practicability to compose, edit, analyse and export vectors and/or raster data in different available formats.

Subsequently, QGIS allows users to create maps and operate with different layers that can be created with the application or directly imported into the software. Working with layers is an important feature of this software that allows an easier analysis on the information presented on each project. The data that can be added to a model is unlimited and therefore QGIS it is a very powerful tool widely use in civil engineering and also in transport planning.

In the model generated for this thesis, QGIS 3.4.4 *Madeira* was used in order to define and place the centroids of the zoning done by IMQ 2013. Like mentioned before (3.1), when modelling and estimating origin-destination matrices it is necessary to divide the study area in smaller zones and determine a centroid for each zone. In order to do so, the IMQ 2013 zoning was imported into QGIS and the centroids were placed following some steps explained in this section.

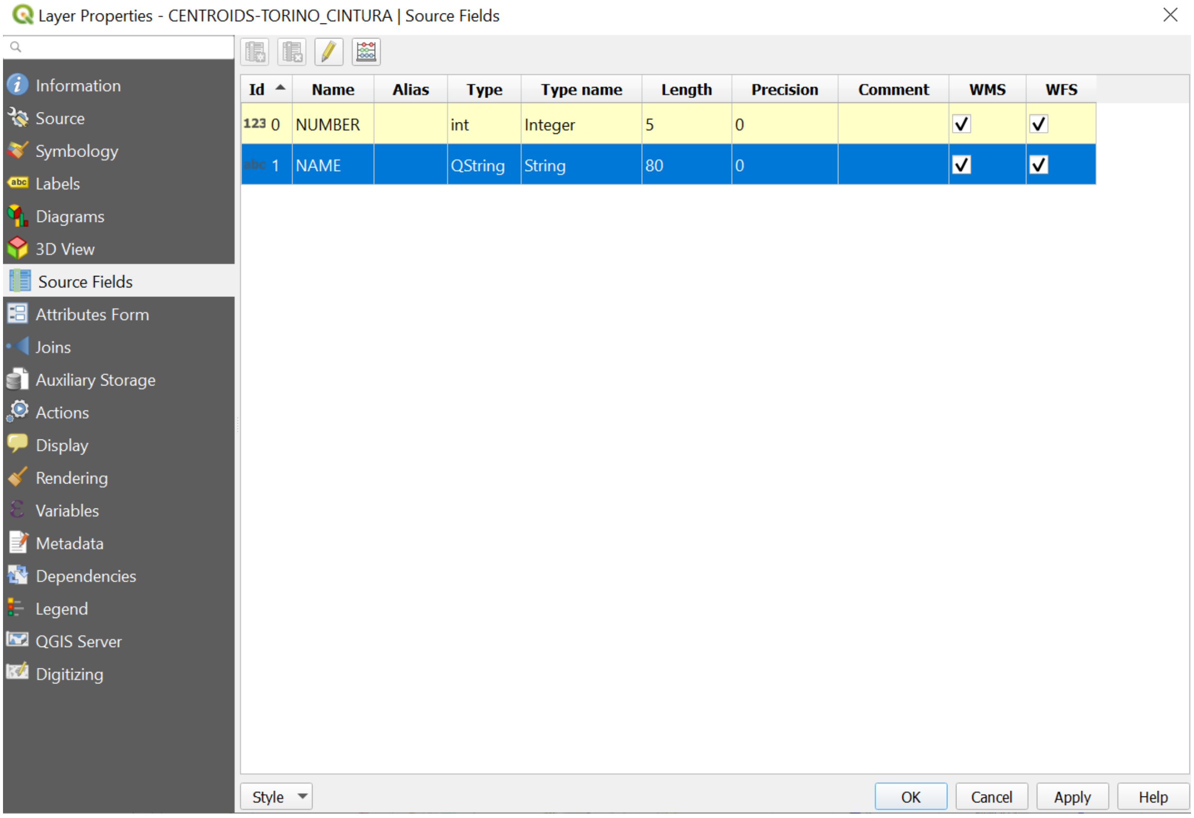
First of all, the main production and attraction points were singled out considering as production poles the main residential areas and as attraction points schools and universities, hospitals and medical centers, shopping centers, airports, hotels, parks, touristic places such as museums, cinemas, theaters and also factories. This main generators and attractors of traffic were defined by importing vector layers where the information exposed before was presented. The vector layers were downloaded from the geoportal of Turin city and Piedmonts Region.

Afterwards, already knowing where the principal poles are located it was possible to place the centroids, this means to place the points from which it is consider that all trips will begin and end in each zone. Centroids were located in each sample zone being aware that the aim of *centroid location* is minimizing the error that comes as a consequence of using an aggregate model. Like already mentioned in the previous section, because it is not possible to analyze a model by using the exact origin and destination of each trip, centroids are placed where most of the main poles in each zone are located.

In order to import the zoning already done by IMQ2013 and all the shapefiles used for placing centroids, it is necessary to go to the menu *Layer-Add Layer-Add Vector Layer* and select the desired shapefile. The base map of the project was added by using the *Quick Map Services* plug in. To do so it is necessary to add the mentioned plug in into the software and use the menu *Web-Quick Map Services-OSM-OSM standard*. To create the centroids, first a layer should be created with the menu *Layer-Create Layer-New Shapefile Layer* and the features of this layer should be set. Then, by using the *Toggle Editing* and *Add Point Feature* (Table 10 located in Appendix B) it is possible to add the centroids just by clicking on the model where the centroid should be located. The attributes that defined each centroid, in the project done for this thesis, were the number and name of the zones. In Figure 1 it is possible to see this display. The name of the zones and therefore, the name of centroids are listed in Table 11 and Table 12 located in Appendix B.

Figure 1

Centroid Layer Properties - From QGIS 3.4.4 Madeira



3.3. Presentation of OmniTRANS modelling tools and methods

The art of transport planning can be performed macroscopically or microscopically. In the first category the study area is more massive comparing to the second option. When modelling microscopically, the study area generally includes an intersection, a short part of a road or a small-scale part of a city. As a consequence, the modelling of every single vehicle in the study area should be done by making some assumptions on the behaviour of each driver. On the other hand, large study areas can include entire cities or even a larger territory like a city and its surroundings. Subsequently, when modelling macroscopically it is not possible to have the same precision. Normally in this cases the traffic is modelled as a whole and it is possible to observe and analyse the general state of traffic. Macroscopically, assumptions are made on an aggregated level in view of the fact that it is not possible to analyse the performance of a vehicle as a single unit. In this dissertation a macro modelling will be used.

OmniTRANS is a transport planning software designed to model multi-modal systems of transportation. This application helps the transport planner to solve several issues and problems that may be present in a current network or may appear after applying some modifications on a network. The software allows very complex and realistic modelling because there are no limits on the amount of information that can be introduced. In other words, the zoning (amount of zones), links and nodes that can be included in the model are unlimited. This is the reason why this tool is useful in order to represent an accurate network given that in reality the infrastructure of a city is very convoluted.

In this thesis, the zoning was imported, the network was singled out (roads, junctions, among others) and at the end, the traffic flow was applied. This procedure was performed in order to observe, understand and analyse the general state of traffic. Anyways, the main focus of this thesis is the updating of O/D matrices. It is also possible but elaborate to use OmniTRANS in order to estimate origin-destination matrices. In this project a thorough procedure was developed in order to do so. Liked explained in Chapter I, matrix estimation is a major application in the field of transport planning because the use of estimated matrices can, to an extent, mitigate the need of having updated survey information which is very expensive and time-consuming.

When estimating matrices, it is necessary to use a *prior matrix* and some information on traffic counts[4], screenlines, trip end data, among others to generate a new matrix with up to the date information. The *prior matrix* can be, for example, an origin-destination matrix of an older survey that will be adjusted with the information mentioned before. The input data used in the estimation procedure is easier and cheaper to compute than an entire transport survey. In the development of this thesis, the OmniTRANS 8.0.36 software was used in order to update matrices using an old survey and traffic counts and trip end information from a more recent year. In other words, a *prior matrix* (derived from the IMQ 2013 survey) was updated (with traffic counts and trip ends of the year 2019) and therefore, the software provided an *estimated matrix* representing trips from the year 2019.

Then, to estimate origin-destination matrices, the above mentioned additional information can be used. This additional input data will act as a restriction for the software that has to consider it together with the prior matrix in order to perform the estimation. The possible input data is the following one:

- Prior O/D matrix: Contains travel demand data that may be outdated.
- Traffic counts: Gives information on the amount of vehicles and/or pedestrians that passes through a point in the network. Traffic counts can be retrieved manually or automatically with devices placed in the infrastructure.
- Screenline: It contains information of a set of traffic counts. In other terms, it contains data related to the traffic passing through different locations. When estimating matrices, it is important to define screenlines carefully in order to avoid a bias output.
- Block: Includes the demand information of a group of O/D pairs. In other words, it defines the O/D pairs of different zones. This kind of data is obtained from surveys.

[4] Counts provide information on the number of trips passing a certain point in the network.

- Trip end: This is a more-specific block information. It includes the total production or attraction of a determined zone. It can be retrieved when there is detailed information on the zone's characteristics.

In the project developed for this dissertation, prior matrices, traffic counts, screenlines and trip ends were used. It is possible when programing the code for the estimation, to give an order to these constraints which results in some of them being more important than others.

3.3.1. Centroids, nodes and links

The combination of centroids, nodes and links makes up the transport network or transport supply. Ortúzar and Willumsen (2011) describe transport supply as:

> *The first distinctive characteristic of transport supply is that it is a service and not a good. Therefore, it is not possible to stock it, for example, to use it in times of higher demand. A transport service must be consumed when and where it is produced, otherwise its benefit is a lost. For this reason, it is very important to estimate demand with as much accuracy as possible in order to save resources by tailoring the supply of transport services to it.*
>
> *Many of the characteristics of transport systems derive from their nature as a service. In very broad terms a transport system requires a number of requires a number of fixed assets, the infrastructure, and a number of mobile units, the vehicles. It is the combination of these, together with a set of rules for their operation, that makes possible the movement of people and goods*. (p. 4)

Like mentioned briefly at the beginning of the chapter (section 3.1), in order to make an analysis, the whole study area should be divided in smaller zones. In order to use aggregate models[5], each zone will have a centroid in which it is assumed all trips will begin and end. This also means that all the zone's characteristics are concentrated in a single point called *centroid*.

The actual network is represented by a graph using links and nodes. In order to define them, it is necessary to determine the level of detail of the study from the supply side (or infrastructure side). In an extreme case, the study would be performed by singling out every road and by defining the specific characteristics of each one. This would be a very expensive model[6], so the normal procedure is to integrate links in different groups that are set to have the same characteristics. In this study, the network was modelled as a direct graph so nodes were used to represent junctions and links were added to simulate homogeneous roads between junctions. Also, not all the roads that exist in reality were included given that the modelling was done in an aggregated way. Small residential streets were omitted when making up the simulations even though in reality every infrastructure is used.

In the project created for the development of this thesis, the centroid of every zone is linked to the network with one or more connectors. These connectors should be strategically chosen in order to represent the behaviour of traffic flow as accurately as possible. Connectors should be included where a natural entry or exit is present.

When drawing links, there are some important characteristics that should be defined. Some of this characteristics are inherent to the group to which the link belongs to and others are characteristics of the specific link. These important attributes are mentioned below:

- Length
- Travel Speed (at free flow speed or given observed value)
- Capacity (expressed in passenger car unit [pcu] per hour)

---

[5] Aggregate models are used when information at a zonal level is available. This kind of models tend to be less accurate but they also are, less data-hungry and simpler to manage. Anyways, the use of aggregated information can be the cause of some errors in the modelling and estimation of matrices. It is always necessary to take aggregation errors into consideration when analysing the output of a model using aggregated data.

[6] A model is considered to be expensive not only for monetary reasons but also when it is very time-consuming.

- Type (freeway, local street, among others)
- Width and/or number of lanes
- Bus lanes, tolls, etc.

In order to draw the infrastructure in the model, OmniTRANS has some specific functions. Links, nodes are centroids are represented by different buttons and by using them together with the A*ddition* button, the network will be created (Table 13 located in Appendix C). To locate nodes and centroids, it is first necessary to press the button of the object that should be added (*Centroid* button or *Node* button), then press the *Addition* button and finally click on the place in the project where the element should be added. In order to create links the same procedure should be used and, then, links are placed by double clicking on the created node. It is also possible to follow a not linear path without adding nodes. This is done by clicking just one time on the project. To see and change the attributes of the elements, it is necessary to press the element button, the *Single selection* button and double click on the desired element.

The specifics on how centroids, links and nodes were imported, defined and drawn for this project will be fully explained in Chapter V.

3.3.2.Matrix Cube Dimensions and Combinations

When modelling with OmniTRANS, the matrix cube dimensions represent the traffic information used in the model. The main dimensions are four: purpose (P), mode (M), time (T) and user (U).

- Purpose (P): This dimension makes reference to the type of trip being performed. Generally, trips are grouped into three categories which are Home-Based-Work trips (HBW), Home-Based-Other trips (HBO) and Not-Home-Based trips (NHB). This classification, firstly, separates trips that have one extreme as the home of the individual (Home-Based) from others that don’t (NHB). So, in the first two (HBW and HBO) one of the extremes of the trip will always be the home of the individual performing the trip. While in Home-Based-Work trips, individuals go from home to work and vice versa, in Home-Based-Other trips individuals go from home to anywhere except work and vice versa. Finally, Not-Home-Based trips are the ones where none of the extremities is the residence of the individual. It is important to recognize the purpose of a trip because it can, and normally will, influence the behaviour of individuals travelling.

- Mode (M): When talking about mode, the distinction being made is the type of transportation used. Are trips performed using public transport or private transport? Bicycle, car, by feet? In multi-modal models, it is very important to distinguish the different modes of transportation because they clearly have a different impact on the transportation network.
- Time (T): Generally, when modelling and estimating an origin-destination matrix, a specific time of the day is used. Considering the peak hours,[7] is a safe assumption given that this is the moment where traffic is higher. As a consequence, it is also the moment when the network is constrained the most. On a normal week day, there are basically two peaks: one in the morning and one in the afternoon which overall coincide with the time most individuals enter and leave work.
- User (U): This is a dimension used to reference different matrices. Particularly, in the user dimension it can be define an observed matrix and a modelled matrix. This two can then be used to form a prior matrix which is the one used as input to estimate the last matrix. All of these matrices mentioned before will be different users.

There are also two extra dimensions: results and iterations. These are used to define the storage location in network and matrices.

- Results: The current dimension can be used to store information separately. For example, it can be separate in different assignment methods and different matrices can be calculated for each method. Following the exemplification, it is possible to have as *result 1* the All or Nothing assignment method (AoN) and as *result 2* the Deterministic User Equilibrium assignment method (DUE). As sub-results of these methods some matrices can be stored, such as skim matrices (distance, time and generalized costs). When computing the traffic analysis for each method, the matrices will be created and stored independently. It is key to properly define the result dimension for matrix estimation.

[7] Peak hours are the times of the day where the traffic density is higher.

- Iterations: It is also possible to store different results of the same matrix in different iterations.

In order to perform the matrix estimation, some combinations of all the dimensions were created. It is important to highlight that, often, traffic count information and trip end information are not given for the full set of dimensions. For instance, automatic counts do not differentiate between mode of transportation while manual counts do. It is necessary, then, to create some dimension's combinations. Information can be associated with the different combinations made by fusing the first four dimensions explained above (purpose, mode, time and user). In order to have a good matrix estimation, it is advisable to use input information disaggregated at different levels and associated it to different confidence levels.

The dimensions of a project in OmniTRANS can be accessed in the menu bar in *Project–Project Set Up-Dimensions*. New dimensions and sub-dimensions can be added with the *Add new dimension item* and *Add new dimension sub-item* buttons (Table 13 located in Appendix C). In order to add combinations a similar menu is used *Project-Project Set Up-Combinations*. Then, the new combinations are created with the *Add new combination* button and the dimensions of every combination are chosen by setting the dimensions in the upper part of the dialog box and then pressing *Add PMTU* (Table 13 located in Appendix C).

The specific dimensions, sub dimensions and combinations used in the developing of this model are fully described in Chapter V.

3.3.3. Traffic Counts, Screenlines and Trip Ends

A traffic count is a computation of the amount of vehicles and/or pedestrians passing through a particular road or intersection. Counts can be retrieved automatically with different devices placed in the network or manually. As mentioned in section 3.3, counts can be used as an input to estimate matrices. In the OmniTRANS software, the traffic counts are attached to a link and the information included in the count is related to a certain combination. It is also important to associate a weight (or level of confidence) to the counts. Defining the confidence of counts equal to one means the introduced count data in the model is very trustworthy and should be considered reliable information.

Another important input for matrix estimation are *screenlines.* It is vital to make a differentiation between screenlines and screenline intercept matrices. While screenlines are simply counts grouped together, a screenline intercept matrix is an O/D matrix used to define the origin-destination pairs passing through a count. In the estimation of origin-destination matrices, screenline intercept matrices play an important role. Each count will have an intercept matrix which represents the traffic passing that count. All intercept matrices together will form the screenline intercept matrix. Screenline intercept matrices are generated with a job (see section 3.3.4) and the result of such job is, as explained before, a matrix that provides information on which origin-destination pairs pass through each count. In some assignment approaches, such as the All or Nothing (AoN), a zero will indicate the O/D pairs that are not present and a one will indicate the opposite condition. Anyways, there are more precise methods for traffic assignment that will have as a result a screenline matrix that includes fraction values, this is due to multiple routing effects.

To add counts a procedure analogue to adding nodes is used. Counts are located in different links in the network. In order to add screenlines a procedure similar to links is used, taking into consideration that screenlines group counts together. In Table 13 (located in Appendix C), the buttons for counts and screenlines are shown.

Trip end information is added as another constraint in the estimation of the origin-destination matrices. This data consists of the row and column totals that will act as a restriction in the calculation of the matrices. In other words, trip ends represent the target totals of rows and columns of the matrix that will be estimated. In order to add trip ends to the estimation it is necessary to use the *Matrix Cube Manager* and *Combination Trip Ends* tab (see Table 13 located in Appendix C).

The specific counts, screenlines and traffic counts included in the project used for the writing of this thesis are completely explained in Chapter V.

3.3.4.Jobs and Variants

OmniTRANS also has a job engine that is where the computations take place. In order to get the wanted results, jobs can be performed in different ways: they can be separately executed and each of them can include only one process, different jobs can be colligated so one job can *call* another one or it is also possible to have only one job where all processes are included. To calculate matrices, assign traffic, etc. it is necessary to use scripts developed in OmniTRANS Job Language (OJL) and run them. The OJL is an extension of the Ruby Object Oriented programming language and it includes five types of classes (Table 14 to Table 18 located in Appendix C):

- Data Access Classes: As the name suggests is used in order to access every element (matrices, data base, content of vectors, among others).
- Data Analysis Classes: Information can be generated in different kinds of charts (bar charts, grid charts, pie charts and others)
- Data Import/Export Classes: It is possible to import and/or export information from external files.
- Modelling Classes: Used in order to perform the desired process. In this thesis, the modelling will be focus in matrix estimation so, specially the *OtMatrixEstimation* class will be used.
- Utility Classes: Provide an interface to INI files and access to the operating system.

To create a script and run a job the *Job* tab should be selected. Then, *Add job* and *Remove job* buttons can be used. In order to run a job, it is necessary to select it and then press the *Run job* button. Jobs are developed for one project and they can be used in all variants. The buttons are shown in Table 13 located in Appendix C.

In order to manage a project, it is possible to use different variants and sub-variants. Each variant is related to the network and to a matrix. The software always provides a base-variant from which all others can differentiate. In order to create variants, it is possible to duplicate the base variant or any other one with the *Duplicate variant* button. Sub-variants are added with the *Create sub-variant* button. Then the matrix cube associated to each variant is chosen by using the *Associated matrix cube* button (Table 13 located in Appendix C).

The jobs created to estimate origin-destination matrices are explained in Chapter V.

3.4. Traffic Assignment

The traffic assignment is a significant part of the O/D matrix estimation. Given that, it is necessary to assign traffic in order to create the screenlines intercept matrices and with them estimate the O/D matrices. According to Cascetta (2009):

> *Traffic assignment models simulate the interaction of demand and supply on a transportation network. These models allow calculation of performance measures and user flows for each supply element (network link), resulting from origin−destination (O-D) demand flows, path choice behaviour, and the mutual interactions between supply and demand.*

When performing the traffic assignment, the origin-destination trips are transformed into flows in the network. In order to do so, it is necessary to have the demand (matrix), the infrastructure (or network) and the route selection rules. When selecting a path, individuals tend to choose the one that has the lowest cost not just in monetary terms but also considering travel times. Anyways, it is important to understand that travellers make choices regarding their own perception which can be precise or not. In addition, when applying traffic, it is recommended to avoid concentrating all users in the best route because it is not realistic. So, a dispersion should be introduced and it can be done in three different ways:

1. Multi class: Dividing users into classes and associate different factors to this classes.
2. Stochastic: Introducing stochastic variables provides a realistic assignment given that not all users have the same knowledge and perception of costs and times.

3. Congestion: Assuming the travel time can increase when assigning all users to the best route may help with the dispersion of travellers.

Summarizing, there are different ways to conduct the traffic assignment. In the model developed for this thesis, the Deterministic User Equilibrium approach (DUE) was used.

The simplest assignment methods, like the All or Nothing, consider that all drivers choose the same route, so there is no dispersion between users and no congestion in the network. On the other hand, there are other methods like the Deterministic User Equilibrium that consider congestion. The DUE approach is an iterative method that aims for the equilibrium of the network. In this method, the capacity of the links in the network are considered and the traffic volume is assigned in order to reach an equilibrium in the network.

To sum up, the aim of this thesis is the O/D matrix estimation using an old survey matrix, traffic counts and trip ends. In order to accomplish it, it is necessary to use the IMQ 2013 zoning and define a centroid for each zone. Then, using some input information such as a prior matrix, traffic count data and trip ends, the estimation is performed. In order to conduct a good matrix estimation, it is necessary to associate the input information to the correct combination of dimensions and represent the infrastructure in the model in the correct way. In Chapter IV, a review of the IMQ 2013 results will be done. Also, the traffic count information and the trip end information used in the model is analysed.

Chapter IV

Analysis of the Information used in the Model to Estimate Origin-Destination Matrices.

4.1. Examination of the information and results produced by IMQ 2013

An important input in this dissertation is the IMQ survey of 2013 conducted in the Piedmont's region. This information will be used as a starting point in order to estimate origin-destination matrices.

The sample surveys IMQ aims to monitor people's mobility in the region of Piedmont and the perceived quality of both public and private transportation systems. The IMQ surveys are done at regular intervals since the year 1991. The one used in order to develop this thesis is the latest available one which corresponds to year 2013, from now on referred to as IMQ 2013.

Since the year 2006 (because of regional law 4 January 2000, n.1), the IMQ surveys are performed by *Agenzia della Mobilità Piemontese (AMP).*

The first IMQ survey was carried out in the year 1991 with a large sample. Anyhow, from 1994 onwards different surveys have been carried out every two years, alternating large samples and small samples. In the years 1996, 2000, 2004, 2008 and

2013 samples of between 25 and 30 thousand individuals were used while in the years 1994, 1998, 2002, 2006 and 2010 smaller samples of between 5 and 7 thousand individuals were used.

In the year 2013 the research was extended from the province of Turin to the entire Piedmont's region. The survey and research was conducted by the *AMP* with the collaboration of *IRES Piemonte*[8] and the sample was formed by telephone subscribers selected at random from the telephone lists in the different districts of the Piedmont's region. The interviews were, then, conducted exclusively by telephone.

As stated before, the IMQ 2013 was centred in all of the Piedmont's region. Anyways, in this thesis only the information regarding the city of Turin and its surroundings will be used. The Metropolitan Area of the city is composed by Turin and 31 other municipalities (also referred as surroundings in this project). The map and some of the main characteristics of the territory are reported in Figure 2 and Table 2.

Table 2

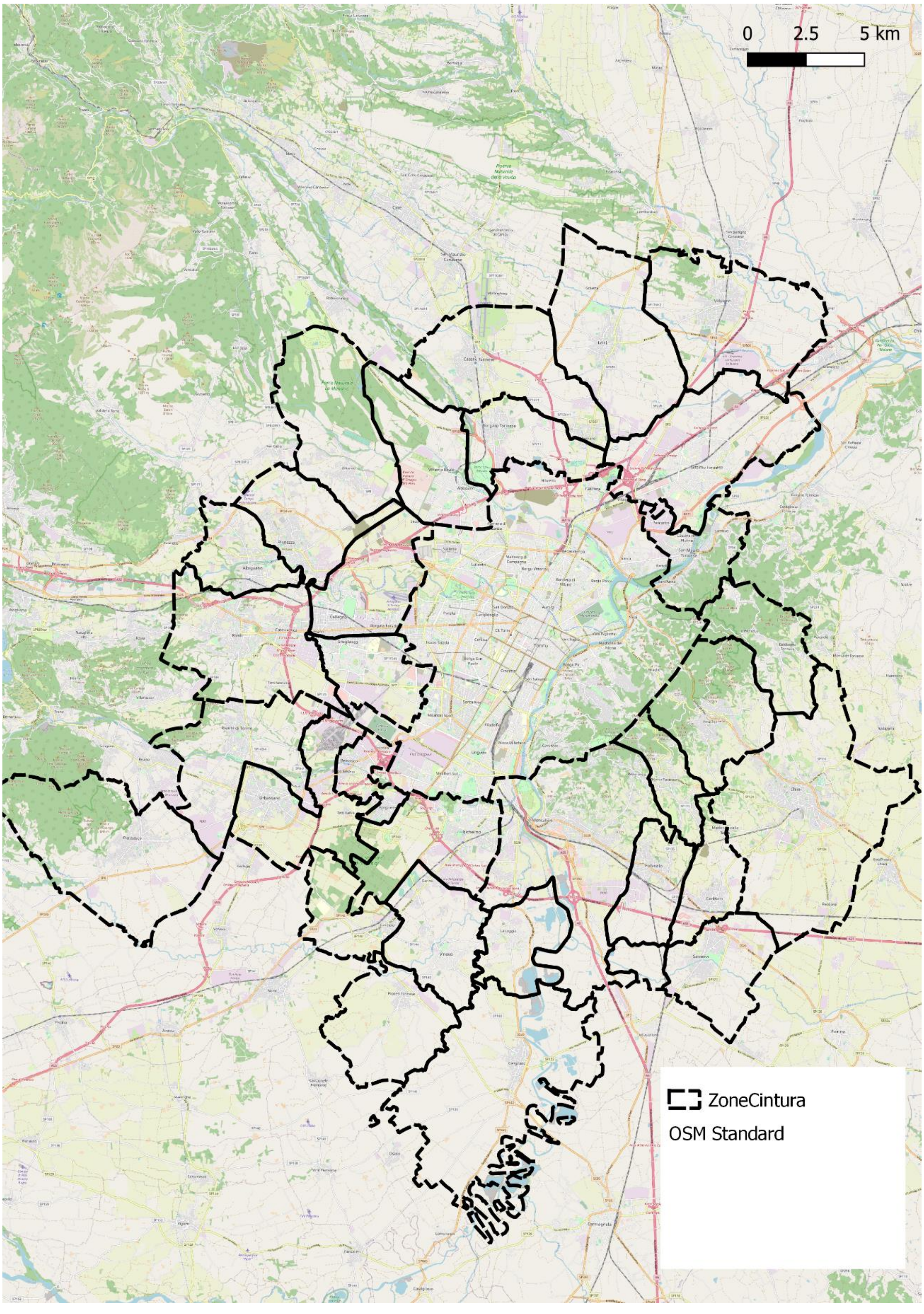
Population, Territory and Housing Density in the Metropolitan Area of Turin

	Resident Population	Total Surface (km^2)	Housing Density (residents per km^2)
Turin	911.823	130	7014
Surroundings	643.695	708	909
Metropolitan Area	1.555.518	838	1856

[8] *IRES Piemonte* is a research institute established in 1958 by the province and the municipality of Turin with the participation of other public and private entities. Afterwards, there was an adhesion of all the provinces in Piedmont.

Figure 2

Location of Metropolitan Area of Turin – From QGIS 3.4.4 Madeira



4.1.1.Interviews and Trips

As mentioned previously (in section 4.1), the IMQ 2013 survey was conducted using a large sample size. This sample was composed by 52.119 individuals older than 10 years old, in the entire Piedmont's region. Anyways, it was also commented before (section 4.1) that only the information related to the Metropolitan Area of Turin is relevant for this study. The sample size considering only Turin and the surroundings is equal to 25.740 individuals (49.38% of the entire sample). According to Florey (1993, p. 1182) "the sample size determines the precision with which a population mean can be estimated".

Interviews were conducted by telephone between Tuesday and Saturday from 9:30 am to 21:30 pm. During the telephonic interviews the information inquired was regarding the trips carried out the day before, and the main treated topics were:

- Time of departure and arrival of each trip
- Place of departure and arrival of each trip
- Purpose of the trip
- Mode of transportation used.

Also, the interviewees were asked to give their opinion regarding the quality of public transport service and the condition of usage of private cars and bicycles. Anyhow, this data is not important for this study so it will not be considered.

After conducting the survey, different information was produced. The final data created by *Agenzia della Mobilità Piemontese* includes two reports, some matrices and an open data file which comprise two tables; one related to the interviews and a second related to trips done in the study area. Both tables and their referential tables are reported in Appendix D (Table 19 to Table 31).

The information relative to the interviews table is the following one:

- Place of residence of the individual being interviewed
- Sex of the individual being interviewed
- Age range of the individual being interviewed
- Number of times they left the house the day before

- Number of trips done in the day before
- Amount of cars of the individual being interviewed
- Activity performed by the individual being interviewed
- Type of school attended by the individual being interviewed
- Educational qualification of the individual being interviewed
- Working condition of the individual being interviewed
- Working sector of the individual being interviewed
- Percentage sampling rate of the stratum to which the interviewed individual belongs.

The information relative to the trips table is the following one:

- Sex of the individual being interviewed
- Age of the individual being interviewed
- Place of residence of the individual being interviewed
- Purpose of the trip
- Place of origin of the trip
- Time of departure of the trip
- Place of destination of the trip
- Time of arrival of the trip
- Type of vehicle used in travel (maximum three)[9] for the trip
- Amount of companions in the car
- Amount of lines used in order to make the trip
- Place of departure of second and/or third vehicle (if appropriate)
- Time of departure of second and/or third vehicle (if appropriate)
- Percentage sampling rate of the stratum to which the interviewed individual belongs.

[9] It is considered public if one or more types of public transport are used, possibly in association with other means. It is considered private if it is a trip carried out with a car (private or car sharing) used as a driver or passenger, possibly in association with other means except public ones. It is considered *other* if no car not public transport is used.

4.1.2.IMQ Zoning

The zoning given by IMQ is divided in four macro-areas: Turin city, the surroundings, the rest of the territory in the province of Turin and the rest of the Piedmont's region. Each macro-area is divided in several sampling zones and the amount of zones depends on the total extent of the macro-area and also on the importance and amount of trips made in the area. The zoning done by the IMQ surveys include 208 different sampling zones divided like shown in Table 3. In Figure 3 a zoom is done and only the 23 zones included in the territory of the city of Turin can be observed while in Figure 4 the zones of Turin and the surroundings are visible.

Table 3

IMQ's zoning division of the Piedmont's Region

	Turin	The Surroundings	Rest of Turin province	Rest of Piedmont
Amount of zones	23	31	40	114

The Metropolitan Area of the city of Turin is composed by Turin and 31 other municipalities (also called the surroundings of the city of Turin). These municipalities are listed in Table 12 located in Appendix B.

Figure 3

IMQ's zoning. Division of the City of Turin – From QGIS 3.4.4 Madeira

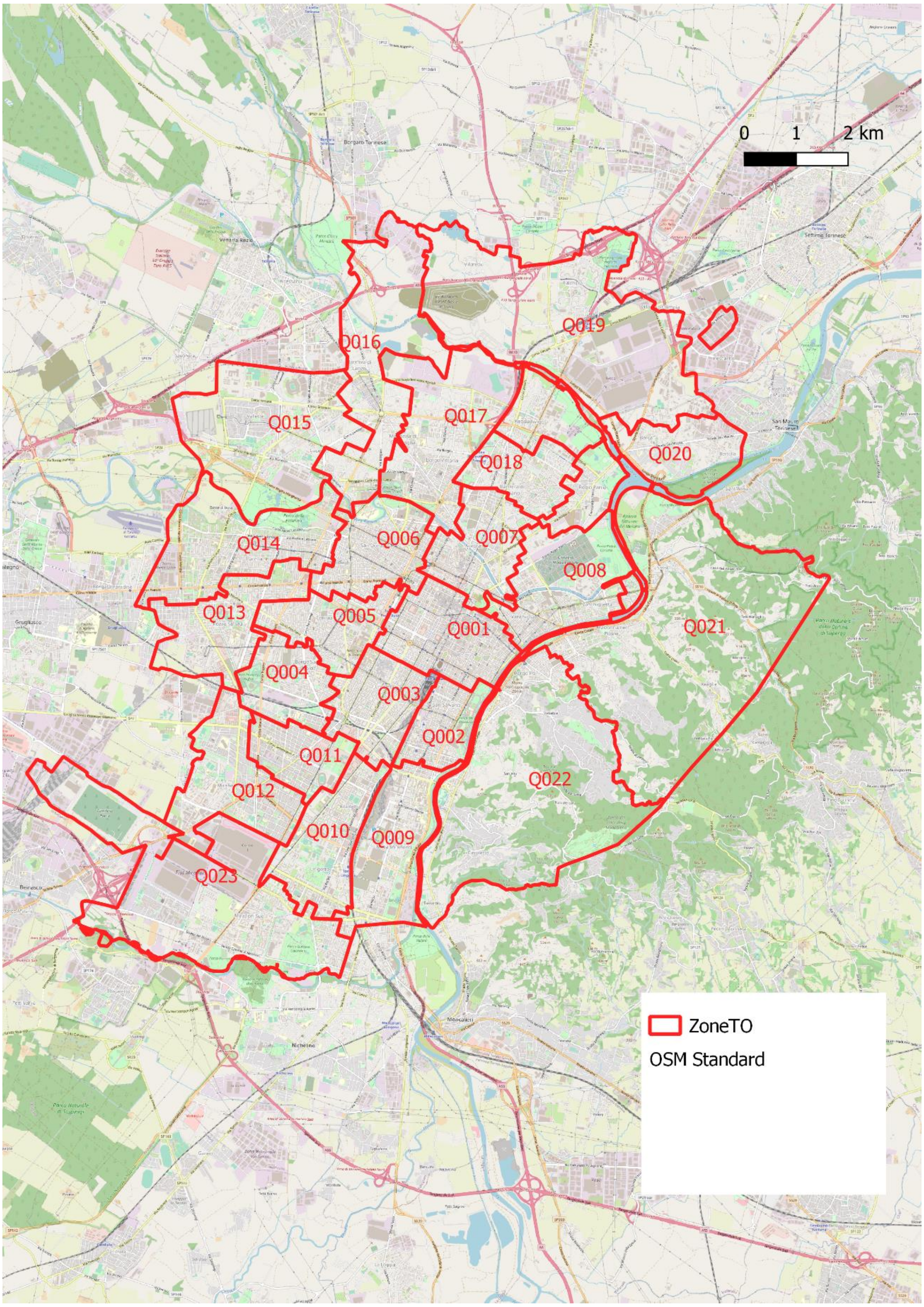
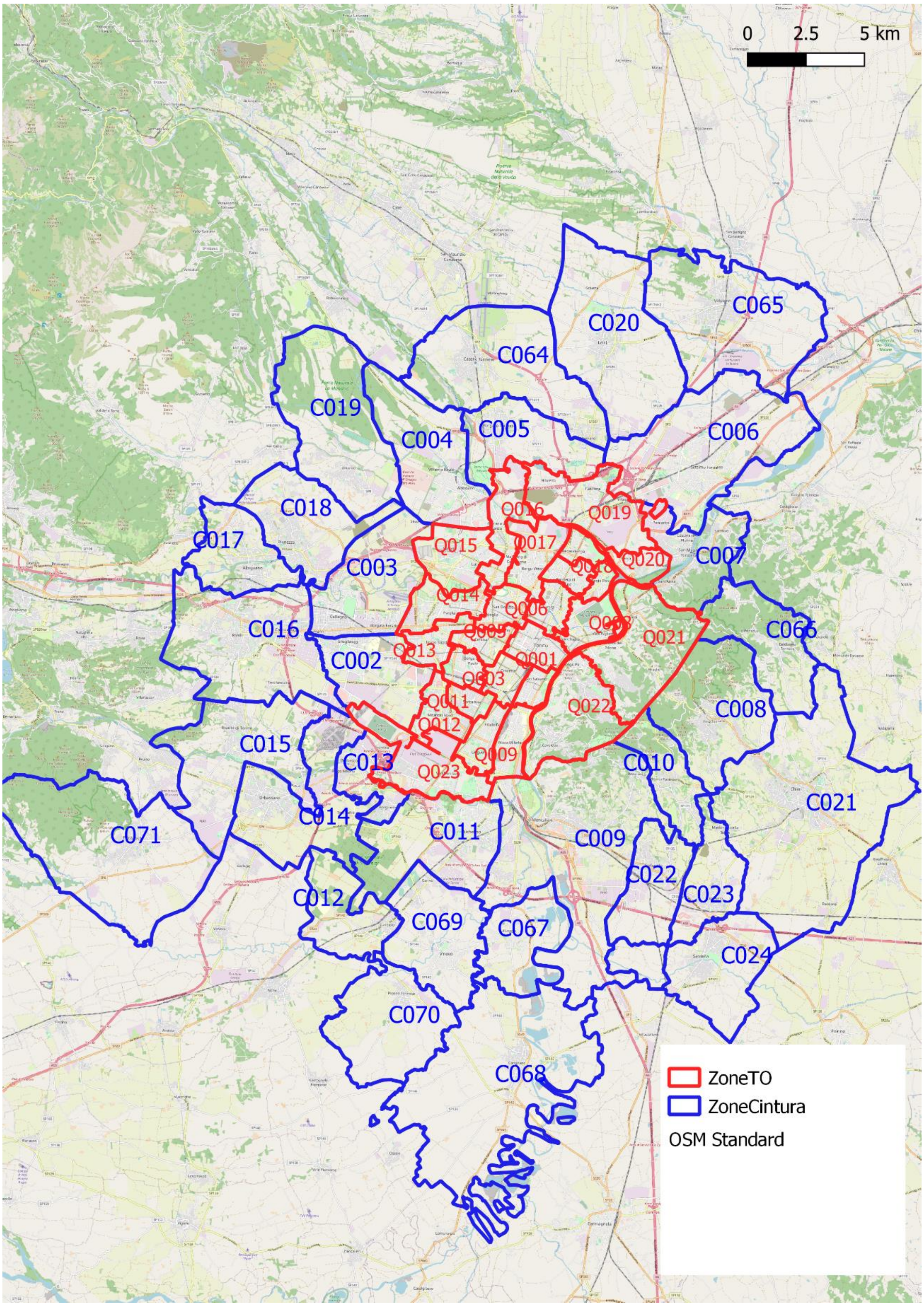


Figure 4

IMQ's zoning. Division of the Metropolitan Area of Turin – From QGIS 3.4.4 Madeira



4.1.3.IMQ Results

The subject of the IMQ 2013 survey is the population, over 10 years old, of the Metropolitan Area of Turin (1.555.518 residents from which 911.823 are residents in the city of Turin and 643.695 are residents of the other 31 municipalities). The sample size of the survey in the Metropolitan Area is equal to 25.740 individuals. The results described in the report (*Rapporto di Sintesi sull'area metropolitana*) produced by *AMP* as a consequence of the IMQ 2013 survey that are more relevant for this thesis are illustrated in this section.

The population between 2000 and 2013 was fairly stable. Anyways there was a small but increasing aging of the population (in the year 2000 the age range over 64 was 20% and in the year 2013 was 26%). Also, as it can be seen in Figure 5 the age range that comprise the higher percentage of habitants is that one between 20 and 49 years old.

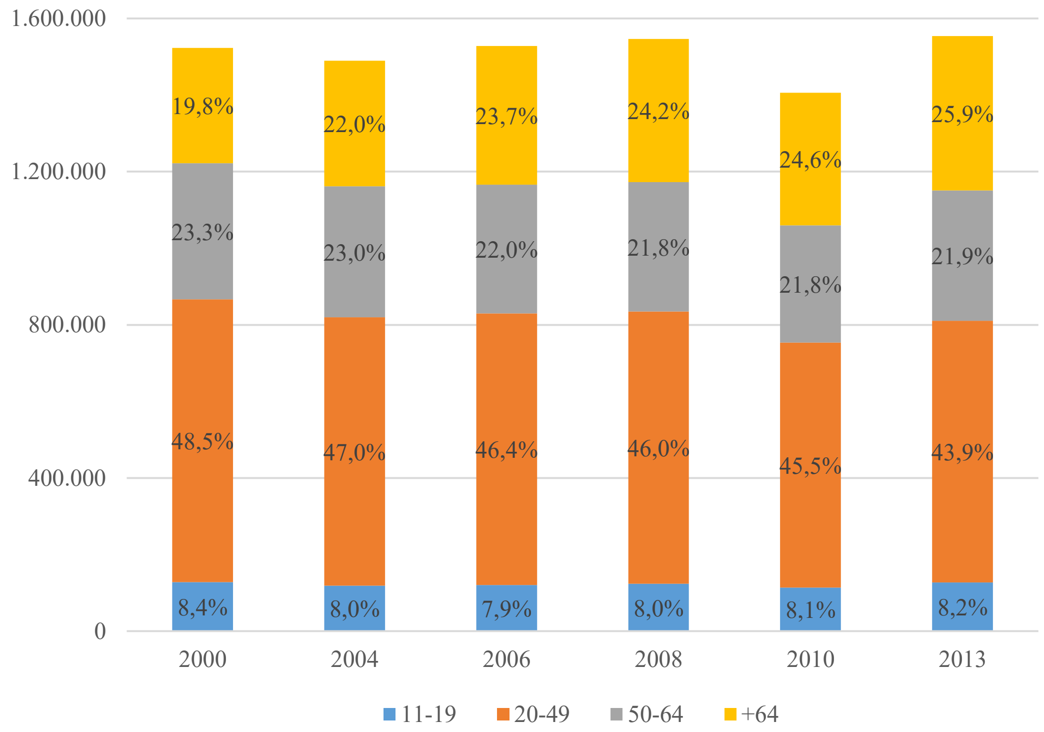
In addition, as stated in Table 2 (page 50) the territory of the Metropolitan Area is equal to 838 km^2 from which the 15.5% belongs to the city of Turin and the rest to the other 31 municipalities. This contrast between the population and the territory is shown in Figure 6.

Moreover, in the year 2012 *L'Assessorato all'Urbanistica e Pianificazione Territoriale della Regione Piemonte* published a study called *Monitoraggio del Consumo di Suolo in Piemonte 2008* in which they estimated that the urbanized area in the city of Turin was equal to 76 km^2 (58% of the territory), while in the surroundings[10] it was equal to 151km^2 (21% of the territory).

[10] The surroundings are called *cintura* in the IMQ 2013.

Figure 5

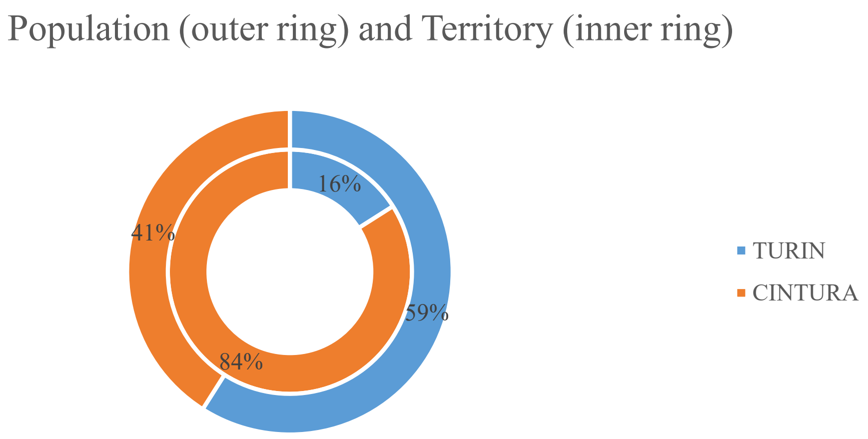
Population older than 10 years old in the Metropolitan Area of Turin



Note: Taken from IMQ 2013

Figure 6

Population and Territory comparison in the Metropolitan Area of Turin

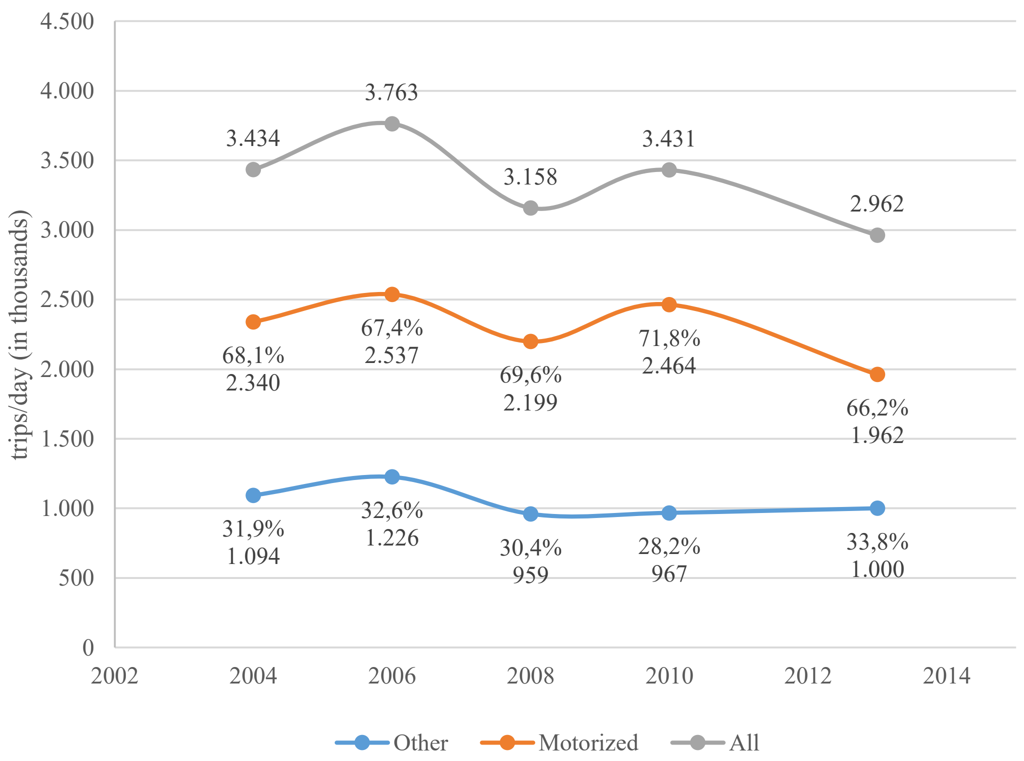


Note: Taken from IMQ 2013

In Figure 7, the total mobility in the metropolitan area of Turin is reported. The residents of this area made, in year 2013, 2.962.000 trips on an average working day from which 1.962.000 were performed with motorized vehicles. Also, it is easy to observe that compared to the previous surveys, in the year 2013 there was a decrease in the overall mobility of citizens and also a huge decrease on the percentage of motorized trips over the total amount.

Figure 7

Total Mobility of the residents in the Metropolitan Area of Turin from 2004 to 2013

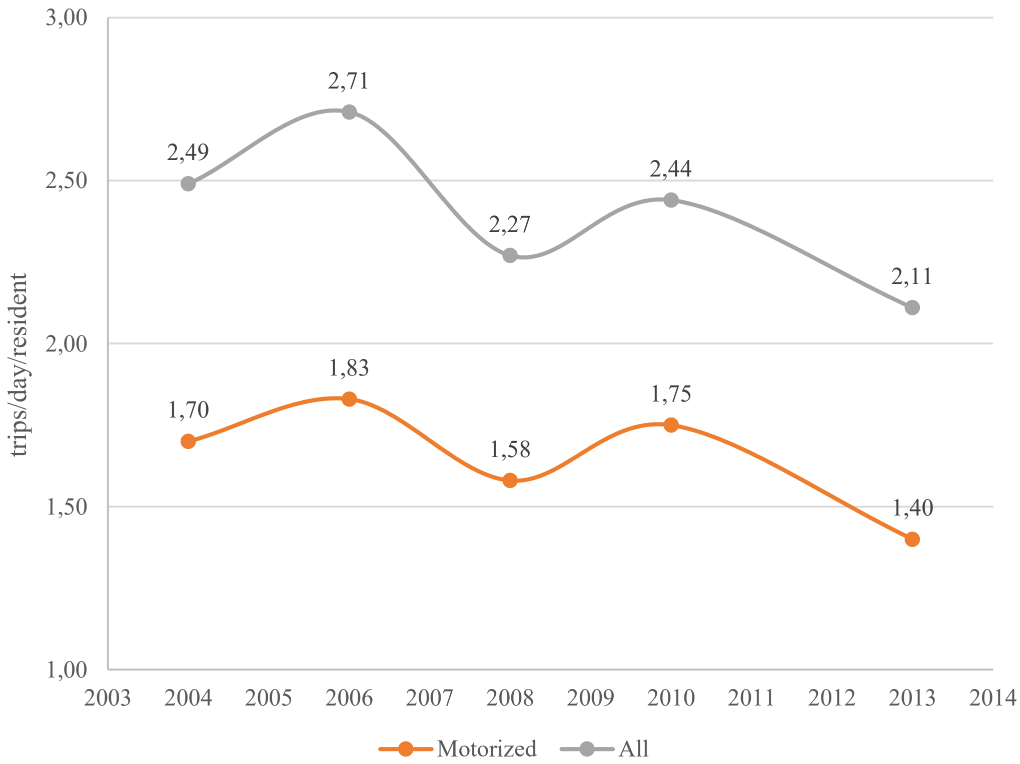


Note: Taken from IMQ 2013

When analysing the mobility per individual (Figure 8), the residents of the Metropolitan Area made, in the year 2013, 2.11 trips per capita in weekdays from which 1.40 were conducted with motorized vehicles. Some important attributes that condition the mobility of citizens are the sex and age of individuals performing the trips. In fact, in the year 2013, men made 2.18 trips per day while women made 2.04 trips per day. When referring to age, the population with the higher mobility is that one between 40 and 49 years old (they made 2.63 trips per day in Turin and 2 trips per day in the surroundings) and the group with the lower one is that of residents older than 69 years (1.49 trips per day in Turin and 1.33 trips per day in the surroundings).

Figure 8

Individual Mobility of the residents in the Metropolitan Area of Turin from 2004 to 2013

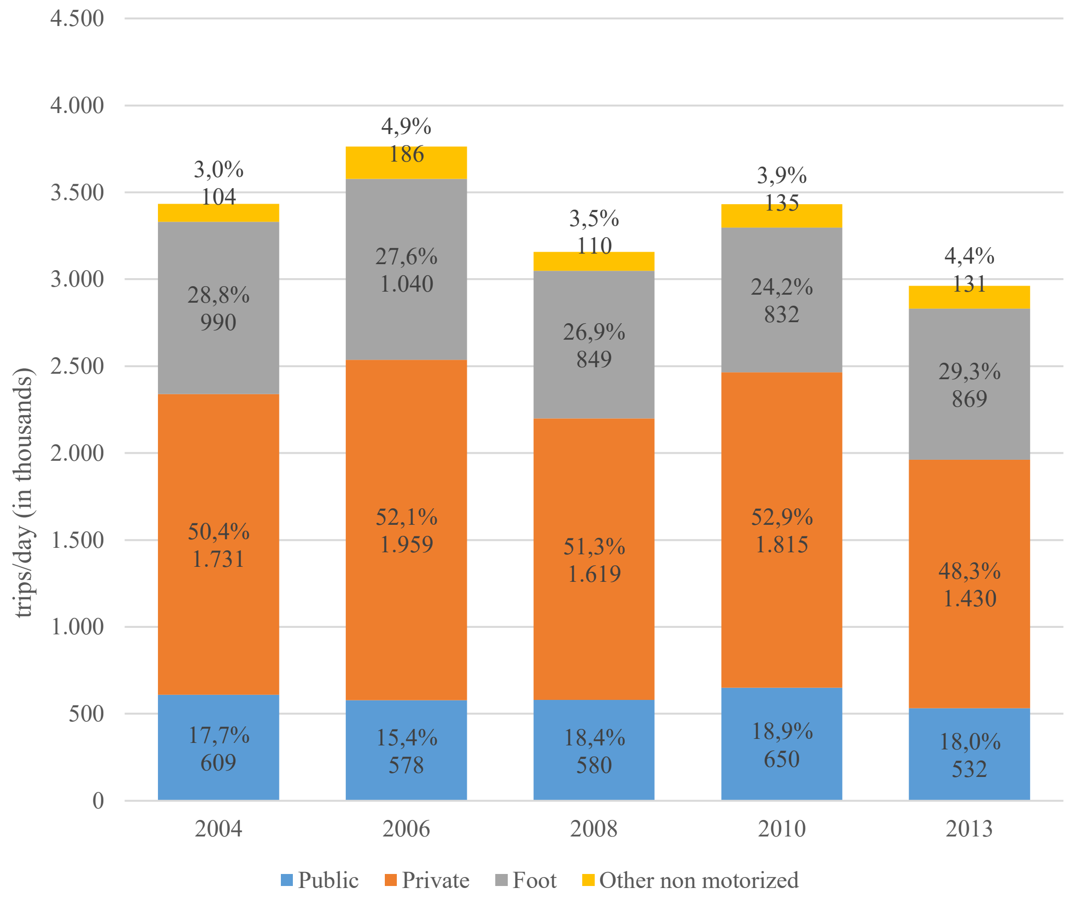


Note: Taken from IMQ 2013

When considering which modes of transportation were used the most, is important to remember that the overall mobility had a decrease in year 2013 as well as the percentage of motorized mobility. Consequently, the use of other types of transportation was increased. In Figure 9, it is easy to see that the percentage of not only private motorized but also public motorized trips had decreased compared to all the previous surveys conducted between the year 2004 and the year 2013.

Figure 9

Total Mobility according to transportation use of the residents in the Metropolitan Area of Turin from 2004 to 2013

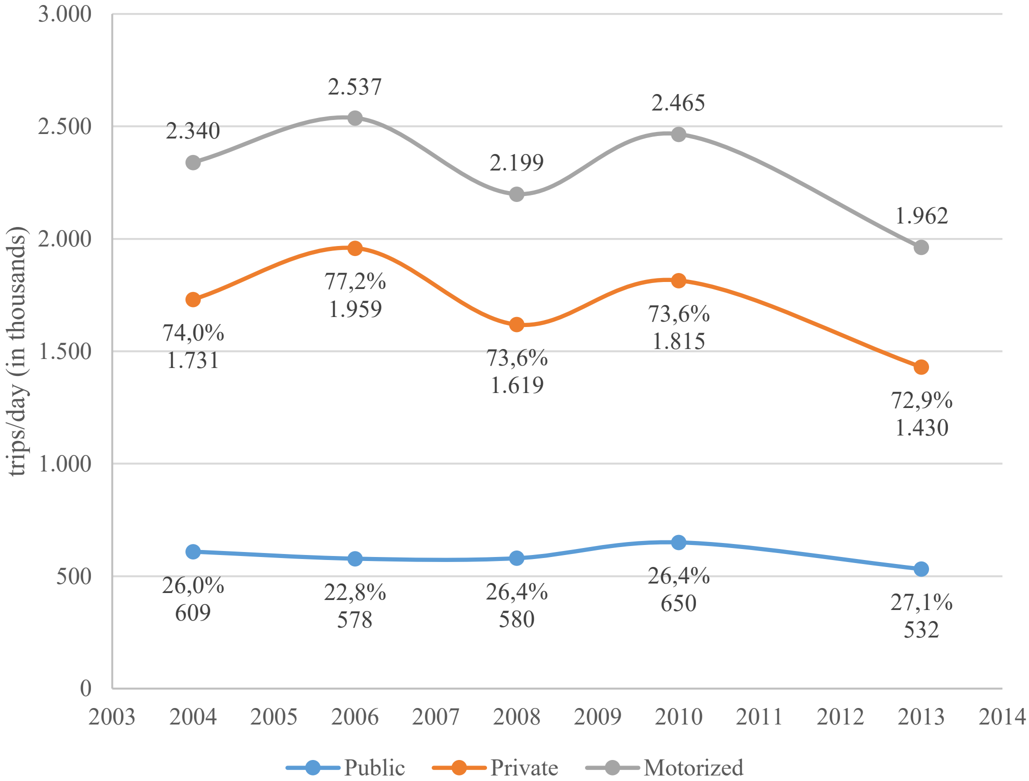


Note: Taken from IMQ 2013

Also, it is important to notice that although the car was still the most used mean of transportation, in the year 2013 the lowest percentage of car use was registered. Moreover, considering only the motorized kind of trips (Figure 10), in the year 2013 the percentage of trips performed with public transport was the highest one (27.1%) since 2004.

Figure 10

The use of motorized modes of transportation of the residents in the Metropolitan Area of Turin from 2004 to 2013

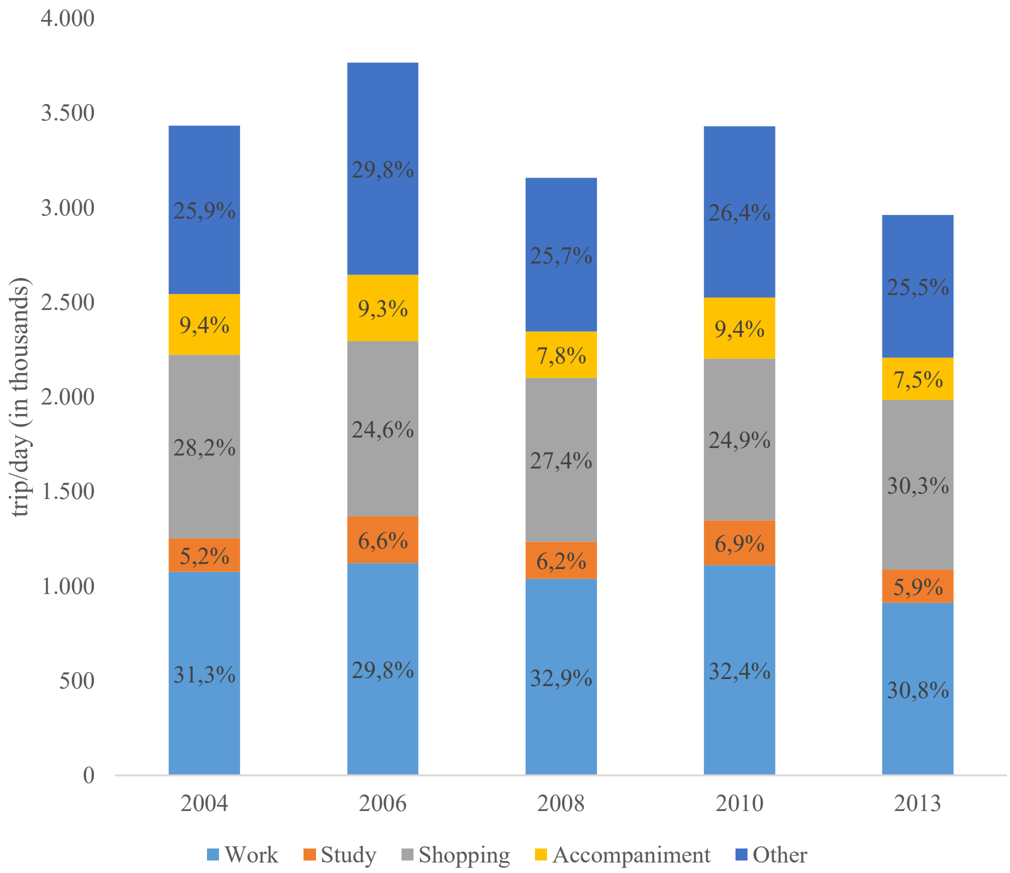


Note: Taken from IMQ 2013

Every trip, is performed for a purpose and, as commented previously (3.3.2) the purpose of the trip will always influence the behaviour of the driver. In the year 2013, according to Figure 11, 36.7% of trips were performed for work and study purposes, 30.3% for shopping reasons and the rest for other activities such as accompaniment, visiting friends and family, going to the doctor, among others. It is key to realize that in the year 2013, the movements done for work purposes reached its absolute minimum since 2004.

Figure 11

Purpose of Mobility of residents in the Metropolitan Area of Turin from 2004 to 2013

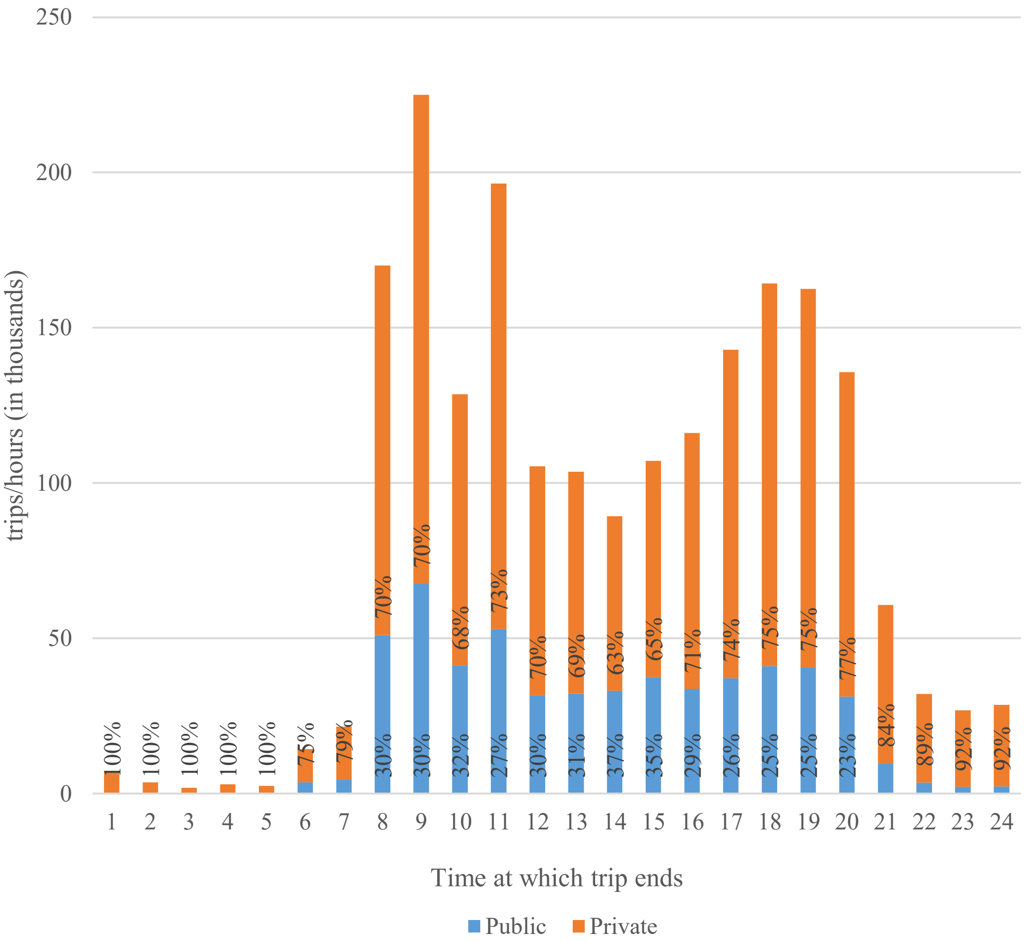


Note: Taken from IMQ 2013

The hourly distribution of trips conducted in the Metropolitan Area of Turin, in the year 2013, was also registered. In Figure 12, there are peaks reached between 8 and 9 in the morning and other ones between 18 and 19 in the evening. As stated in Chapter III, these are, normally, the moments when individuals enter and leave work. It is also observable that the maximum peak for public transport use is approximately at 14, which is the time of day when students finish their school day. The peak hour in the year 2013 was between 7:43:00 and 8:42:00.

Figure 12

Distribution of Mobility during the day of the residents in the Metropolitan Area of Turin



Note: Taken from IMQ 2013

4.1.4.IMQ Matrices

Using the Open Data file given by the IMQ 2013, which contains the raw data obtained from interviews, the matrices used in this thesis were generated. These OD matrices are essential for the development of the model used in this thesis. The mentioned matrices were created for three different time periods. Two of them coincide with the time periods for which traffic counts were obtained (see next section). Moreover, the third matrix was created for an entire day analysis.

In order to select the most relevant time ranges a peak hour analysis was performed using the raw data provided by the IMQ survey. In this way, the morning and afternoon peaks were obtained at 8.30am and 6pm correspondingly. The 8.30am peak coincides with the statement given by IMQ 2013 that said that the peak hour was in between 7:43:00 and 8:42:00. The peak analysis was performed by deriving the cumulative and discrete number of trips for every hour. Then the maximum one in the morning and the maximum one in the afternoon were highlighted. See peak hour analysis in Table 32 located in Appendix E.

On the other hand, the time ranges considered in traffic counts are the ones listed below. In order to generate matrices that include both peaks, the second and sixth time ranges were used. So, the two *time range matrices* were created, one for trips performed between 7:00 and 9:00 and the other one for trips in between 17:00 and 20:30.

1. From 00:00 to 07:00
2. From 07:00 to 09:00
3. From 09:00 to 13:00
4. From 13:00 to 14:30
5. From 14:30 to 17:00
6. From 17:00 to 20:30
7. From 20:30 to 24:00

The three mentioned matrices (morning peak, afternoon peak and entire day analysis) were generated considering the traffic from a specific day. In order to select the appropriate day some computations were carried out. Like it was explained above (in section 4.1.1), the IMQ information was separated in two tables. The first one includes some general information asked in the interviews and the second one the trip information given by the respondents. Taking this into consideration, first a cross-reference was made between the two tables in order to assign a date to each trip. In order to do so, the date of the interview was assigned to each trip and then the date of the trip was considered as the day before the interview. IMQ 2013 specifies that: “Nel corso del colloquio telefonico sono state chieste alcune informazioni riguardo gli spostamenti effettuati il giorno precedente…” [During the telephone interview, some information was asked about the movements made the previous day] (Agenzia della Mobilità Piemontese, 2022).

Secondly, the weight of each trip was calculated. In order to do so, the weight was considered to be inversely proportional to the sampling rate, already given in the trip information table. Also specified in the survey: "…le informazioni campionarie dovranno essere quindi ponderate con pesi inversamente proporzionali al tasso di campionamento…" [The sample information must therefore be weighted with weights inversely proportional to the sampling rate] (Agenzia della Mobilità Piemontese, 2022).

Last, using the month and the day in which each trip was performed and the weights, the following pivot table was created (Table 4).

Table 4

Amount of trips in the universe performed per month in each day of the week by residents of Piedmont in the Metropolitan Area of Turin according to the IMQ 2013 interviews

	Monday	Tuesday	Wednesday	Thursday	Friday	Total
2013-04	60.094	51.266	26.034		38.447	175.840
2013-05	275.210	288.468	177.479	326.491	303.060	1.370.708
2013-06	29.846	76.739	67.127	55.437	52.324	281.472
2013-09	37.265	18.440	20.475	27.869	28.953	133.001
2013-10	73.478	119.755	116.022	111.020	64.672	484.947
2013-11	72.558	78.511	78.578	85.072	56.061	370.779
2013-12	17.406	20.071	284	145	74	37.979
Total	565.857	**653.250**	485.999	606.033	543.589	2.854.728
Average 5	570.946					
Average 3	581.761					

Considering Table 4, the day of the week with the higher traffic is Tuesday which sums a total of 653.250 trips. As a consequence, the matrices that were generated and used in this thesis are those that consider the traffic during Tuesday of trips using the car as the transportation method. To consider all cars, the two categories from IMQ 2013 that were used are *car as a driver* and *taxi*.

It is important to highlight the big difference between the totals of each day of the week. Normally, when analysing trips by day, Monday and Friday have a different distribution because they are closer to the weekend. Anyways, Tuesday, Wednesday and

Thursday should have a similar total. According to IMQ 2013, the traffic on Wednesdays is a 25% lower than the one on Tuesdays. When considering the average values, *average 5* indicates the average between the five days of the week and *average 3* the one between Tuesday, Wednesday and Thursday. It is possible to say, then, that the value for Tuesdays is 12,5% higher than the average between all days of the week and 11% higher than the average between that day, Wednesdays and Thursdays. The high difference between the days of the week could mean that there is an error or some bias information considered in the survey. Anyways, the matrices used in this thesis are generated with the traffic situation on Tuesdays in order to consider the higher amount of trips and therefore the worst case scenario.

Finally, the matrices were obtained by creating pivot tables considering origin, destinations, trips weights and some filters. The three matrices used as prior matrices and produced with all the information mentioned above are located in Appendix F as Matrix 18, Matrix 19 and Matrix 20. In general terms these matrices illustrate the following information:

1. Trips between 7 and 9am on Tuesdays performed by car
2. Trips between 5 and 8:30pm on Tuesdays performed by car
3. Trips on Tuesdays performed by car

In the *time range matrices*, an average between departure and arrival time was done. Then, the time considered in order to filter trips and create both matrices, is the average time. Like this, the trips that start in one time range and finish in another are included in the time slot to which the mean time between departure and arrival belongs to.

4.2. Considerations regarding the Traffic Counts used in the Project

The input information used in the model in which this thesis is based, is prior matrices, traffic counts and trip ends. For the project, the traffic count data from the year 2019 available within the Transportation research group of Politecnico di Torino was used. The given information contains the values of traffic counts for the peak hour of the seven days of the week and also different values that correspond to different times. So every count had 56 values associated to it: seven for the seven days of the week and other seven values per day (recorded at different times of the day). The time ranges considered in the information are those mentioned in the previous section (4.1.4).

4.2.1. Traffic Counts and Peak Hour

Several analysis and calculations were done with the given data and like this, the day with the higher traffic volume in the peak hour was defined for every count. Considering the morning peak hour calculated with the Open Data file given by IMQ 2013 (8.30am) it is possible to say, then, that the morning peak hour is included in the 07-09am time range. So, the amount of counts that have the maximum volume, between 7 and 9am, in the same day of the week were added up together. Finally, it was determined that, from 89 counts, 62 of them had a higher traffic volume in Tuesday. This is also consistent with the information obtained by IMQ 2013 were Tuesday are the day of the week with the higher amount of trips (see section 4.1.4). In Table 5 and Figure 13 , it is possible to see the amount of counts that have higher traffic in each day of the week.

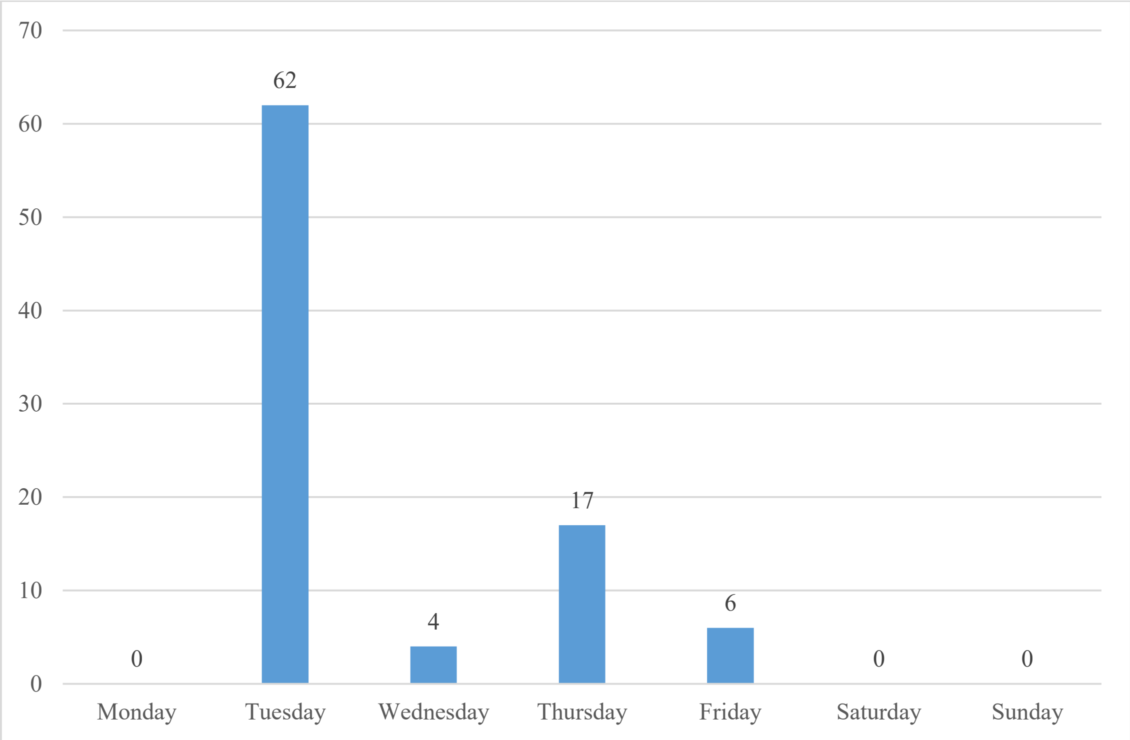
Table 5

Day of the week with the maximum traffic volume in traffic counts in between 7 and 9am

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0	62	4	17	6	0	0

Figure 13

Day of the week with the maximum traffic volume in traffic counts in between 7 and 9am



In addition, some computations were performed in order to analysed the development of traffic counts during one week. In order to do so, five random traffic count positions were chosen and the continuity of the amount of counts at different days (between time range 07-09am) are illustrated in the figures below (Figure 14, Figure 15, Figure 16, Figure 17 and Figure 18).

On all of the figures except Figure 15, the maximum traffic in between 7 and 9am occurs on Tuesday, lending support to the conclusion made from Table 5 and Figure 13. On the other hand, in Figure 15 the difference between the maximum value (occurring on Thursday) and the one from Tuesday is minimal. While the highest value is 507, that one of Tuesday is 505.

Also, it is important to highlight the fact that during the weekends the traffic volumes decrease quite substantially. This is consistent with the fact that, quite possibly most of the trips performed between 7 and 9 am are home-based-work trips (HBW). This kind of trip, already explained in section 3.3.2, considers movements done between the home of individual performing the trip and the work place of the same individual. By definition, then, HBW trips decrease substantially during weekends.

Figure 14

Traffic count information in 7-9am range during an entire week (Corso Novara - LNG: 7,70329; LAT: 45,07654)

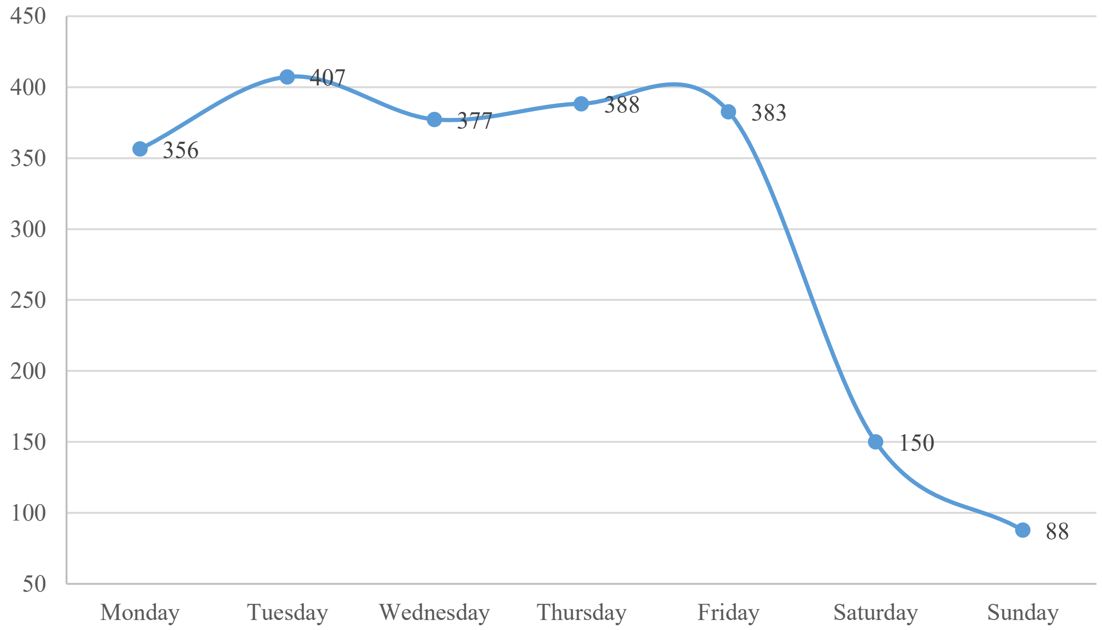


Figure 15

Traffic count information in 7-9aam range during an entire week (Corso Peschiera - LNG: 7,65548; LAT: 45,0624)

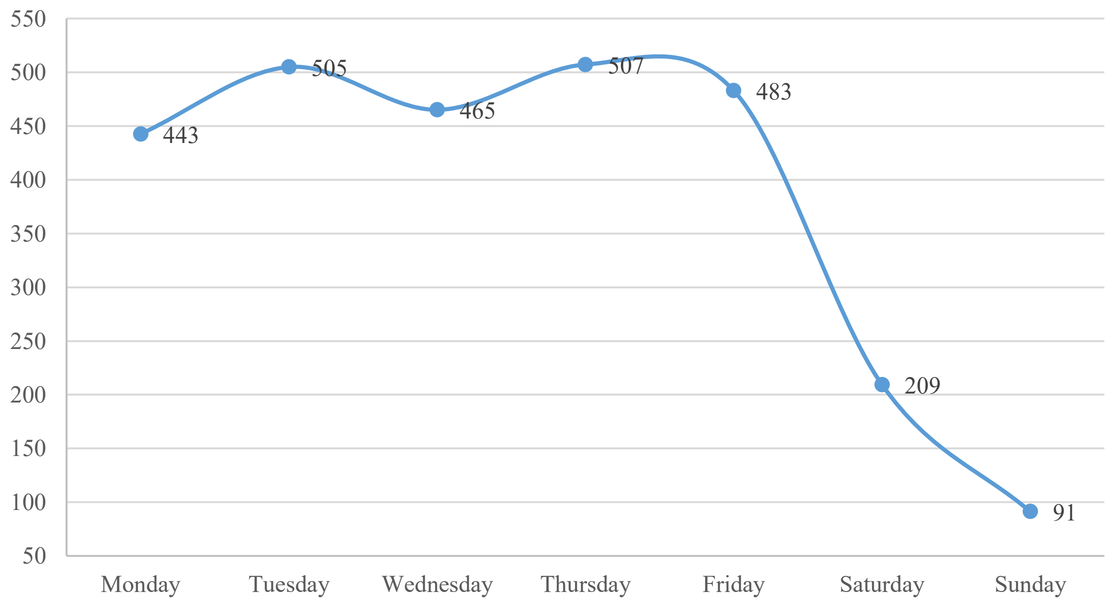


Figure 16

Traffic count information in 7-9am range during an entire week (Corso Regina Margherita - LNG: 7,65943; LAT: 45,08468)

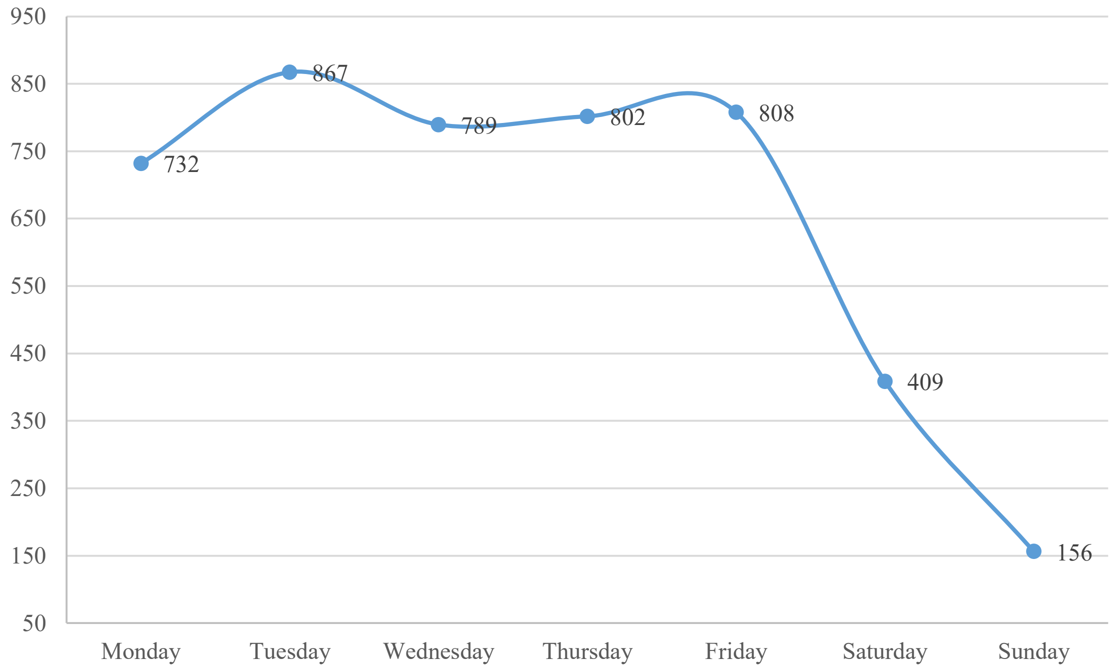


Figure 17

Traffic count information in 7-9am range during an entire week (Corso Rosselli - LNG: 7,65454; LAT: 45,05354)

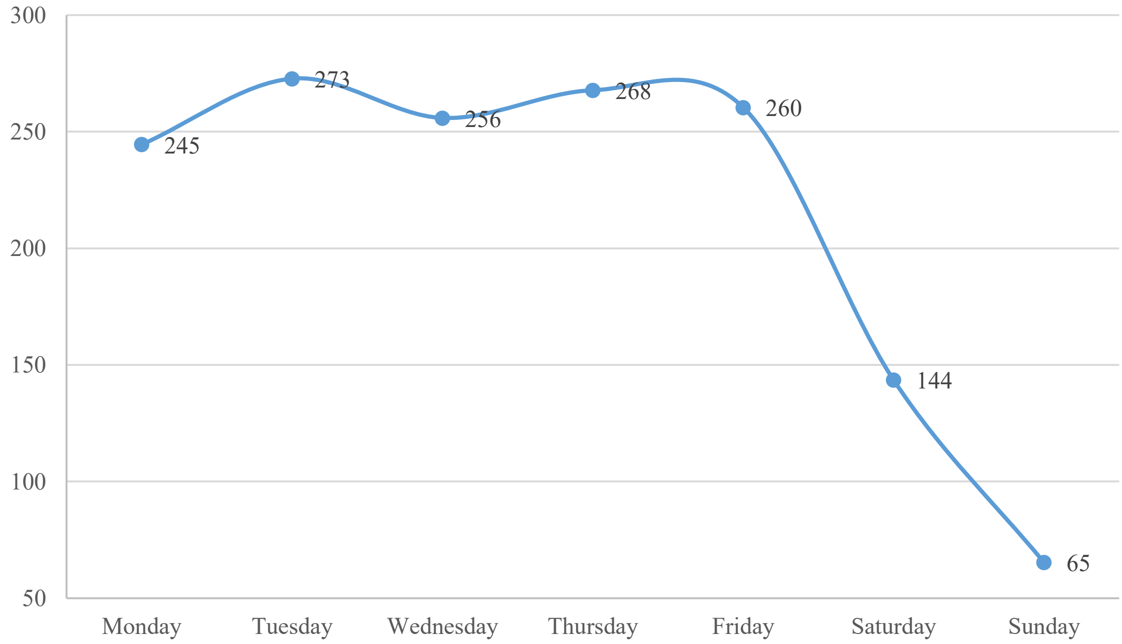
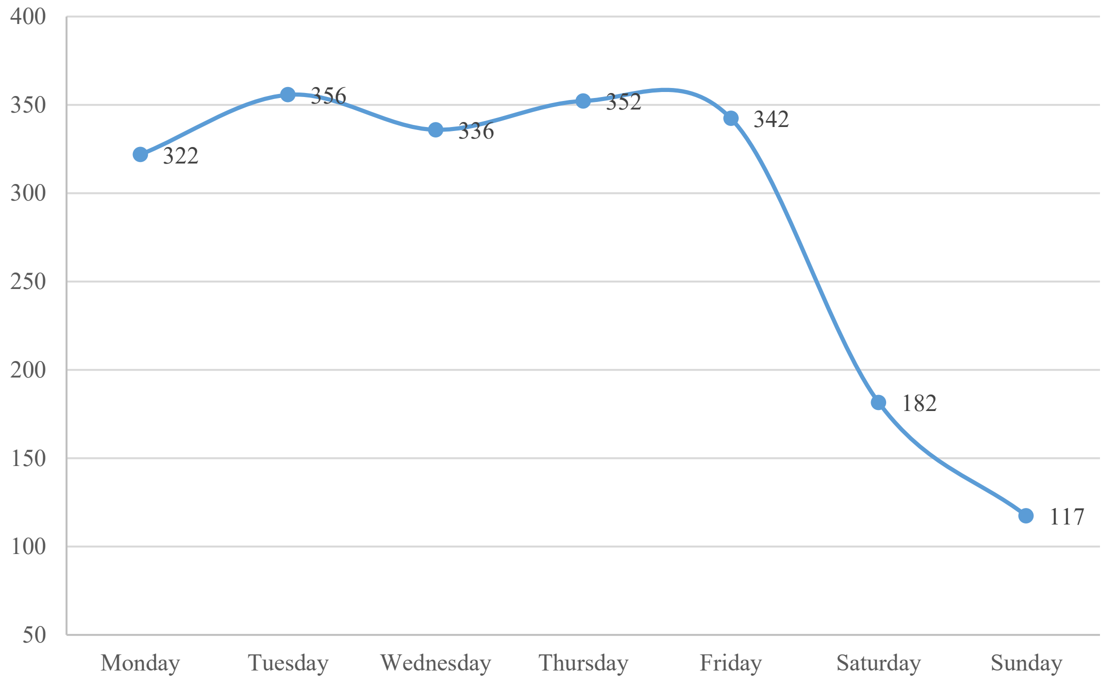


Figure 18

Traffic count information in 7-9am range during an entire week (Corso Vittorio Emanuele II - LNG: 7,68165; LAT: 45,06174)



Then, the same procedure was done considering the afternoon peak (6pm) included in the time range between 17:00 and 20:30. For this peak, the configuration is quite different. From Table 6 and Figure 19 it is possible to see that the day that have more amount of counts with the maximum volume between 17:00 and 20:30 is Wednesday. Also from these, it is possible to observe that the maximum volumes are more dispersed than in the previous analysis. So, although most of the maximum volumes occur on Wednesdays a high percentage of the maximums also happen on Thursday and to a lesser extent on Fridays and Tuesdays.

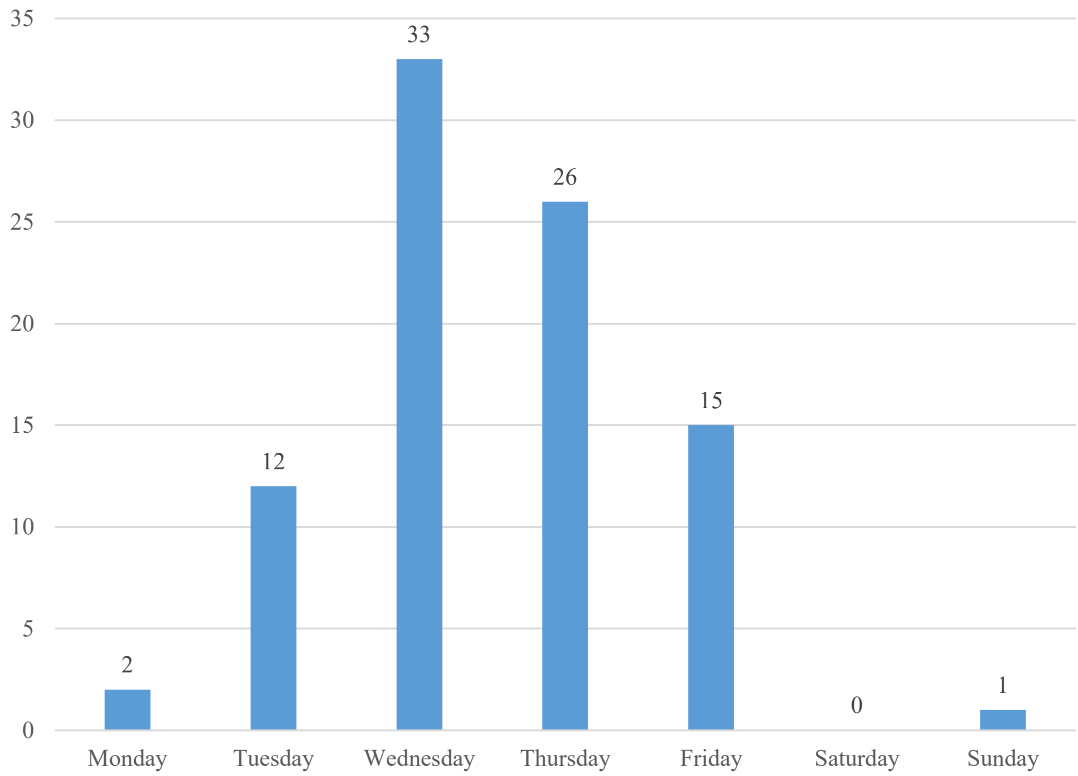
Table 6

Day of the week with the maximum traffic volume in traffic counts in between 5 and 8:30pm

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
2	12	33	26	15	0	1

Figure 19

Day of the week with the maximum traffic volume in traffic counts in between 5 and 8:30pm



Like mentioned above while in the morning peak, almost 70% of counts had the maximum volume on Tuesday, in the afternoon peak the distribution is more dispersed. So, for the afternoon peak, 37% of the counts have a maximum volume on Wednesday, 29% on Thursdays, 17% on Fridays, 13% on Tuesdays and the rest between Mondays and Sundays.

The computation of the development of traffic for the time range in which the afternoon peak is included, is shown in Figure 20, Figure 21, Figure 22, Figure 23 and Figure 24. In these figures, it is possible to see the dispersion of maximum volumes. Anyways, it is also clear that the values in the weekdays (from Monday to Friday) are quite uniform while there is a decrease of counts during the weekends.

Figure 20

Traffic count information in 5-8:30pm range during an entire week (Corso Novara - LNG: 7,70329; LAT: 45,07654)

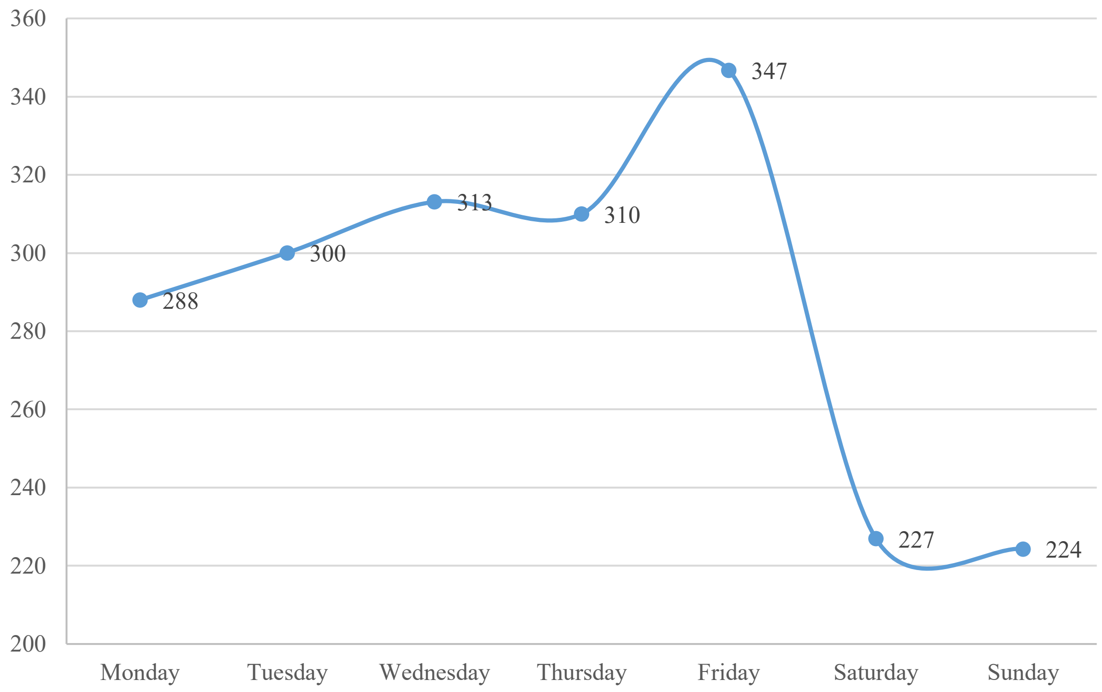


Figure 21

Traffic count information in 5-8:30pam range during an entire week (Corso Peschiera - LNG: 7,65548; LAT: 45,0624)

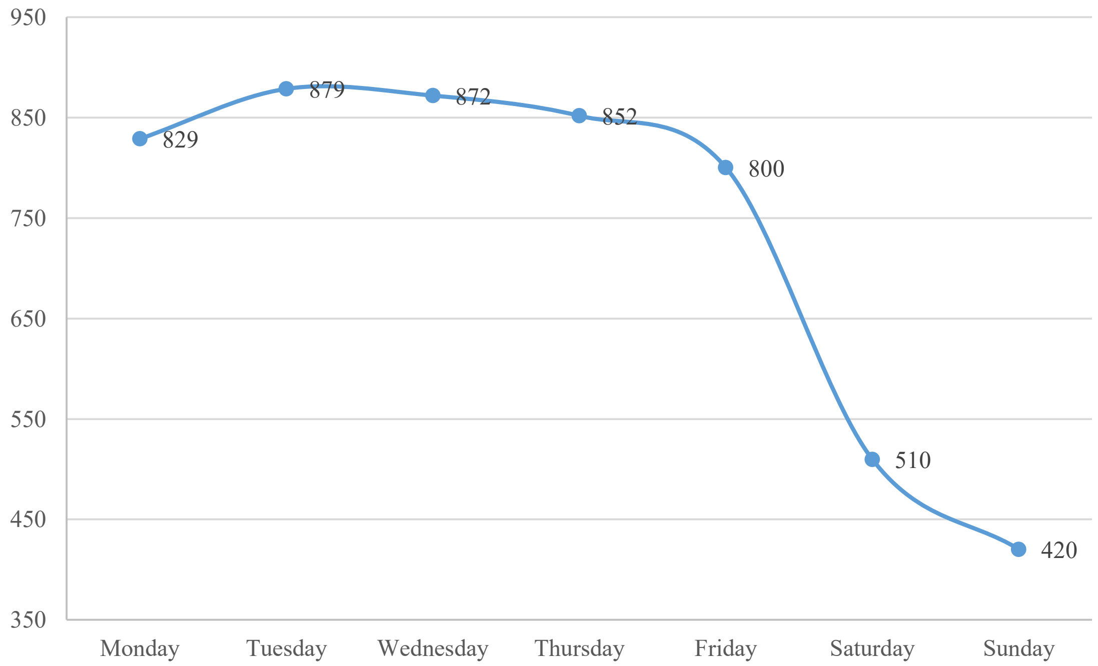


Figure 22

Traffic count information in 5-8:30pm range during an entire week (Corso Regina Margherita - LNG: 7,65943; LAT: 45,08468)

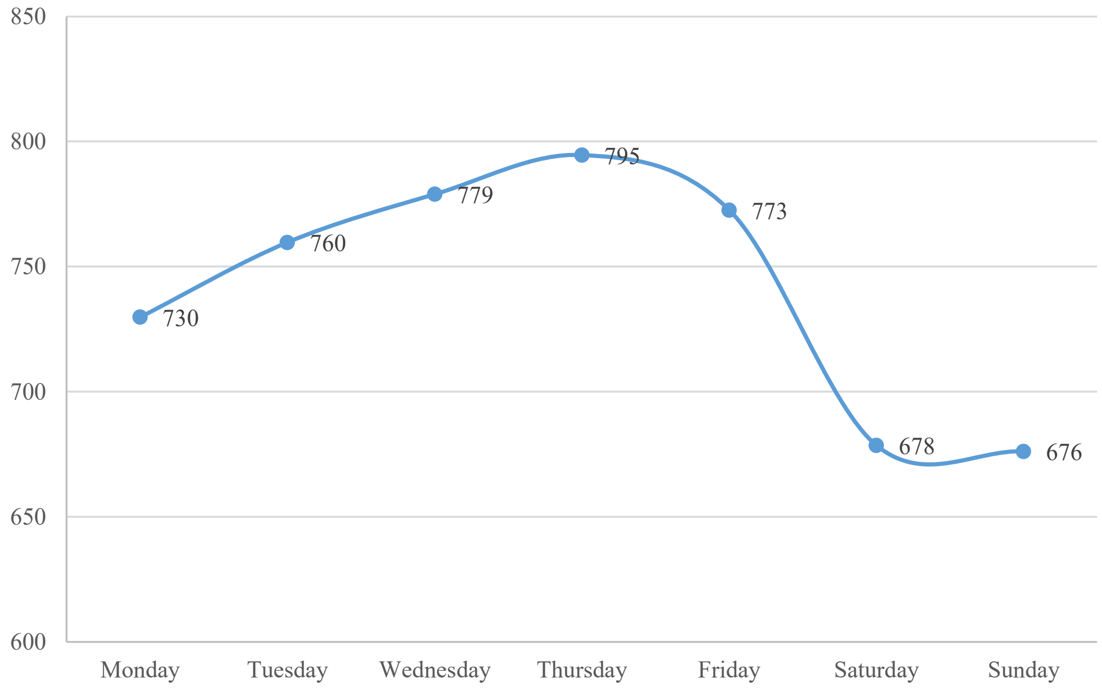


Figure 23

Traffic count information in 5-8:30pm range during an entire week (Corso Rosselli - LNG: 7,65454; LAT: 45,05354)

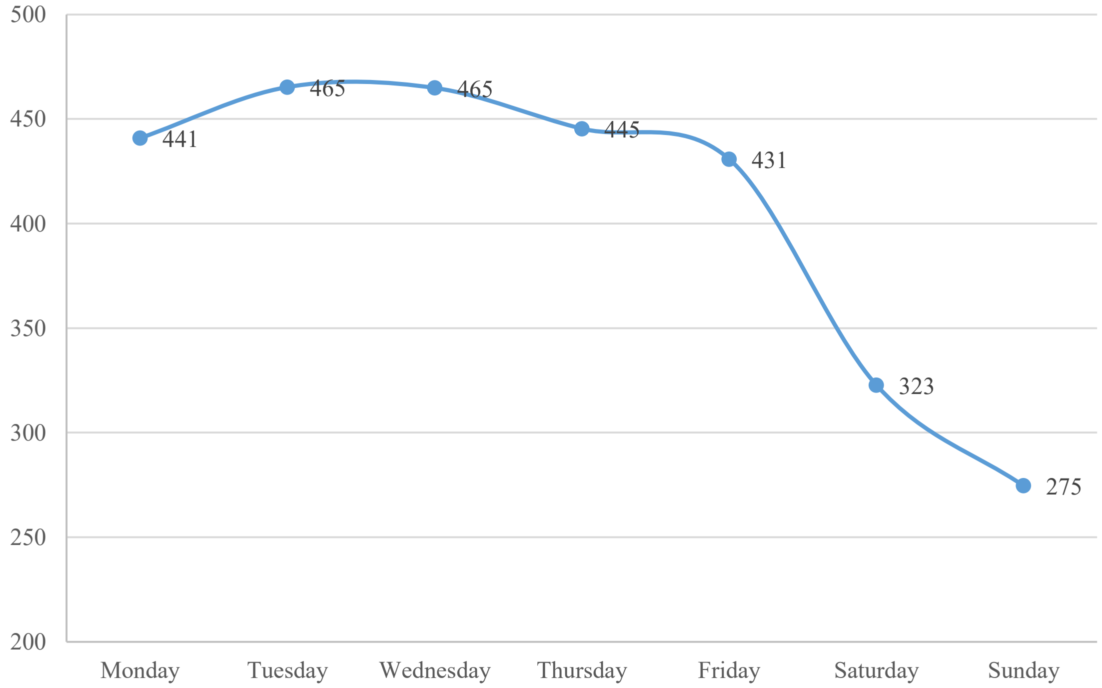
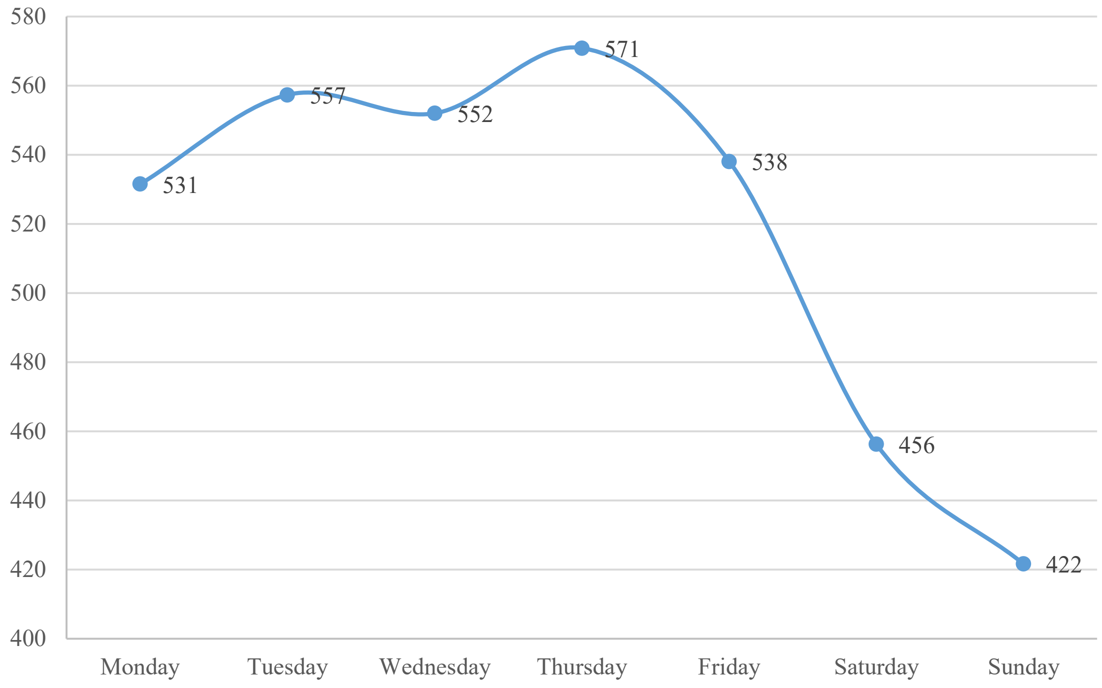


Figure 24

Traffic count information in 5-8:30pm range during an entire week (Corso Vittorio Emanuele II - LNG: 7,68165; LAT: 45,06174)



4.2.2.An Entire Day Analysis for Traffic Counts

Moreover, an analysis procedure was performed in order to understand the movements of traffic during an ordinary week day. In this case, the traffic volumes during Tuesday in the same five traffic count position were considered. Tuesday was taken into consideration in order to be consistent with the matrices generated in the previous section (4.1.4).

From the figures below (Figure 25 to Figure 29) it is possible to see that the distribution of traffic throughout the day depends on the position on the count. Given that, if the count is located on the way to a factory zone or a financial zone, most probably most of the movements will be HBW trips made at times where individuals enter and leave the work place. On the other hand, if the count is located on a commercial area, not only individuals that work in the area should be considered but also the clients.

Figure 25

Traffic count information during Tuesday (Corso Novara - LNG: 7,70329; LAT: 45,07654)

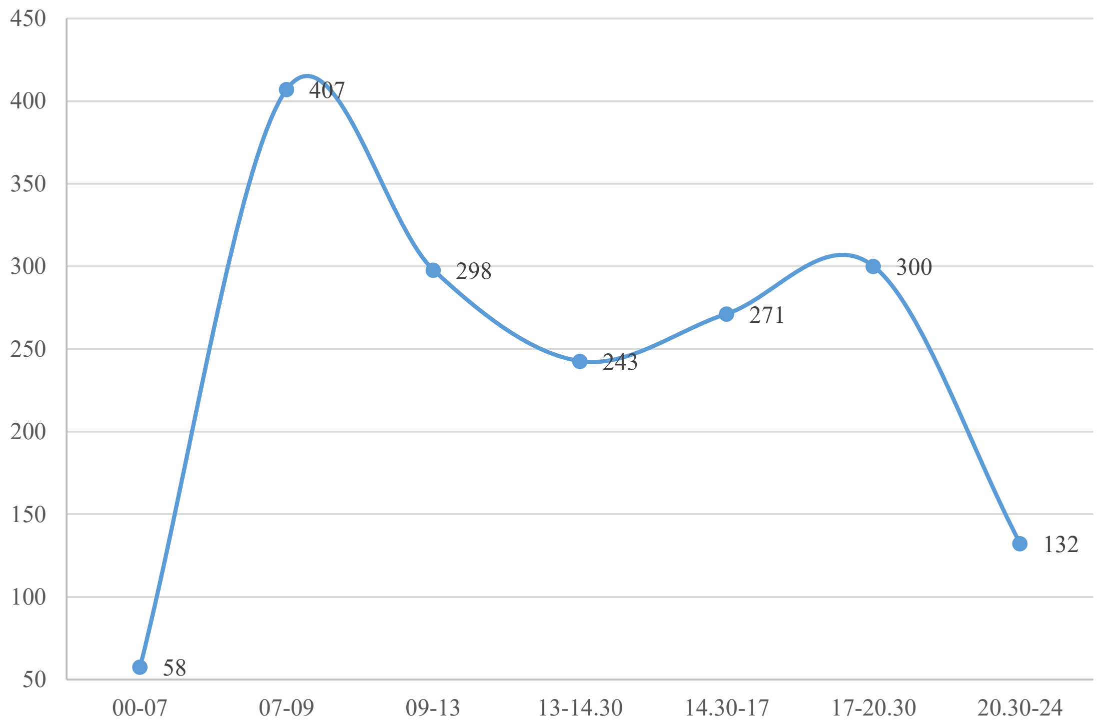


Figure 26

Traffic count information during Tuesday (Corso Peschiera - LNG: 7,65548; LAT: 45,0624)

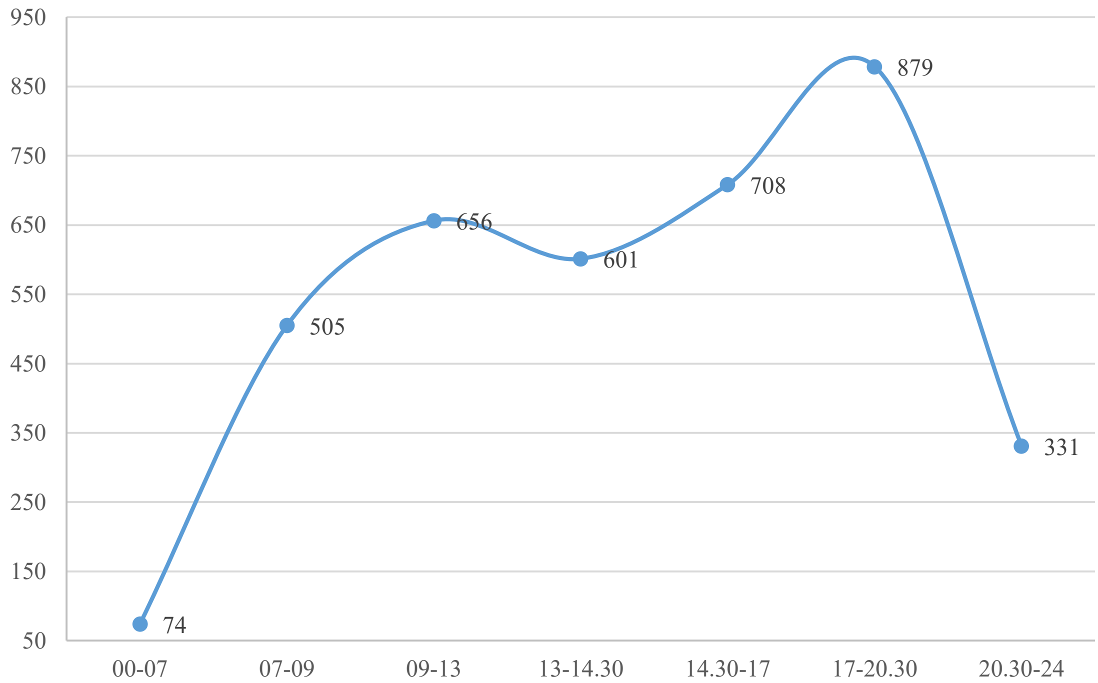


Figure 27

Traffic count information during Tuesday (Corso Regina Margherita - LNG: 7,65943; LAT: 45,08468)

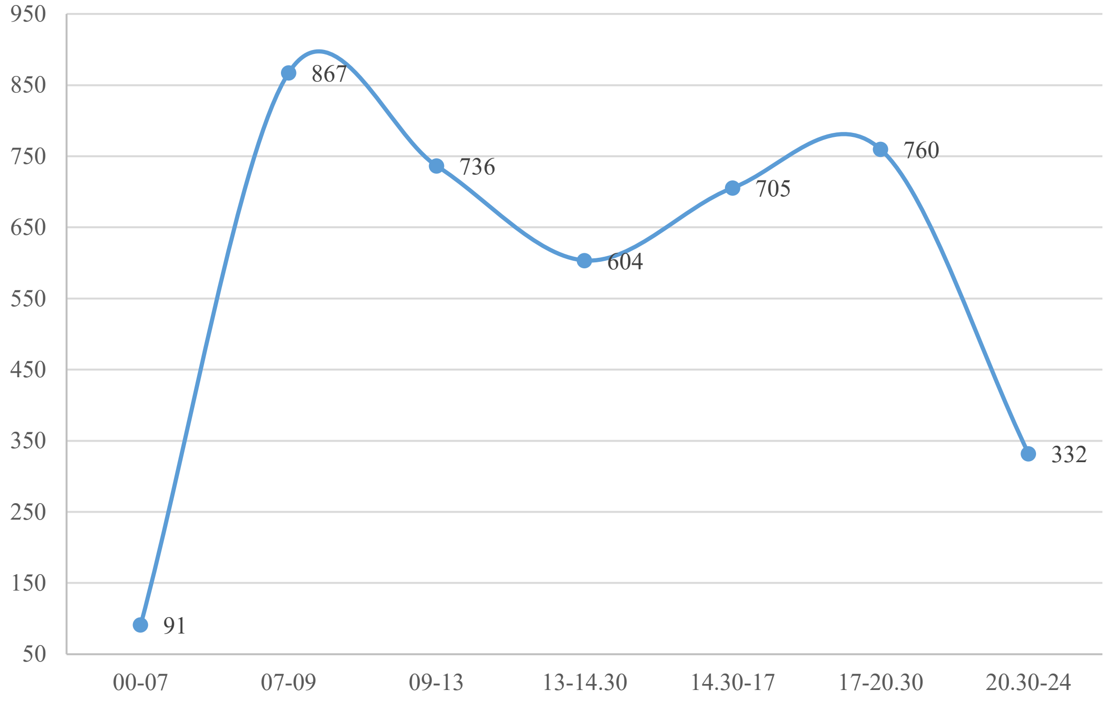


Figure 28

Traffic count information during Tuesday (Corso Rosselli - LNG: 7,65454; LAT: 45,05354)

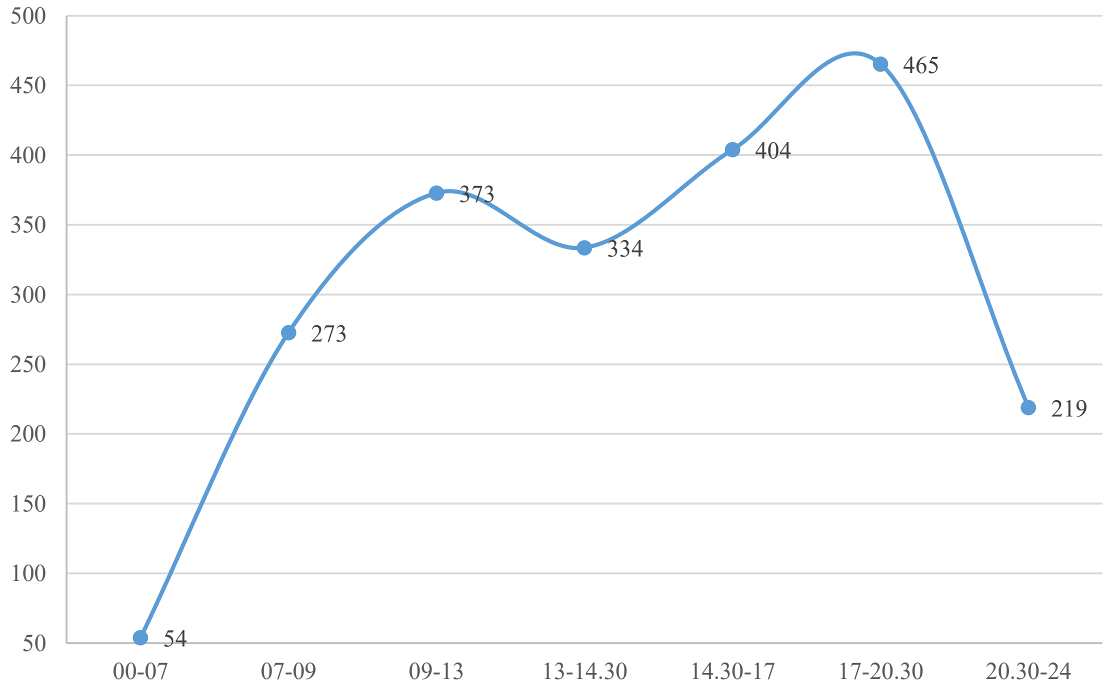
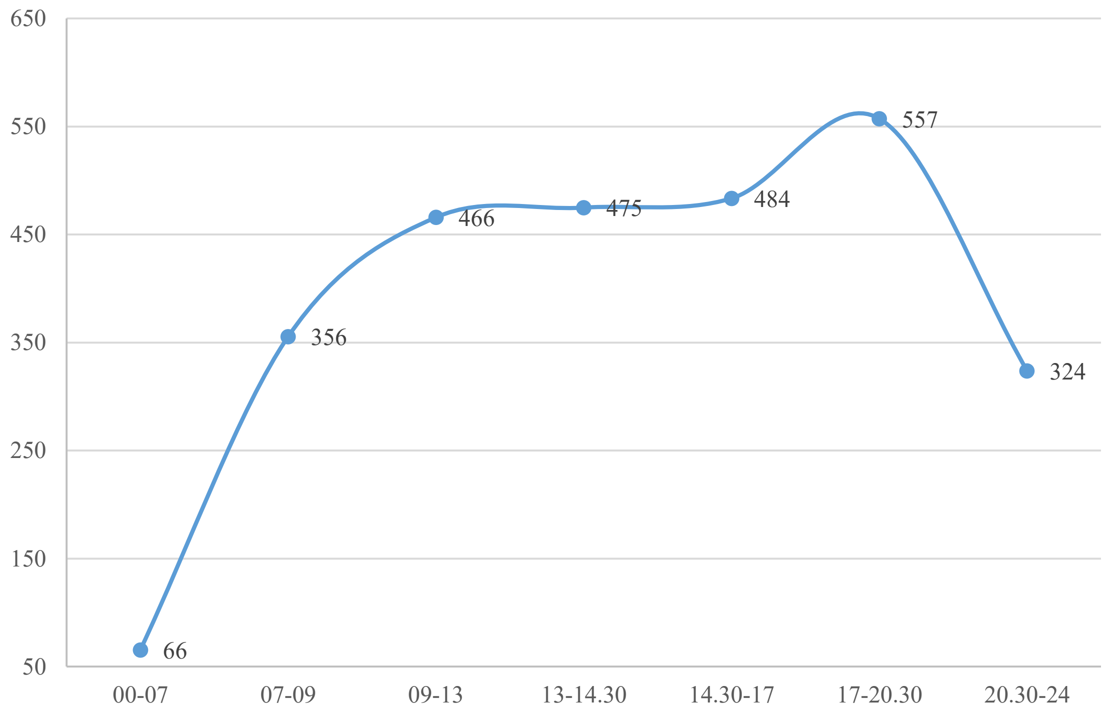


Figure 29

Traffic count information during Tuesday (Corso Vittorio Emanuele II - LNG: 7,68165; LAT: 45,06174)

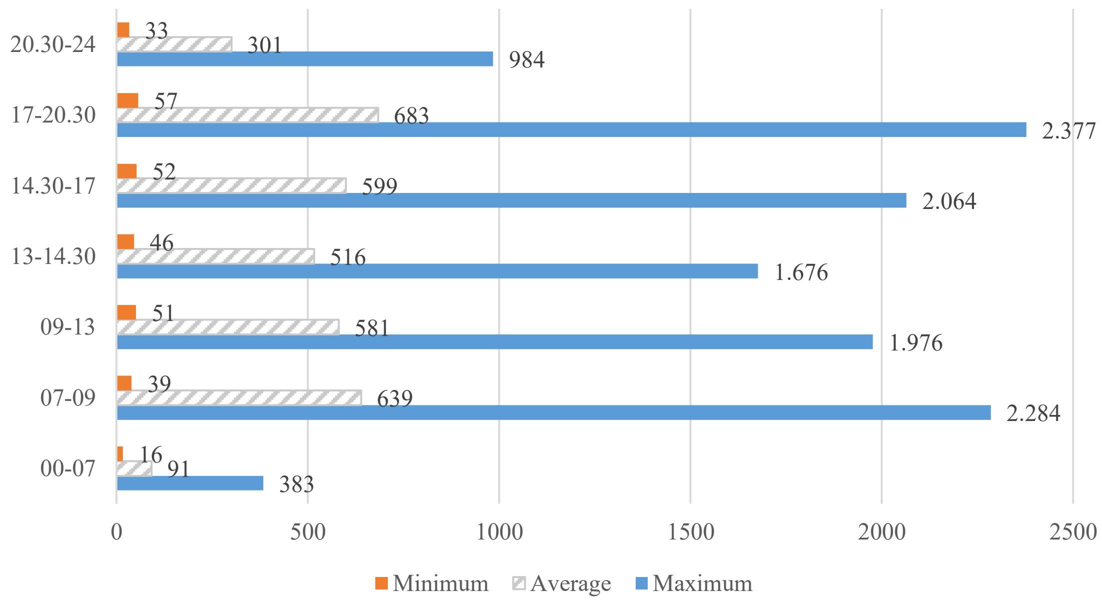


4.2.3. Traffic Counts per Time Range

Finally, an analysis on the amount of vehicles passing through counts at the different time ranges during Tuesday was performed. In Figure 30 a general scheme of all traffic counts at different times is shown. So, from this figure it is possible to see the minimum, maximum and average amount of vehicles passing in between both time slots. The values were taken considering the 89 traffic counts used in the project.

Figure 30

Amount of vehicles during Tuesday in different time ranges



Also, in Table 33 located in Appendix G the amount of vehicles in each count is listed for both peak times. The table is organized in order to show the values of traffic counts from smaller to larger according to the morning peak hour. From this table it is possible to realize in more detail the amount of vehicle per location at each time slot.

.

4.2.4.Heavy Vehicles versus Light Vehicles in Traffic Counts

As stated at the beginning of the section, traffic counts information is a crucial input data used in the creation of the model done for this thesis. The aim of adding traffic counts in the project is that one of updating the prior matrices produced with the IMQ 2013 data. In order to use the traffic counts and the IMQ matrices generated together, it is necessary to consider the fact that traffic counts include heavy vehicles and consequently reduce the value of counts so as to include only light vehicles.

The traffic count information used in the development of this thesis, do not differentiate between light and heavy vehicles. To obtain the percentages used in the reduction of the traffic count values, some other traffic counts were considered. This new data provides information on the values of counts in 23 arcs that enter the city of Turin. Given that, generally, there are more heavy vehicles entering the city that driving through the city some computations were done. For the 24hs analysis (entire day) all the flows of the day were summed up and the percentage of heavy vehicles for each arc was calculated. Finally, the first quartile of the distribution of the 23 values was considered as the percentage to use. For the morning and afternoon peaks, the same procedure was done but considering the times included in the correspondent time slot. As a result, the traffic counts values were reduced a 6% for the entire day analysis done for Tuesdays, a 7% for the morning peak analysis and 3% for the afternoon peak. In Table 34 located in Appendix G, the computations explained above are illustrated. Also, in Table 35 located in Appendix G, the traffic counts values used in this thesis with the heavy vehicle reduction are shown.

4.3. PUMS Matrices used as Trip End Information

Up to now, the two pieces of important information introduced in this thesis and therefore used in the model to update O/D matrices are: IMQ matrices and traffic counts. As explained in section 3.3.3, trip end information can be also very useful when estimating matrices with OmniTRANS. In order to determine the trip end information used in this work, some matrices generated for the year 2019 in the context of the *Sustainable Urban Mobility Plan - Piano Urbano della Mobilità Sostenibile* (PUMS) were used.

The PUMS was introduced in the Italian legislation approximately twenty years ago, in order to overcome the limitations of the *Piano Urbani del Traffico*, confined to the management of the existing networks. The PUMS was then made mandatory for urban areas of at least 100,000 inhabitants from 2017. This new approach aim was to define the framework of strategic interventions, to be implemented in the short, medium and long term, in order to create and introduce policies in the urban mobility system. The PUMS understood the urban mobility system as a whole made up by different components (public transport network, individual motorized traffic, non-motorized mobility).

In the PUMS (Piano Urbano della Mobilità Sostenibile) report called *Rapporto Finale*[11] published in May 2021 by *Città Metropolitana di Torino* a reconstruction of the demand mobility in the year 2019 was made. Such reconstruction was performed in the Province of Turin using data released by the TIM/Olivetti Big Data platform, obtained by processing the anonymized traces of individual's GPS devices whose owner, for whatever reason, spend part of their time within the boundaries of the Province of Turin.

In the report, the demand mobility obtained using the GPS information was expressed with three different matrices. The first (Matrix 21 located in Appendix H) shows the movements of residents and workers of Piedmont while the second one (Matrix 22 located in Appendix H) expresses the movements of residents of other regions that work or study in Piedmont. The third (Matrix 23 located in Appendix H) shows the movements done for reasons other than work and study.

Analysing the above matrices and following the reasoning described in the mentioned report, it is possible to see that the summation of matrices totals is around two million movements (exactly 2.009.611 movements) which is almost half of the movements shown for the same area and same period of time in the IMQ reports for 2013. As a consequence of such mismatch, it appears that the TIM data were not much used when elaborating the PUMS for the Turin metropolitan area in 2021. This conclusion was considered in this thesis and a hypothesis was created to be able to use such data.

It is clear, by the difference between the IMQ information and the summation of Matrix 21, Matrix 22 and Matrix 23 located in Appendix H that either the calculated GPS matrices (matrices from the PUMS report) are mistaken or that they represent something other than individual trips. The hypothesis considered for this thesis is, that these matrices represent tours rather than trips. According to McGuckin and Nakamoto (2004):

[11] Retrieved October 13, 2022 from: http://www.cittametropolitana.torino.it/cms/risorse/trasporti-mobilita-sostenibile/dwd/pums/RapportoFIN_v10.pdf

As a result of the research conducted in this process, FHWA has developed an operational definition of a "trip chain" as a sequence of trips bounded by stops of 30 minutes or less. A stop of 31 minutes or more defines the terminus of a chain of trips, and that chain of trips is considered a tour. (p.3)

4.3.1. Considerations to Transform IMQ trip matrices into tour matrices

In order to test this theory, the IMQ raw data information was grouped so as to create tour matrices that were, then, possible to compare to those shown in the PUMS report.

The first step was to group the trips into tours. IMQ provides how many times the interviewee leaves home within the observation period (exits) and the number of the movement made by every individual being interviewed. Then, in this work, all trips performed in the same exit number were considered part of one tour. In other words, if a same individual performed a first exit composed of three movements and a second one composed of four movements, that would represent two tours (the first including three single trips and the second four).

The second important step was the definition of the departure and arrival zones. The departure zone was always considered as the zone from which the tour starts. In other words, the departure zone of the first trip in the tour. On the other hand, the arrival zones were considered as the arrival zone of the last trip in the tour only if this zone was different compared to the departure zone of the tour. Otherwise, the tour's arrival zone was considered as the departure zone of the last trip involved in the tour. This was done because most tours considered the return home as their last trip. If this consideration was not made, the tour matrices would consider most of the trips only in the diagonal of such matrices. In other words, most tours would start and end in the same zone (the individual's home).

To calculate the weight of each tour, in order to create the *tour matrices* referred to the universe, a relation was made between the summation of the weights of the trips composing the tour and the ratio between the total number of trips and the total number of tours. In other words, to calculate the weights, two extra matrices were created: the first one reported the amount trips between the origin-destination zones in the Province of Turin while the second one did the same with the tours. Then, the ratio between these two matrices grand total was calculated and the result was equal to 2,08 which is consistent with the fact that the PUMS reported that summated values of Matrix 21, Matrix 22 and Matrix 23 located in Appendix H show a grand total value that is about half the grand total value provided by IMQ. To round up, the weights of the tours were expressed as the summation of the weights of every trip in the tour divided by 2,08.

In order to perform a comparison, it was also very important to match the *dimensions* of the IMQ and the PUMS matrices. The IMQ matrices (analysed in this thesis) were created using the trip information of residents in Piedmont travelling in the Province of Turin. Then, Matrix 24 located in Appendix H was generated by summing up Matrix 21 and Matrix 23 and considering only the zones within the province. Matrix 22 was excluded given it considers movements performed by residents of other regions.

4.3.2.Zoning of IMQ and PUMS matrices

As it is possible to see in all the matrices from the PUMS report (Matrix 21, Matrix 22, Matrix 23 and Matrix 24) located in Appendix H, the zoning used in these matrices and derived from GPS information is quite different to the one used in IMQ and therefore in this work. The zones included in these matrices report show 11 zones composed of the municipalities listed in Table 36 located in Appendix H. In Figure 33 the zoning used in the PUMS matrices is illustrated. It is a fact, then, that in order to match and compare IMQ matrices to PUMS matrices it is necessary to aggregate the IMQ zones. The IMQ zones integrated in PUMS zoning are shown in Table 37 located in Appendix H and Figure 32. Finally, the aggregated tour matrix done with the IMQ 2013 raw data is illustrated as Matrix 25 located in Appendix H.

Figure 31

PUMS zoning. Division of the Province of Turin – From QGIS 3.4.4 Madeira

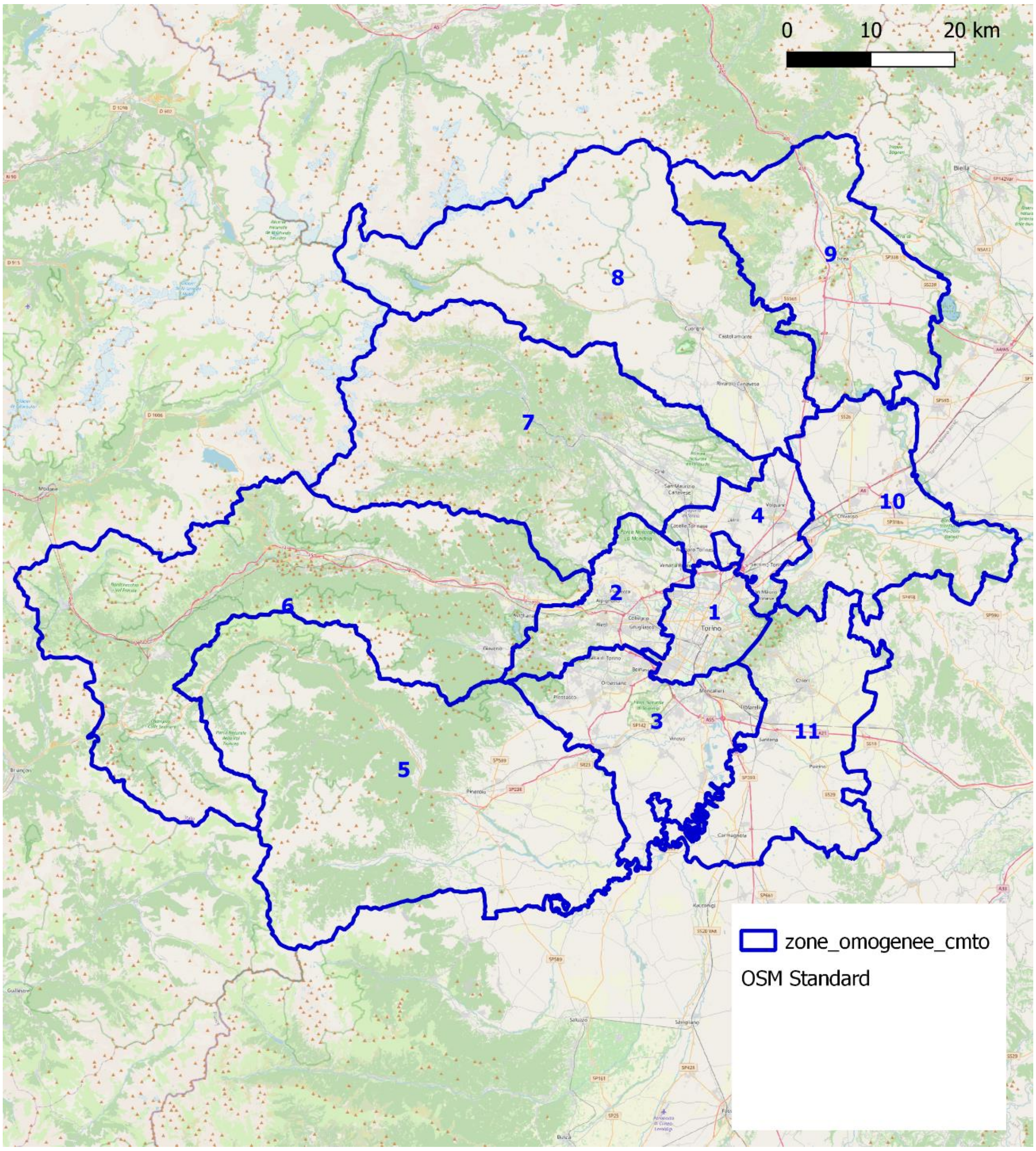
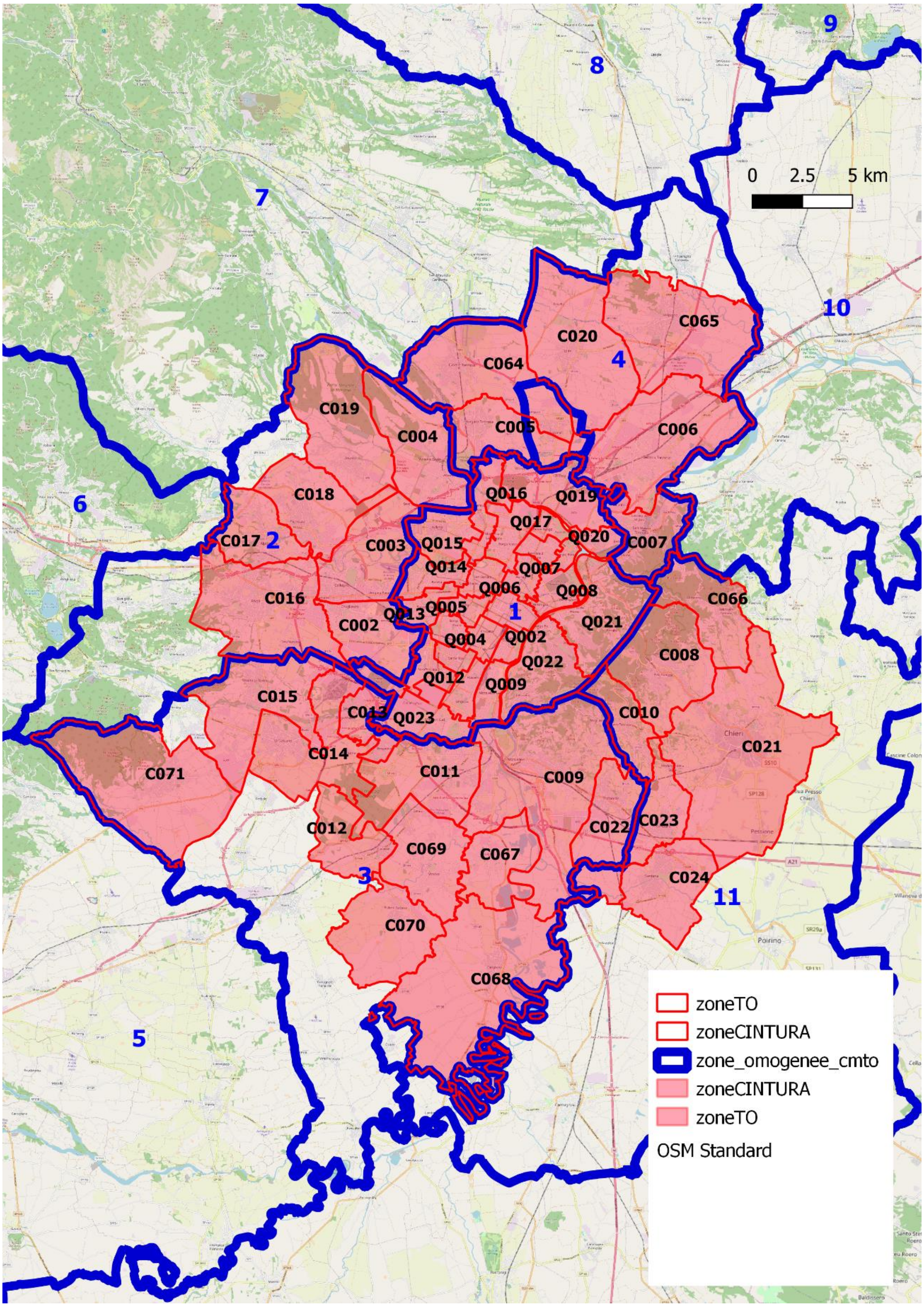


Figure 32

IMQ zones included in the PUMS zoning – From QGIS 3.4.4 Madeira



4.3.3. Validation of PUMS matrices

Comparing the summation of Matrix 21 and Matrix 23, expressed as Matrix 24, and Matrix 25 (all located in Appendix H) it is possible to see that the relative difference of the grand totals between both matrices is 20% while the relative difference in Turin is equal to 23%. In other words, the total values of the 2013 matrix are higher than those of the 2019 matrix. In Matrix 26, also located in Appendix H, the relative difference between every zone are shown and it is possible to see how the 2019 matrix (Matrix 24) decreases respect to the 2013 one (Matrix 25). This decrease is consistent with the decrease in the population of Turin and the decrease of mobility shown in the analysis made in section 4.1.3, Figure 8, Figure 9 and Figure 10. According to the webpage of *Istat (Istituto Nazionale di Statistica)* in the section *Ricostruzione della Popolazione 2002-2019*[12], the population at the beginning of 2013 (January 1) in the Province of Turin was equal to 2.286.885 while at the beginning of 2019, it was equal to 2.238.663 (this shows a 2% decrease). This decrease in the population is higher in the city of Turin (3,7%).

Finally, it is possible to say that in the analysis performed and explained above it was demonstrated the validity of the matrices shown in the PUMS report of May 2021, expressing such matrices as *tour matrices* rather than *trip matrices.* Therefore, the information provided by the PUMS report was used as a trip end constraint in the estimation of matrices in this work.

To sum up, the information produced by the IMQ survey conducted in the year 2013 is used in this thesis in order to create the OD matrices which are then presented as input data in the model (prior matrices). Also, the traffic count information taken from Politecnico di Torino is used in the model. Moreover, the tour matrices from the PUMS report (May 2021) are used as trip end information which is a constraint of the OmniTRANS model. The aim of the project is to obtain, through an estimation using the mentioned information (prior old matrices, traffic counts and trip ends), the up-to-date traffic volumes. Then, the renewed estimated volumes will represent the traffic behaviour from the year in which traffic counts and trip ends were obtained. The output of the model

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[12] Retrieved October 13, 2022 from: https://demo.istat.it/app/?i=RIC

is also presented as origin-destination matrices. In Chapter V, the methodology used to create the model and execute the matrix estimation and its results will be explained.

Chapter V

Estimation of Origin-Destination Matrices: Modelling, Procedures and Comparison of Results.

As briefly mentioned before (section 3.3), in order to perform the matrix estimation, it is necessary to have some input information such as a prior matrix, traffic counts, trip end information, among others. It is always beneficial to have a greater amount of input data so as to perform a more precise O/D matrix estimation.

In this dissertation, the estimation was carried out by using as a starting point a matrix developed with the IMQ 2013 information. This origin-destination matrix was, then, updated with traffic count and trip end information information from the year 2019 (pre-pandemic). The traffic count data was taken into consideration in the city of Turin while the surroundings and its centroids were included as *external areas.*

In this section, the model construction and the steps for its creation are explained in detail.

5.1. Model Setting

5.1.1.Zoning

To create the model, the first step is to import the zoning. Evidently, because information from the IMQ 2013 is being used, the sample zones of this project match that ones used in the IMQ surveys. As mentioned before (4.1.2), the study area is the city of Turin and its surroundings (also called *cintura* in the survey) and it is divided in 54 smaller zones. Like stated in Table 3 (page 54), only 23 of the sample zones belong to the city of Turin while the other 31 to its surroundings.

The IMQ zoning divides the city of Turin in different neighbourhoods and the surroundings in different municipalities. The list of sample zones are listed in Table 11 and Table 12 located in Appendix B. In these tables the IMQ code is specified and also the number assigned when importing them into OmniTRANS. It is also possible to see the zoning in Figure 3 and Figure 4 of section 4.1.2, pages 55 and 56.

To import the shapefile containing the zoning into OmniTRANS it was first necessary to join the layers containing the zoning of Turin and the zoning of the surroundings. In this case, the procedure was done using the QGIS 3.4.4 *Madeira* software. To do so, the layers *ZoneTO* and *ZoneCintura*, were selected and merged using the menu *Vector-Data Management Tools-Merge Vector Layers*. After that, the new layer containing the entire project's zoning was exported using the menu *Export-Save Feature As* and choosing the format, name, coordinates and location of the created file containing the zoning. In this case the format used was *ESRI shapefile.*

Finally, in order to add the shapefile into OmniTRANS, the menu *Project-Import-Shapefile (ArcView GIS)* was used. To add a shapefile, it is necessary to follow five steps:

1. Input folder: Select the folder where the shapefiles that are being imported are located.
2. Select ArcView.ini: If it is the first time importing the shapefile, the option *Use this wizard to build a new ARCVIEW.INI* should be selected.

3. Objects to import: Select the elements that are being imported (nodes, links, centroids, counts, screenlines, etc.). It is possible to import more than one element at a time.
4. Edit the database mapping: Using the Database Mapping Editor.
5. Various options: Six options have to be considered in this last step. *All areas are new*, should be selected when the areas cannot be found in the OmniTRANS database while *Use default "epsilon",* should be selected in order to consider as part of a screenline a count that is located near a screenline point. If the distance from the screenline point to the count is equal or below the *epsilon* value, then the count is considered as part of the screenline. In case the *Use default "epsilon"* is not selected, an *epsilon* value should be defined. Other options are *Use default values for missing link attributes* and *Overrule "snap" project setting.* The last one is used when elements like nodes or points are too close together and should be considered as only one object. Lastly, the final two options are *Reduce link points,* it is used because having many points can be very demanding for the software and *Scale link length.*

Once this five steps are completed, the importing job can be run and the desired layers will be added to the project.

5.1.2.Centroids

Continuing with the model creation and setting, it is also required to import into OmniTRANS the centroid of each zone. In this thesis, QGIS 3.4.4 *Madeira* was used for centroid location and creation. The process in order to define the centroids was explained above (section 3.2, page 34). Anyhow, it is important to detail the layers used in order to determine them:

- Resident Population in the city of Turin in the year 2013
- Residential buildings
- School buildings
- School areas

- Hospitals
- Hospital area
- Hospitalization facilities
- Commercial facilities
- Shopping centres
- Markets
- Cinema buildings
- Cinema area
- Theatre buildings
- Theatre area
- Museum buildings
- Museum area
- Library building
- Library area
- Parking facilities
- Parks
- Airports
- Train stations.

All of the layers were downloaded from *Geoportale Piemonte* and *Geoportale Città di Torino*.

Once these shapefiles were imported into QGIS (using the menu *Layer-Add Layer-Add Vector Layer*), centroids were defined (using the *Toggle Editing* and *Add Point Feature*). As mentioned before (section 3.1), when using centroids, it is assumed that all attributes of the sample zone are concentrated in one point. It is extremely important to place centroids considering that the aim is minimizing the aggregation error consequence of this assumption. In other terms, centroids are the points where all trips are assumed to begin and end and this supposition introduces some errors in the model which should be minimized. In Figure 33 and Figure 34 it is possible to see the centroid location done for this thesis.

Figure 33

Centroid location in the City of Turin - From QGIS 3.4.4 Madeira

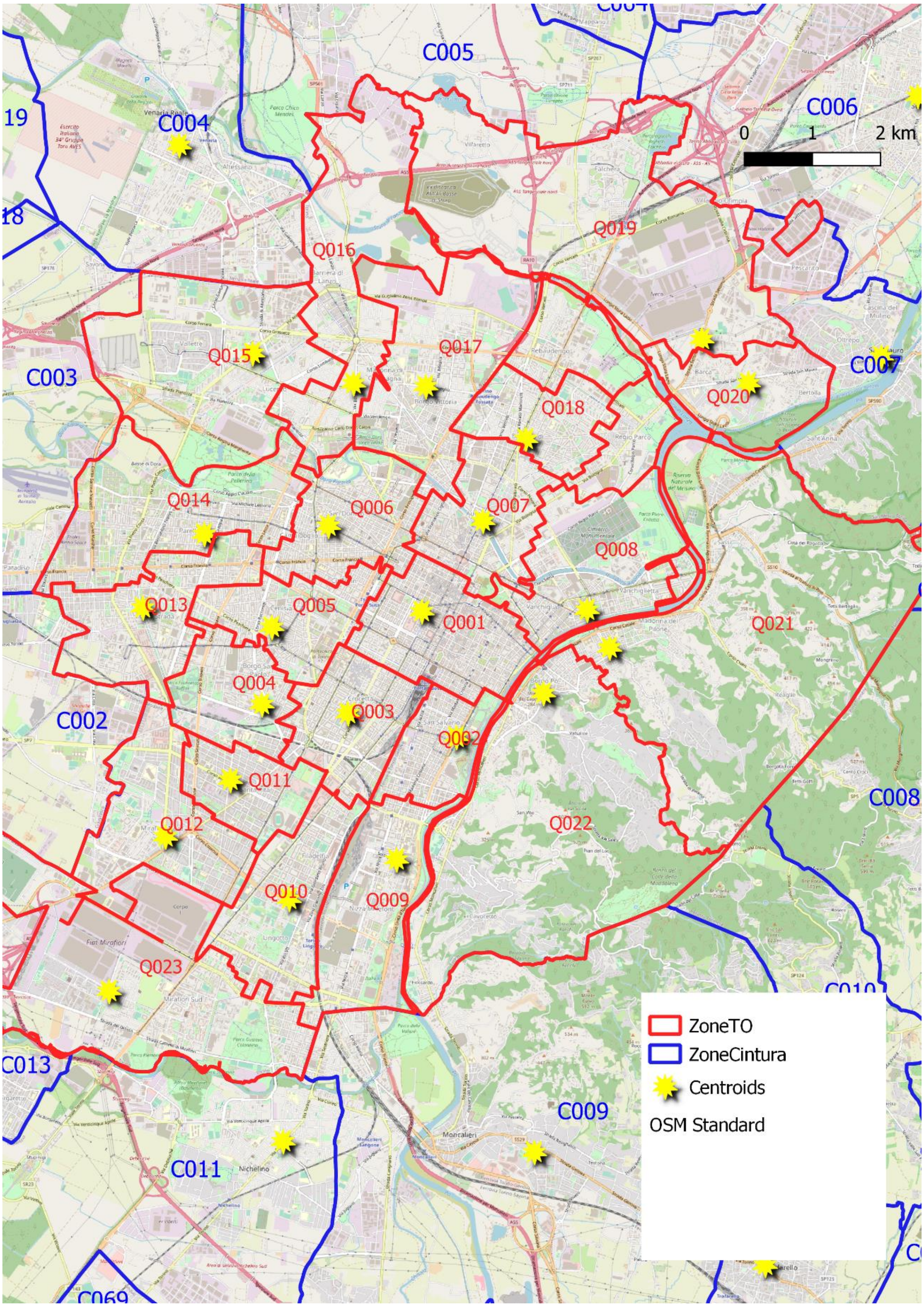
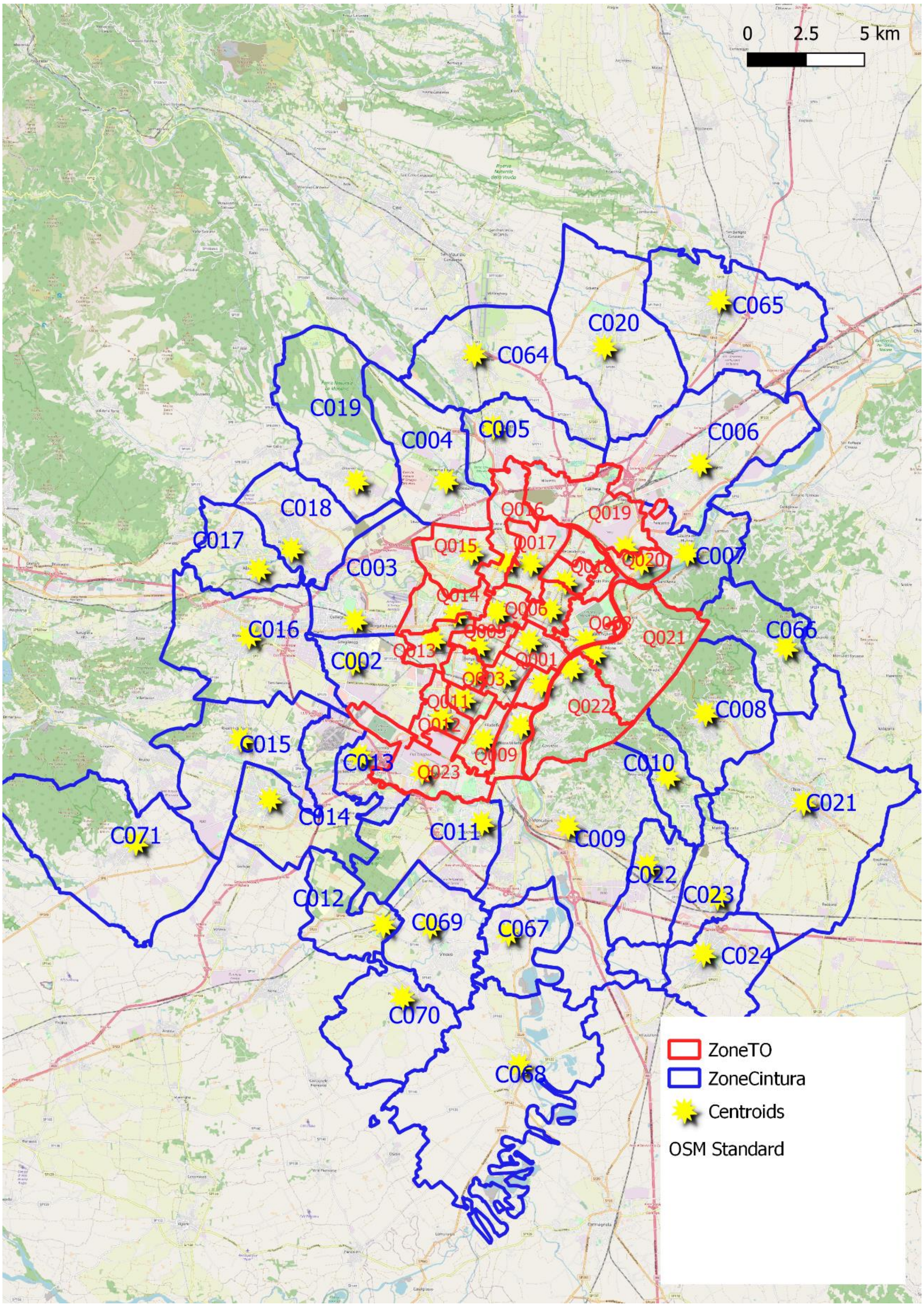


Figure 34

Centroid location in the Metropolitan Area of Turin - From QGIS 3.4.4 Madeira



The exportation of centroids from QGIS and importation into OmniTRANS was done following the same procedure explained for the zoning. It is important to highlight that in the importation of centroids into OmniTRANS, the software numbered them from 1 to 54. The number corresponding to every IMQ zone is illustrated in Table 11 and Table 12 in Appendix B.

5.1.3.Road Network

Next, it was necessary to define and import the road network (links and nodes). In this project, a graph representing the road network in the city of Turin that is available within the Transportation research group from Politecnico di Torino was imported into the OmniTRANS software. In order to import these data, the same procedure to the one used for the zoning was performed.

To connect the surroundings to the city's roads, many key roads and connectors were drawn manually, following the explanation in section 3.3.1. The connectors were defined after analysing the possible connections between the surrounding's municipalities and the city of Turin. So, the connectors that unite the centroids in the surroundings and the network represent the main access points into the city of Turin.

It is important to highlight that despite the fact that in reality all network infrastructures are used, in this model not all roads and highways were singled out. Four different kind of links were defined in order to recreate the infrastructure:

- Motorways
- Two lane roads
- Local roads
- Connectors.

The characteristics of each kind of links were assigned as shown in Table 7. The attributes illustrated in this table were determined in order to respect the reality of the existing network and simulate the traffic in such infrastructure. In Figure 35 and Figure 36 the network (centroids, links and nodes) used for the project is represented.

Table 7

Links attributes

	Speed	Capacity	Free Flow Speed[13]	Saturation Flow [14]	Speed at capacity
Motorway	80	4000	100	10	10
Two lane road	30	1000	30	10	10
Local road	20	1000	20	10	10
Connector	15	9999	30	1500	15

Note: the speed, the free-flow speed and the speed at capacity are expressed in km/h while the capacity and the saturation flow are expressed in veh/h.

5.1.4.Reference Map

Once the zoning and the infrastructure are defined in the software, it is possible to add a map that will facilitate the reading of the information. The background map is added as a picture by using the *Maps* button, the *Addition* button and drawing a rectangle on the screen. Holding the *Ctrl* key, it is possible to maintain the aspect ratio of the image used as a map. In order to fit the map, it is necessary to reference two known points in the map and two known points in the network. Then, the *Edit object* button is used (see Table 13 in Appendix C) and the references are singled out. The reference points should, preferably, be far away from each other. The final result of the model setting, which includes the zoning, the network definition and the background map is visible in Figure 35 and Figure 36.

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[13] "The theoretical speed of traffic when density zero, that is, when no vehicles are present" (Highway Capacity Manual, 2000, p.5-6, definition 1)

[14] "The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced". (Highway Capacity Manual, 2000, p.5-14)

Figure 35

Project's network (Turin and Surroundings) – From OmniTRANS 8.0.36

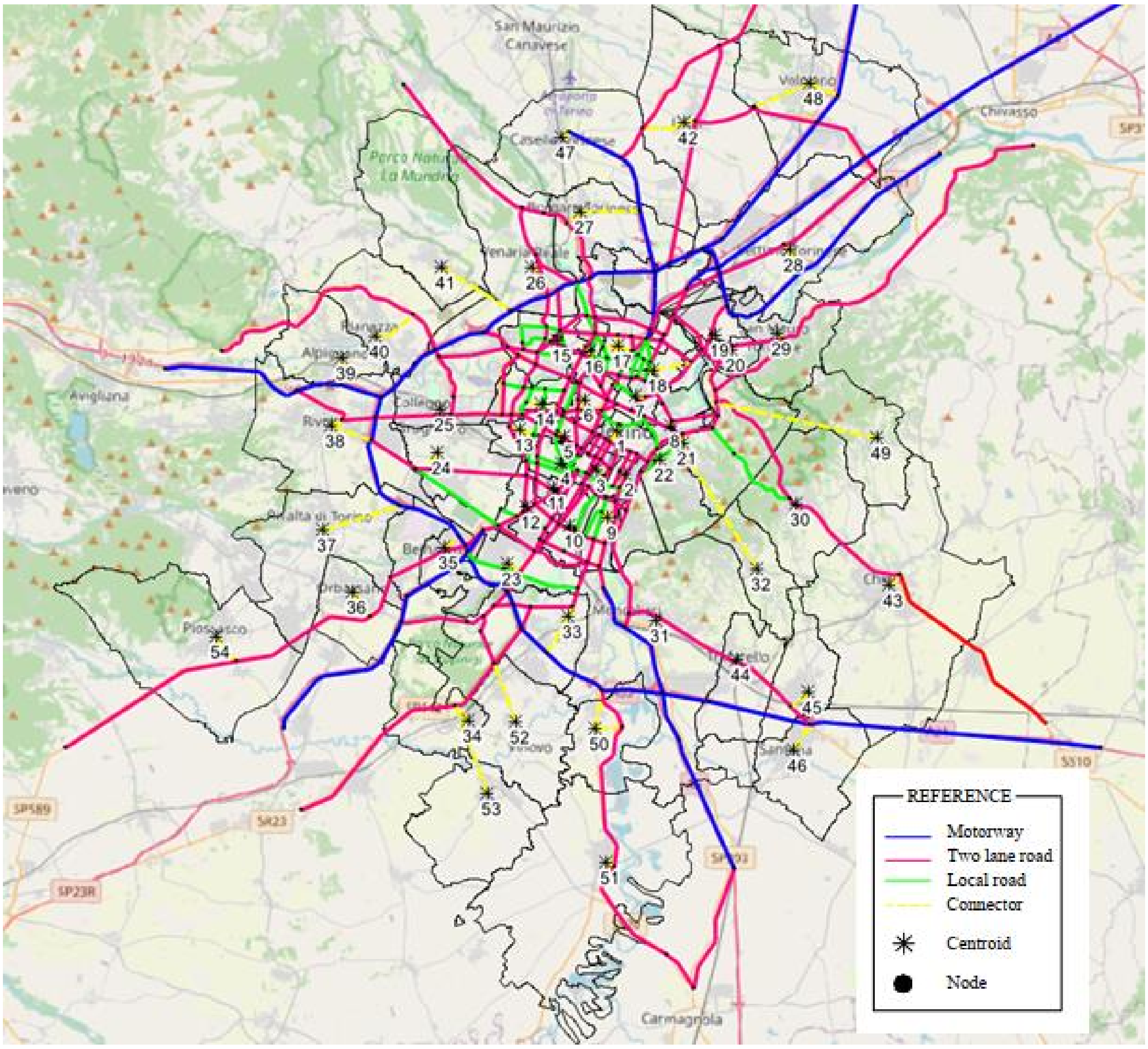
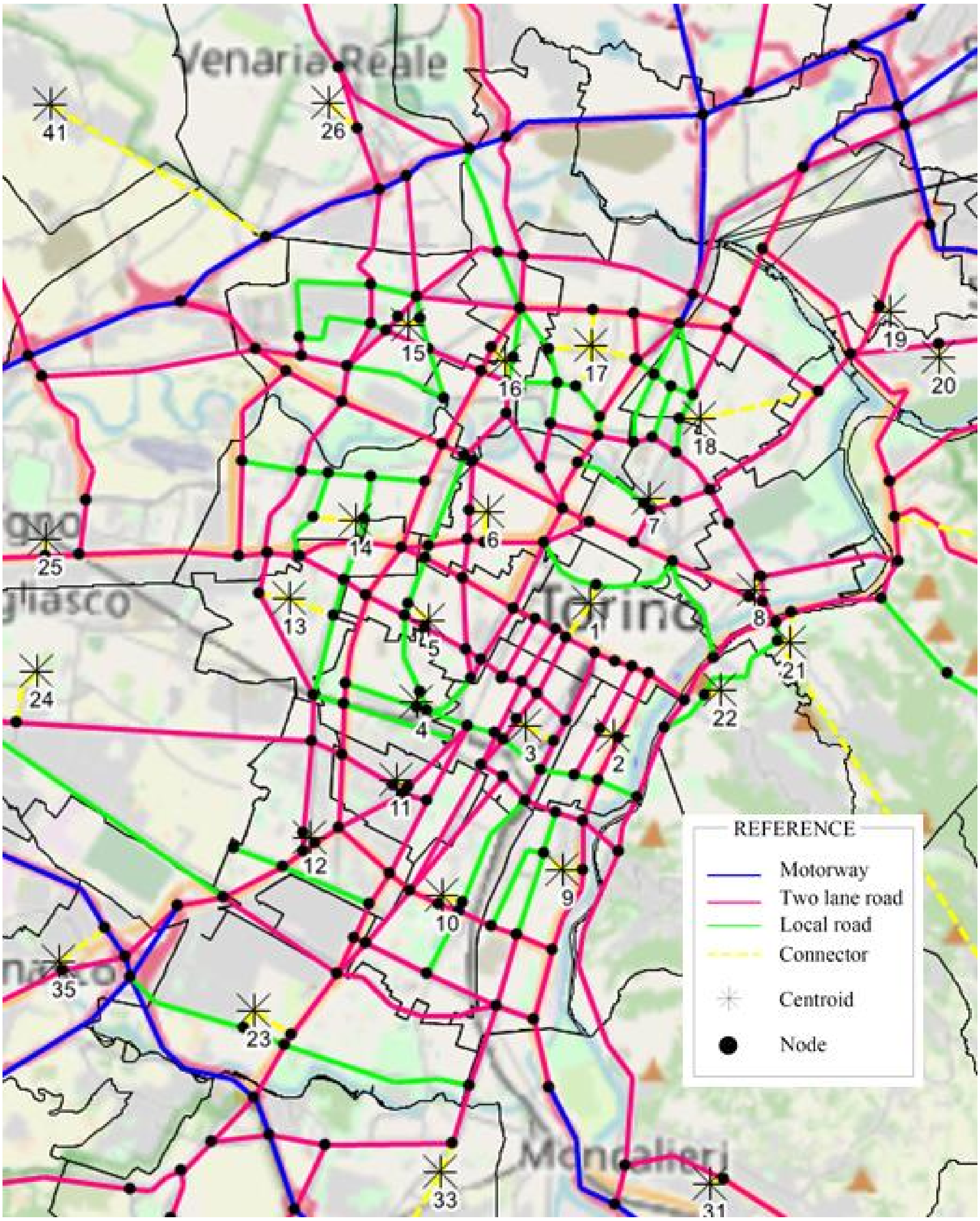


Figure 36

Project's network (Turin) – From OmniTRANS 8.0.36



5.2. Data Modelling

A mentioned many times in chapter IV, sections 4.1.4 and 4.2, the matrix estimation in this thesis was carried out for the peak hour demand volume (morning and afternoon) as well as for the entire day traffic volume. Such analysis was performed using the Tuesday's car traffic volume. It is also important to say that the estimations were performed twice: first without considering trip end data from the PUMS report and then adding such constraint.

5.2.1.Matrix Cube Dimensions and Combinations

In section 3.3.2, the importance of defining the appropriate dimensions and combinations is highlighted. Such procedure is essential for an accurate matrix estimation. In this project, several dimensions and three combinations were determined.

The network in a project always has two dimensions: mode and time [M, T] while matrices have four dimensions: purpose, mode, time and user [P, M, T, U]. In other terms, a network can be fully described by determining the mode of transportation associated to it and the time period analysis for which it will be used. Then again, for a matrix definition, the notions of purpose and users are also important. Like mentioned in 3.3.2, the attitude towards a trips change according to the purpose of the trip.

When doing the assignment of traffic and the estimation of matrices, the same mode and time dimensions should be referenced in both, the network and the matrices. In the model created for this dissertation, the dimensions and combinations used are shown in Figure 37 and Figure 38.

Figure 37

OmniTRANS dimensions used in the project – From OmniTRANS 8.0.36

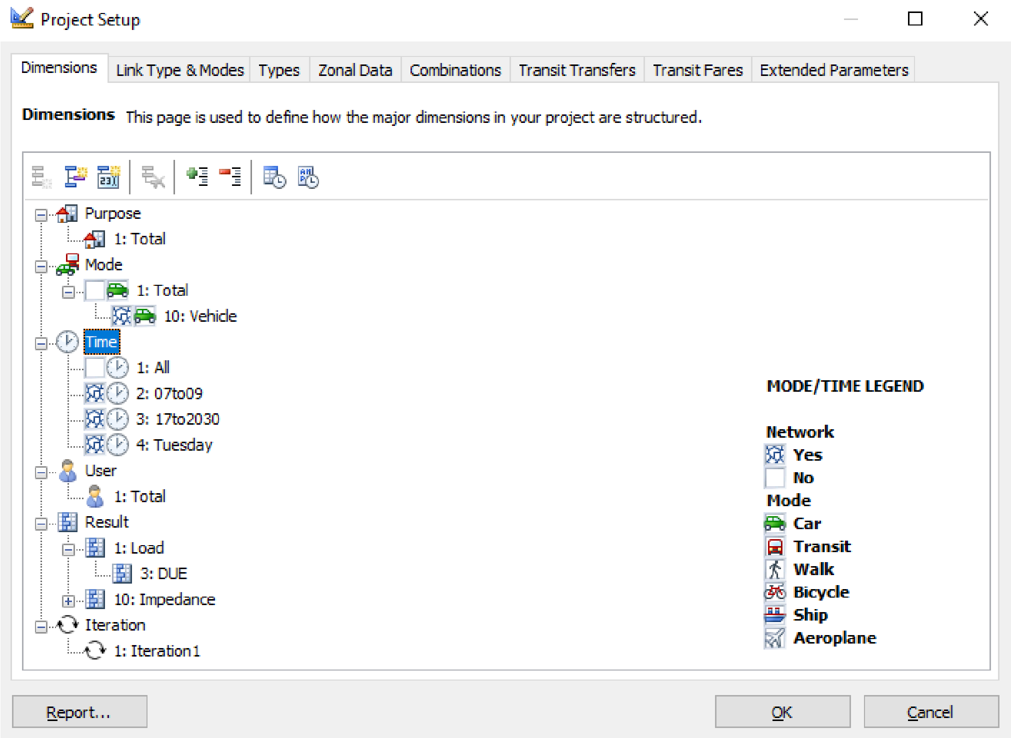
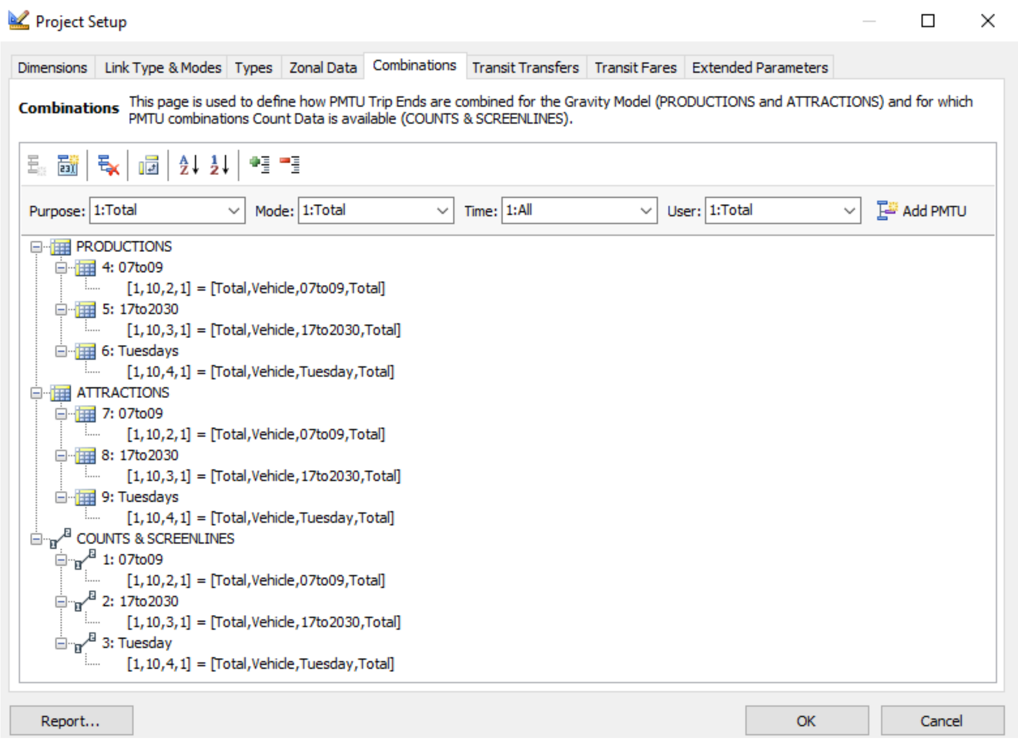


Figure 38

OmniTRANS combinations used in the project – From OmniTRANS 8.0.36



It is also important to emphasize the fact that, at the beginning, three variants were created to carry out different analysis. The first one was called *Morning Peak* and was used for the estimation of the morning peak OD matrix, the second was called *Afternoon Peak* and the third one *Tuesdays.* In the *Morning Peak* variant, the dimensions of the network were [10, 2] = [Vehicle, 07to09] while in the second one they were [10, 3] = [Vehicle, 17to2030]. Finally, for the entire day analysis on Tuesdays, the network dimensions were [10, 4] = [Vehicle, Tuesday]. The dimensions specified before, give the understanding that in every situation the car was considered as the transportation mode. On the other hand, regarding time, every variant make reference to a different period in order to separate all three analyses.

It is important to create different variants in a project in order to perform separate analysis. In this case, the analyses were differentiated according to the considered time period. In the end, as it is mentioned further on (section 5.3), other three variants were created. In the first three the traffic of the prior, or IMQ, matrix was examined while in the other three the estimated matrix given by the software was studied.

If no variants were created, peak hour traffic (morning and afternoon) and the 24-hour traffic (Tuesday's traffic) would have been assigned in the *BaseCube* variant. A procedure done like this would complicate the scrutiny and comparison of results. This is why the definition of the correct variants is key for an optimal modelling.

As a consequence of the explanation above, three combinations were created. Combination 1: 07to09 [1, 10, 2, 1] = [Total, Vehicle, 07to09, Total] was used for the counts and screenlines related to the traffic of morning peak while combination 2: 17to2030 [1, 10, 3, 1] = [Total, Vehicle, 17to2030, Total] and combination 3: Tuesday [1, 10, 4, 1] = [Total, Vehicle, Tuesday, Total] were used for every element included in the afternoon peak hour analysis and the entire day analysis performed for Tuesday's traffic correspondingly.

Creating the right combinations is important in order to assign different values of counts to the same element. Following this approach, all counts elements in the network were assigned a morning peak hour value, an afternoon peak hour value and a 24-hour value (Tuesday). Then, for the matrix estimation, the count value that was used is that one that corresponds to the same dimensions of the network and the prior matrix. In other words, the location of all traffic counts used in the three situations is the same. Anyways, like the value of the amount of vehicles passing through traffic counts change according to considered time range, different values have to be assign to each count. This is done using different combinations.

5.2.2.Prior Matrices

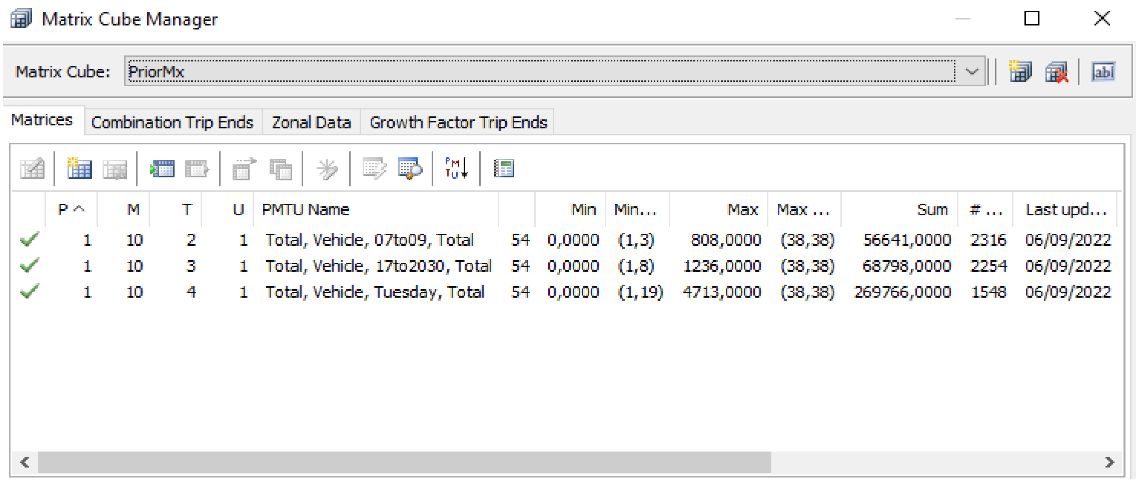
Following the dimensions and combinations already created, and in order to differentiate time periods, three matrices were considered as prior matrices in this thesis. The dimensions (see Figure 37) used for these matrices were [1, 10, 2, 1] = [Total, Vehicle, 07to09, Total] for the morning peak analysis, [1, 10, 3, 1] = [Total, Vehicle, 17to2030, Total] for the afternoon peak analysis and [1, 10, 4, 1] = [Total, Vehicle, Tuesday, Total] for the 24-hour analysis. All three matrices dimensions are shown in Figure 39.

Once dimensions and combinations were defined, the prior matrices were uploaded into the software. This action was performed, in OmniTRANS, by defining a matrix cube. For the purpose of this thesis, as explained in 4.1.4, the prior matrices were created with the IMQ 2013 data. In order to upload a matrix, it is necessary to use the *Matrix Cube Manager* and then press the *Add new matrix cube.* It is possible to choose the name of the matrix cube and then by using the *Add new matrix to this Matrix Cube* button, it is possible to choose the dimensions and the amount of centroids associated to it (see Table 13 in Appendix C). Once, the matrix is created by double clicking on it, the values of the O/D pairs can be written or imported.

In this project, one matrix cube was created and called *PriorMx.* Inside this matrix cube three different matrices were added. The first one, containing the morning peak trip information, the second one with the afternoon peak hour data and the third one with the entire day information. The associated dimensions to all three matrices are mentioned at the beginning of the section and illustrated in Figure 39.

Figure 39

Matrix Cube: Prior Matrix – From OmniTRANS 8.0.36



To generate the prior matrices that were uploaded in the software, the information from IMQ 2013 was used. The given raw data listed all the trips performed by the residents of the region of Piedmont. These mentioned matrices report the trips done between all zones in the Metropolitan Area of Turin (listed in Table 11 and Table 12 located in Appendix B). The prior matrices, used in the project were introduced in section 4.1.4, and are reported as Matrix 18, Matrix 19 and Matrix 20 located in Appendix F.

5.2.3. Traffic Counts

The traffic counts selected for this project were those consistent with the modelled road network. Some evaluations were done and 89 counts were included in the model and therefore in the estimation.

From the data analysed in the previous chapter (section 4.1.4 and 4.2), it was possible to notice that when comparing the traffic volume for the different days of the week, Tuesdays was the day with the higher amount of trips. This is why the analysis for each range is done with the traffic volume corresponding to Tuesday. There are three time periods considered in the analysis: morning peak (from 07:00 to 09:00), afternoon peak (from 17:00 to 20:30) and an entire day (from 00:00 to 24:00).

In order to add the counts to the model, they were first added to QGIS from a CVS file by choosing the file and the proper coordinates, *X field* and *Y field* in window from menu *Layer-Add Layer-Add Delimited Text Layer*. In this case the *X field* is the longitude and the *Y field* is the latitude. Knowing the location, the traffic count information was added to the model in OmniTRANS manually, one by one, using the *Count* button together with the *Addition* button and defining the values for each one of them.

In the software, counts are placed in links as they indicate a value equal to the traffic passing through a specific point in the network. When creating the counts in the software, it is necessary to specify the value of the element for every combination created, like shown below in Figure 40. In this figure, an example of a count attribute is illustrated.

When estimating the matrices for this thesis, counts were considered as a main constraint and the weight value associated to them was equal to one for all counts. The definition of the counts weights can be done during the creation of counts (as it is possible to see in Figure 40). Anyways, they can also be defined when writing the job. In Table 35 located in Appendix G the counts used in the model and their values are reported. In Figure 41 the traffic count locations are illustrated.

Figure 40

Traffic count's attributes – From OmniTRANS 8.0.36

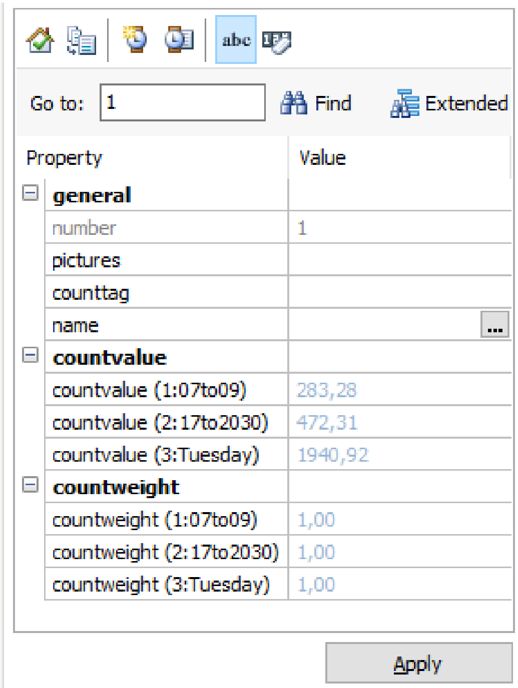
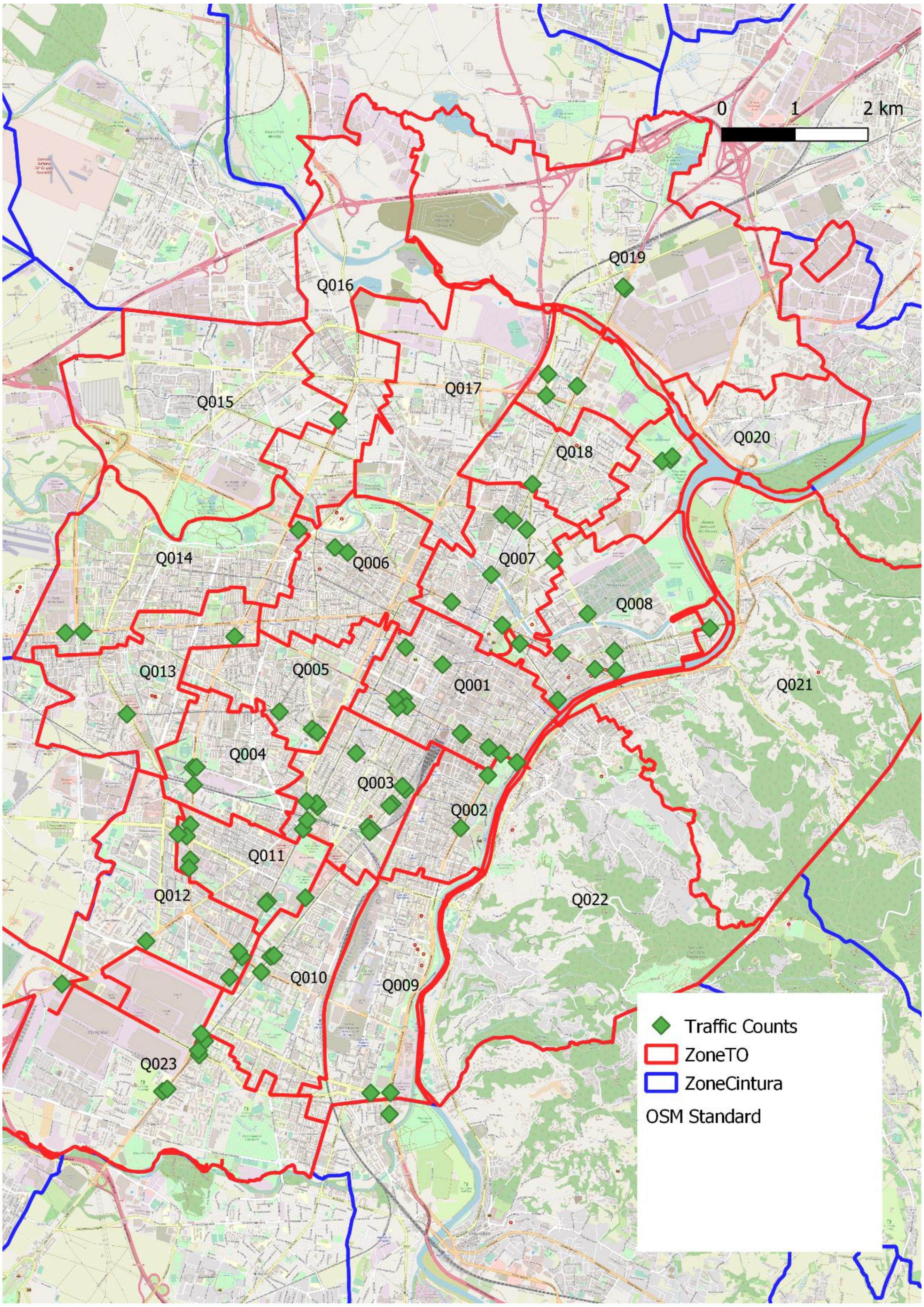


Figure 41

Traffic Counts location - From QGIS 3.4.4 Madeira



5.2.4.Screenlines

Before performing the matrix estimation, it is also necessary to create the screenlines. These elements were created manually in the model. In order to draw them it is necessary to use the *Screenline* button and the *Addition* button. Then, it is possible to click in the counts that should be incorporated into the screenline. When modelling with screenlines it is important to take into consideration the following advice:

- Screenlines should include between two and four counts
- One count can be used in more than one screenline
- Avoid screenlines that are crossed by the same O/D pair more than once
- Avoid screenlines between counts located in roads with big differences regarding traffic, such as highways and local roads.

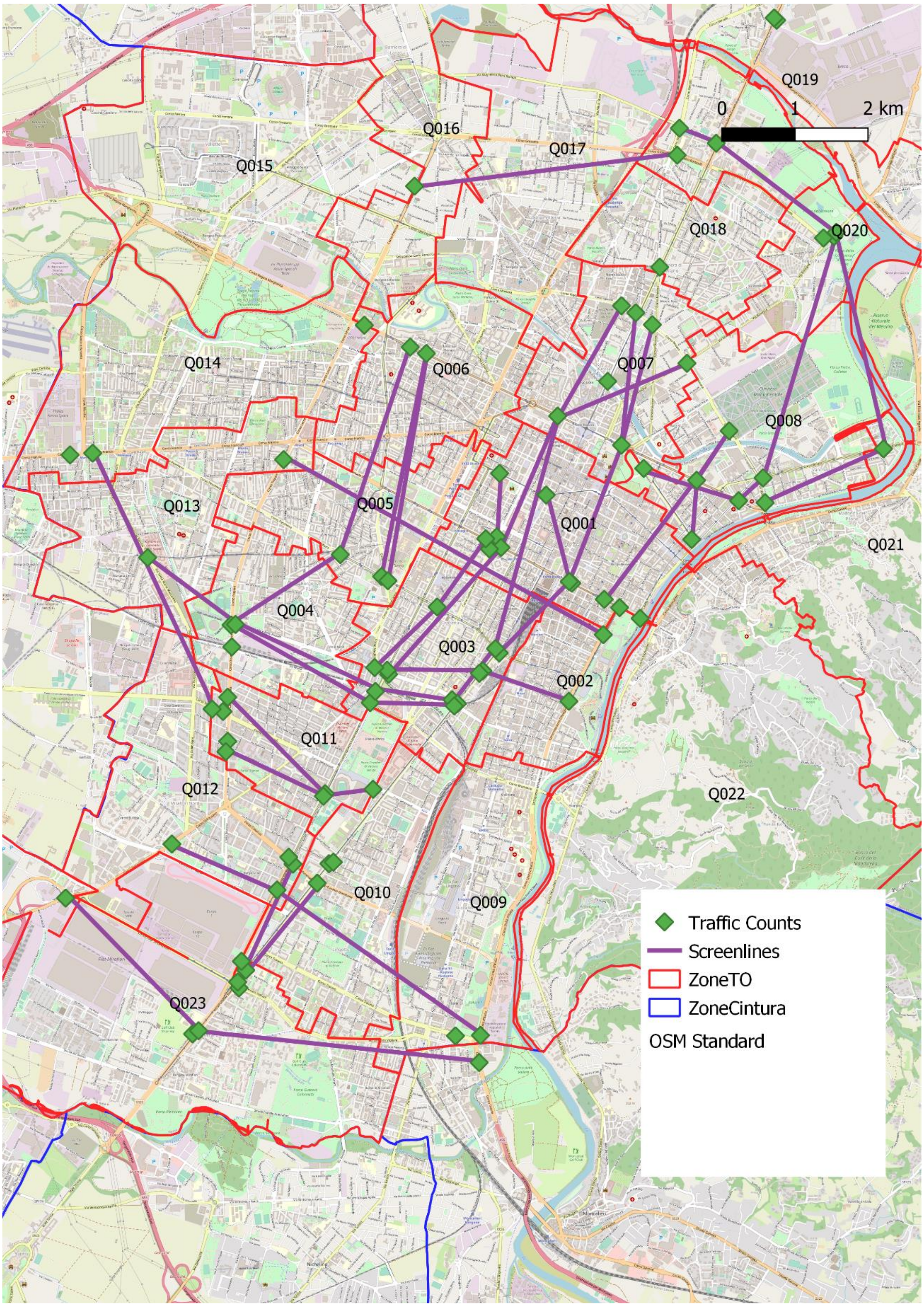
For an optimal estimation, 34 screenlines were designed and implemented in the model. The criteria followed in the creation of such elements was to group traffic counts of alternative route choices together. In other terms, screenlines were generated considering that traffic counts on alternative paths should be connected in order to compute all counts in the estimation.

The modelling of screenlines constrains the software into considering all counts grouped together as one entity. For instance, if there are two alternative paths joining centroids 1 and 2 and there are different traffic counts in each path, a screenline is created in order to consider both counts when computing the traffic between the mentioned centroids. Furthermore, the generation of screenlines helps with the accuracy of the estimation given that it adds important information to the traffic assignment and matrix estimation algorithm.

As explained for counts, when creating screenlines it is also possible to assign the weight value. In this case all of them were assigned a value equal to one. In Figure 42 the network with introduced counts and generated screenlines is visible.

Figure 42

Project with Counts and Screenlines – From QGIS 3.4.4 Madeira



5.2.5. Trip End Data

The last step before the estimation of matrices is the addition of the trip end data. As mentioned in section 3.3.3, in order to incorporate trip ends in the model, it is necessary to open the matrices using the *Matrix Cube Manager* and then write or paste the trip end information in the *Combination Trip Ends* tab.

In this thesis, the trip end information is computed using the PUMS matrices for the year 2019, presented in the report published on May 2021. Once the IMQ 2013 raw data was modelled in order to create a matrix which is analogue to the PUMS matrix (following procedures in sections 4.3.1 and 4.3.2), a comparison between the PUMS and the new mentioned matrix was done. As already said in section 4.3.3, the relative difference matrix between both (Matrix 26) is located in Appendix H. It is important to highlight that these matrices represent tours done by the residents of Piedmont in the Province of Turin. Anyways, the analysed matrices in this work represent individual trips performed by residents of Piedmont in the Metropolitan Area of Turin (city of Turin and the 31 municipalities of the surroundings). Following this, in order to create the trip end information, it was necessary to perform some computations.

Trip ends were calculated by considering the relative difference between the PUMS and the IMQ 2013 aggregated matrices. This difference expressed as a percentage was used in order to update the trip ends of the matrices derived from the IMQ 2013 raw data, also called prior matrices in this work (Matrix 18, Matrix 19 and Matrix 20). In other words, the totals of rows and columns of the matrices derived from IMQ 2013 in the three different time periods were increased or decreased by the difference (in percentage) between the aggregated IMQ matrix (Matrix 25) and PUMS matrix (Matrix 24). This percentage values are shown in Matrix 26. The trip end data values used in the model are listed in Table 38 located in Appendix I.

5.2.6. OmniTRANS Jobs

5.2.6.1. Traffic Assignment and Screenline Intercept Matrix

Ultimately, in order to complete the estimation, some jobs were created using OmniTRANS. In order to perform the matrix estimation, it is first necessary to create the screenline intercept matrices. This type of matrices, as mentioned before (3.3.3), are origin-destination matrices used to define the O/D pairs passing through the counts. It seems obvious, then, that in order to calculate the screenline intercept matrices it is a requisite to carry out the traffic assignment.

In this thesis, the traffic assignment method used is the Deterministic User Equilibrium. Like explained in 3.4, the mentioned method aims for the network equilibrium. The code written in order to assign traffic is the first part of Job 1, Job 2 and Job 3 located in Appendix J. In order to perform the traffic assignment in OmniTRANS, it is necessary to choose the assignment method, the load (which is selected by writing the appropriate dimensions) and the number of iterations. Finally, when running it, the traffic assignment is achieved.

Once the traffic assignment is performed, it is necessary to calculate the screenline intercept matrices. After that, it is finally possible to estimate the origin-destination matrices.

As mentioned above, the first step to estimate matrices is assigning traffic and generating the screenline intercept matrices. To do this an *OtTraffic* class should be created by using *OtTraffic.new.* Then, the assignment method is defined. Third step is determining the output link volume storage, the network and the O/D matrix. This is done using the *PMTU* dimensions. Last step is defining the amount of iterations and running the traffic assignment (*execute).*

To calculate the screenline intercept matrix it is necessary to use the *OtTraffic.screenlineMatrix* class and specify the dimensions of such matrix. After that, it is possible to determine if the traffic count data should be all included or not and run the calculation of the screenline intercept matrix.

5.2.6.2. Estimation of Matrices

The second part of the jobs (Job 1, Job 2 and Job 3) is the estimation of the matrices. Because the matrix estimation was performed with different time periods and therefore different input data (prior matrices, traffic counts and trip ends), six matrix estimations were done. The information used in each of them is listed below:

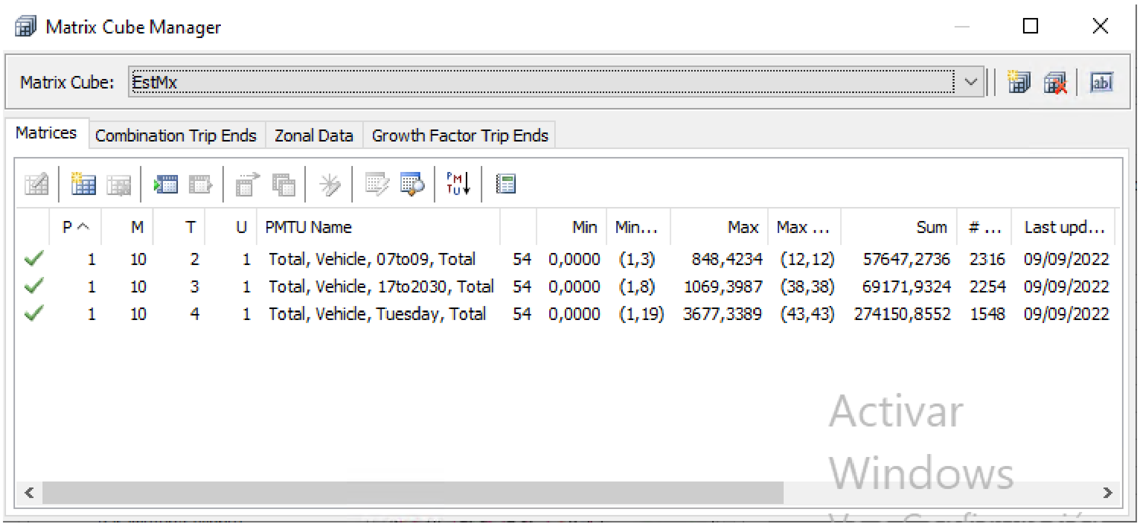
1. Morning peak hour prior matrix, morning peak hour count data, Deterministic User Equilibrium traffic assignment.
2. Afternoon peak hour prior matrix, afternoon peak hour count data, Deterministic User Equilibrium traffic assignment.
3. 24-hour prior matrix, 24-hour count data, Deterministic User Equilibrium traffic assignment.
4. Morning peak hour prior matrix, morning peak hour count data, Deterministic User Equilibrium traffic assignment, morning peak trip ends.
5. Afternoon peak hour prior matrix, afternoon peak hour count data, Deterministic User Equilibrium traffic assignment, afternoon peak trip ends.
6. 24-hour prior matrix, 24-hour count data, Deterministic User Equilibrium traffic assignment, 24-hour trip ends.

For the matrix estimation an *OtMatrixEstimation* class should be created (*OtMatrixEstimation.new).* Initially, the input or prior matrix and the screenline matrix should be define. Then, the order of constrains should be determined. The order should be written as a string mentioning the initial letter of the constraints (Blocks, Counts, Screenlines, Trip ends). In order to indicate which counts and screenlines should be use in each case, the functions *selectedCounts* and *selectedScreenlines* are used. In addition, utilizing the *screenlineElasticity* and *countElasticity*, it is possible to assign weights to the constraints. The last steps are defining the amount of iterations, the name of the output matrix cube and running the code. It is also possible to ask the program to show the matrix and trip end totals (*showMatrixTotals* and *showTripEndTotals*). The new estimated matrix will be stored as a cube matrix and will have the name given in the job as shown in Figure 43.

It is important to highlight, the same job can be used to estimate matrices making and not making use of trip end information, given that when specifying the input matrix all information related to that matrix (like trip ends) will be considered. In other words, to estimate matrices using trip ends, the trip end data should be incorporated in model and to estimate matrices without the trip end constraint, the trip end data shouldn't be present in the model.

Figure 43

Matrix Cube: Estimated Matrices – From OmniTRANS 8.0.36



5.3. Analysis of the Obtained Results

The estimated matrices obtained with the execution of the jobs explained above (section 5.2.5) are illustrated as Matrix 27, Matrix 28, Matrix 29, Matrix 30, Matrix 31 and Matrix 32 located in Appendix K. In order to perform a deep analysis of the results obtained with the model application explained in sections 5.1 and 5.2, three extra variants were added to the project and the new estimated matrices were assigned to this variants.

5.3.1. Comparison between Matrices

5.3.1.1. Differences between IMQ 2013 and the Estimated Matrix for the year 2019 without the trip end constraint

In order to quantify the difference in the rows and columns totals of the IMQ 2013 matrices and the estimated matrices without trip ends, some plots and reports were generated. The variation of the values between these can be seen in Figure 44 to Figure 49. In Figure 44, Figure 46 and Figure 48 a comparison between the matrix row totals of both matrices is done. The same analysis was performed for the matrix column totals in Figure 45, Figure 47 and Figure 49. In order to show with a higher accuracy the difference between row and column totals in all time periods the appropriate reports were created and added at the end of Appendix L.

Figure 44

Matrix Row Total Comparison for the morning peak hour analysis between IMQ 2013 and the Estimated Matrix without trip end data – From OmniTRANS 8.0.36

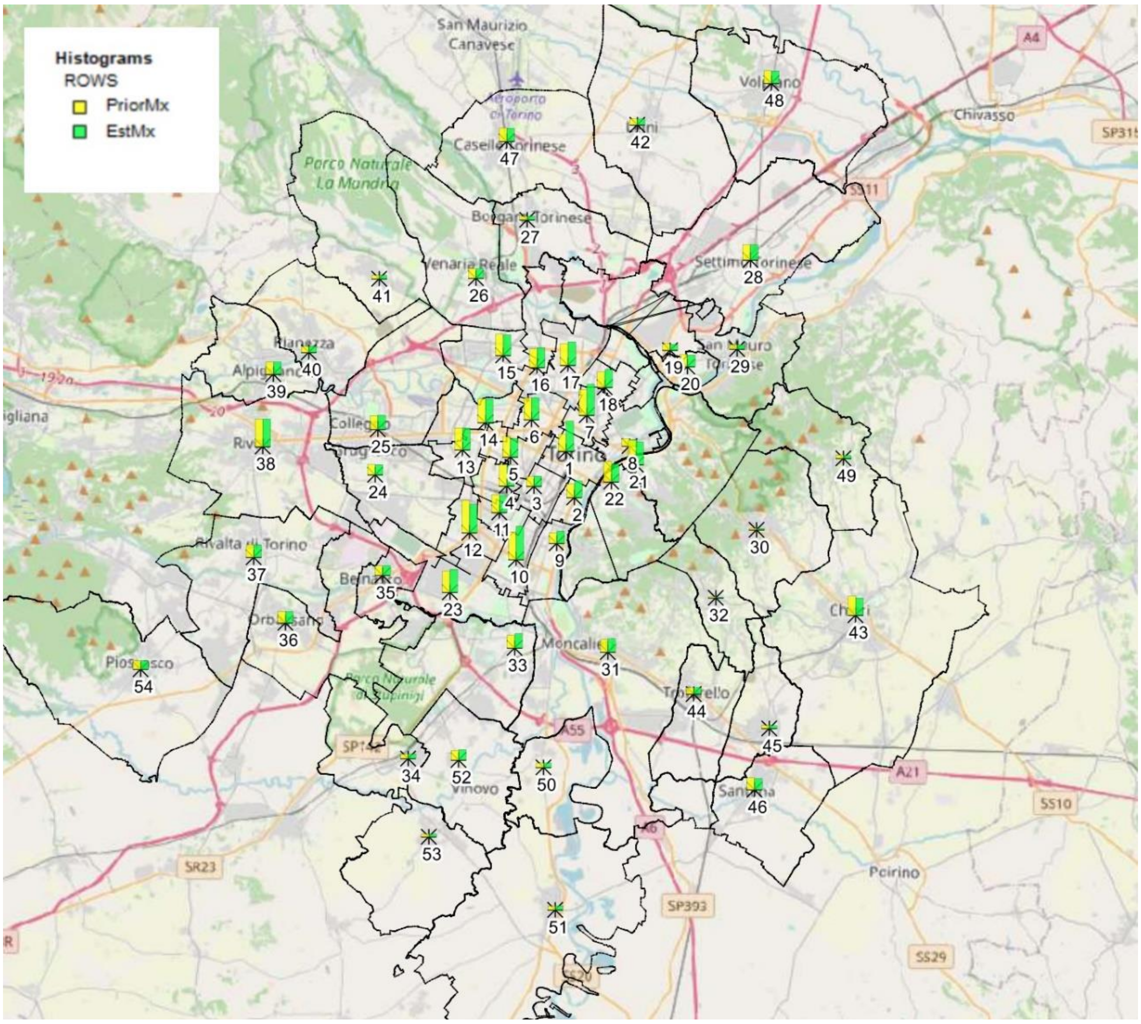


Figure 45

Matrix Column Total Comparison for the morning peak hour analysis between IMQ 2013 and the Estimated Matrix without trip end data – From OmniTRANS 8.0.36

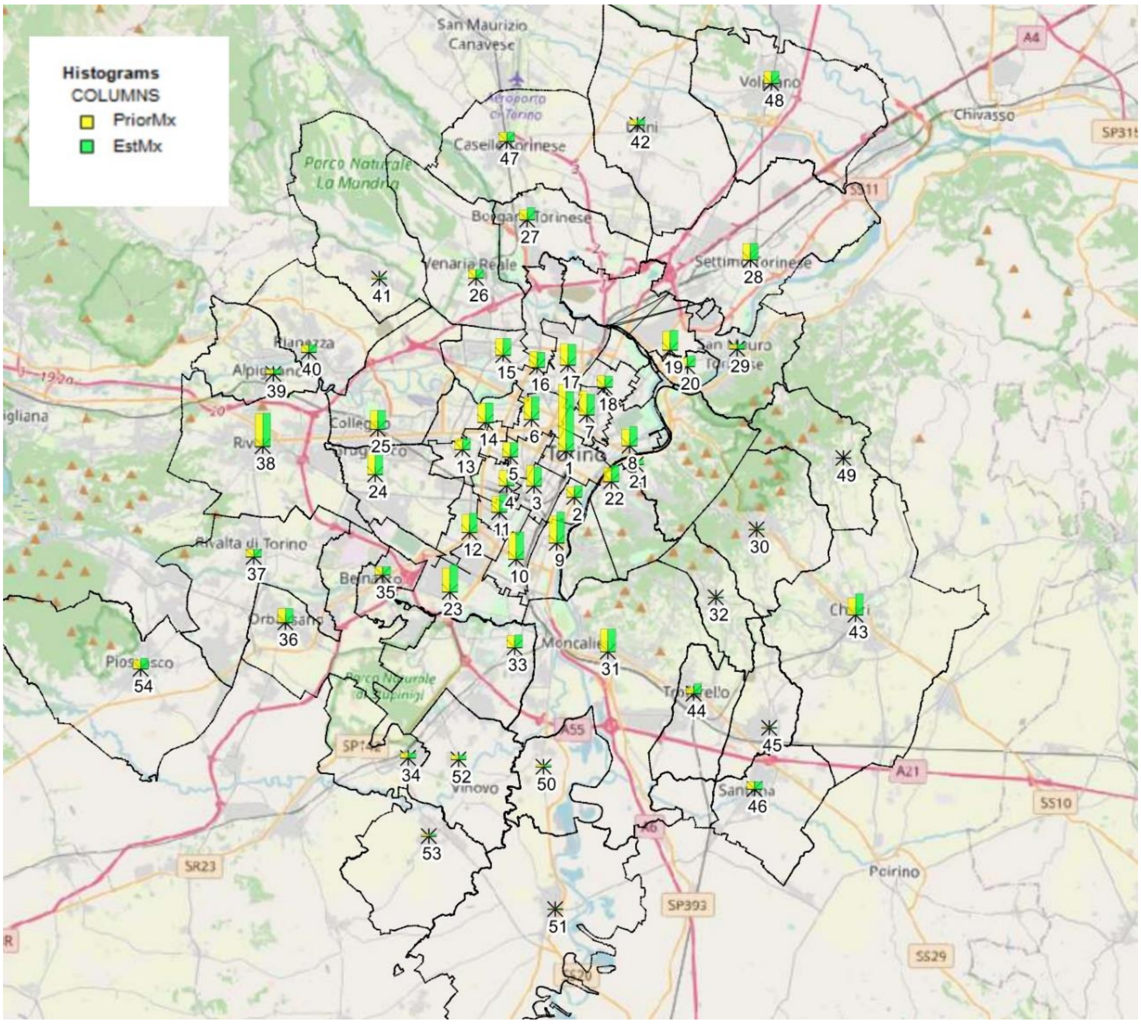


Figure 46

Matrix Row Total Comparison for the afternoon peak hour analysis between IMQ 2013 and the Estimated Matrix without trip end data – From OmniTRANS 8.0.36

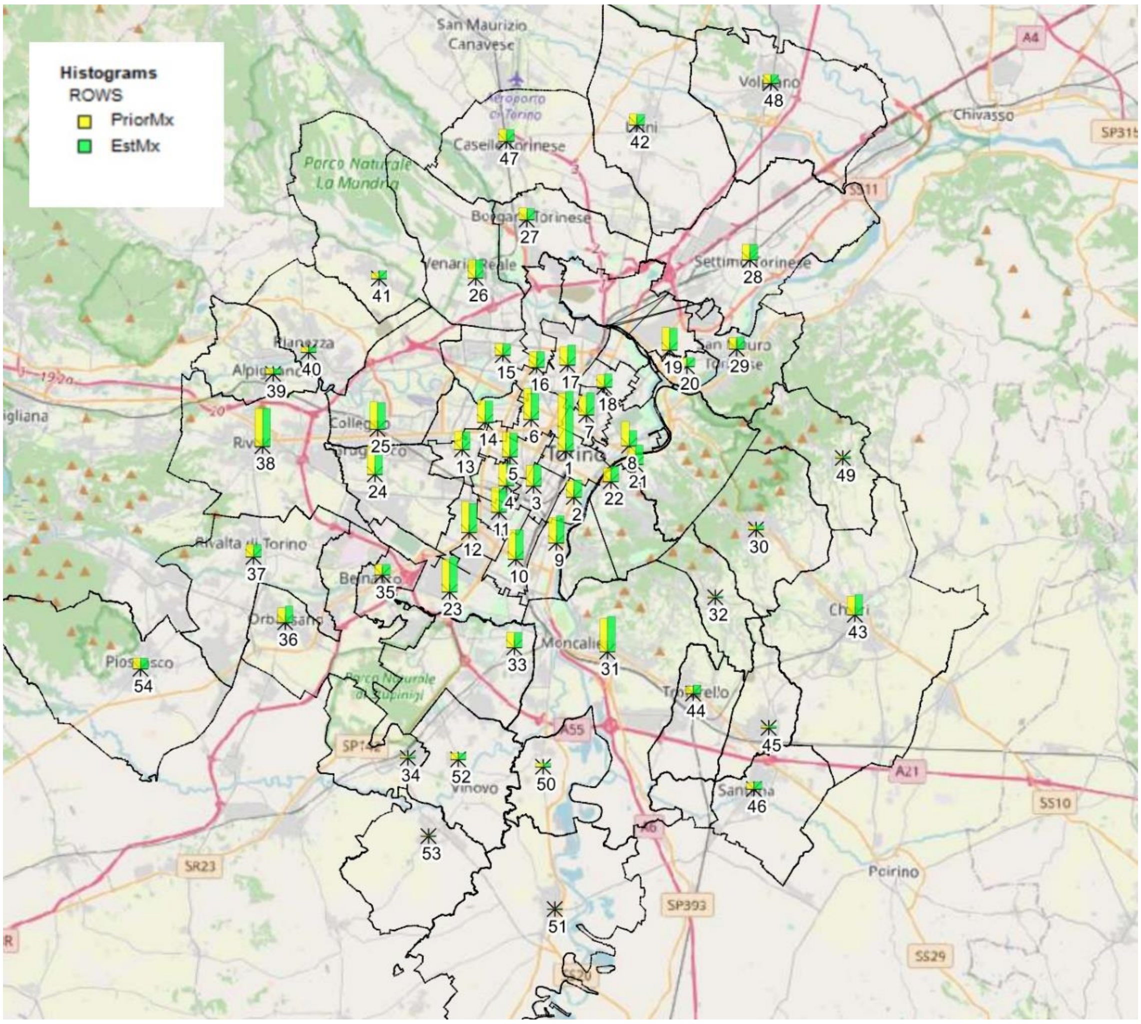


Figure 47

Matrix Column Total Comparison for the afternoon peak hour analysis between IMQ 2013 and the Estimated Matrix without trip end data – From OmniTRANS 8.0.36

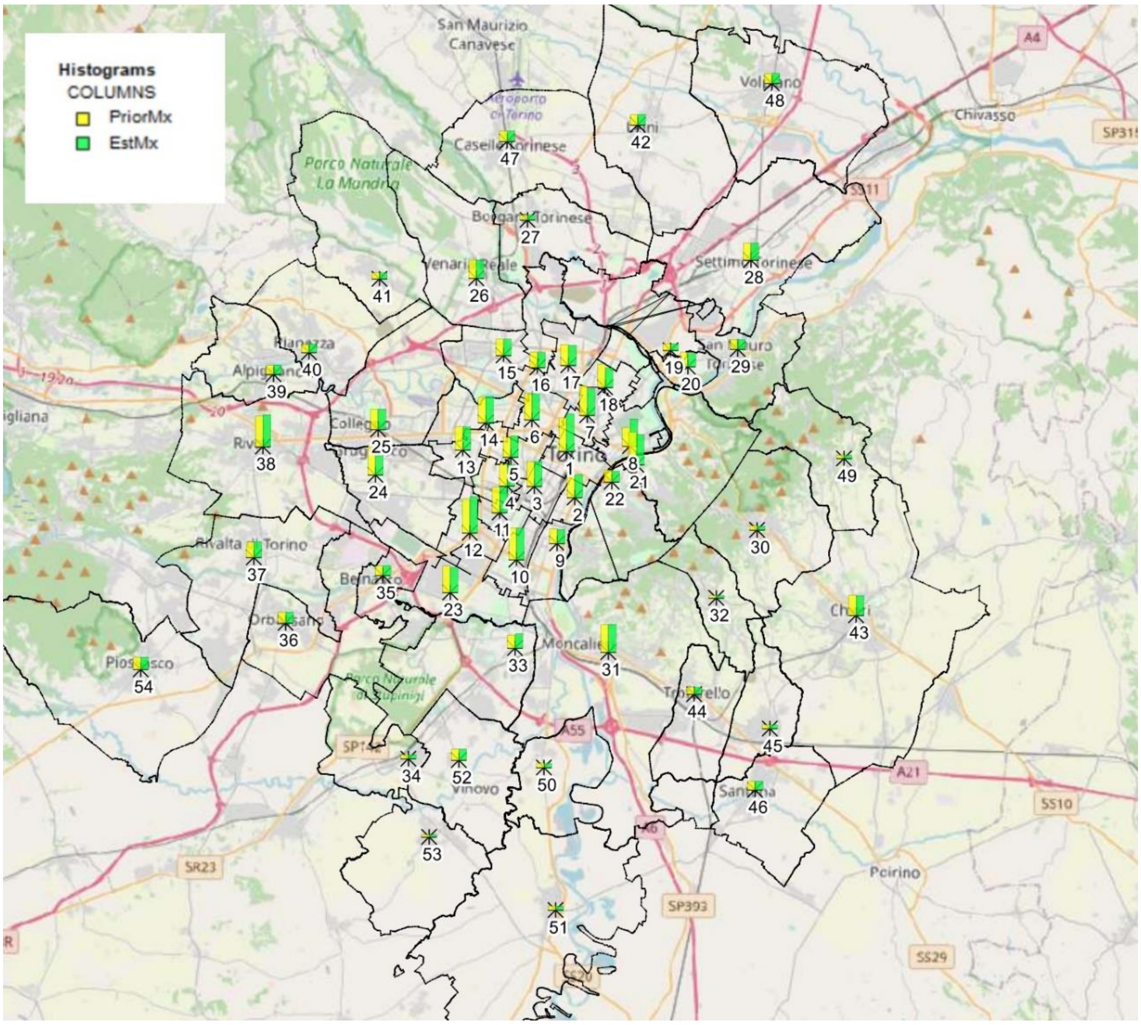


Figure 48

Matrix Row Total Comparison for the entire day analysis between IMQ 2013 and the Estimated Matrix without trip end data – From OmniTRANS 8.0.36

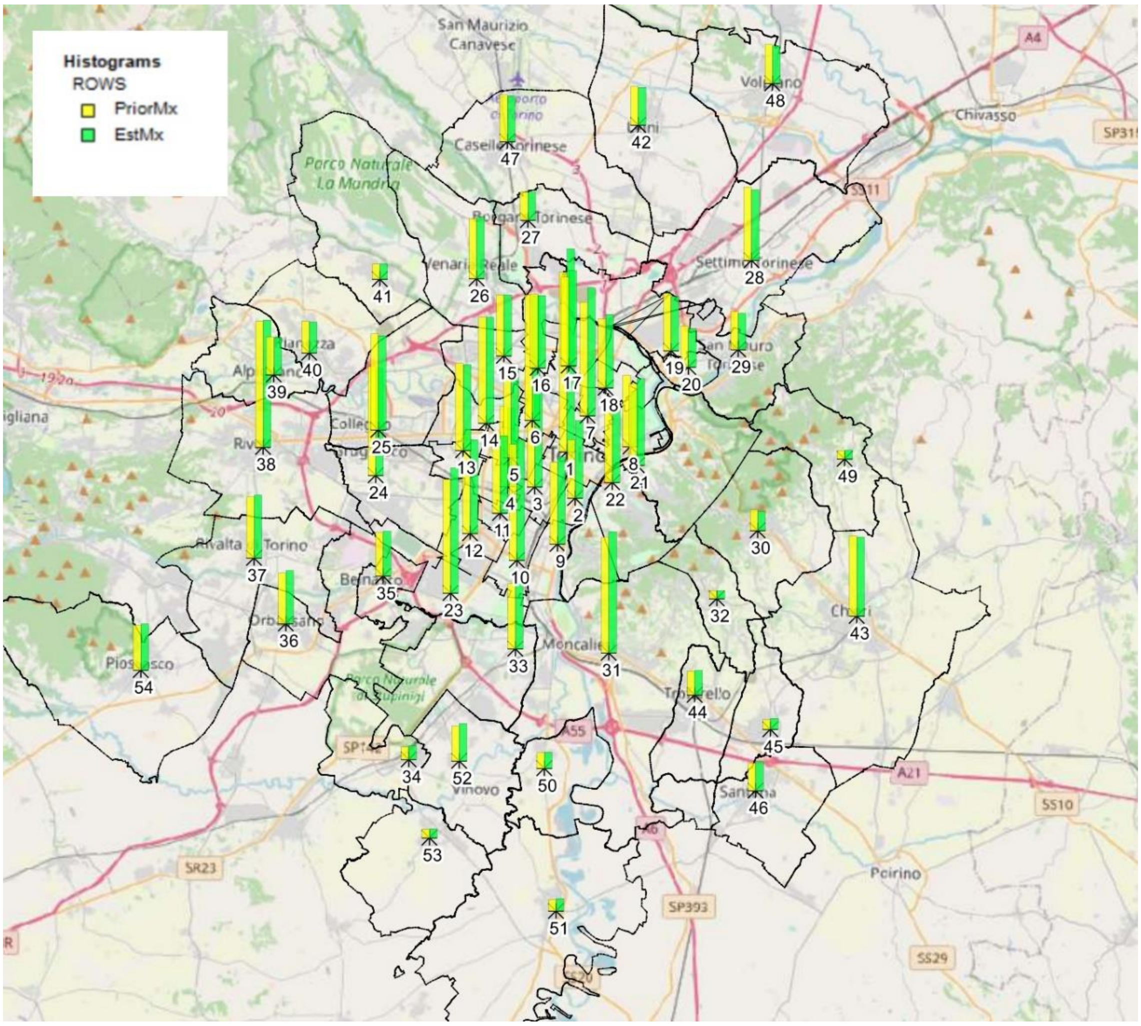
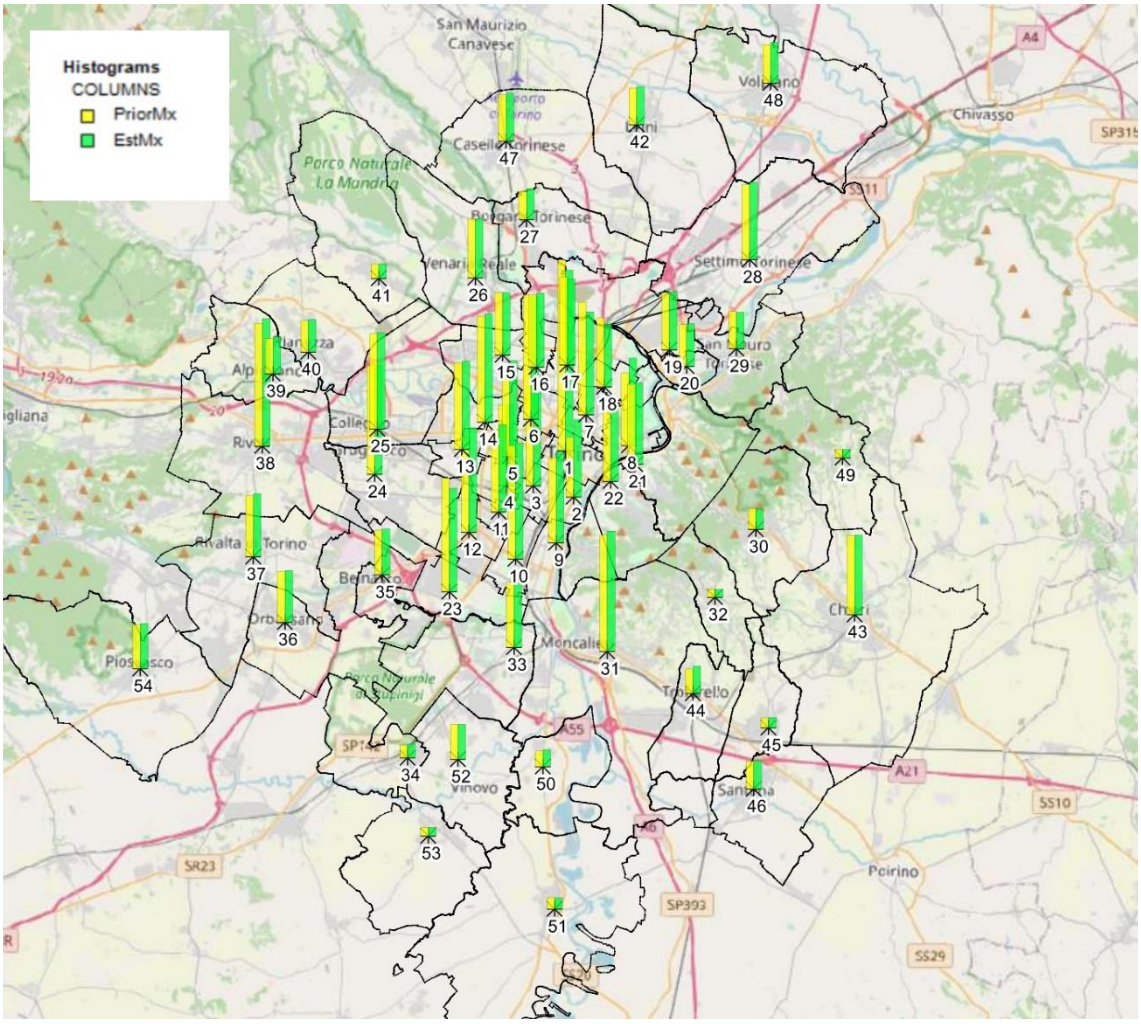


Figure 49

Matrix Column Total Comparison for the entire day analysis between IMQ 2013 and the Estimated Matrix without trip end data – From OmniTRANS 8.0.36



During a first analysis of the exposed information, it is possible to see that the estimated matrix for the year 2019 has higher values of demand than that used as a prior matrix belonging to the year 2013. This does not coincide with the fact that the population in Turin decreased from the year 2013 to the year 2019 (as already said in section 4.3.3). Also, the matrices from the PUMS report showed a decrease on the demand which is not consistent with the results of the estimated matrices without trip end information. Given this, the remaining computations and comparisons will be made with the matrices that were estimated using trip end information.

5.3.1.2. Differences between IMQ 2013 and the Estimated Matrix for the year 2019 with trip end information

The same plots and reports generated for the previous section were generated in this case using the IMQ 2013 and the estimated matrices that consider the trip end constraint. The variation of the values between the prior and the estimated matrices (with trip end information) can be seen in Figure 50 to Figure 55. The respective reports were also added at the end of Appendix L.

Figure 50

Matrix Row Total Comparison for the morning peak hour analysis between IMQ 2013 and the Estimated Matrix with trip end data – From OmniTRANS 8.0.36

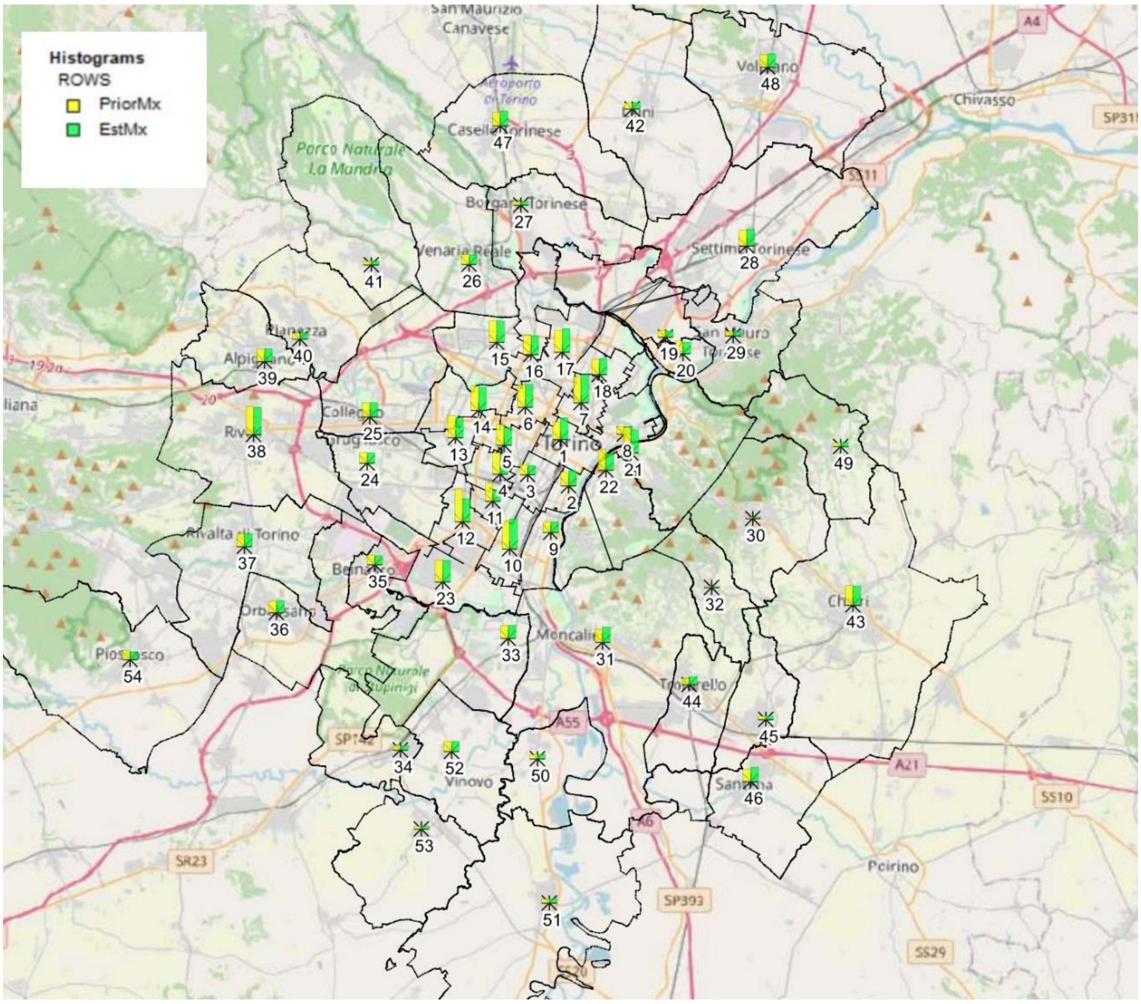


Figure 51

Matrix Column Total Comparison for the morning peak hour analysis between IMQ 2013 and the Estimated Matrix with trip end data – From OmniTRANS 8.0.36

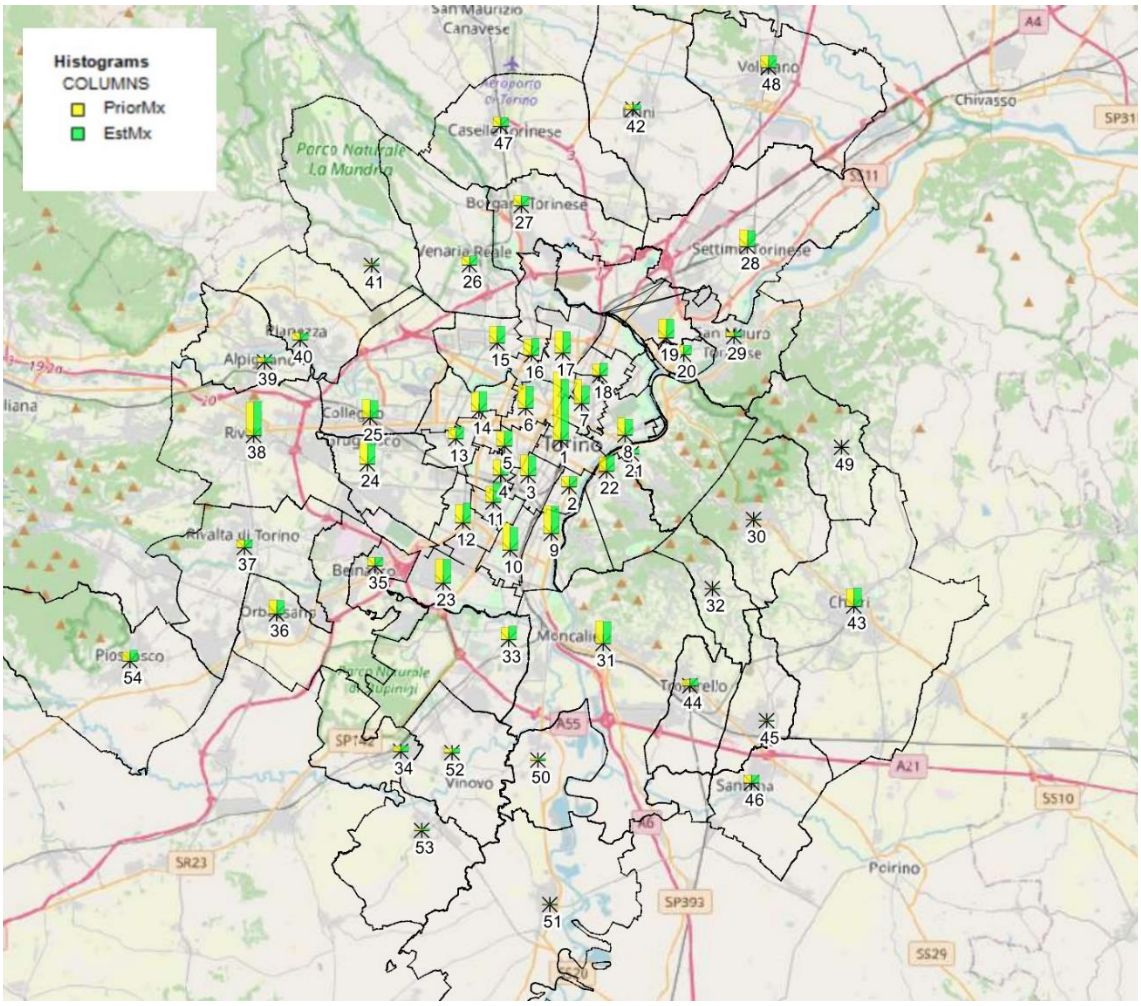


Figure 52

Matrix Row Total Comparison for the afternoon peak hour analysis between IMQ 2013 and the Estimated Matrix with trip end data – From OmniTRANS 8.0.36

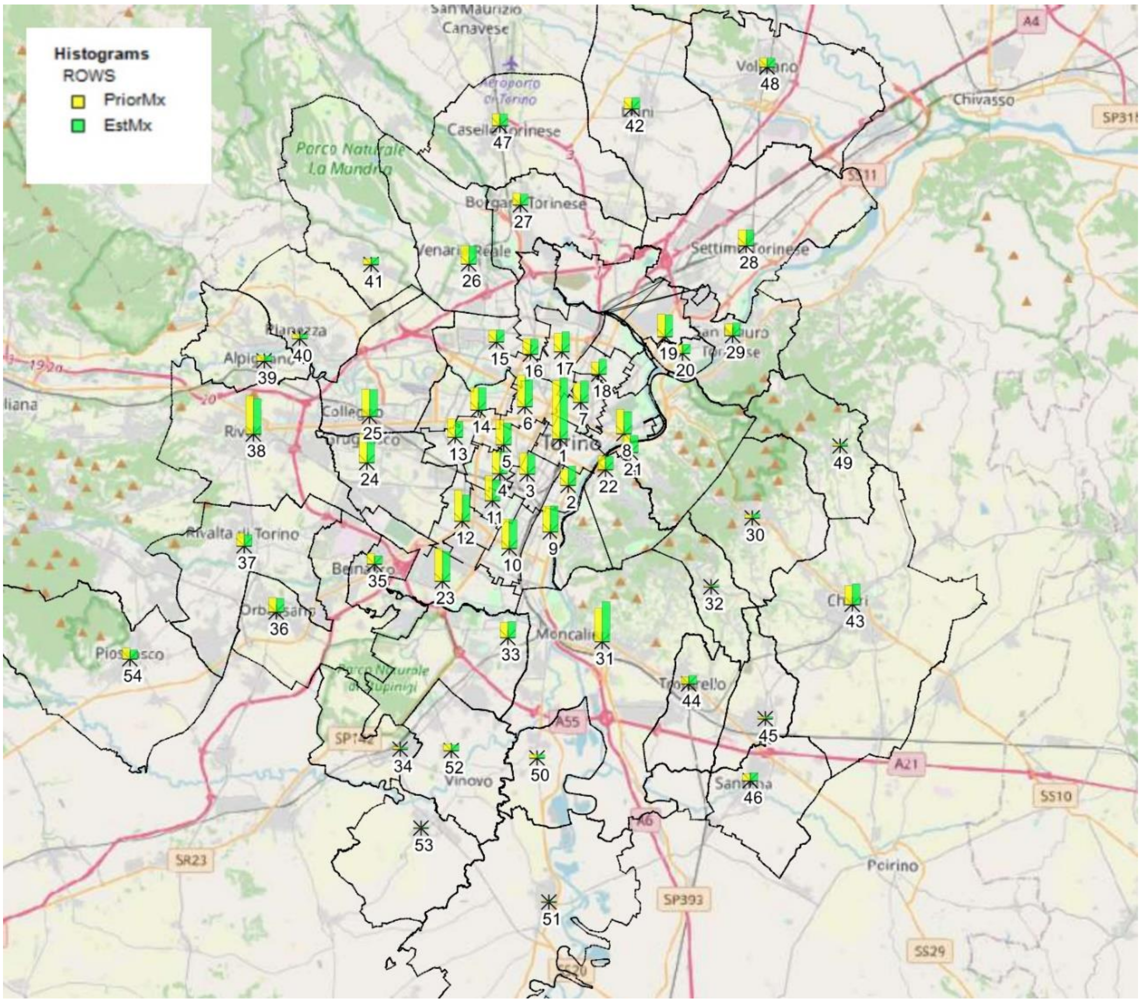


Figure 53

Matrix Column Total Comparison for the afternoon peak hour analysis between IMQ 2013 and the Estimated Matrix with trip end data – From OmniTRANS 8.0.36

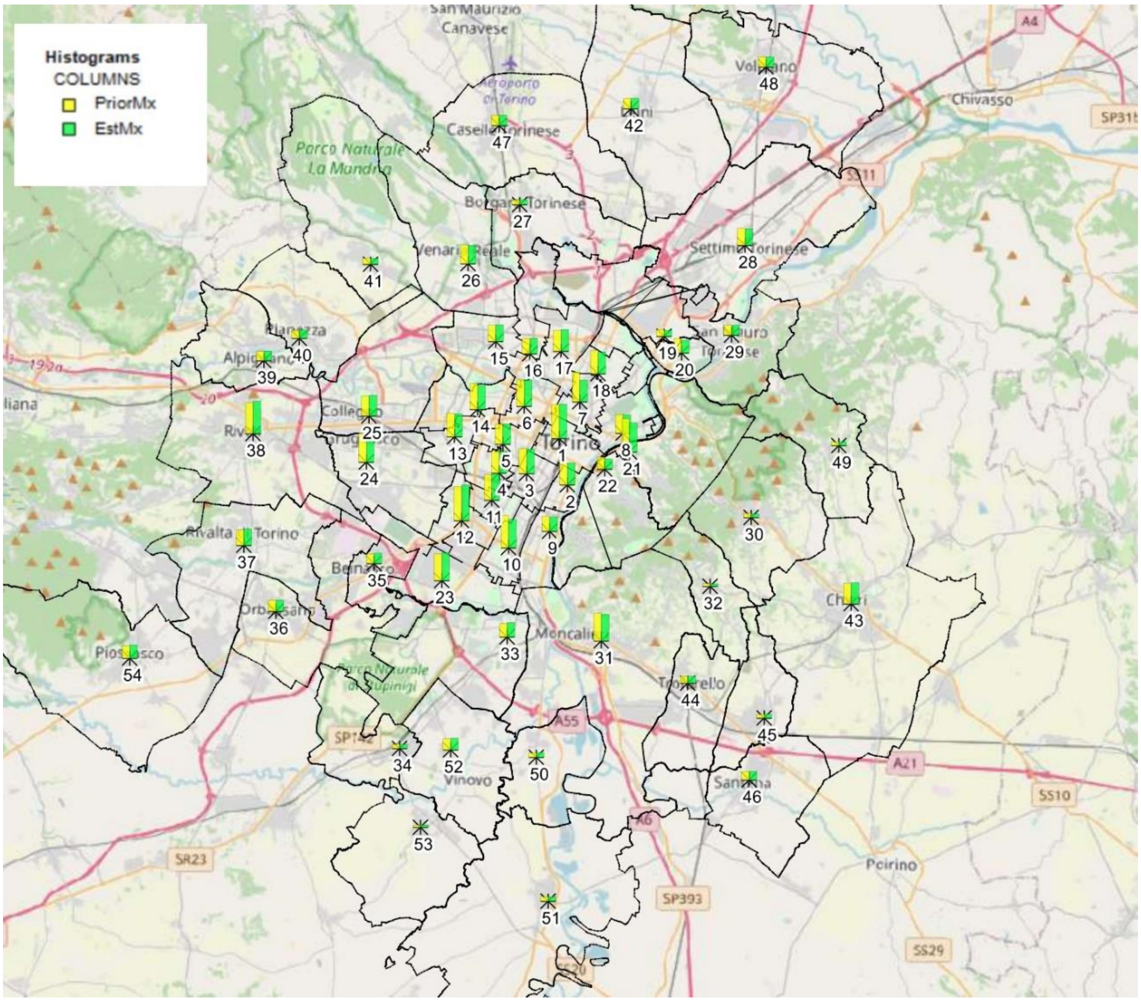


Figure 54

Matrix Row Total Comparison for the entire day analysis between IMQ 2013 and the Estimated Matrix with trip end data – From OmniTRANS 8.0.36

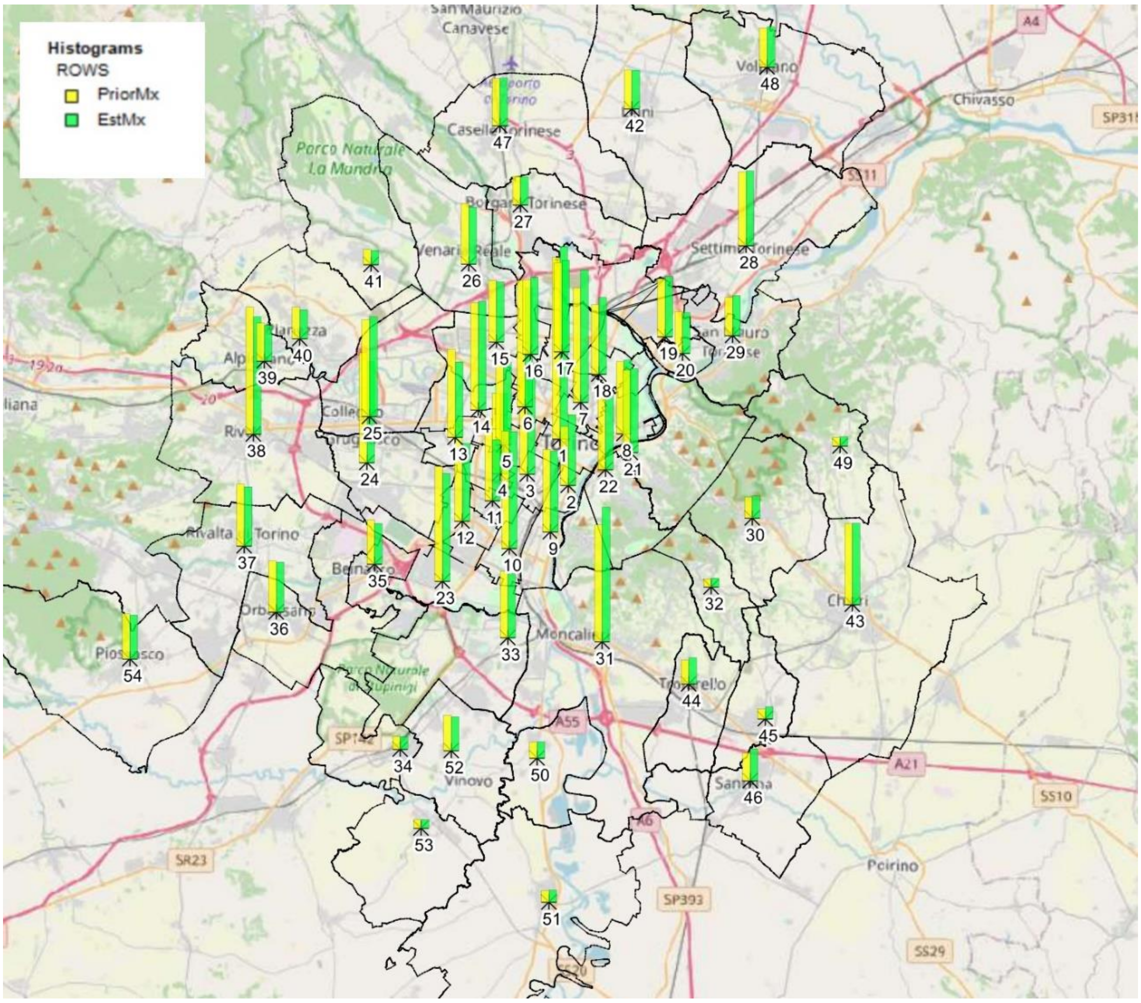
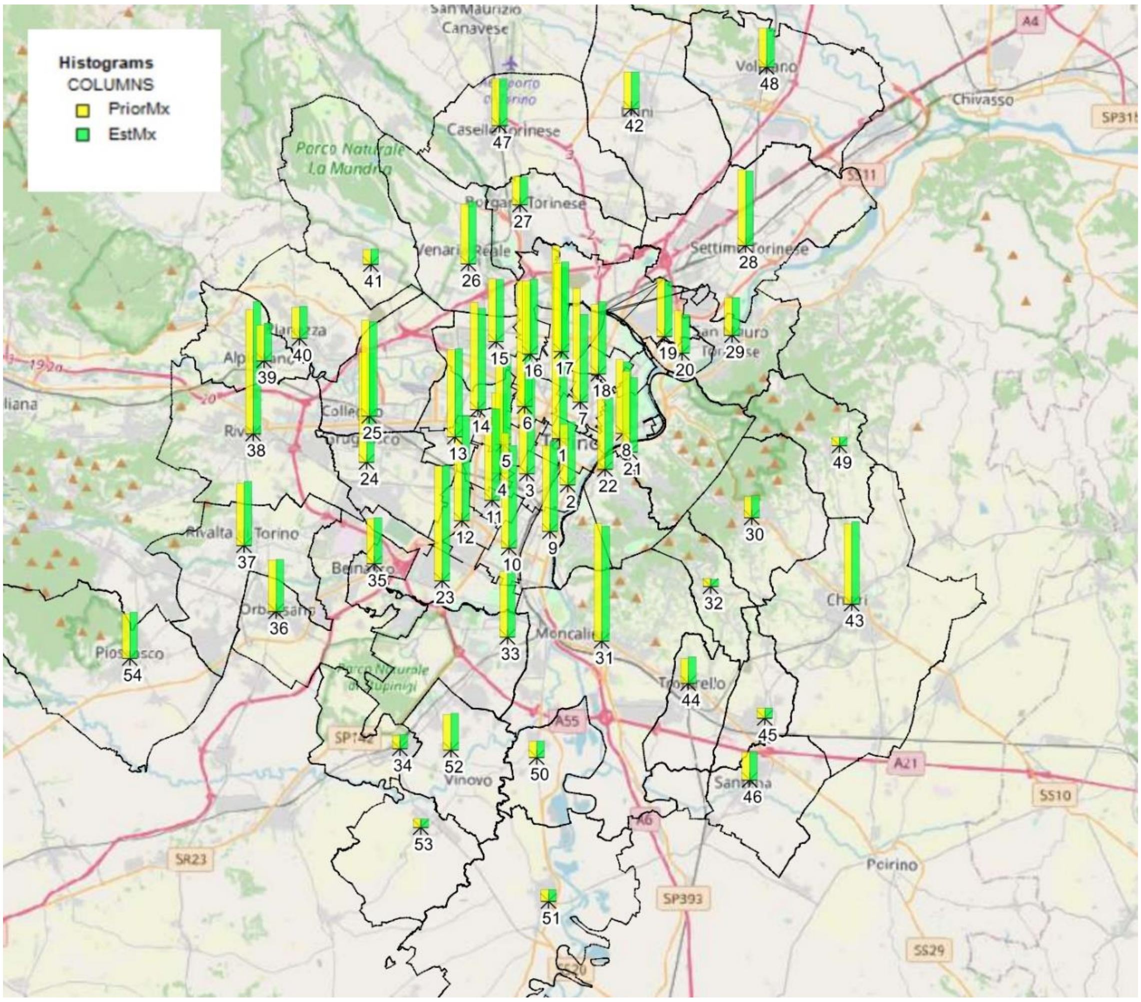


Figure 55

Matrix Column Total Comparison for the entire day analysis between IMQ 2013 and the Estimated Matrix with trip end data – From OmniTRANS 8.0.36



Analysing the pictures and reports generated in this section, it is possible to see a decrease on the demand for the year 2019 respect to the year 2013. To understand the difference between the matrices taken from IMQ 2013 data and those estimated using traffic counts and trip end data from 2019, some more computations were performed. Matrix 33, Matrix 34 and Matrix 35 located in Appendix L, show the relative difference between prior and estimated matrices for the three time periods. These new matrices include the information presented in the reports generated with OmniTRANS (relative difference of row and columns totals), but they also add extra data regarding the relative difference between every zone.

From these matrices, it is possible to see that the relative difference of the grand totals is that of 2% for the peak hours and 1% for the entire day. Considering that the relative difference between the population of 2013 and that of 2019 in the province of Turin is equal to 2%[15] and in the city of Turin is equal to 3,7%, the results obtained with the estimation are considered to be better representative of the travel demand for the year 2019.

In order to highlight the zones in which the estimated matrices decreased or increased the most, Table 39 located in Appendix L was created. This table shows the zones that have a relative difference higher than 10%. Then, in green it is possible to identify the centroids for which all time periods increased over the stablished limit, in yellow those that have two time periods with a relative difference over 10% and in red the centroids for which only one time period had an important increment or decrement.

5.3.1.3. Differences between PUMS matrix and the Estimated Matrix for the year 2019 with trip end information

In order to properly analyse the obtained results, it is necessary to make a comparison between the three estimated matrices with trip end information (morning peak, afternoon peak and Tuesdays) and the matrices taken from the PUMS report. In this case, the correlation can be more difficult to find given that there are the following four mismatches between these matrices:

1. the IMQ and PUMS zoning is different, as shown in section 4.3.2
2. these matrices consider different movements (trips for estimated matrices and tours for PUMS matrices), according to the assumption introduced in section 4.3.
3. estimated matrices refer to car trips, whereas PUMS matrices encompass all travel modes.

[15] As stated in section 4.3.3, the population in the province of Turin between the years 2013 and 2019 decreased from around 2.286.885 to 2.238.663 individuals (taken from Istat webpage).

4. the represented time periods are also different, since in this thesis simulation were run for morning peaks, afternoon peaks and entire day (Tuesday) whereas PUMS matrices are related to a typical day.

The following 4 steps process is implemented to address such discrepancies and make these matrices comparable.

Step 1: Aggregate the three estimated matrices obtained for this work and the three prior matrices used in this work to match the zones of the matrices in the PUMS report.

First, to match the zoning of both the three estimated and PUMS matrices, the former were aggregated for the zones shown in the PUMS. The same aggregation process was made for the three prior matrices from IMQ data. Table 36 in Appendix H shows the definition of the PUMS zones. It is also important to highlight that in this comparison only zones 1, 2, 3, 4 and 11 from the PUMS report are used. This is due to the fact that zones 5 to 10 include only municipalities outside the Metropolitan Area of Turin (see Figure 32 in page 86). The result is shown in Matrix 3 to Matrix 5 for the estimated matrices and in Matrix 6 to Matrix 8 for the prior matrices.

Matrix 3

O/D Trip Estimated Matrix (aggregated at PUMS zones), time range: 07-09.

	1	2	3	4	11	Total
1	24.746	3.625	2.482	1.262	594	32.710
2	3.018	2.565	362	191	0	6.136
3	2.986	504	2.911	72	114	6.586
4	1.745	135	0	2.168	0	4.048
11	1.470	77	329	11	1.203	3.090
Total	33.966	6.906	6.084	3.703	1.911	52.570

Matrix 4

O/D Trip Estimated Matrix (aggregated at PUMS zones), time range: 17-20.30.

	1	2	3	4	11	Total
1	29.384	3.679	4.322	1.317	1.357	40.058
2	3.442	4.889	456	180	131	9.097
3	3.542	510	3.672	63	302	8.089
4	1.929	171	80	2.460	0	4.640
11	1.205	21	213	0	1.230	2.669
Total	39.502	9.269	8.743	4.019	3.020	64.554

Matrix 5

O/D Trip Estimated Matrix (aggregated at PUMS zones), Tuesday (all day).

	1	2	3	4	11	Total
1	127.568	13.648	11.041	6.818	2.692	161.768
2	14.389	18.656	1.626	495	257	35.423
3	10.849	1.726	19.662	194	985	33.416
4	6.887	495	194	10.602	0	18.178
11	2.791	257	985	33	6.535	10.601
Total	162.485	34.783	33.508	18.143	10.468	259.387

Matrix 6

O/D Trip Prior Matrix (aggregated at PUMS zones), time range: 07-09.

	1	2	3	4	11	Total
1	26.157	3.997	2.087	1.878	407	34.526
2	3.301	2.370	321	163	0	6.155
3	2.698	484	3.189	64	128	6.564
4	1.900	135	0	1.840	0	3.875
11	1.103	129	362	33	1.330	2.956
Total	35.158	7.115	5.959	3.979	1.865	54.076

Matrix 7

O/D Trip Prior Matrix (aggregated at PUMS zones), time range: 17-20.30.

	1	2	3	4	11	Total
1	31.019	3.698	3.724	1.510	1.132	41.083
2	4.214	4.658	452	167	195	9.686
3	3.120	558	3.884	66	369	7.997
4	2.117	163	97	2.318	0	4.695
11	782	29	231	0	1.320	2.362
Total	41.253	9.107	8.387	4.061	3.016	65.824

Matrix 8

O/D Trip Prior Matrix (aggregated at PUMS zones), Tuesdays (all day).

	1	2	3	4	11	Total
1	127.568	13.648	11.041	6.818	2.692	161.768
2	14.389	18.656	1.626	495	257	35.423
3	10.849	1.726	19.662	194	985	33.416
4	6.887	495	194	10.602	0	18.178
11	2.791	257	985	33	6.535	10.601
Total	162.485	34.783	33.508	18.143	10.468	259.387

Step 2: Transformation of PUMS and IMQ tour matrices into trip matrices

Then, the matrix from the PUMS report (Matrix 24 in Appendix H) was multiplied by 2,08 in order to transform the tours into trips, according to the assumptions introduced in section 4.3.1. Therefore, a PUMS matrix of trips is obtained. On the other hand, the IMQ matrix of trips was derived from the IMQ raw data. The IMQ matrix of trips is comparable to the PUMS matrix of trips. In other words, the former follows the PUMS zoning.

Step 3: Ratios between matrices from step 1 and those from step 2

At this point, the differences between the matrices are the considered modes and the referenced time period. To cope with this mismatch, the ratios between each of the three estimated matrices and the above mentioned PUMS matrix of trips were computed. The ratios between the three prior matrices and the above mentioned IMQ matrix of trips were also calculated. Results are shown respectively in Matrix 9 to Matrix 11 and Matrix 12 to Matrix 14, were ratios are expressed in percent values.

Matrix 9

Percent ratios of Matrix 3 in the PUMS matrix of tips

	1	2	3	4	11	Total
1	2%	3%	2%	2%	2%	2%
2	2%	1%	1%	2%	0%	2%
3	2%	2%	1%	3%	1%	2%
4	3%	2%	0%	2%	0%	2%
11	5%	10%	2%	1%	1%	2%
Total	2%	2%	2%	2%	1%	2%

Matrix 10

Percent ratios of Matrix 4 in the PUMS matrix of tips

	1	2	3	4	11	Total
1	2%	3%	3%	2%	4%	2%
2	3%	3%	2%	2%	19%	2%
3	3%	2%	2%	3%	2%	2%
4	3%	2%	4%	3%	0%	3%
11	4%	3%	1%	0%	1%	2%
Total	2%	3%	2%	2%	2%	2%

Matrix 11

Percent ratios of Matrix 5 in the PUMS matrix of trips

	1	2	3	4	11	Total
1	9%	11%	12%	8%	12%	10%
2	9%	9%	6%	6%	24%	9%
3	11%	6%	8%	8%	5%	9%
4	9%	6%	9%	13%	0%	11%
11	15%	18%	4%	3%	6%	8%
Total	10%	10%	9%	10%	7%	9%

Matrix 12

Percent ratios of Matrix 6 in the IMQ matrix of trips

	1	2	3	4	11	Total
1	2%	4%	3%	4%	2%	2%
2	3%	1%	2%	6%	0%	1%
3	4%	3%	1%	5%	1%	2%
4	4%	4%	0%	1%	0%	2%
11	5%	9%	3%	4%	1%	2%
Total	2%	2%	2%	2%	1%	2%

Matrix 13

Percent ratios of Matrix 7 in the IMQ matrix of trips

	1	2	3	4	11	Total
1	2%	4%	5%	3%	5%	2%
2	4%	2%	3%	6%	15%	2%
3	5%	4%	2%	5%	3%	2%
4	5%	5%	5%	2%	0%	3%
11	3%	2%	2%	0%	1%	1%
Total	2%	2%	2%	2%	2%	2%

Matrix 14

Percent ratios of Matrix 8 in the IMQ matrix of trips

	1	2	3	4	11	Total
1	8%	15%	13%	14%	11%	8%
2	15%	6%	10%	17%	20%	9%
3	16%	11%	8%	15%	8%	10%
4	15%	14%	10%	8%	0%	10%
11	12%	18%	9%	4%	5%	6%
Total	9%	8%	9%	10%	6%	9%

Step 4: Differences between ratios from prior and estimated matrices

The final step is to compute the difference between the two sets of ratios obtained in step 3. The result is shown in the following three matrices.

Matrix 15

Difference between Matrix 9 and Matrix 12

	1	2	3	4	11	Total
1	0,4%	-1,6%	-0,5%	-2,0%	0,1%	0,2%
2	-1,3%	0,5%	-0,7%	-3,4%	0,0%	0,2%
3	-1,6%	-1,2%	0,0%	-1,5%	-0,5%	-0,2%
4	-1,6%	-2,3%	0,0%	1,0%	0,0%	0,2%
11	0,2%	0,3%	-1,3%	-2,8%	0,3%	0,5%
Total	0,2%	0,1%	-0,1%	0,0%	0,3%	0,1%

Matrix 16

Difference between Matrix 10 and Matrix 13

	1	2	3	4	11	Total
1	0,4%	-1,3%	-1,0%	-1,2%	-0,5%	0,3%
2	-1,9%	1,0%	-1,1%	-3,7%	4,2%	0,1%
3	-1,8%	-1,6%	0,1%	-2,1%	-1,5%	-0,3%
4	-1,8%	-2,7%	-1,1%	0,9%	0,0%	0,1%
11	0,7%	0,5%	-0,8%	0,0%	0,4%	0,5%
Total	0,2%	0,3%	-0,1%	0,1%	0,4%	0,2%

Matrix 17

Difference between Matrix 11 and Matrix 14

	1	2	3	4	11	Total
1	1,7%	-3,4%	-1,8%	-5,7%	0,7%	1,2%
2	-5,8%	3,2%	-4,1%	-11,3%	3,7%	0,5%
3	-5,0%	-5,3%	-0,2%	-6,7%	-3,8%	-1,2%
4	-5,9%	-8,3%	-1,2%	4,3%	0,0%	0,6%
11	2,9%	-0,3%	-4,3%	-1,1%	1,4%	1,7%
Total	1,0%	1,3%	-0,6%	0,3%	1,3%	0,8%

The prior matrices and the IMQ matrix of trips are all derived from the same raw data, this means that the ratios in this case are consistent. Then, from step 4 it is possible to notice the small difference in the ratios between estimated and prior matrices for each case. This leads to the conclusion that the estimated matrices represent accurately the matrices from the PUMS report given that the percent ratios of the estimated matrices in the PUMS matrix of trips is similar to the percent ratios of the prior matrices in the IMQ matrix of trips.

5.3.2. Validating of the Methodology

To validate and obtain some parameters which indicate the effectiveness of the estimated values, two assumptions are taken:

1. As mentioned before (in section 5.3.1.3), the prior matrices and the IMQ matrix of trips are all derived from the same IMQ raw data, this means that the percent ratios in this case are consistent
2. The matrices taken from the PUMS report are accurate in representing tours, as discussed in section 4.3, specially 4.3.3.

With these two assumptions, the validity of the method was calculated by analysing the correlation coefficient (which indicates the strength of the relationship between data) and the R-square value (which shows the proportion of the variation in Y explained by X or, in other words, how well the model explains the variation in the data). This is done between the estimated and PUMS matrices. In order to match every *dimensions* and compare the corresponding matrices, first, the above mentioned PUMS matrix of trips (i.e. Matrix 24 located in Appendix H times 2,08) was multiplied by the ratios reported in Matrix 12 to Matrix 14 (shown in step 3 from the previous section).

In Table 8 the coefficients of correlation between rows and columns totals of estimated and PUMS matrices are shown. The coefficients show positive very near to one values and this indicates a strong correlation between them.

Table 8

Coefficients of correlation

	07-09	17-20.30	Tuesday
Rows Totals	0,9978	0,9978	0,9975
Columns Totals	0,9992	0,9989	0,9986

Then, Figure 56, Figure 57 and Figure 58 were generated considering rows and columns totals of corresponding matrices from estimations and PUMS. From the figures below it is possible to see that the lowest value of R-square is 0,9958 while the maximum one is 0,9975. This shows the high accuracy with which the estimated values match the PUMS (or observed) values.

It is also important to comment on the equations of the curves shown in the figures below. The slope value showed in all curves, is near but higher than one and this shows an overestimation of the method. Also, the intercepts in the equations are all near to zero (considering the high scales of trips that are analysed).

Figure 56

Calculation of R-square value to validate the methodology. Analysed period: morning peak.

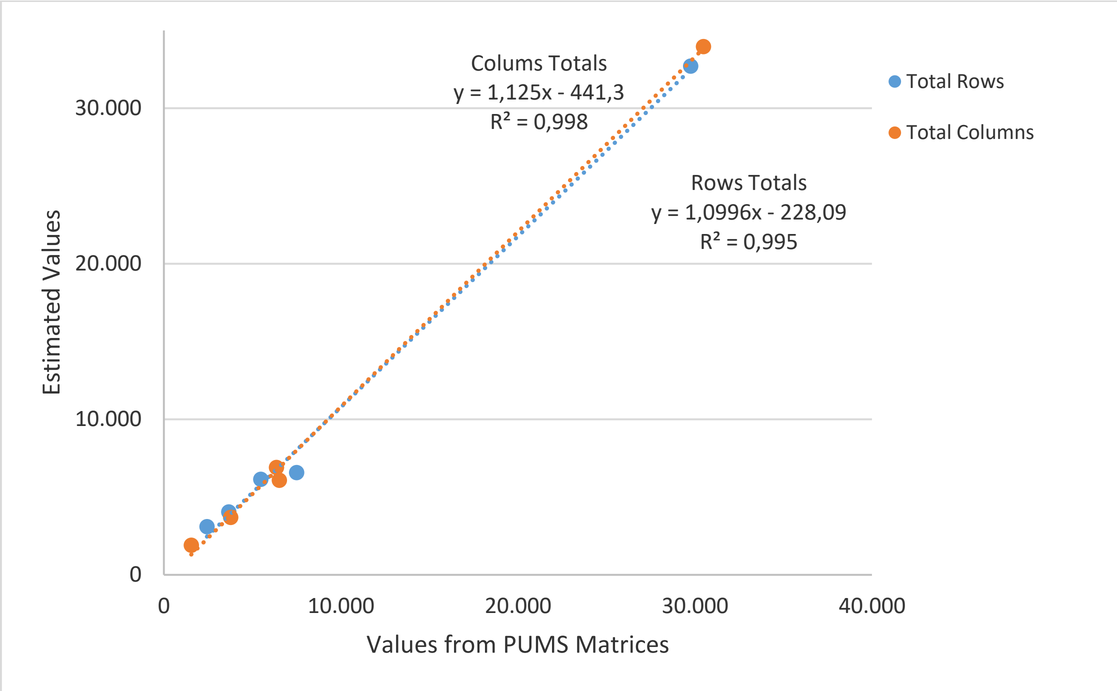


Figure 57

Calculation of R-square value to validate the methodology. Analysed period: afternon peak.

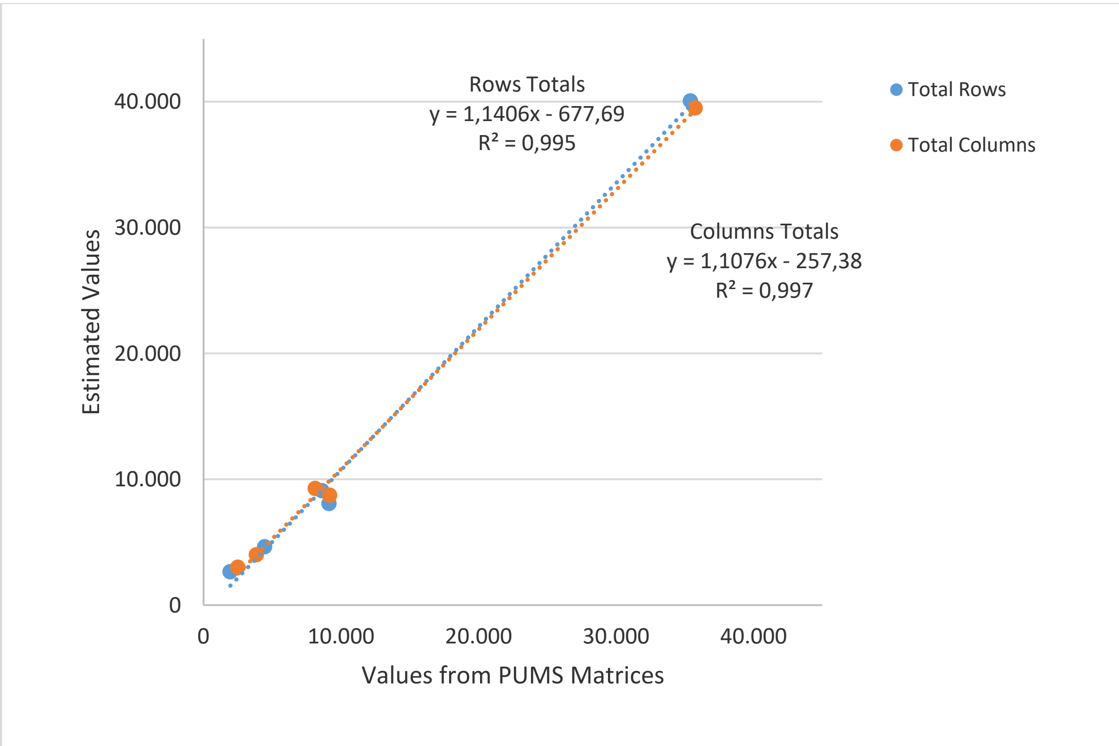
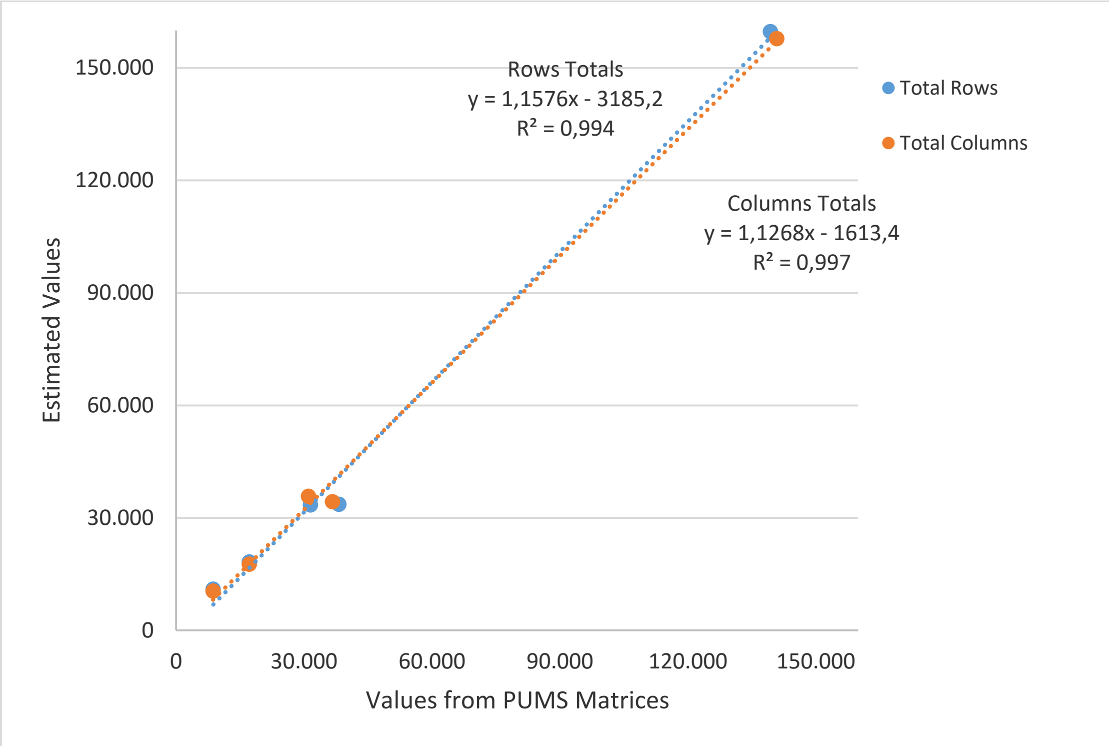


Figure 58

Calculation of R-square value to validate the methodology. Analysed period: Tuesdays (all day)..



5.3.3. Comparison between Flows

In order to compare flows, the assignment of traffic of the prior matrix demand volume was done for all time periods (in the initial variants). Then, the same assignment was done with the estimated volumes of traffic (in the new created variants). In other words, the IMQ matrices traffic was assigned to the original three variants (*Morning Peak, Afternoon Peak and Tuesday)* while the estimated matrices given by the software were applied to three new variants called *Results-MP, Results-AP, Results-Tue.* The codes used for the assignment of traffic are shown in Appendix J (Job 4, Job 5 and Job 6).

In Figure 59 to Figure 64 the traffic assignment performed for the analysis of the prior and estimated matrices is illustrated. These figures show the load of traffic (expressed by the widths of the bands attached to the links) and the count value (represented with different colours). For each time slot, the colour references were chosen so that the light-blue bands represent those links without count information.

Figure 59

Assignment of Prior Matrix demand volumes for the morning peak hour (City of Turin) – From OmniTRANS 8.0.36

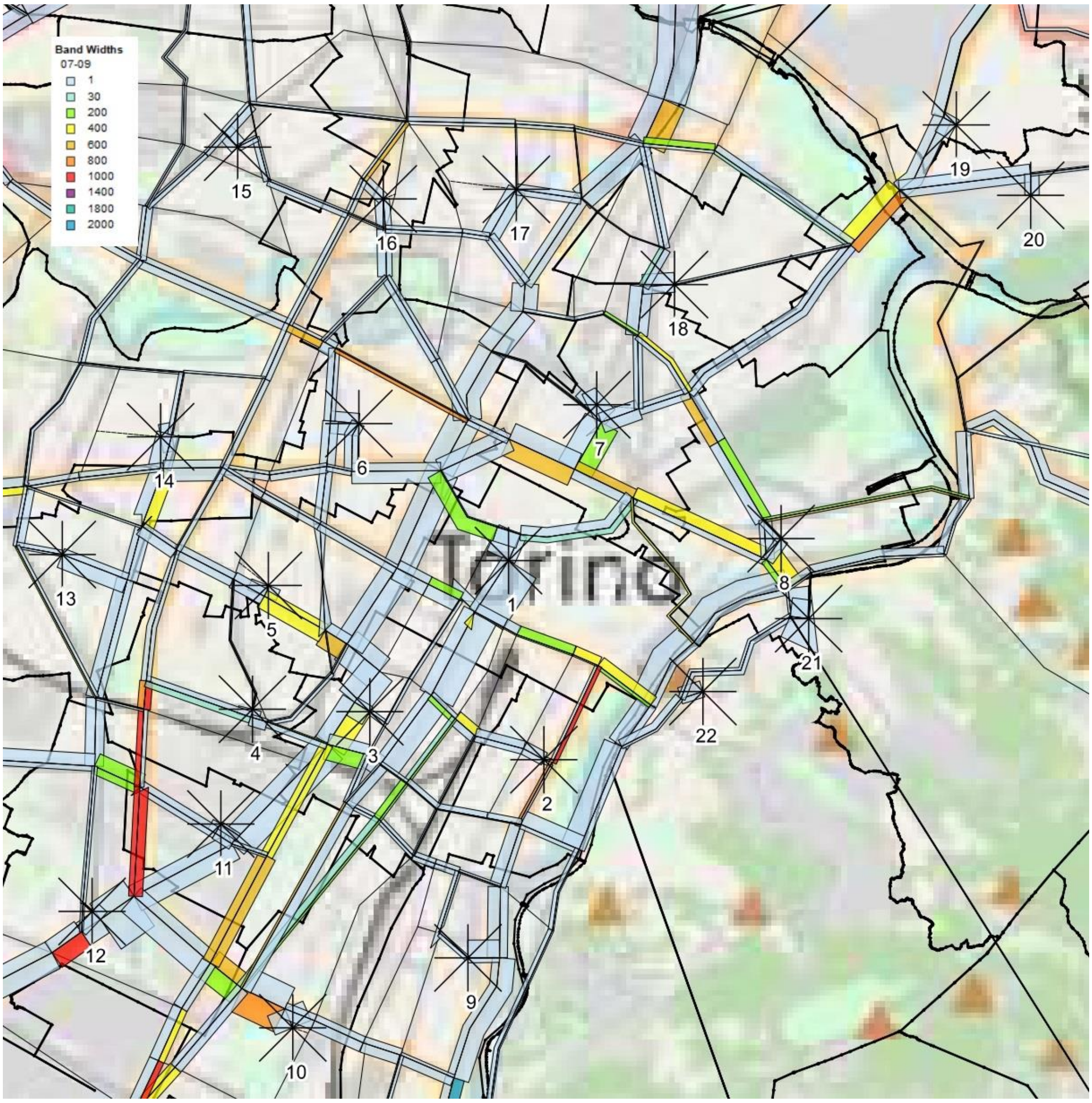


Figure 60

Assignment of Estimated Matrix demand volumes for the morning peak hour (City of Turin) – From OmniTRANS 8.0.36

Figure 61

Assignment of Prior Matrix demand volumes for the afternoon peak hour (City of Turin) – From OmniTRANS 8.0.36

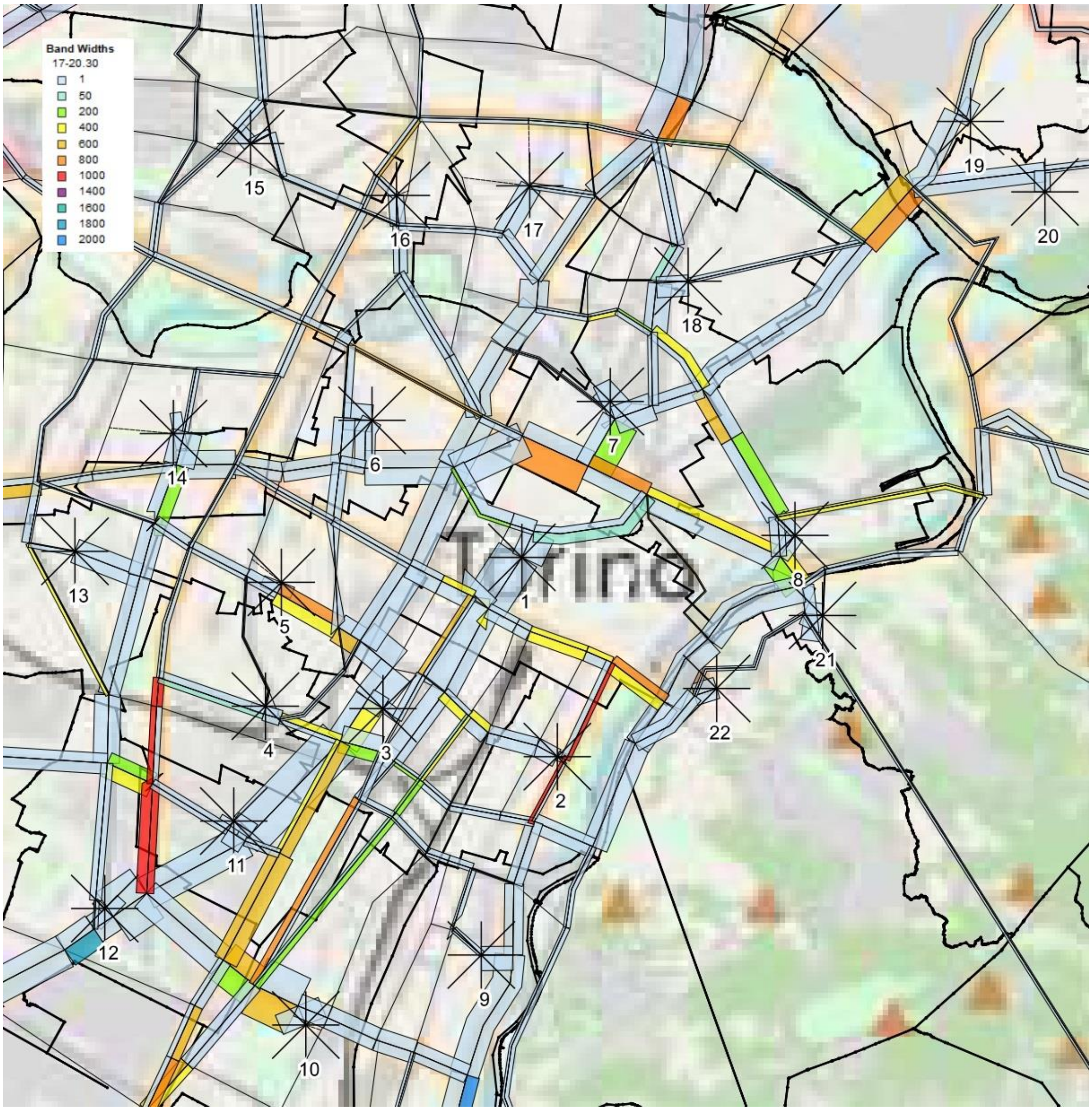


Figure 62

Assignment of Estimated Matrix demand volumes for the afternoon peak hour (City of Turin) – From OmniTRANS 8.0.36

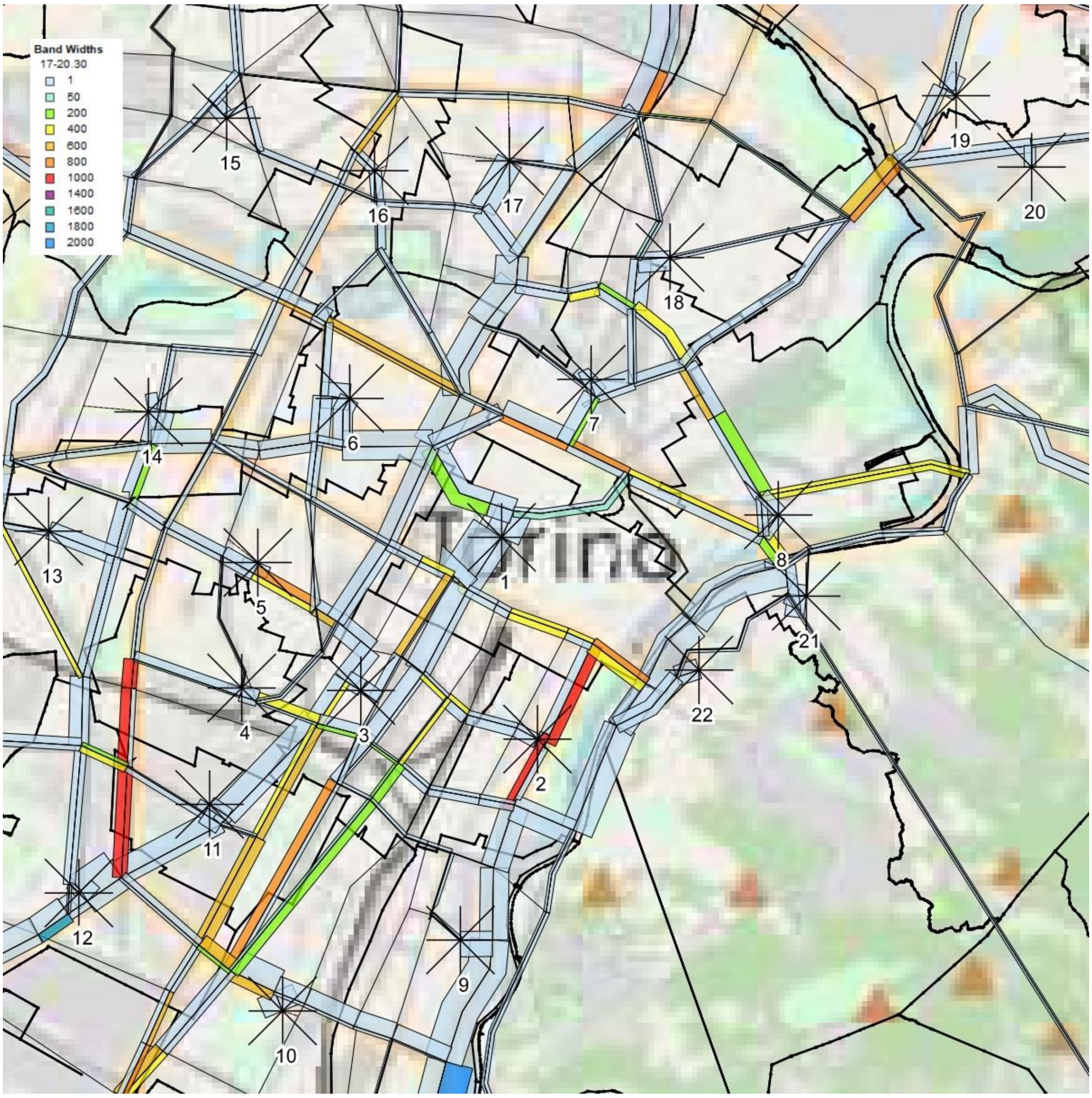


Figure 63

Assignment of Prior Matrix demand volumes for an entire day (City of Turin) – From OmniTRANS 8.0.36

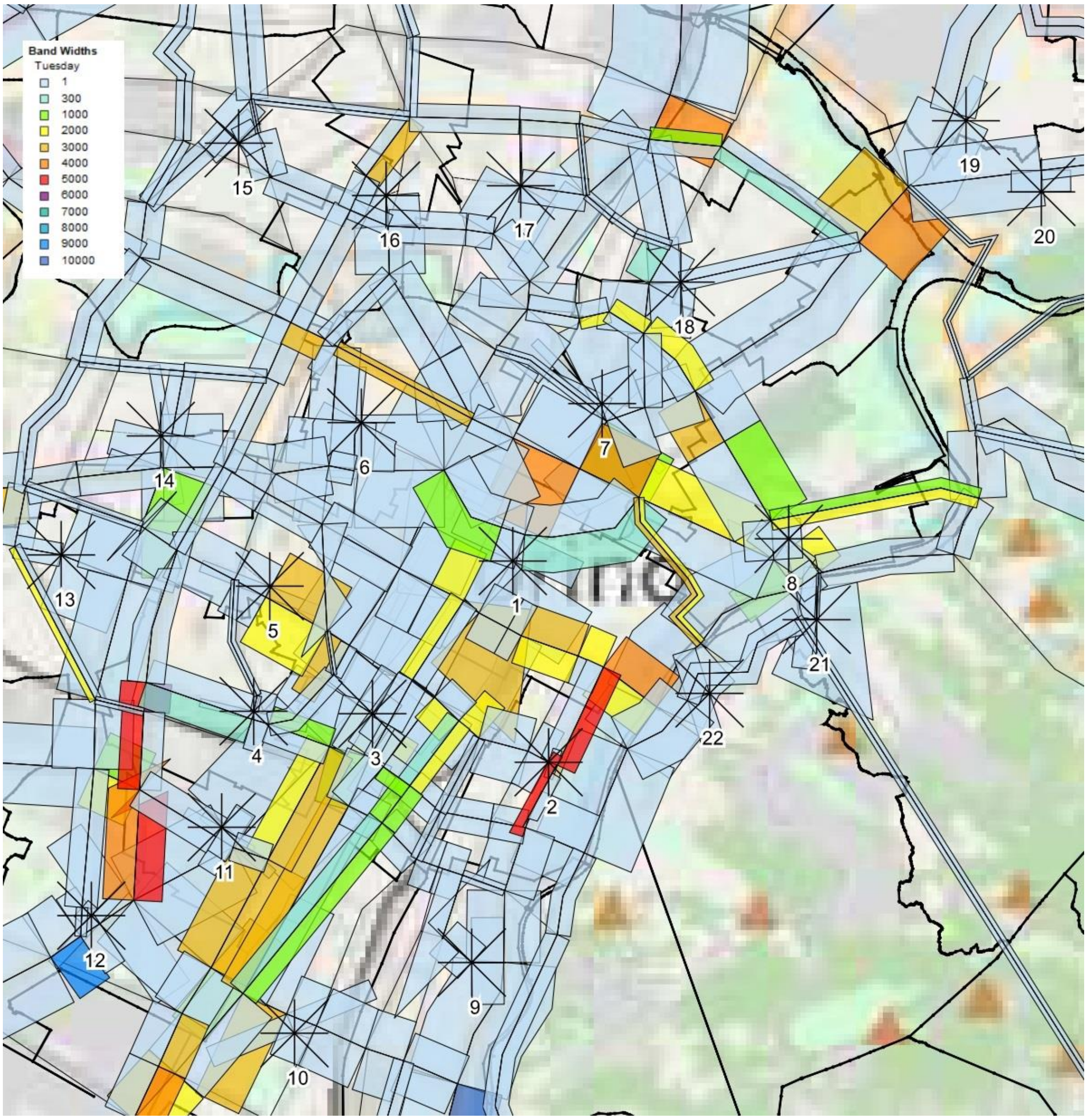
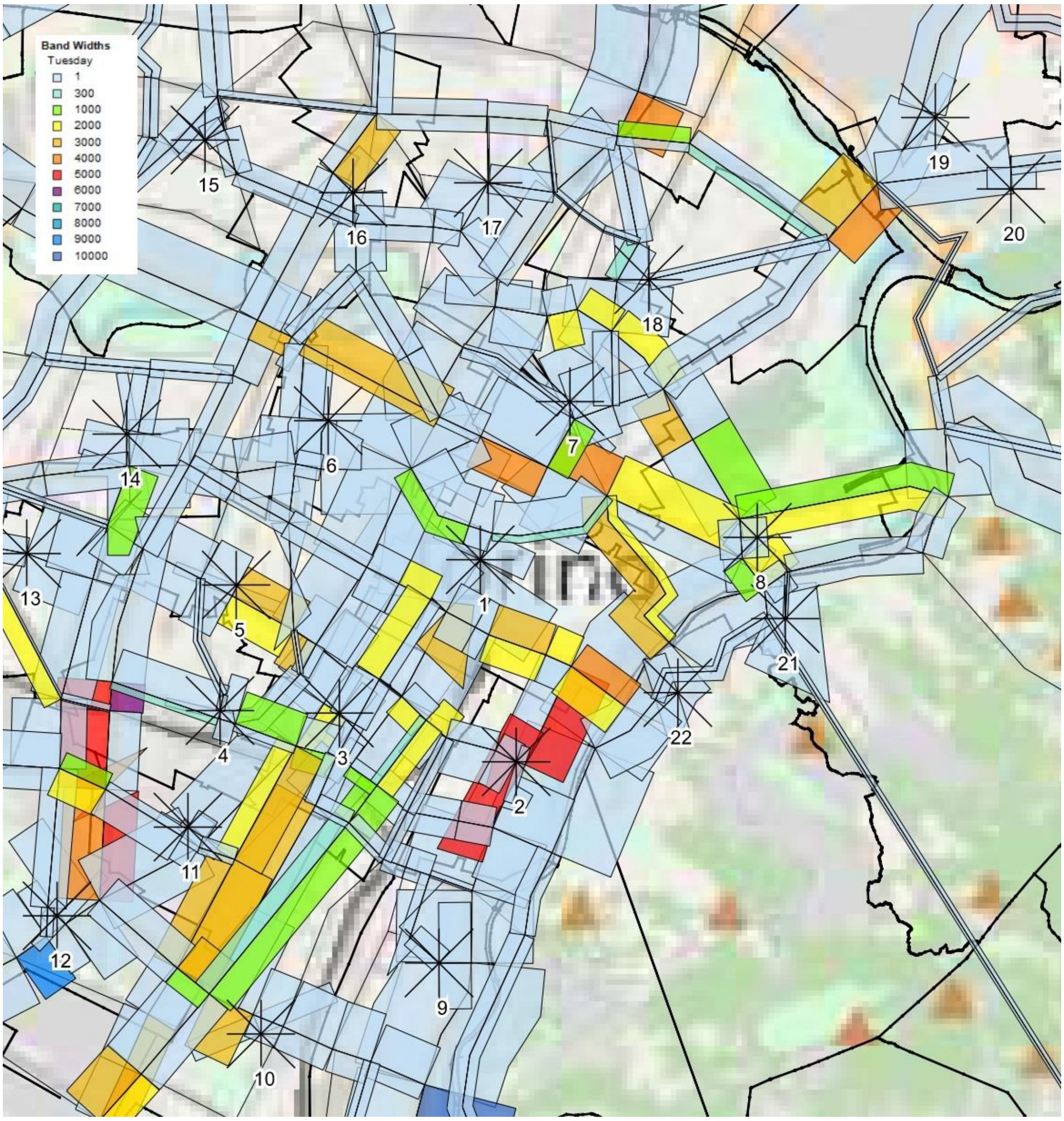


Figure 64

Assignment of Estimated Matrix demand volumes for an entire day (City of Turin) – From OmniTRANS 8.0.36



Analysing the figures above, it is possible to see the consistency between count values and the assign flows given that in every case when the bands are wider, in the links with traffic count data, the colour of the band also represents a count with a high value. In other words, the colours of the band do not change between the prior and estimated matrix assignment (the value of the count is always the same). Anyways, it is possible to see an increment on the width of the band when the count has a high value (see colour scale for every time range).

Chapter VI

Conclusions

This chapter will conclude the thesis by summarising the key aspects of the work in relation to the goals stablished at the beginning. It will also review the limitations of the study and propose opportunities for future research.

This study aimed to test the functionality implemented in the OmniTRANS software to estimate matrices based on prior matrices and traffic counts to check to which extent it can be used to obtain updated origin-destination matrices from an old matrix by considering more recent traffic counts. We examine to this effect a case study in the Turin metropolitan area, trying to update the 2013 matrix from the latest regional travel survey by considering traffic counts from 2019, and additionally considered an observed matrix from 2019 that was retrieved from the PUMS technical documentation for validation purposes.

The results indicate that the explained approach is fairly accurate, with a good match between updated matrices and PUMS matrices. Correlations between row and column totals are higher than 0.99 and linear regression lines have slopes near one and intercepts near zero. In general terms, it can be said that following all the exposed procedures, it is possible to get a quite precise estimation of origin-destination matrices using an initial matrix (old O/D matrix) and updating it with traffic counts and trip end data from another year.

This work provides an evaluation of the method based in the OmniTRANS software for the updating of old origin-destination matrices. In doing so, this thesis tests the approach in the city of Turin and its surroundings. When used, this method can provide decision makers with update information which helps the creation, organization, systemization and application of transport policies.

On the other hand, the main limitation to this thesis is the requirement of trip end information. This key point in the model can be considered a limitation due to the fact that the information available for the analysis of different cities and territories is not the same. While traffic counts are generally measured and considered everywhere, trip end data is more difficult to estimate. In this thesis, trip end data was calculated using matrices obtained from the above mentioned PUMS report. Anyways, this data can also be estimated by taking into consideration the percentage change in the population or other available information. Further steps of the work might consider the generalization for other modes of transportation and the comparison of updated matrices with traffic count data from different years.

To conclude, it can be said that the method used in this work to update origin-destination matrices provide accurate results. This results are expressed as updated travel demand matrices and these are essential for the task of transport planning.

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Appendix A – Literature Review: Case Studies

Table 9

Literature's review case studies comparison

	Input	Methodology	Period	Model Setting	Effective Measure	Goals
Gonzalez et al. (2020)	Traffic counts and OD matrix	Maximum entropy theory using GAMS (General Algebraic Modelling System)	AM peak hour. From 6 to 9	Case study in Medellin (Colombia). 16 zones, 1516 nodes, 4502 links and 36 traffic count stations	RMSE and MAPE	To estimate passenger car trips that match traffic counts. In other words, to consider the available information and incorporate these data to a new OD matrix estimation model, to have good results without conducting OD surveys so often. Compare results using traffic counts for different years.
Toledo and Kolechkina (2013)	OD estimated matrix from old studies and traffic counts	Linear approximation of assignment matrix. Implemented in MATLAB using Mezzo model for traffic assignment	AM peak hour. From 7 to 8.	Located in Sodermalm, Stockholm, Sweeden, the network has 577 nodes and 1101 links. 55 traffic counts were used	Comparison with state-of-the-art approaches such as Lundgren et al. and SPSA	To generate a new method to solve the Dynamic O/D Estimation (DODE) that is applicable for large and complex networks.
Savrasovs and Pticina (2017)	Video recordings and traffic counts	Use video recording to construct an initial O/D matrix. Then, this matrix is calibrated by the application of TFlowFuzzy which basically calibrates the matrix using existing conditions (in this case, traffic counts)	PM peak hour. From 17:15 to 18:30	Located in Riga city, capital of Latvia. The network included 14 zones. The analysed territory connects several residential districts	R-square and Mean Relative Error	To demonstrate the application of the methodology of O/D matrix evaluation based on video recording and traffic counts
Moghadam et al. (2015)	To infer the vehicular traffic origin-destination matrix for LA using sensor information of traffic counts and speeds obtained in real-time from LA road intersections	Linear least square optimization problem. Implemented in Python using the scipy.optimize package	Three states of traffic: AM peak hour (7-7:30), PM peak hour (19-19:30 and afternoon traffic (13-13:30).	Rectangular region including USC and downtown Los Angeles. Includes 5498 intersections and 7584 arterial road segments	Average error for different cases in the three situations.	To infer the vehicular traffic origin-destination matrix for LA using traffic counts and speeds obtained road intersections

	Input	Methodology	Period	Model Setting	Effective Measure	Goals
Larijani et al. (2015)	Mobile phone data, sensor data and surveys	Bahoken and OlteanuRaimond (2007). In this case a flow is determined by taking the first two points and the last two points of the trajectory	One week day, from 6 to 10 and from 14-21	The study was performed in the Paris region. Using the Voroni scale, a matrix of 3040x3040 was considered at first.		To separate the transportation mode in urban areas by estimating O/D matrices using mobile phone data.
Basso et al. (2022)	Traffic counts from toll gates, Simpli Route (SR) data and economic sectors of companies owning trucks	Decision tree model and Proportionality factors	July 2019 and company-owned heavy vehicles	Autopista Central (AC) is 60 km long and crosses 10 of the 34 of the Metropolitan Area of Santiago de Chile	MAPE and Parson correlation between land use and distribution obtained with this methodology	To understand the urban freight transportation in Santiago, Chile, using multiple data sources.
Hora et al. (2017)	Sets of routes and stops of the system, Automatic Fare Collection (AFC) data and walking distance matrix	Trip Changing Method (TCM) to estimate alighting stops and infer OD matrices. Matrices were calculated at stop level and aggregated at zonal level	All trips made using bus, tram and metro in January 2013. Considering the day started at 3 AM and finished at 2:59 AM	Porto's network (Brazil) has 3988 stops. The metro has 6 routes and 81 stops while the bus has 71 routes and the tram 3 routes. Buses and trams share stops	Results were compared to OD totals obtained at municipality level in the 2011 census.	To provide an OD matrix for the city of Porto, allowing to improve the quality of its public transport system

RMSE - Root Mean Square Error: Error between estimated and real values.
MAPE - Mean Average Percentage Error.
R-square - Coefficient of determination: The proportion of the variation in the dependent variable that is predictable from the independent variable(s).

Appendix B – QGIS functions and list of zone's names

Table 10

QGIS functions

Toggle Editing	
Add Point Feature	

Table 11

List of zones in Turin

IMQ Code	OmniTRANS number	Name
Q001	1	CENTRO
Q002	2	SAN SALVARIO
Q003	3	CROCETTA
Q004	4	BORGO SAN PAOLO
Q005	5	CENISIA
Q006	6	SAN DONATO
Q007	7	AURORA
Q008	8	VANCHIGLIA
Q009	9	NIZZA MILLEFONTI
Q010	10	LINGOTTO
Q011	11	SANTA RITA
Q012	12	MIRIAFORI NORD
Q013	13	POZZO STRADA
Q014	14	PARELLA
Q015	15	VALLETTE
Q016	16	MADONNA CAMPAGNA
Q017	17	BORGO VITTORIA
Q018	18	BARRIERA DI MILANO
Q019	19	FALCHERA
Q020	20	BARCA
Q021	21	MADONNA PILONE
Q022	22	CAVORETTO
Q023	23	MIRIAFORI SUD

Table 12

List of zones in the surroundings

IMQ Code	OmniTRANS number	Name
C002	24	GRUGLIASCO
C003	25	COLLEGNO
C004	26	VENARIA REALE
C005	27	BORGARO TORINESE
C006	28	SETTIMO TORINESE
C007	29	SAN MAURO TORINESE
C008	30	PINO TORINESE
C009	31	MONCALIERI
C010	32	PECETTO TORINESE
C011	33	NICHELINO
C012	34	CANDIOLO
C013	35	BEINASCO
C014	36	ORBASSANO
C015	37	RIVALTA DI TORINO
C016	38	RIVOLI
C017	39	ALPIGNANO
C018	40	PIANEZZA
C019	41	DRUENTO
C020	42	LEINI
C021	43	CHIERI
C022	44	TROFARELLO
C023	45	CAMBIANO
C024	46	SANTENA
C064	47	CASELLA TORINESE
C065	48	VOLPIANO
C066	49	BALDISSERO TORINESE
C067	50	LA LOGGIA
C068	51	CARIGNANO
C069	52	VINOVO
C070	53	PIOBESI TORINESE
C071	54	PIOSSASCO

Appendix C – OmniTRANS functions and classes

Table 13

Functions and buttons in OmniTRANS

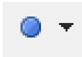
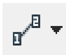
Centroid setting	
Node setting	
Link setting	
Count setting	
Screenline setting	
Addition	
Single select	
Add new dimension item Add new combination Duplicate variant	
Add new dimension sub-item Create sub-variant	
Matrix Cube Manager	
Add job	
Remove job	
Run job	
Associated matrix cube	
Maps	
Edit map	

Table 14

Data Access Classes

OtCordonCube	This class is used to process cordon matrices generated by the OtTraffic and OtTransit Classes. A cordon cube has PMTURI dimensions
OtMatrix	This class provides a set of methods to access and work with the contents of matrices
OtMatrixCube	This class is used to process matrices that are stored within a cube that has PMTU dimensions
OtNetwork	This class provides a collection of methods for retrieving data from or putting data to the network that is associated with the current variant
OtQuery	This class is used to query the database
OtScreenlineCube	This class is used to process screenline matrices generated by the OtTraffic and OtTransit Classes and would be used as input when running a matrix estimation using the OtMatrixEstimation class. A screenline cube has PMTURI dimensions
OtSelectedLinkCube	This class s is used to process selected link matrices generated by the OtTraffic and OtTransit Classes. A selected link cube has PMTURI dimensions
OtSkimCube	This class is used to process skim matrices generated by the OtTraffic and OtTransit Classes. A skim cube has PMTURI dimensions
OtStationCube	This class is used to process station (stop-to-stop) matrices generated by the OtStationCube Class. A station cube has PMTURI dimensions
OtTable	This class is used to access the database
OtVector	This class provides a set of methods to access and work with the contents of vectors.

Note: Taken from OmniTRANS manual. (2022). Compatible with OmniTRANS V8.0.36

Table 15

Data Analysis Classes

OtChart	This class provides methods to generate charts
OtChartBar	This class provides methods to generate bar-charts
OtChartGrid	This class provides methods to generate grid-charts
OtChartLine	This class provides methods to generate line-charts
OtChartPie	This class provides methods to generate pie-charts

Note: Taken from OmniTRANS manual. (2022). Compatible with OmniTRANS V8.0.36

Table 16

Data Import/Export Classes

OtArcViewImport	This class is used to import an ArcView GIS project into an OmniTRANS project variant
OtArcViewExport	This class is used to export an ArcView GIS project from an OmniTRANS project variant
OtAsciiImport	This class is used to import data in generic ASCII format into an OmniTRANS project variant
OtAsciiExport	This class is used to export an OmniTRANS project variant into a generic ASCII format
OtOmnitransImport	This class is used to import data from another OmniTRANS project
OtSaturnImport	This class is used to import Saturn networks into an OmniTRANS project variant
OtTripsImport	This class is used to import a TRIPS network into an OmniTRANS project variant
OtTripsExport	This class is used to export an OmniTRANS network into TRIPS ASCII format

Note: Taken from OmniTRANS manual. (2022). Compatible with OmniTRANS V8.0.36

Table 17

Modelling Classes

OtChoice	This class provides methods for choice modelling
OtGravity	This class provides access to the simultaneous multi-modal Gravity Model
OtGrowthFactor	This class provides access to the Growth Factor Model
OtMatrixEstimation	This class provides access to the Matrix Estimation model
OtStreamLine	This class provides access to the Dynamic Traffic assignment and analysis functionality in OmniTRANS (OtStreamLine)
OtTraffic	This class provides access to the Static Traffic assignment and analysis functionality in OmniTRANS
OtTransit	This class provides access to the Public Transit assignment and analysis functionality in OmniTRANS
OtTripEnd	This class provides methods for trip end modelling

Note: Taken from OmniTRANS manual. (2022). Compatible with OmniTRANS V8.0.36

Table 18

Utility Classe

OtIniFile	This class provides an interface to INI files
OtSystem	This class provides access to the operating system

Note: Taken from OmniTRANS manual. (2022). Compatible with OmniTRANS V8.0.36

Appendix D – Open Data Information of IMQ survey

Table 19

Interview information table

Interview ID	Day	Code Residence Zone	Residence	Sex	Age Range	Exits	Amount of exits	Amount of Trips	Amount of cars	Activity	Type of School	Activity Condition	Activity Sector	Study Title	Anagrafic Residence	Sample Rate
08138545	19-sep-13	C011	Cintura	1	2	2	1	3	1	1			6	4	1	3,2261
08138565	19-sep-13	C006	Cintura	1	1	2	1	2	1	8	5			4	1	3,0837
08138615	19-sep-13	C011	Cintura	2	4				3	10				4	1	2,8292
08138661	24-sep-13	C011	Cintura	2	2	2	1	2	1	9				4	1	3,1319
08138684	19-sep-13	C006	Cintura	2	2	2	1	2	2	8	5			4	1	3,1274
08138692	19-sep-13	C003	Cintura	1	1	2	1	2	2	8	2			3	1	2,9995
08138699	19-sep-13	C006	Cintura	1	1				1	8	5			4	1	3,0837
08138702	19-sep-13	C004	Cintura	1	2	2	1	3	2	1			2	5	4	3,1407
08138709	19-sep-13	C002	Cintura	1	4	2	1	2	1	10				3	1	2,7882
08138711	19-sep-13	C009	Cintura	2	2				2	3		2	2	4	1	3,1568
08138722	19-sep-13	C007	Cintura	2	3				1	9				4	1	2,9626
08138724	19-sep-13	C005	Cintura	2	1	2	1	2	1	8	2			3	1	3,3333
08138730	20-sep-13	C009	Cintura	1	2				3	12				4	1	3,2605
08138733	19-sep-13	C005	Cintura	2	3	2	1	3	2	3		2	3	3	1	2,8786
08138737	19-sep-13	C011	Cintura	2	2	2	1	2	1	9				2	1	3,1319
08138739	19-sep-13	C004	Cintura	1	2				1	12				5	1	3,1407
08138742	19-sep-13	C007	Cintura	2	4				1	10				4	1	2,8462
08138744	19-sep-13	C006	Cintura	2	3	2	1	2	1	10				2	1	2,9866
08138747	20-sep-13	C004	Cintura	2	3	2	1	2	1	9				4	1	3,0196
08138749	19-sep-13	C009	Cintura	2	4				0	10				3	1	3,0004

Note: Taken from IMQ 2013 Open Data file. The table is 52.119 rows long. Here only 20 information rows have been reproduced as an example.

Table 20

Trip Information Table

Interview ID	Exit Prog	Trip Prog	Sex	Age Range	Code Residence Zone	Purpose of Trip	Code Residence Origin	Prov of Origin	Hour of Exit	Code Residence Arrival	Prov of Arrival	Hour of Arrival	Transport Mode	Mode 1	Mode 2	Mode 3	Amount Comp	Amount Urban Lines	Code of Other Urban	Code 2 Mode	Prov 2 Mode	Time 2 Mode	Code 3 Mode	Prov 3 Mode	Time 3 Mode	Sample Rate
08138796	1	2	1	3	C002	08	C002	001	09:23	C002	001	09:30	2													3,1258
08138796	2	1	1	3	C002	09	C002	001	13:00		007	15:30	1	12	01						007	15:20				3,1258
08138796	2	2	1	3	C002	08		007	17:30	C002	001	20:00	1	01	12						007	17:40				3,1258
08138829	1	1	2	3	C003	01	C003	001	07:00	C064	001	07:45	1	03			0									3,0637
08138829	1	2	2	3	C003	08	C064	001	14:15	C003	001	15:00	1	03			1									3,0637
08138829	2	1	2	3	C003	04	C003	001	17:00	C009	001	17:30	1	03			1									3,0637
08138829	2	2	2	3	C003	08	C009	001	19:30	C003	001	20:00	1	03			1									3,0637
08138855	1	1	1	1	C006	06	C006	001	09:30	Q003	001	09:50	1	02												3,0837
08138855	1	2	1	1	C006	08	Q003	001	12:10	C006	001	12:30	1	02												3,0837
08138861	1	1	2	2	C011	09	C011	001	08:15	R420	004	09:30	1	04												3,1319
08138861	1	2	2	2	C011	05	R420	004	15:00	C011	001	15:50	1	04												3,1319
08138861	1	3	2	2	C011	08	C011	001	16:15	C011	001	16:30	1	04												3,1319
08138864	1	1	2	2	C011	04	C011	001	09:00	C011	001	09:10	2													3,1319
08138864	1	2	2	2	C011	09	C011	001	09:20	C011	001	09:30	2													3,1319
08138864	1	3	2	2	C011	08	C011	001	16:50	C011	001	17:00	2													3,1319
08138868	1	1	2	3	C006	07	C006	001	09:00	C006	001	09:15	2													2,9866
08138868	1	2	2	3	C006	08	C006	001	11:15	C006	001	11:30	2													2,9866
08138868	2	1	2	3	C006	01	C006	001	14:00	Q023	001	14:30	1	03			0									2,9866
08138868	2	2	2	3	C006	08	Q023	001	22:00	C006	001	22:30	1	03			0									2,9866
08138871	1	1	2	4	C011	04	C011	001	14:20	Q008	001	15:35	1	06				2								2,8292
08138871	1	2	2	4	C011	08	Q008	001	17:45	C011	001	19:00	1	06				2								2,8292
08138872	1	1	2	3	C011	04	C011	001	10:00	C011	001	10:10	2													3,1121
08138872	1	2	2	3	C011	08	C011	001	10:50	C011	001	11:00	2													3,1121
08138872	2	1	2	3	C011	07	C011	001	17:00	C011	001	17:10	2													3,1121
08138872	2	2	2	3	C011	08	C011	001	18:50	C011	001	19:00	2													3,1121

Note: Taken from IMQ 2013 Open Data file. The table is 105.098 rows long. Here only 25 information rows have been reproduced as an example. Prog is Progressive and Prov is Province

Table 21

Reference table: Activity of Residents

Code Activity	Label
1	Entrepreneur / Freelancer
2	Officer / Manager
3	Clerk / Commerce Attendant
4	Worker
5	Teacher
6	Representative
7	Craftsman / Trader
8	Student
9	Housewife
10	Retired
11	Waiting for 1st work
12	Unemployed
13	Other

Note: Taken from IMQ 2013 Open Data file

Table 22

Reference Table: Activity's Sector

Code Activity’s Sector	Activity’s Sector
1	Agriculture
2	Industry
3	Commerce / Handicraft
4	Services
5	Public administration
6	Other

Note: Taken from IMQ 2013 Open Data file

Table 23

Reference Table: Sex of Residents

Code Sex	Label
1	Males
2	Females

Note: Taken from IMQ 2013 Open Data file

Table 24

Reference table: Age Range of Residents

Code Age Range	Description
1	From 11 to 19
2	From 20 to 49
3	From 50 to 64
4	65 and more

Note: Taken from IMQ 2013 Open Data file

Table 25

Reference Table: Mode of Transportation

Code Mode of Transport	Type of Mode	Public/Private
01	By feet	Other
02	Motorcycle	Other
03	Car as driver	Private
04	Car as passenger	Private
05	Taxi	Other
06	Urban suburban bus and/or GTT Tram (TO and surroundings)	Public
07	GTT suburban bus	Public
08	Urban transport (bus, trolley bus, tram, underground) of other municipalities and other cities other than Turin	Public
09	Suburban Bus Other Company	Public
10	Company bus	Public
11	School bus	Public
12	Trenitalia railway	Public
13	GTT Railway (Canavesana, TO - Ceres TO - Chieri)	Public
15	Other	Other
16	Personal bicycle	Other
20	Bike sharing system	Other
19	GTT automatic subway	Public
21	Car sharing system vehicle as driver	Private
22	Other rail carrier (TRENORD, SSIF, FART, SBB-CFF-FFS, SNCF, BLS)	Public
23	Other public terrestrial means (funicular, cable car)	Public
24	Other public means on water (boat, hydrofoil)	Public

Note: Taken from IMQ 2013 Open Data file

Table 26

Reference Table: Type of Residence

Code Type of Residence	Type of Residence
1	At the house he is answering from
2	In another address of the same Municipality
3	In another Municipality of the Piedmont Region
4	Somewhere else

Note: Taken from IMQ 2013 Open Data file

Table 27

Reference Table: Purpose of Trip

Code Purpose of Trip	Label
01	Go to work
02	Work reasons
03	Study
04	Purchases / Commissions
05	Accompaniment
06	Medical treatments / visits
07	Sport / Leisure
08	Homecoming
09	Visits to relatives / friends
10	Other
11	Return home on the interview day

Note: Taken from IMQ 2013 Open Data file

Table 28

Reference Table: Type of School

Code School	Type of School
1	Elementary School
2	High School
3	Extracurricular courses of the Region
4	Other extracurricular courses
5	University / Polytechnic
6	Post graduate specialization courses

Note: Taken from IMQ 2013 Open Data file

Table 29

Reference Table: Study Title

Code Title	Study Title
1	No title
2	Primary school diploma
3	Middle School diploma
4	High school diploma
5	Degree
6	Post graduate specialization courses

Note: Taken from IMQ 2013 Open Data file

Table 30

Reference Table: Municipality in each Province

Code Province	Province	Province Code	Prog Municipality	Code ISTAT	Denomination
001	Torino	TO	001	001001	Agliè
001	Torino	TO	002	001002	Airasca
001	Torino	TO	003	001003	Ala di Stura
001	Torino	TO	004	001004	Albiano d'Ivrea
001	Torino	TO	005	001005	Alice Superiore
001	Torino	TO	006	001006	Almese
001	Torino	TO	007	001007	Alpette
001	Torino	TO	008	001008	Alpignano
001	Torino	TO	009	001009	Andezeno
001	Torino	TO	010	001010	Andrate
001	Torino	TO	011	001011	Angrogna
001	Torino	TO	012	001012	Arignano
001	Torino	TO	013	001013	Avigliana
001	Torino	TO	014	001014	Azeglio
001	Torino	TO	015	001015	Bairo
001	Torino	TO	016	001016	Balangero
001	Torino	TO	017	001017	Baldissero Canavese
001	Torino	TO	018	001018	Baldissero Torinese
001	Torino	TO	019	001019	Balme
001	Torino	TO	020	001020	Banchette

Note: Taken from IMQ 2013 Open Data file. The table is 7.983 rows long. Here only 20 rows in the province of Turin are considered.

Table 31

Reference Table: Municipalities of Piedmont's Region

Code ISTAT	Zone Code	Municipality
001120	C002	GRUGLIASCO
001090	C003	COLLEGNO
001292	C004	VENARIA
001028	C005	BORGARO TORINESE
001265	C006	SETTIMO TORINESE
001249	C007	SAN MAURO TORINESE
001192	C008	PINO TORINESE
001156	C009	MONCALIERI
001183	C010	PECETTO TORINESE
001164	C011	NICHELINO
001051	C012	CANDIOLO
001024	C013	BEINASCO
001171	C014	ORBASSANO
001214	C015	RIVALTA DI TORINO
001219	C016	RIVOLI
001008	C017	ALPIGNANO
001189	C018	PIANEZZA
001099	C019	DRUENTO
001130	C020	LEINI
001078	C021	CHIERI
001280	C022	TROFARELLO
001048	C023	CAMBIANO
001257	C024	SANTENA
001063	C064	CASELLE TORINESE
001314	C065	VOLPIANO
001018	C066	BALDISSERO TORINESE
001127	C067	LA LOGGIA
001058	C068	CARIGNANO
001309	C069	VINOVO
001193	C070	PIOBESI TORINESE
001194	C071	PIOSSASCO
001272	T000	TORINO

Note: Taken from IMQ 2013 Open Data file. The table includes 1.206 municipalities. Here only Turin and the surroundings are considered.

Appendix E – Peak Hour Analysis

Table 32

Peak Hour Definition

Departure Time	Cumulative	Discrete	Hourly Flow
00:00	0	0	
00:30	50	50	50
01:00	177	127	177
01:30	225	48	175
02:00	299	74	122
02:30	312	13	87
03:00	340	28	41
03:30	373	33	61
04:00	495	122	155
04:30	527	32	154
05:00	589	62	94
05:30	861	272	334
06:00	1180	319	591
06:30	1711	531	850
07:00	2618	907	1438
07:30	5948	3330	4237
08:00	11796	5848	9178
08:30	**18237**	**6441**	**12289**
09:00	21897	3660	10101
09:30	26437	4540	8200
10:00	29285	2848	7388
10:30	33932	4647	7495
11:00	37089	3157	7804
11:30	40077	2988	6145
12:00	44627	4550	7538
12:30	47418	2791	7341
13:00	50401	2983	5774
13:30	52925	2524	5507
14:00	55514	2589	5113
14:30	58754	3240	5829
15:00	61099	2345	5585
15:30	64467	3368	5713
16:00	67268	2801	6169
16:30	71782	4514	7315
17:00	75980	4198	8712
17:30	79909	3929	8127

Departure Time	Cumulative	Discrete	Hourly Flow
18:00	**85346**	**5437**	**9366**
18:30	89113	3767	9204
19:00	93769	4656	8423
19:30	96572	2803	7459
20:00	99078	2506	5309
20:30	100420	1342	3848
21:00	101511	1091	2433
21:30	102339	828	1919
22:00	102975	636	1464
22:30	103546	571	1207
23:00	104157	611	1182
23:30	104598	441	1052
00:00	105098	500	941

Appendix F – Prior Matrices

Matrix 18

O/D Trip Prior Matrix derived from IMQ 2013 raw data, time range: 07-09. Trips made by the residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023
Q001	103	100			100	103		231		98		98		101				199					98
Q002							100		99			101						100				100	200
Q003	294					103	100										97						
Q004	197		98	298	104	100	100			202			99	100									
Q005	300		99	100		100					100		96	204	104		129						
Q006	407				100	103	101	103	104	200						102	101	99					
Q007	199				104	305	97	206	102			102				207	104	104	102				
Q008	102	102						99								102			102			100	
Q009			99						203														
Q010	299	101				100				400	198	99											100
Q011	101					107	198			98	100	100	100		199		100						
Q012	299		101	97					195	293	198	491		100		101							398
Q013	193		100	196				96			96		100		98				96	98			191
Q014	100	100	100	201	100	100	100				100		101	402	98								100
Q015		101			98					101				98	392	196			199				
Q016	98					75	294								98	129	261		129				75
Q017	259					101	100		103					129	130	129	261						
Q018	205	98	102					102			102				102					102			102
Q019				107			102										108	102		98			
Q020						94										99	98	100	98	196			
Q021	213			89				99	304	111		102	89						98		222	111	
Q022	98						99		103	98		99						99		98		592	
Q023	200		199		99					201	101						101		101				202
C002	200	32	33					33				35	32	32		65	65						33
C003	162				32	64			64		32		64	32					32	32			
C004	63		33		32		67		33			32		63		36	32	63					63
C005	30		35											32					32				
C006	96	32	66		32		33	33	95						32				65				
C007	31											32					32		34		31	65	
C008														32									
C009				31	62	31		32	65	30									30			33	
C010	32					32																	
C011	222		65					32	31		31											31	
C012								33	32	33						32						33	
C013	99		33	34					33	66							32				32		
C014	34		34		34																		34
C015			68		33	65	64	32	34		32			32			32		32				33
C016	68	32	158	32	64	63	96	32	95		67	63	63						64				32
C017	67					95			33	32			32	32	32				32				65
C018	33	34			33				34	34			31										
C019			32					33											65				32
C020	34								33										68	34			
C021	66		66		33			66	67	33						32			33		32		
C022	35		35			33			103	33					33								
C023	30				32				32					32			32						
C024	67						32	32	67				32										67
C064	69		64	32	35		128	35						35			35		32	35			32
C065	99						32				32	33		33			66	34		32			
C066							31		31												31		31
C067	34	34										34											
C068			31							31	34		31										
C069	67									33				34									
C070		32					31																
C071					32				65							32			32			32	
TOTAL	**5304**	**796**	**1652**	**1216**	**1161**	**1774**	**1904**	**1329**	**2159**	**2124**	**1224**	**1421**	**869**	**1522**	**1318**	**1262**	**1685**	**900**	**1475**	**725**	**349**	**1098**	**1888**

	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C067	C068	C069	C070	C071	TOTAL
Q001																				101	35										**1365**
Q002	100	100		100																	101										**1100**
Q003																								100						97	**790**
Q004	202		96	98																											**1693**
Q005			100		100			100																						100	**1632**
Q006		103													202																**1727**
Q007												102								102	102				102						**2043**
Q008																															**607**
Q009				100						31							104			104			99							104	**845**
Q010	302	101						202							300																**2201**
Q011	198									100																					**1400**
Q012					97														100		97										**2566**
Q013	193	98													98	98															**1750**
Q014	98												100	100																	**1902**
Q015			101		101	98						101													98						**1684**
Q016		98	36	98																										98	**1490**
Q017	127				256										130																**1724**
Q018				101				102									102														**1223**
Q019																															**517**
Q020		99															99								98						**980**
Q021		102				31		89					89		111										102						**1962**
Q022		99									136													98							**1618**
Q023	101		101											101	199																**1704**
C002	161	32						33					32																		**817**
C003	97	260			32			32							165																**1099**
C004			160		31			32							31																**772**
C005			33	97															33												**292**
C006				32	547	63									33				66												**1225**
C007						134																									**360**
C008							67													32											**131**
C009	31							443		126					31						33					31					**1008**
C010									37																						**101**
C011								94		457													32					34			**1028**
C012										33	130																		32		**356**
C013		32								33	33	231	33		32													32			**754**
C014								66	31			103	408	67	100																**910**
C015	32	32						32				33	131	163	65									32						32	**1010**
C016	32	160						32		32	32		33	63	808		64														**2186**
C017	33	33		33											162	262	32														**973**
C018				67											34		136	34													**469**
C019																	32	98													**293**
C020		34	34		33	33													67					66	38						**475**
C021	33							98					33		32					793			65			32					**1516**
C022								65				33	32							32	71										**503**
C023	32																			32		32									**251**
C024		32						100					66							34	32	33	367								**962**
C064				35	35														32					399	32						**1064**
C065				33	66														65						468						**993**
C066													31							103				33							**291**
C067								139		36	34															33					**344**
C068								31			31				32											32	65				**319**
C069	34							101		101			36										33			34		272	33		**777**
C070		31									32																		93		**218**
C071												32	65	97	32				32											258	**711**
TOTAL	**1805**	**1447**	**660**	**794**	**1297**	**360**	**67**	**1791**	**68**	**948**	**428**	**635**	**1086**	**592**	**2598**	**359**	**569**	**132**	**396**	**1332**	**471**	**65**	**597**	**728**	**939**	**162**	**65**	**338**	**158**	**689**	**56.734**

Matrix 19

O/D Trip Prior Matrix derived from IMQ 2013 raw data, time range: 17-20:30. Trips made by the residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007
Q001	101	200	501	98	100	304	301			200	100	197	98	110	101	163	97	307			202		99	98	132	95		32	31
Q002	202	201	100					102		101	107						100	101			102				35				
Q003	295		294		103		102				100		100	99				102						33	34	33	35	33	
Q004			97	397	100	96					195	97		201	32			102			89			169	32				
Q005	305			104	297	205	205				208				199							103	99		132				
Q006	200		202		101	101	101	199			100			101	98	178	102		201	94	100	99	101		64	33			
Q007		100		100		102	102	99						198		98	129	102								65		65	63
Q008	203					103		306					96				231	102		99	302					95		33	31
Q009		99	100						203	101	107	195									102	103		165		33		64	35
Q010	98		96	202		201	101			299	132	230			101						111	101	406						
Q011				301	100				98	99	199	399	96										101	32				34	
Q012	196	103		99			102			298	199	595					129				100	202		203		66			32
Q013					195			191		199	100		297	100										100	32				
Q014		100				204						330	296	202	101	98				99						32	32	32	
Q015		102									199				98			91						100	32	136			
Q016							205	102						98		129	325			99	102			33					
Q017	97		97		100		129	100								197	261						101	98	32	32		32	
Q018	101						104											193	102	102	111	99		32		32	32	32	
Q019						99	311						96	102	101			205			286		101			34		65	34
Q020	94																	102		196	94				32				32
Q021	203	102						111				100		100						94	200		89	32					31
Q022	297	200						100				102									102			32					
Q023	98	207	99		100	101	103		99	201			191	101						99			303	65		32			
C002			100	241	96					202	32	99	96	98									101	812	163		33		
C003		100			100	135				101			198		32	67		102	101		102	99		65	586	32			
C004				96				101					96		234	104	31						101			613	33		
C005		100		98		101			100			100						134									127		
C006					100			32									127	102							64			590	34
C007							31								98				33	130								128	460
C008														100															
C009	31				100				104	300	98		96					102			89		103	65	32	32			
C010																					111								
C011	32								31		132										111	32	165			36	32		
C012																													
C013			102				102		104	99										34			35						
C014						32								100							89			32					
C015	35											32		100									101		32				
C016						101				200		100	98				130		101		111		101	64	131			33	
C017										99														32	32				
C018									104																				
C019	31															75										32			
C020							34					100		100													33	66	
C021							102		137																				
C022		101					102	32																					
C023														100															
C024	33								99															29					
C064			100			201																98					32		
C065							102								98													97	
C066																				99									
C067																													
C068																													
C069																													
C070														32															
C071			97	32					104	32						98													
TOTAL	**2651**	**1713**	**1985**	**1768**	**1592**	**2086**	**2342**	**1475**	**1185**	**2530**	**2007**	**2674**	**1852**	**2042**	**1292**	**1207**	**1662**	**1849**	**537**	**1145**	**2615**	**935**	**2106**	**2291**	**1595**	**1461**	**389**	**1337**	**783**

	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	TOTAL
Q001		125	37	160		33		33	64	32	34		34	100		32	34	35	32		34		101			**4585**
Q002		30									34										34		36			**1284**
Q003							67	32	32				37	36				32				31			32	**1663**
Q004		31				34			64																32	**1765**
Q005								65			33															**1955**
Q006	34	64	32	31				64	32	32																**2465**
Q007							32	32	64			33						32	32	31				31		**1511**
Q008				32					134			33		65			32							36		**1933**
Q009		202		95	65	33			64	33				67	32		33				36				65	**2033**
Q010						66				32	34			33								31			32	**2305**
Q011		198		63		99		32	32													34			32	**1948**
Q012					33				31												34					**2422**
Q013	32	100				34						33					32									**1445**
Q014	32	33	33					32											66				34			**1756**
Q015										32			34		33							31		32		**919**
Q016														32			32						33		32	**1223**
Q017									32							32		35	66							**1438**
Q018																			34							**975**
Q019		30						32	32	32		65	101	33											32	**1790**
Q020																			32	99						**683**
Q021			111	111		32								32												**1347**
Q022		98		63					35																32	**1062**
Q023		221		63		35	34	33	32	65		32	34				67	32		31					99	**2578**
C002		31				32		32	32		34			33		32										**2295**
C003						32		32	131		33		34				32							31		**2147**
C004													34													**1443**
C005										33	67							67								**927**
C006							31						66					35	65							**1244**
C007								32																		**912**
C008	132													34												**266**
C009		796		63			35	64	32					33	101	69	67				36	35	67	31	36	**2617**
C010																										**111**
C011		64		382	33					32													138			**1218**
C012					125				32													31				**188**
C013						193	34	68							33								33			**837**
C014						33	370	129	64		36				32		66			31					129	**1143**
C015						36	67	366	133					32											65	**998**
C016						32	132	65	1236	194	70			65								32				**2997**
C017									63	167	33						33									**459**
C018									63	32	170	33														**402**
C019											67	259														**464**
C020													276					129	134							**873**
C021	98	31						32						892	67	64				65						**1490**
C022		31												36	193	35	32									**561**
C023															35	32										**167**
C024														32	33		265						33			**525**
C064													97					403		33						**964**
C065													69						300				34			**700**
C066														64												**163**
C067		69																			138	64	33			**304**
C068																						64				**64**
C069		31			70														34		33		337			**505**
C070																								33		**65**
C071						32	66	35																	359	**856**
TOTAL	**329**	**2185**	**213**	**1062**	**326**	**754**	**868**	**1212**	**2436**	**714**	**644**	**488**	**816**	**1619**	**556**	**295**	**694**	**832**	**794**	**290**	**346**	**353**	**879**	**194**	**979**	**68.986**

Matrix 20

O/D Trip Prior Matrix derived from IMQ 2013 raw data, Tuesday (all day). Trips made by the residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007
Q001	408	402	1197	197	900	1016	900	537	311	1100	100	495	387	611	101	237	402	609		94	613	199	298	165	292	226	30	130	31
Q002	302	201	100	100	100	101	298	102	99	304	107	101		100	202	134	201	298			301	397	300	133	135		100	32	
Q003	1294	100	1285	389	502	202	407		100	197	100		395	199		98	194	102				98	497	164	34	65	35	98	
Q004	197	100	389	992	407	292	198	104	104	202	391	296	302	504	133			206	107		178		98	507	63	96	98		
Q005	903	100	502	299	596	305	309	98	198		615	98	590	304	303		229					103	231	228	163	163		100	
Q006	1115	101	202	196	305	1023	705	508	308	200	208		503	405	98	484	308	302	303	94	311	197	202		335	66	101	33	
Q007	800	200	305	295	104	813	709	601	307	101	198	203		295		706	462	408	617			98	103		35	98	135	202	63
Q008	407	102		104	202	508	394	912		101			96		101	102	231	205	102	201	725	100		65	33	95		128	101
Q009	311	99	199	104	296	204	307		744	233	205	195					103				102	303	501	197	99	33	100	127	70
Q010	897	399	197	202		401	101	101	298	1095	528	1120	331	100	101						111	101	1308	302	101				
Q011	201		100	398	407	208	198		338	197	434	805	195	100	199		100	204		98		98	404	493	162			34	
Q012	495	203	101	296			203		228	1083	804	1284	102	200		101	129				202	500	398	539		66	100	97	32
Q013	387		395	399	590	302		286		499	195	102	695	600	98				96	98		197	191	453	325	161			
Q014	511	298	100	504	510	505	197			100	100	430	698	2012	502	264				99			201	260	64	95	32	32	
Q015	101	202		133	199	98				101	199		98	402	790	460		296	199			197		132	161	341		132	98
Q016	265	134	98			283	604	102				101		258	294	654	1014		333	99	102		142	65	166	273	196		
Q017	566	201	194		229	409	462	100	103		100			228	130	819	1784	102	108	98			101	256	32	63	33	416	63
Q018	506	298	102	206		401	309	205			204				296		203	486	307	509	210	99	102	32	102	63	134	167	31
Q019				107		99	923						96	102	101	129	108	409	620	206	388		101		133	163	32	199	66
Q020	94					94		201			98		98			99	98	509	206	593	94	196	99		131			32	161
Q021	613	301		178		211		636	304	111		202	89	100		102		210	286	94	1613	111	190	32	102				94
Q022	600	300	98			98	99	100	201	98	98	500	197	103	197			99		196	213	1693		32	99				65
Q023	474	307	497	98	300	303	103		499	1407	296	297	191	203		67	101		101	99	101		1317	198		196			32
C002	265	32	164	509	128			65	98	302	394	538	453	457	32	65	256	32			32	32	198	3055	556		33		32
C003	323	135	34	63	164	434	70	33	131	101	162		325	64	161	166	130	102	133	32	102	99	99	357	3095	32		98	
C004	226		65	96	163	66	98	196	66			66	161	95	373	237	63	63	65				196		32	2060	33	31	
C005	30	100	35	98		101	135		100			100		32		196	33	134	32					33		33	653	32	
C006	196	32	98		132	33	98	128	127		34	97		32	132		287	167	199	32					98	31	32	3004	194
C007	62						63	101	70			32			98		63	31	99	195	94	65		32				225	1743
C008	63					66	35						32	133							34								
C009	283	30	30	31	193	95	32	130	263	530	198	32	228	33		67		205	30		208	162	336	188	32	32			
C010	102					32								33		104					111								
C011	421		127					32	289	64	325	35								35	111	94	259			69	32		
C012								33	65	33						32						169							
C013	99		135	132			136		172	197		35	34		101		32	102		34	64		138	65	32				
C014	68		67		34	32					34	67		100							123		34	32		34		31	
C015	68	34	100		65	198	64	32	66		64	32		133			32		32				134	65	64				32
C016	226	32	158	96	64	460	96	134	128	200	67	164	257	32			162		164		146	35	430	196	524	31		33	
C017	196					95			33	163			129	32	32	32			32				65	65	163		33		
C018	67	34			33	33			138	68			31					102		99		103		34	33		67		
C019	31	34	32				33	33					33			109			65				32			32			
C020	68		138	33		67	34		33			100		100	34		34		68	34		232	34		69	34	33	267	33
C021	234		170		33		102	99	204	33						32	35		33		32			65					
C022	35	101	67		32	33	102	32	138	33	101				131														
C023	62				32			33	32					132			32							32					
C024	134						32	32	166				32										67	29	32				
C064	69		196	32	35	201	128	35					35	35	32	32	35		32	35		98	32			32	167	71	
C065	99						168		33		32	33		66	98		66	66	102	130							33	195	
C066		31					31		31											99	31		31						
C067	34	34							36			34							34										
C068			31		33					31	34		31		31								35						
C069	171	36								33				34		33								34					
C070		32					31	36						32	32										31				
C071	32		130	32	132				169	65	32					163			32			32	99	65					
TOTAL	**15112**	**4744**	**7838**	**6319**	**6921**	**9822**	**8915**	**5777**	**6728**	**8979**	**6456**	**7591**	**6841**	**8402**	**4933**	**5724**	**6925**	**5453**	**4538**	**3301**	**6355**	**5808**	**9003**	**8598**	**7529**	**4683**	**2240**	**5949**	**2941**

	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	TOTAL
Q001	63	251	102	355		99	68	68	131	68	34		102	268	35	62	134	69	99		34		171			**14199**
Q002		30						34	32		34	34			101						34		36	32		**4612**
Q003		30		127		33	67	100	95			32	37	102	33			196				31			130	**7566**
Q004		31				132			96				33					32							32	**6319**
Q005		193					34	65	64		33			33	32	32						33			100	**7058**
Q006	66	160	32	31			32	198	361	95	33		67					201								**9889**
Q007	35	32				238	32	64	64			33	34	102	102		32	128	168	31				31		**8984**
Q008		130		32	33			32	134			33		65	32	33	32	35						36		**5641**
Q009		299		289	65	172		66	64	33	138			204	103	32	166		65	31	36				169	**6465**
Q010		530		64		196			300	32	68			33	33							31	33		65	**9176**
Q011		198		325		99	34	64	67						101				32			34			32	**6356**
Q012		32		35	33	35	67	32	164				100		97						34					**7788**
Q013	32	228				34			225	162	31	33					32	35				31				**6911**
Q014	133	33	33				100	133	32	32			100			132		35	66				34	32		**8407**
Q015						101				32			34		131			32	98			31		32		**4829**
Q016		67	104		32				99			109		32				32					33		163	**5854**
Q017						32		32	162					35		32		35	66							**6989**
Q018		205				102					102								66							**5453**
Q019		30						32	164	32		65	101	33				32			34				32	**4538**
Q020				35		34					99		34					35	130	99						**3267**
Q021	34	89	111	142		64	123		146					32					102	31						**6455**
Q022		162		94	169				35		103		232					98							32	**6010**
Q023		524		259		138	34	134	331	65		32	34				67	32		31		35			99	**9002**
C002		188				65	32	65	196	65	34			65		32	29						34		65	**8598**
C003		32				32		64	524	131	33		69				32							31		**7595**
C004		32		100			34		31			32	34					32								**4747**
C005				32						33	67		33					167	33							**2240**
C006							31		33				267					71	195							**5782**
C007								32																		**3006**
C008	1052	31												162						38						**1646**
C009	31	3660		572		31	101	64	63	99				165	195	69	198				271	66	101	31	69	**9155**
C010			210				31																			**622**
C011		569		2123	33	33	31	64		32							32				71		269		32	**5182**
C012				71	381	33			32												34	31	33	63		**1009**
C013		31		33	33	1019	410	168	98						33								65		64	**3460**
C014		101	31	31		377	1615	526	232		36			33	32		99			31			36		163	**3998**
C015		64		64		168	493	2255	294					32				32							229	**4846**
C016		63		32	32	98	233	261	4713	353	165			65								32	34		32	**9950**
C017									385	1352	131						33									**2971**
C018							36		165	131	1226	99														**2500**
C019											99	652														**1185**
C020													1030					327	211						32	**3046**
C021	200	165					33	32	65					4087	99	159	164			196	32	31				**6338**
C022		159				33	32							99	664	35	65									**1891**
C023		69												159	35	123	33									**772**
C024		198		32			99			33				164	65	33	996						33			**2179**
C064								32					327					1960	32	33						**3713**
C065													211					32	1665				34			**3061**
C066							31							235				33		134						**687**
C067		271		71	34									32							480	96	67	35		**1261**
C068		66			31				32					31							96	448				**930**
C069		165		167	70	65	36		34								33		34		67		1721	33		**2765**
C070		31			63																35		33	320		**675**
C071		69		32		64	163	229	32				32												1944	**3550**
TOTAL	**1646**	**9219**	**622**	**5147**	**1009**	**3526**	**4030**	**4846**	**9697**	**2779**	**2467**	**1153**	**2912**	**6269**	**1920**	**772**	**2179**	**3678**	**3061**	**655**	**1261**	**930**	**2765**	**675**	**3485**	**271.131**

Appendix G – Traffic Counts

Table 33

Traffic count values in peak hours (without heavy vehicle reduction) ordered from smallest to larger value according to the morning peak

Name	07-09	17-20.30
Via Pietro Micca	39	57
Corso Unione Sovietica	53	74
Via Vigliani	63	154
Corso Turati	89	99
Corso Rosselli	113	123
Corso Giulio Cesare	149	193
Via Botticelli	152	123
Via Cernaia	235	403
Corso Regina Margherita	241	370
Corso Sebastopoli	250	294
Corso Unione Sovietica	254	313
Corso Cosenza	270	220
Corso Rosselli	270	352
Corso Rosselli	273	465
Corso Turati	274	275
Corso Giulio Cesare	276	238
Corso Turati	292	331
Corso Belgio	305	487
Corso Rosselli	305	295
Corso Sommeiller	337	457
Corso Vittorio Emanuele II	356	557
Corso San Maurizio	381	467
Corso Galileo Ferraris	388	518
Corso Novara	404	400
Corso Turati	405	445
Via Botticelli	406	349
Corso Novara	407	300
Corso Sebastopoli	409	522
Corso Vittorio Emanuele II	414	601
Corso Vittorio Emanuele II	421	540
Corso Galileo Ferraris	438	706
Corso Unione Sovietica	463	562
Corso Tortona	465	479
Corso Vittorio Emanuele II	468	435

Name	07-09	17-20.30
Corso Sommeiller	473	547
Corso Peschiera	505	879
Corso Unione Sovietica	507	511
Corso IV Novembre	507	565
Corso Vittorio Emanuele II	527	584
Corso Lecce	528	404
Corso Novara	528	552
Corso Regina Margherita	531	462
Corso Vittorio Emanuele II	562	605
Corso Duca Degli Abruzzi	564	436
Via S. Maria Mazzarello	565	539
Corso Peschiera	570	546
Corso Unione Sovietica	575	657
Corso San Maurizio	585	647
Corso Novara	586	591
Ponte Amedeo VIII	592	703
Corso IV Novembre	599	747
Corso Francia	604	657
Corso Regina Margherita	614	705
Ponte Umberto I	620	1012
Corso Einaudi	620	919
Corso Agnelli	640	734
Corso Peschiera	657	634
Corso Galileo Ferraris	660	884
Corso Cosenza	662	811
Corso Novara	671	638
Corso Agnelli	672	663
Corso Potenza	748	772
Corso Belgio	758	557
Corso Agnelli	786	771
Corso Unione Sovietica	812	793
Corso Regina Margherita	814	704
Corso Vercelli	820	831
Corso Regina Margherita	824	989
Corso Maroncelli	829	773
Corso Regina Margherita	837	825
Corso Giambone	865	763
Corso Regina Margherita	867	760
Corso Giulio Cesare	940	1064
Ponte Amedeo VIII	979	894
Corso Francia	979	937
Corso Massimo D'azeglio	1058	1044

Name	07-09	17-20.30
Corso Trapani	1069	1116
Corso Agnelli	1075	952
Corso Massimo D'azeglio	1077	1164
Corso Giulio Cesare	1147	897
Corso Siracusa	1170	1042
Corso Giulio Cesare	1193	1294
Corso Trapani	1199	1389
Corso Siracusa	1246	1187
Corso Siracusa	1266	1250
Corso Orbassano	1474	2058
Corso Orbassano	1749	1626
Corso Trieste	2238	2377
Corso Unita' D'italia	2284	2162

Table 34

Percentage of heavy vehicles in each arc in different time slots (first quartile)

Tuesday		07-09		17-20.30	
Arcs	%HV	Arcs	%HV	Arcs	%HV
5095	4%	353	5%	353	3%
50623	4%	50623	5%	1257	14%
353	5%	841	7%	5120	4%
41021	6%	5095	7%	242	4%
548	6%	50367	7%	904	7%
534	**6%**	**41021**	**7%**	**50623**	**3%**
41061	6%	534	7%	841	3%
841	6%	41061	7%	548	4%
50367	6%	393	8%	1252	4%
242	7%	242	8%	1239	11%
1252	8%	50253	8%	5407	18%
393	8%	548	8%	393	3%
5120	9%	5120	10%	41021	3%
1228	10%	5122	11%	5122	8%
50253	10%	1228	11%	5095	2%
904	10%	1252	11%	5120	6%
893	11%	904	13%	893	7%
1257	11%	893	14%	50710	6%
50710	11%	1257	14%	534	4%
5122	13%	1239	18%	1228	7%
1239	16%	5407	18%	50367	4%
5120	20%	50710	19%	50253	5%
5407	22%	5120	57%	41061	3%

Table 35

Traffic Count Information used in the thesis (with heavy vehicle reduction)

Name	Direction	LNG	LAT	07-09	17-20.30	Tuesday
Corso Belgio	negative	7,72	45,07	283	472	1941
Corso Novara	negative	7,70	45,08	379	291	1606
Corso Giulio Cesare	negative	7,71	45,12	874	1032	4682
Via S. Maria Mazzarello	negative	7,62	45,06	525	523	2395
Corso Peschiera	positive	7,65	45,06	530	530	2802
Corso Giulio Cesare	positive	7,70	45,10	1109	1255	5947
Corso Regina Margherita	positive	7,68	45,08	766	959	4632
Corso Regina Margherita	negative	7,69	45,08	778	800	4318
Corso San Maurizio	positive	7,69	45,07	354	453	2477
Corso Belgio	positive	7,71	45,07	705	540	2824
Corso Novara	positive	7,70	45,08	624	619	3248
Corso Giulio Cesare	positive	7,69	45,08	257	231	1164
Corso Novara	positive	7,69	45,09	545	573	2972
Corso Novara	negative	7,69	45,09	376	388	2112
Corso Novara	negative	7,69	45,09	491	535	2871
Ponte Amedeo VIII	negative	7,72	45,10	551	682	3317
Via Botticelli	positive	7,72	45,10	141	119	687
Via Botticelli	negative	7,70	45,10	377	339	1826
Corso Vitorio Emanuele II	positive	7,69	45,06	391	523	2528
Corso Peschiera	negative	7,66	45,06	470	852	3530
Corso Peschiera	positive	7,66	45,06	611	615	3181
Corso Agnelli	positive	7,65	45,04	731	748	3525
Corso Agnelli	negative	7,65	45,04	625	643	3266
Corso Giambone	positive	7,65	45,03	804	740	3812
Corso Galileo Ferraris	negative	7,65	45,04	614	858	3810
Corso IV Novembre	positive	7,65	45,05	557	724	3318
Corso IV Novembre	negative	7,65	45,05	471	548	2650
Corso Rosselli	positive	7,66	45,05	284	286	1599
Corso Duca Degli Abruzzi	positive	7,66	45,05	524	423	2282
Corso Galileo Ferraris	positive	7,67	45,07	361	503	2481
Corso Sommeiller	negative	7,67	45,05	440	530	2496
Corso Sommeiller	positive	7,67	45,06	313	443	2143
Corso Maroncelli	negative	7,67	45,02	771	750	3315
Corso Massimo D'azeglio	negative	7,68	45,05	984	1012	5228
Corso Turati	positive	7,67	45,05	376	432	2120
Corso Turati	negative	7,67	45,05	83	96	516
Corso Massimo D'azeglio	positive	7,69	45,06	1001	1129	5572
Corso Regina Margherita	negative	7,70	45,07	493	448	2456
Corso Regina Margherita	positive	7,66	45,08	807	737	3850
Corso Regina Margherita	negative	7,66	45,08	571	684	3439
Ponte Umber I	negative	7,69	45,06	577	981	4195
Corso Giulio Cesare	positive	7,71	45,12	1067	871	4483
Corso Vitrio Emanuele II	positive	7,67	45,07	523	587	3245
Corso Galileo Ferraris	negative	7,67	45,07	408	685	2894

Name	Direction	LNG	LAT	07-09	17-20.30	Tuesday
Corso Vitrio Emanuele II	negative	7,67	45,07	385	583	2908
Corso Giulio Cesare	positive	7,69	45,09	139	187	890
Corso Siracusa	positive	7,63	45,05	1177	1212	5569
Corso Siracusa	negative	7,63	45,05	1088	1011	4941
Corso Lecce	positive	7,64	45,07	491	392	1925
Corso Siracusa	negative	7,63	45,05	1159	1151	5509
Corso Unione Sovietica	negative	7,65	45,03	49	72	327
Corso Unione Sovietica	positive	7,65	45,03	236	304	1271
Corso Unione Sovietica	negative	7,64	45,02	535	638	3099
Corso Agnelli	positive	7,64	45,02	1000	923	4358
Corso San Maurizio	negative	7,70	45,07	544	628	3145
Corso Unione Sovietica	negative	7,63	45,02	430	545	2574
Corso Unione Sovietica	positive	7,63	45,02	756	769	3647
Corso Rosselli	negative	7,65	45,05	254	451	1994
Corso Potenza	positive	7,66	45,10	695	749	3423
Via Vigliani	negative	7,64	45,02	58	149	532
Corso Unione Sovietica	positive	7,64	45,02	471	496	2332
Corso Orbassano	positive	7,63	45,04	1371	1996	9656
Corso Cosenza	positive	7,64	45,03	251	214	1116
Corso Cosenza	negative	7,64	45,04	616	786	3686
Corso Sebaspoli	negative	7,63	45,05	232	285	1274
Corso Trapani	positive	7,63	45,06	1115	1348	6075
Corso Trapani	negative	7,63	45,06	994	1082	5069
Corso Rosselli	positive	7,64	45,06	105	120	523
Corso rna	negative	7,71	45,07	433	465	2341
Corso Rosselli	positive	7,67	45,05	251	342	1500
Corso Turati	positive	7,67	45,05	271	321	1503
Corso Turati	negative	7,67	45,05	255	267	1530
Corso Vitrio Emanuele II	negative	7,69	45,06	435	422	2476
Corso Regina Margherita	positive	7,70	45,07	224	359	1610
Corso Einaudi	negative	7,66	45,06	577	892	3855
Corso Vitrio Emanuele II	positive	7,68	45,06	331	541	2563
Corso Vitrio Emanuele II	negative	7,68	45,06	386	566	3147
Corso Trieste	positive	7,67	45,02	2081	2306	10856
Corso Francia	positive	7,61	45,07	911	909	4325
Corso Francia	positive	7,62	45,07	561	638	3030
Via Cernaia	positive	7,67	45,07	218	391	1897
Corso Regina Margherita	positive	7,65	45,09	757	683	3501
Ponte Amedeo VIII	positive	7,72	45,10	910	868	4556
Corso Vercelli	positive	7,70	45,11	763	806	4082
Corso Agnelli	positive	7,64	45,03	595	712	3070
Corso Orbassano	positive	7,61	45,03	1626	1577	7019
Corso Unita' D'italia	positive	7,67	45,02	2124	2097	10294
Corso Sebaspoli	positive	7,63	45,05	380	506	2250
Via Pietro Micca	positive	7,68	45,07	36	55	328

Appendix H – PUMS Matrices, PUMS Zoning and Comparison with IMQ

Matrix 21

Daily O/D Tour Matrix. Tours made by residents and workers of Piedmont in the Province of Turin and surroundings.

	1	2	3	4	5	6	7	8	9	10	11	20	30	40	50	90	Total
1	291.409	32.011	28.794	16.045	2.256	2.730	3.733	633	228	4.171	7.351	0	830	1.405	2.131	3.588	397.315
2	31.600	44.316	6.110	2.097	222	3.207	1.788	0	0	88	153	0	0	17	13	10200	99.811
3	28.445	6.167	51.471	484	2.352	759	32	0	0	49	4.207	0	0	69	82	13.956	108.073
4	15.863	1.960	460	20.261	0	4	1.849	223	9	2.967	211	0	11	0	0	7065	50.883
5	2.259	188	2.315	0	25.818	90	0	0	0	4	17	0	0	0	1576	18509	50.776
6	2.779	3.260	784	4	123	9.249	79	0	0	4	0	0	0	0	0	13298	29.580
7	3.850	1.682	26	1.838	0	81	8.642	53	0	12	4	0	0	0	0	12688	28.876
8	730	8	0	241	0	0	19	4.973	263	50	0	0	0	0	0	10586	16.870
9	221	0	0	4	0	0	0	262	6.260	163	0	0	41	0	0	8284	15.235
10	4.095	112	54	2.937	0	0	4	51	160	9.805	37	0	458	4	0	8242	25.959
11	7.006	184	4.240	239	19	0	0	0	0	47	21.021	0	0	986	1.597	8.578	43.917
20	863	0	0	16	0	0	0	0	61	478	0		157315	630	0		159.363
30	1.292	9	96	0	0	0	0	0	0	0	950	0			1889		4.236
40	2.096	12	97	0	1.622	0	0	0	0	0	1.527						5.354
50	0	0	0	0	0	0	0	0	0	0	0						0
90	0	0	0	0	0	0	0	0	0	0	0					4	4
Total	392.508	89.909	94.447	44.166	32.412	16.120	16.146	6.195	6.981	17.838	35.478	0	158.655	3.111	7.288	114.998	1.036.252

Taken from PUMS report May 2021t

Matrix 22

Daily O/D Tour Matrix. Tours made by residents in other regions (that work and/or study at Piedmont) in the Province of Turin and surroundings.

	1	2	3	4	5	6	7	8	9	10	11	20	30	40	50	90	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	101	0	0	18	119
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14
5	0	0	0	0	0	0	0	0	0	0	0	0	991	0	0	155	1.146
6	0	0	0	0	0	0	0	0	0	0	0	0	468	101	0	49	618
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	684	684
9	0	0	0	0	0	0	0	0	0	0	0	0	302	0	0	44	346
10	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	8
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
30	105	0	0	0	0	0	0	0	0	0	0	0			0		105
40	4	0	0	0	0	0	0	0	0	0	0	0					4
50	0	0	0	0	0	0	0	0	0	0	0	0	533				533
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21		21
Total	109	0	0	0	0	0	0	0	0	0	0	0	2.399	101	25	980	3.614

Taken from PUMS report May 2021

Matrix 23

Daily O/D Tour Matrix. Tours made by residents of Piedmont (for purposes other than work and study) in the Province of Turin and surroundings.

	1	2	3	4	5	6	7	8	9	10	11	20	30	40	50	90	Total
1	323.672	34.455	30.923	17.374	2.343	2.870	3.942	687	259	4.457	7.879	0	2.933	2.123	2.284	5.956	442.157
2	34.000	48.572	6.568	2.241	231	3.378	1.859	0	0	99	173	0	71	22	13	12.103	109.330
3	30.600	6.589	56.289	535	2.440	778	32	0	0	53	4.453	0	99	74	82	16.529	118.553
4	17.015	2.094	523	22.148	0	8	1.974	228	9	3.209	231	0	24	45	0	8.703	56.211
5	2.368	200	2.398	0	27.221	91	0	0	0	4	18	0	0	0	1.664	20.849	54.813
6	2.923	3.405	799	4	123	9.991	88	0	0	4	0	0	8	0	0	15.169	32.514
7	4.072	1.758	31	1.969	0	87	9.353	54	0	12	4	0	0	0	0	13.968	31.308
8	752	8	0	253	0	0	20	5.222	280	51	0	0	5	0	0	11.468	18.059
9	223	0	0	8	0	0	0	273	6.889	169	0	4	51	0	0	9.589	17.206
10	4.353	127	60	3.188	0	0	4	56	162	10.616	41	0	528	4	0	9.564	28.703
11	7.398	201	4.458	252	20	0	0	0	0	51	22.848	0	10	1.031	1.682	10.142	48.093
20	0	0	0	0	0	0	0	0	9	0	0	0	0	4	0		13
30	3.099	83	68	42	0	4	0	4	67	548	4	6			28		3.953
40	2.066	9	111	8	0	9	5	0	0	0	983	0					3.191
50	2.209	12	101	0	1.707	0	0	0	0	0	1.600	0	12				5.641
90	0																0
Total	434.750	97.513	102.329	48.022	34.085	17.216	17.277	6.524	7.675	19.273	38.234	10	3.741	3.303	5.753	134.040	969.745

Taken from PUMS report May 2021

Matrix 24

Daily O/D Tour Matrix. Tours made by residents of Piedmont in the Province of Turin (from matrices 21 and 23).

	1	2	3	4	5	6	7	8	9	10	11	Total
1	615.081	66.466	59.717	33.419	4.599	5.600	7.675	1320	487	8.628	15.230	818.222
2	65.600	92.888	12.678	4.338	453	6.585	3.647	0	0	187	326	186.702
3	59.045	12.756	107.760	1019	4.792	1537	64	0	0	102	8.660	195.735
4	32.878	4.054	983	42.409	0	12	3.823	451	18	6.176	442	91.246
5	4.627	388	4.713	0	53.039	181	0	0	0	8	35	62.991
6	5.702	6.665	1583	8	246	19.240	167	0	0	8	0	33.619
7	7.922	3.440	57	3.807	0	168	17.995	107	0	24	8	33.528
8	1482	16	0	494	0	0	39	10.195	543	101	0	12.870
9	444	0	0	12	0	0	0	535	13.149	332	0	14.472
10	8.448	239	114	6.125	0	0	8	107	322	20.421	78	35.862
11	14.404	385	8.698	491	39	0	0	0	0	98	43.869	67.984
Total	815.633	187.297	196.303	92.122	63.168	33.323	33.418	12.715	14.519	36.085	68.648	1.553.231

The zone’s names are listed below:

Zone 1: City of Turin

Zone 2: AMT Ovest

Zone 3: AMT Sud

Zone 4: AMT Nord

Zone 5: Pinerolese

Zone 6: Valli Susa e Sangone

Zone 7: Ciriacese - Valli di Lanzo

Zone 8: Canavese Occidentale

Zone 9: Eporediese

Zone 10: Chivassese

Zone 11: Chierese – Carmagnole

Zone 20: Direttrice Nord

Zone 30: Direttrice Nord-Est

Zone 40: Direttrice Sud-Est

Zone 50: Direttrice Sud

Zone 90: Other zones

Table 36

Municipalities included in each zone reported in the PUMS matrices

Zones	Municipalities
1	Turin
2	Alpignano, Buttigliera Alta, Collegno, Druento, Grugliasco, Pianezza, Reano, Rivoli, Rosta, San Gillio, Sangano, Trana, Venaria, Villarbasse.
3	Beinasco, Bruino, Candiolo, Carignano, Castagnole P.te, La Loggia, Moncalieri, Nichelino, None, Orbassano, Pancalieri, Piossasco, Piobesi Torinese, Rivalta di Torino, Trofarello, Vinovo, Virle Piemonte, Volvera.
4	Borgaro Torinese, Caselle Torinese, Leinì, Mappano, San Benigno C.se, San Mauro Torinese, Settimo Torinese, Volpiano.
5	Airasca, Angrogna, Bibiana, Bobbio Pellice, Bricherasio, Buriasco, Campiglione Fenile, Cantalupa, Cavour, Cercenasco, Cumiana, Fenestrelle, Frossasco, Garzigliana, Inverso Pinasca, Luserna San Giovanni, Lusernetta, Macello, Massello, Osasco, Perosa Argentina, Perrero, Pinasca, Pinerolo, Piscina, Pomaretto, Porte, Pragelato, Prali, Pramollo, Prarostino, Roletto, Rorà, Roure, Salza di Pinerolo, San Germano C., San Pietro Val Lemina, San Secondo di P., Scalenghe, Torre Pellice, Usseaux, Vigone, Villafranca Piemonte, Villar Pellice, Villar Perosa.
6	Almese, Avigliana, Bardonecchia, Borgone di Susa, Bruzolo, Bussoleno, Caprie, Caselette, Cesana T.se, Chianocco, Chiomonte, Chiusa di San Michele, Claviere, Coazze, Condove, Exilles, Giaglione, Giaveno, Gravere, Mattie, Meana di Susa, Mompantero, Moncenisio, Novalesa, Oulx, Rubiana, Salbertrand, San Didero, San Giorio di Susa, Sant'Ambrogio di Torino, Sant'Antonino di Susa, Sauze di Cesana, Sauze d'Oulx, Sestriere, Susa, Vaie, Valgioie, Venaus, Villar Dora, Villarfocchiardo.

Zones	Municipalities
7	Ala di Stura, Balangero, Balme, Barbania, Cafasse, Cantoira, Ceres, Chialamberto, Ciriè, Coassolo T.se, Corio, Fiano, Front, Germagnano, Givoletto, Groscavallo, Grosso, La Cassa, Lanzo Torinese, Lemie, Lombardore, Mathi, Mezzenile, Monastero di Lanzo, Nole, Pessinetto, Rivarossa, Robassomero, Rocca Canavese, San Carlo Canavese, San Francesco al C., San Maurizio C.se, Traves, Usseglio, Val della Torre, Vallo Torinese, Vauda Canavese, Varisella, Villanova Canavese, Viù.
8	Agliè, Alpette, Bairo, Baldissero C.se, Borgiallo, Bosconero, Busano, Canischio, Castellamonte, Castelnuovo Nigra, Ceresole Reale, Chiesanuova, Ciconio, Cintano, Colleretto C., Cuceglio, Cuorgnè, Favria, Feletto, Forno C.se, Frassinetto, Ingria, Levone, Locana, Lusigliè, Ozegna, Pertusio, Pont Canavese, Prascorsano, Pratiglione, Ribordone, Rivara, Rivarolo Canavese, Ronco Canavese, Salassa, San Colombano B., San Giorgio C.se, San Giusto C.se, Noasca, Oglianico, San Ponso, Sparone, Torre Canavese, Valperga, Valprato Soana, Vialfrè.
9	Albiano d'Ivrea, Andrate, Azeglio, Banchette, Barone C.se, Bollengo, Borgofranco, Borgomasino, Brosso, Burolo, Candia C.se, Caravino, Carema, Cascinette d'Ivrea, Chiaverano, Colleretto Giacosa, Cossano C.se, Fiorano C.se, Issiglio, Ivrea, Lessolo, Loranzè, Maglione, Mercenasco, Montalenghe, Montalto Dora, Nomaglio, Palazzo Canavese, Parella, Pavone Canavese, Perosa Canavese, Piverone, Orio Canavese, Quagliuzzo, Quassolo, Quincinetto, Romano Canavese, Rueglio, Salerano Canavese, Samone, San Martino C.se, Scarmagno, Settimo Rottaro, Settimo Vittone, Strambinello, Strambino, Tavagnasco, Traversella, Valchiusa, Val di Chy, Vestignè, Vidracco, Vische, Vistrorio.
10	Brandizzo, Brozolo, Brusasco, Caluso, Casalborgone, Castagneto Po, Castiglione Torinese, Cavagnolo, Chivasso, Cinzano, Foglizzo, Gassino Torinese, Lauriano, Mazzè, Montanaro, Monteu da Po, Rivalba, Rondissone, San Raffaele Cimena, San Sebastiano da Po, Torrazza Piemonte, Verolengo, Verrua Savoia, Villareggia.
11	Andezeno, Arignano, Baldissero Torinese, Cambiano, Carmagnola, Chieri, Isolabella, Lombriasco, Marentino, Mombello di Torino, Montaldo T.se, Moriondo T.se, Osasio, Pavarolo, Pecetto T.se, Pino Torinese, Poirino, Pralormo, Riva presso Chieri, Santena, Sciolze, Villastellone.

Table 37

Aggregation of IMQ zones into PUMS zones

PUMS zones	IMQ zones
1	Q001 to Q023.
2	C002 to C004, C016 to C019, E028 and E030
3	C009, C011 to C015, C022, C067 to C071, E025 and E026
4	C005 to C007, C020, C064 and C065
5	E027, E039 to E044
6	E045 to E047
7	E031 and E032, E048 to E051, E063
8	E034, E052 and E053, E058 and E059
9	E054, E060 to E062, E072 to E074
10	E035, E055 to E57
11	C008, C010, C021, C023 and C024, C066, E036 to E038

Matrix 25

Daily O/D Tour Matrix derived from IMQ 2013 raw data. Tours made by residents of Piedmont in the province of Turin.

	1	2	3	4	5	6	7	8	9	10	11	Total
1	795.527	35.563	28.439	17.878	2.473	1.184	3.077	2.088	1.890	3.343	4.409	895.870
2	52.855	141.618	8.605	1.565	1.693	2.493	983	313	253	274	278	210.929
3	39.229	6.372	119.550	651	4.089	256	317	130	191	278	3.974	175.035
4	25.995	1.515	671	59.997	0	93	2.045	962	253	1.194	317	93.042
5	9.766	986	3.228	90	90.354	0	0	201	89	88	328	105.128
6	8.949	6.277	746	91	0	47.589	422	0	99	0	0	64.172
7	13.254	5.722	482	3.502	370	289	52.450	936	654	183	181	78.023
8	7.383	281	434	2.695	89	0	2.011	50.501	4.634	637	90	68.754
9	6.028	463	417	1.152	0	0	187	4.717	68.600	3.355	93	85.012
10	12.356	665	424	5.060	99	95	0	90	2.030	47.661	652	69.133
11	18.425	929	7.101	509	418	96	93	193	111	128	64.537	92.538
Total	989.767	200.390	170.099	93.190	99.584	52.095	61.584	60.129	78.802	57.139	74.859	1.937.637

Matrix 26

Relative Difference Matrix between IMQ Tour Matrix (Matrix 25) and PUMS Tour Matrix (Matrix 24) in the Province of Turin.

	1	2	3	4	5	6	7	8	9	10	11	Total
1	-23%	87%	110%	87%	86%	373%	149%	-37%	-74%	158%	245%	-9%
2	24%	-34%	47%	177%	-73%	164%	271%	-100%	-100%	-32%	17%	-11%
3	51%	100%	-10%	57%	17%	500%	-80%	-100%	-100%	-63%	118%	12%
4	26%	168%	46%	-29%	-	-87%	87%	-53%	-93%	417%	39%	-2%
5	-53%	-61%	46%	-100%	-41%	-	-	-100%	-100%	-91%	-89%	-40%
6	-36%	6%	112%	-91%	-	-60%	-60%	-	-100%	-	-	-48%
7	-40%	-40%	-88%	9%	-100%	-42%	-66%	-89%	-100%	-87%	-96%	-57%
8	-80%	-94%	-100%	-82%	-100%	-	-98%	-80%	-88%	-84%	-100%	-81%
9	-93%	-100%	-100%	-99%	-	-	-100%	-89%	-81%	-90%	-100%	-83%
10	-32%	-64%	-73%	21%	-100%	-100%	-	19%	-84%	-57%	-88%	-48%
11	-22%	-59%	22%	-3%	-91%	-100%	-100%	-100%	-100%	-23%	-32%	-27%
Total	-18%	-7%	15%	-1%	-37%	-36%	-46%	-79%	-82%	-37%	-8%	-20%

Appendix I – Trip End Information

Table 38

Trip End Information used in the model for the estimation of O/D matrices

Zone	07-09		17-20.30		Tuesdays	
	∑rows	∑columns	∑rows	∑columns	∑rows	∑columns
Q001	1243	4349	4172	2174	12921	12392
Q002	1001	653	1168	1405	4197	3890
Q003	719	1355	1513	1627	6885	6427
Q004	1540	997	1606	1450	5750	5181
Q005	1485	952	1779	1306	6423	5675
Q006	1571	1455	2243	1711	8999	8054
Q007	1859	1562	1375	1921	8176	7310
Q008	553	1089	1759	1210	5133	4737
Q009	769	1771	1850	972	5883	5517
Q010	2003	1742	2098	2075	8350	7363
Q011	1274	1004	1773	1646	5784	5294
Q012	2335	1165	2204	2193	7087	6224
Q013	1593	713	1315	1519	6289	5609
Q014	1731	1248	1598	1675	7650	6890
Q015	1533	1081	836	1060	4395	4045
Q016	1356	1035	1112	990	5327	4694
Q017	1569	1381	1309	1363	6360	5679
Q018	1113	738	887	1516	4962	4471
Q019	471	1210	1629	441	4130	3721
Q020	891	595	621	939	2973	2707
Q021	1785	286	1226	2144	5874	5211
Q022	1473	900	966	767	5469	4762
Q023	1551	1548	2346	1727	8192	7382
C002	727	1678	2043	2130	7653	7996
C003	978	1346	1911	1484	6759	7002
C004	687	614	1284	1358	4225	4355
C005	286	786	908	386	2196	2218
C006	1201	1284	1219	1324	5667	5889
C007	352	356	894	775	2946	2911
C008	96	62	194	303	1201	1514
C009	1129	2060	2931	2513	10254	10602
C010	74	63	81	196	454	573
C011	403	1091	1021	1221	3367	5919
C012	147	492	298	375	1843	1160
C013	1129	730	2931	867	10254	4055
C014	113	1249	124	999	697	4635
C015	1151	681	1364	1394	5804	5573
C016	1946	2416	2668	2265	8856	9018

Zone	07-09		17-20.30		Tuesdays	
	∑rows	∑columns	∑rows	∑columns	∑rows	∑columns
C017	866	334	408	664	2644	2584
C018	418	529	358	599	2225	2294
C019	261	123	413	454	1054	1073
C020	466	392	855	808	2985	2883
C021	1107	1226	1087	1489	4626	5768
C022	526	542	450	639	2800	2208
C023	183	60	122	271	564	710
C024	702	549	383	638	1591	2005
C064	1043	721	944	824	3639	3641
C065	973	929	686	786	3000	3031
C066	213	0	119	267	501	603
C067	1077	187	588	397	2441	1450
C068	1192	75	1079	406	4159	1070
C069	1112	388	784	1011	3429	3180
C070	326	182	182	223	769	776
C071	386	793	340	1126	1412	4008

Appendix J – OmniTRANS Jobs

Job 1

Estimating Matrices (Deterministic User Equilibrium, morning peak)

```
my_traffic_assignment=OtTraffic.new
my_screenline_matrix=OtTraffic.new

#TRAFFIC ASSIGNMENT
writeln "Traffic Assignment"
my_traffic_assignment.assignMethod=USEREQUILIBRIUM
#To define where to store output
my_traffic_assignment.load=[1,10,2,1,3,1]
#Dimension of network
my_traffic_assignment.network=[10,2]
#Dimension of OD matrix
my_traffic_assignment.odMatrix=[1,10,2,1]
my_traffic_assignment.iterations=10
#Run Traffic Assignment
my_traffic_assignment.execute
writeln "Traffic Assignment Complete"

#SCREENLINE INTERCEPT MATRIX
writeln "ScreenLine Matrix"
#Dimensions of ScreenLine Matrix
my_screenline_matrix.screenlineMatrix=[1,10,2,1,3,1]
#Include all counts
my_screenline_matrix.allCounts=true
#Run ScreenLine Matrix
my_screenline_matrix.execute

#MATRIX ESTIMATION
writeln "Estimating Matrices"
my_matrix_estimation=OtMatrixEstimation.new
#Define Prior Matrix
my_matrix_estimation.inputMatrixCube='PriorMx'
#Dimension of OD matrix
my_matrix_estimation.odMatrix=[[1,10,2,1]]
#Dimension of screenline intercept matrix
my_matrix_estimation.screenlineMatrix= [[1,10,2,1,3,1]]
#Order of restrictions
my_matrix_estimation.order= 'BSCT'
my_matrix_estimation.screenlineElasticity=1
my_matrix_estimation.iterations=1
#Output
my_matrix_estimation.outputMatrixCube= 'EstMx'
```

```
my_matrix_estimation.showMatrixTotals=true
#Run Matrix Estimation
my_matrix_estimation.execute
```

Job 2

Estimating Matrices (Deterministic User Equilibrium, afternoon peak hour)

```
my_traffic_assignment=OtTraffic.new
my_screenline_matrix=OtTraffic.new

#TRAFFIC ASSIGNMENT
writeln "Traffic Assignment"
my_traffic_assignment.assignMethod=USEREQUILIBRIUM
#To define where to store output
my_traffic_assignment.load=[1,10,3,1,3,1]
#Dimension of network
my_traffic_assignment.network=[10,3]
#Dimension of OD matrix
my_traffic_assignment.odMatrix=[1,10,3,1]
my_traffic_assignment.iterations=10
#Run Traffic Assignment
my_traffic_assignment.execute
writeln "Traffic Assignment Complete"

#SCREENLINE INTERCEPT MATRIX
writeln "ScreenLine Matrix"
#Dimensions of ScreenLine Matrix
my_screenline_matrix.screenlineMatrix=[1,10,3,1,3,1]
#Include all counts
my_screenline_matrix.allCounts=true
#Run ScreenLine Matrix
my_screenline_matrix.execute

#MATRIX ESTIMATION
writeln "Estimating Matrices"
my_matrix_estimation=OtMatrixEstimation.new
#Define Prior Matrix
my_matrix_estimation.inputMatrixCube='PriorMx'
#Dimension of OD matrix
my_matrix_estimation.odMatrix=[[1,10,3,1]]
#Dimension of screenline intercept matrix
my_matrix_estimation.screenlineMatrix= [[1,10,3,1,3,1]]
#Order of restrictions
my_matrix_estimation.order= 'BSCT'
my_matrix_estimation.screenlineElasticity=1
my_matrix_estimation.iterations=1
```

```
#Output
my_matrix_estimation.outputMatrixCube= 'EstMx'
my_matrix_estimation.showMatrixTotals=true
#Run Matrix Estimation
my_matrix_estimation.execute
```

Job 3

Estimating Matrices (Deterministic User Equilibrium, entire day)

```
my_traffic_assignment=OtTraffic.new
my_screenline_matrix=OtTraffic.new

#TRAFFIC ASSIGNMENT
writeln "Traffic Assignment"
my_traffic_assignment.assignMethod=USEREQUILIBRIUM
#To define where to store output
my_traffic_assignment.load=[1,10,4,1,3,1]
#Dimension of network
my_traffic_assignment.network=[10,4]
#Dimension of OD matrix
my_traffic_assignment.odMatrix=[1,10,4,1]
my_traffic_assignment.iterations=10
#Run Traffic Assignment
my_traffic_assignment.execute
writeln "Traffic Assignment Complete"

#SCREENLINE INTERCEPT MATRIX
writeln "ScreenLine Matrix"
#Dimensions of ScreenLine Matrix
my_screenline_matrix.screenlineMatrix=[1,10,4,1,3,1]
#Include all counts
my_screenline_matrix.allCounts=true
#Run ScreenLine Matrix
my_screenline_matrix.execute

#MATRIX ESTIMATION
writeln "Estimating Matrices"
my_matrix_estimation=OtMatrixEstimation.new
#Define Prior Matrix
my_matrix_estimation.inputMatrixCube='PriorMx'
#Dimension of OD matrix
my_matrix_estimation.odMatrix=[[1,10,4,1]]
#Dimension of screenline intercept matrix
my_matrix_estimation.screenlineMatrix= [[1,10,4,1,3,1]]
#Order of restrictions
my_matrix_estimation.order= 'BSCT'
my_matrix_estimation.screenlineElasticity=1
```

```
my_matrix_estimation.iterations=1
#Output
my_matrix_estimation.outputMatrixCube= 'EstMx'
my_matrix_estimation.showMatrixTotals=true
#Run Matrix Estimation
my_matrix_estimation.execute
```

Job 4

Assigning Traffic (Deterministic User Equilibrium, morning peak)

```
writeln "DUE Assignment"
my_traffic_assignment=OtTraffic.new
my_traffic_assignment.assignMethod=USEREQUILIBRIUM
my_traffic_assignment.load=[1,10,2,1,3,1]
my_traffic_assignment.iterations=10
my_traffic_assignment.execute
```

Job 5

Assigning Traffic (Deterministic User Equilibrium, afternoon peak)

```
writeln "DUE Assignment"
my_traffic_assignment=OtTraffic.new
my_traffic_assignment.assignMethod=USEREQUILIBRIUM
my_traffic_assignment.load=[1,10,3,1,3,1]
my_traffic_assignment.iterations=10
my_traffic_assignment.execute
```

Job 6

Assigning Traffic (Deterministic User Equilibrium, entire day)

```
writeln "DUE Assignment"
my_traffic_assignment=OtTraffic.new
my_traffic_assignment.assignMethod=USEREQUILIBRIUM
my_traffic_assignment.load=[1,10,4,1,3,1]
my_traffic_assignment.iterations=10
my_traffic_assignment.execute
```

Appendix K – Estimated Matrices

Matrix 27

O/D Trip Estimated Matrix for year 2019, time range: 07-09, without trip end data. Trips made by residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C067	C068	C069	C070	C071	TOTAL
Q001	8	25	0	0	56	3	0	262	0	433	0	1	0	28	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	586	629	0	0	0	0	0	0	0	0	0	**2197**
Q002	0	0	0	0	0	0	4	0	566	0	0	21	0	0	0	0	0	104	0	0	0	340	10	48	172	0	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	91	0	0	0	0	0	0	0	0	0	**1429**
Q003	118	0	0	0	0	252	4	0	0	0	0	0	0	0	0	0	197	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	237	0	0	0	0	0	8	**817**
Q004	8	0	5	507	74	289	4	0	0	142	0	0	42	36	0	0	0	0	0	0	0	0	0	208	0	112	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1517**
Q005	39	0	64	93	0	76	0	0	0	0	20	0	67	40	74	0	85	0	0	0	0	0	0	0	0	64	0	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	987	**1695**
Q006	210	0	0	0	126	87	1	437	0	43	0	0	0	0	0	37	70	655	0	0	0	0	0	0	64	0	0	0	0	0	0	0	0	0	0	0	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1829**
Q007	219	0	0	0	65	129	304	137	517	0	0	9	0	0	0	37	36	66	325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	346	82	0	0	0	43	0	0	0	0	0	**2339**
Q008	92	133	0	0	0	0	0	210	0	0	0	0	0	0	0	25	0	0	73	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**537**
Q009	0	0	60	0	0	0	0	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	218	0	0	0	0	0	412	0	0	0	0	0	0	106	0	0	20	0	0	83	0	0	0	0	0	0	5	**960**
Q010	800	218	0	0	0	38	0	0	0	711	81	38	0	0	0	0	0	0	0	0	0	0	75	82	42	0	0	0	0	0	194	0	0	0	0	0	0	308	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2586**
Q011	6	0	0	0	0	12	0	0	0	15	118	99	206	0	418	0	9	0	0	0	0	0	0	447	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1334**
Q012	37	0	17	28	0	0	0	0	0	0	448	932	0	110	0	693	0	0	0	0	0	0	2	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	**2313**
Q013	18	0	142	69	0	0	0	280	0	0	0	0	153	0	153	0	0	0	1	1	0	0	0	323	249	0	0	0	0	0	0	0	0	0	0	0	0	195	184	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1769**
Q014	37	124	92	8	55	224	3	0	0	0	42	0	100	662	100	0	0	0	0	0	0	0	26	107	0	0	0	0	0	0	0	0	0	0	0	163	131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1873**
Q015	0	121	0	0	52	0	0	0	0	97	0	0	0	157	386	181	0	0	205	0	0	0	0	0	0	88	0	126	18	0	0	0	0	0	123	0	0	0	0	0	0	0	0	0	0	0	0	114	0	0	0	0	0	**1667**
Q016	65	0	0	0	0	81	5	0	0	0	0	0	0	0	48	59	234	0	167	0	0	0	73	0	78	212	455	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	**1528**
Q017	149	0	0	0	0	95	699	0	26	0	0	0	0	89	56	52	204	0	0	0	0	0	0	109	0	0	0	258	0	0	0	0	0	0	0	0	0	132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1868**
Q018	334	59	121	0	0	0	0	100	0	0	38	0	0	0	29	0	0	0	0	284	0	0	127	0	0	0	20	0	0	0	14	0	0	0	0	0	0	0	0	96	0	0	0	0	0	0	0	0	0	0	0	0	0	**1223**
Q019	0	0	0	12	0	0	147	0	0	0	0	0	0	0	0	0	70	30	0	188	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**447**
Q020	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	21	40	18	203	239	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	0	0	0	0	0	0	0	230	0	0	0	0	0	**906**
Q021	0	0	0	5	0	0	0	0	547	72	0	0	0	0	0	0	0	0	0	0	271	68	0	0	0	0	0	0	65	0	390	0	0	0	0	0	0	395	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	**1826**
Q022	2	0	0	0	0	0	0	0	352	121	0	189	0	0	0	0	0	35	0	0	0	686	0	0	7	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	**1459**
Q023	217	0	294	0	267	0	0	0	0	158	194	0	0	0	0	0	151	0	55	0	0	0	354	56	0	46	0	0	0	0	0	0	0	0	0	0	67	131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1990**
C002	0	0	0	0	0	0	0	73	0	0	0	19	37	10	0	12	140	0	0	0	0	0	132	204	61	0	0	0	0	0	80	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**829**
C003	54	0	0	0	16	129	0	0	0	0	162	0	57	47	0	0	0	0	25	3	0	0	0	78	316	0	0	30	0	0	49	0	0	0	0	0	0	157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1124**
C004	68	0	50	0	14	0	38	0	0	0	0	66	0	82	0	27	47	7	0	0	0	0	171	0	0	113	0	31	0	0	53	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**798**
C005	39	0	60	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	32	0	0	0	0	0	0	28	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	**288**
C006	115	2	106	0	94	0	14	3	0	0	0	0	0	0	28	0	0	0	60	0	0	0	0	0	0	0	11	614	55	0	0	0	0	0	0	0	0	37	0	0	0	83	0	0	0	0	0	0	0	0	0	0	0	**1221**
C007	8	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	10	0	54	0	27	28	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**327**
C008	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	**113**
C009	0	0	0	479	2	1	0	0	26	55	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	0	126	0	428	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	8	0	0	0	0	**1138**
C010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**73**
C011	657	0	60	0	0	0	0	0	76	0	14	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	100	0	141	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0	25	0	0	**1141**
C012	0	0	0	0	0	0	0	0	67	22	0	0	0	0	0	132	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	9	135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	**402**
C013	19	0	9	15	0	0	0	0	0	0	0	0	0	0	0	0	66	0	0	0	5	0	0	0	59	0	0	0	0	0	0	0	22	88	322	60	0	46	0	0	0	0	0	0	0	0	0	0	0	0	51	0	0	**763**
C014	4	0	5	0	119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	89	1	0	0	83	425	56	83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**940**
C015	0	0	12	0	131	105	9	0	0	0	73	0	0	35	0	0	43	0	25	0	0	0	82	25	38	0	0	0	0	0	48	0	0	0	30	154	155	61	0	0	0	0	0	0	0	0	27	0	0	0	0	0	2	**1054**
C016	348	125	25	8	29	94	12	3	0	0	140	111	51	0	0	0	0	0	45	0	0	0	73	23	176	0	0	0	0	0	45	0	13	51	0	36	55	697	0	77	0	0	0	0	0	0	0	0	0	0	0	0	0	**2238**
C017	282	0	0	0	0	116	0	0	0	0	0	0	21	35	18	0	0	0	19	0	0	0	123	20	30	0	7	0	0	0	0	0	0	0	0	0	0	115	175	31	0	0	0	0	0	0	0	0	0	0	0	0	0	**991**
C018	167	28	0	0	15	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	29	0	161	33	0	0	0	0	0	0	0	0	0	0	0	0	**475**
C019	0	0	41	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	47	0	0	0	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	98	0	0	0	0	0	0	0	0	0	0	0	0	**303**
C020	40	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	62	18	0	0	0	0	48	26	0	36	28	0	0	0	0	0	0	0	0	0	0	0	0	82	0	0	0	0	66	39	0	0	0	0	0	**462**
C021	46	0	319	0	1	0	0	107	57	10	0	0	0	0	0	6	0	0	35	0	18	0	0	0	0	0	0	0	0	0	203	0	0	0	0	0	0	9	0	0	0	0	447	0	0	164	0	0	59	0	0	0	0	**1481**
C022	88	0	80	0	0	2	0	0	111	160	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0	0	0	15	19	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	0	0	**547**
C023	46	0	0	0	2	0	0	0	21	0	0	0	0	11	0	0	204	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	29	0	0	0	0	0	0	0	0	**333**
C024	122	0	0	0	0	0	306	0	52	0	0	0	46	0	0	0	0	0	0	0	0	0	60	0	14	0	0	0	0	0	55	0	0	0	0	28	0	0	0	0	0	0	18	1	36	245	0	0	0	0	0	0	0	**982**
C064	76	0	94	34	93	0	73	4	0	0	0	0	0	46	0	0	52	0	27	3	0	0	88	0	0	0	11	36	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	370	31	0	0	0	0	0	**1074**
C065	115	0	0	0	0	0	19	0	0	0	16	13	0	46	0	0	104	4	0	17	0	0	0	0	0	0	11	72	0	0	0	0	0	0	0	0	0	0	0	0	0	79	0	0	0	0	0	476	0	0	0	0	0	**971**
C066	0	0	0	0	0	0	33	0	52	0	0	0	0	0	0	0	0	0	0	0	36	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116	0	0	0	16	0	0	0	0	0	0	**260**
C067	31	89	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	0	9	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	**354**
C068	0	0	40	0	0	0	0	0	0	22	48	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	34	0	0	0	19	0	0	0	0	0	0	0	0	0	0	27	64	0	0	0	**359**
C069	96	0	0	0	0	0	0	0	0	34	0	0	0	35	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	141	0	41	0	0	39	0	0	0	0	0	0	0	0	0	57	0	0	42	0	260	34	0	**804**
C070	0	40	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	**237**
C071	0	0	0	0	176	0	0	0	0	0	0	0	0	0	0	31	0	0	34	0	0	112	0	0	0	0	0	0	0	0	0	0	0	0	40	106	128	42	0	0	0	46	0	0	0	0	0	0	0	0	0	0	20	**734**
TOTAL	**4779**	**963**	**1696**	**1259**	**1386**	**1745**	**1675**	**1620**	**2545**	**2097**	**1395**	**1538**	**881**	**1534**	**1322**	**1313**	**1762**	**919**	**1492**	**753**	**357**	**1279**	**1722**	**1766**	**1460**	**689**	**948**	**1308**	**367**	**70**	**1790**	**74**	**1078**	**444**	**636**	**1090**	**593**	**2592**	**359**	**583**	**131**	**395**	**1580**	**807**	**64**	**591**	**738**	**946**	**163**	**64**	**336**	**158**	**1074**	**58.925**

Matrix 28

O/D Trip Estimated Matrix for year 2019, time range: 17-20:30, without trip end data. Trips made by residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006
Q001	26	59	706	17	170	82	47	0	0	457	39	38	115	275	35	92	51	21	0	0	144	0	70	23	118	33	0	41
Q002	56	137	50	0	0	0	0	114	0	95	20	0	0	0	0	0	210	13	0	0	275	0	0	0	34	0	0	0
Q003	95	0	322	0	116	0	0	0	0	0	94	0	143	8	0	0	0	308	0	0	0	0	0	18	37	28	66	103
Q004	0	0	5	316	57	59	0	0	0	0	172	219	0	8	25	0	0	291	0	0	0	0	0	167	18	0	0	0
Q005	63	0	0	168	347	195	0	0	0	0	125	0	0	0	321	0	0	0	0	0	0	3	108	0	149	0	0	0
Q006	1047	0	97	0	114	66	0	187	0	0	41	0	0	168	83	244	129	0	0	0	5	5	75	0	38	28	0	0
Q007	0	11	0	24	0	19	340	419	0	0	0	0	0	94	0	38	47	151	0	0	0	0	0	0	0	85	0	52
Q008	13	0	0	0	0	52	0	772	0	0	0	0	58	0	0	0	135	30	0	1	38	0	0	0	0	25	0	0
Q009	0	97	79	0	0	0	0	0	309	164	72	54	0	0	0	0	0	0	0	0	248	461	0	66	0	1	0	0
Q010	88	0	155	575	0	40	0	0	0	992	26	129	0	0	8	0	0	0	0	0	40	67	94	0	0	0	0	0
Q011	0	0	0	302	12	0	0	0	6	35	438	432	175	0	0	0	0	0	0	0	0	0	3	42	0	0	0	11
Q012	4	125	0	40	0	0	0	0	0	7	536	788	0	0	0	0	22	0	0	0	0	118	0	325	0	160	0	0
Q013	0	0	0	0	322	0	0	12	0	0	7	0	625	11	0	0	0	0	0	0	0	0	0	151	51	0	0	0
Q014	0	33	0	0	0	115	0	0	0	0	0	132	199	290	74	116	0	0	0	0	0	0	0	0	0	23	132	217
Q015	0	42	0	0	0	0	0	0	0	0	415	0	0	0	90	0	0	14	0	0	0	0	0	60	20	124	0	0
Q016	0	0	0	0	0	0	0	89	0	0	0	0	0	152	0	165	384	0	0	47	4	0	0	17	0	0	0	0
Q017	164	0	34	0	36	0	485	280	0	0	0	0	0	0	0	87	107	0	0	0	0	0	56	95	6	47	0	32
Q018	15	0	0	0	0	0	287	0	0	0	0	0	0	0	0	0	0	236	131	218	19	32	0	23	0	34	14	24
Q019	0	0	0	0	0	7	368	0	0	0	0	0	8	17	196	0	0	107	0	0	22	0	207	0	0	66	0	86
Q020	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	415	4	0	0	0	35	0	0	0
Q021	5	301	0	0	0	0	0	112	0	0	0	24	0	52	0	0	0	0	0	0	487	0	94	9	0	0	0	0
Q022	86	541	0	0	0	0	0	93	0	0	0	31	0	0	0	0	0	0	0	0	228	0	0	12	0	0	0	0
Q023	106	343	147	0	152	89	0	0	83	180	0	0	65	293	0	0	0	0	0	0	0	0	396	53	0	39	0	0
C002	0	0	0	26	135	0	0	0	0	0	2	105	172	9	0	0	0	0	0	0	0	0	208	1042	221	0	27	0
C003	0	33	0	0	53	76	0	0	0	4	0	0	134	0	23	80	0	268	214	0	4	4	0	69	660	51	0	0
C004	0	0	0	1	0	0	0	53	0	0	0	0	95	0	252	181	50	0	0	0	0	0	115	0	0	658	15	0
C005	0	75	0	165	0	131	0	0	118	0	0	92	0	0	0	0	0	39	0	0	0	0	0	0	0	0	89	0
C006	0	0	0	0	168	0	0	31	0	0	0	0	0	0	0	0	239	22	0	0	0	0	0	0	56	0	0	507
C007	0	0	0	0	0	0	17	0	0	0	0	0	0	0	27	0	0	0	40	260	0	0	0	0	0	0	0	80
C008	0	0	0	0	0	0	0	0	0	0	0	0	0	276	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C009	369	0	0	0	4	0	0	0	170	524	10	0	4	0	0	0	0	16	0	0	283	0	87	34	18	25	0	0
C010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	0	0	0	0	0	0	0
C011	20	0	0	0	0	0	0	0	54	0	18	0	0	0	0	0	0	0	0	0	309	164	153	0	0	31	12	0
C012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C013	0	0	120	0	0	0	0	0	19	19	0	0	0	0	0	0	0	0	0	16	0	0	73	0	0	0	0	0
C014	0	0	0	0	0	980	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	6	0	0	0	0
C015	4	0	0	0	0	0	0	0	0	0	0	200	0	56	0	0	0	0	0	0	0	0	122	0	26	0	0	0
C016	0	0	0	0	0	81	0	0	0	20	0	568	43	0	0	0	202	0	138	0	185	0	111	44	95	0	0	23
C017	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	33	35	0	0	0
C018	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C019	551	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	3	0	0
C020	0	0	0	0	0	0	18	0	0	0	0	73	0	264	0	0	0	0	0	0	0	0	0	0	0	0	18	61
C021	0	0	0	0	0	0	20	0	227	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C022	0	47	0	0	0	0	467	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C023	0	0	0	0	0	0	0	0	0	0	0	0	0	72	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C024	265	0	0	0	0	0	0	0	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
C064	0	0	211	0	0	251	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	22	0
C065	0	0	0	0	0	0	63	0	0	0	0	0	0	0	157	0	0	0	0	0	0	0	0	0	0	0	0	106
C066	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116	0	0	0	0	0	0	0	0
C067	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C068	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C069	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C070	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C071	0	0	69	63	0	0	0	0	11	4	0	0	0	0	0	187	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**2978**	**1842**	**1993**	**1698**	**1686**	**2241**	**2114**	**2182**	**1122**	**2517**	**2015**	**2884**	**1836**	**2080**	**1293**	**1202**	**1575**	**1543**	**522**	**1073**	**2419**	**861**	**1972**	**2301**	**1617**	**1461**	**395**	**1344**

	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	TOTAL
Q001	2	0	715	18	98	0	8	0	8	255	121	124	0	41	287	0	121	204	33	28	0	13	0	61	0	0	**4797**
Q002	0	0	199	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	133	0	9	0	0	**1380**
Q003	0	0	0	0	0	0	0	76	18	21	0	0	0	107	0	0	0	0	74	0	0	0	39	0	0	24	**1696**
Q004	0	0	0	0	0	0	92	0	0	206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	**1752**
Q005	0	0	0	0	0	0	0	0	365	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1882**
Q006	0	16	0	1	68	0	0	0	36	21	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2489**
Q007	82	0	0	0	0	0	0	10	76	176	0	0	57	0	0	0	0	0	21	20	30	0	0	0	16	0	**1768**
Q008	12	0	0	0	3	0	0	0	0	27	0	0	11	0	33	0	0	1	0	0	0	0	0	0	2	0	**1214**
Q009	23	0	115	0	184	108	11	0	0	25	12	0	0	0	61	28	0	20	0	0	0	12	0	0	0	29	**2180**
Q010	0	0	0	0	0	0	45	0	0	0	24	25	0	0	4	0	0	0	0	0	0	0	5	0	0	29	**2346**
Q011	0	0	25	0	6	0	129	0	42	49	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	56	**1817**
Q012	0	0	0	0	0	50	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	**2278**
Q013	0	1	0	0	0	0	51	0	0	0	0	0	99	0	0	0	0	72	0	0	0	0	0	0	0	0	**1401**
Q014	0	13	0	1	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	308	0	0	0	22	0	0	**1691**
Q015	0	0	0	0	0	0	0	0	0	0	22	0	0	20	0	43	0	0	0	0	0	0	22	0	33	0	**906**
Q016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	174	0	0	0	0	122	0	56	**1217**
Q017	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	50	0	26	46	0	0	0	0	0	0	**1587**
Q018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	**1049**
Q019	73	0	1	0	0	0	0	0	41	48	46	0	165	124	96	0	0	0	0	0	0	0	0	0	0	54	**1731**
Q020	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	165	0	0	0	0	0	**696**
Q021	21	0	0	184	215	0	9	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	**1543**
Q022	0	0	51	0	112	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	**1185**
Q023	0	0	257	0	56	0	28	57	27	31	59	0	52	27	0	0	0	82	20	0	6	0	0	0	0	108	**2754**
C002	0	0	57	0	0	0	41	0	41	48	0	47	0	0	0	0	39	0	0	0	0	0	0	0	0	0	**2220**
C003	0	0	0	0	0	0	34	0	34	164	0	38	0	35	0	0	0	51	0	0	0	0	0	0	57	0	**2088**
C004	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	**1443**
C005	0	0	0	0	0	0	0	0	0	0	41	80	0	0	0	0	0	0	57	0	0	0	0	0	0	0	**887**
C006	47	0	0	0	0	0	0	53	0	0	0	0	0	53	0	0	0	0	22	38	0	0	0	0	0	0	**1237**
C007	463	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**918**
C008	0	41	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	**321**
C009	0	0	595	0	165	0	0	37	34	20	0	0	0	0	40	115	34	52	0	0	0	16	22	48	28	25	**2775**
C010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**123**
C011	0	0	53	0	241	18	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	**1202**
C012	0	0	0	0	0	110	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	**180**
C013	0	0	0	0	0	0	248	90	89	0	0	0	0	0	0	92	0	0	0	0	0	0	0	58	0	0	**822**
C014	0	0	0	0	0	0	7	153	26	15	0	8	0	0	0	14	0	20	0	0	0	0	0	0	0	35	**1280**
C015	0	0	0	0	0	0	27	103	280	118	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	65	**1009**
C016	0	0	0	0	0	0	22	185	45	999	149	52	0	0	11	0	0	0	0	0	0	0	26	0	0	0	**2999**
C017	0	0	0	0	0	0	0	0	0	76	192	36	0	0	0	0	0	51	0	0	0	0	0	0	0	0	**439**
C018	0	0	0	0	0	0	0	0	0	77	37	188	68	0	0	0	0	0	0	0	0	0	0	0	0	0	**385**
C019	0	0	0	0	0	0	0	0	0	0	0	5	34	0	0	0	0	0	0	0	0	0	0	0	0	0	**605**
C020	0	0	0	0	0	0	0	0	0	0	0	0	0	235	0	0	0	0	87	85	0	0	0	0	0	0	**841**
C021	0	237	19	0	0	0	0	0	23	0	0	0	0	0	889	63	26	0	0	0	74	0	0	0	0	0	**1579**
C022	0	0	10	0	0	0	0	0	0	0	0	0	0	0	19	97	8	11	0	0	0	0	0	0	0	0	**678**
C023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	29	0	0	0	0	0	0	0	0	0	**175**
C024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	25	0	140	0	0	0	0	0	16	0	0	**588**
C064	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	330	0	10	0	0	0	0	0	**931**
C065	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	226	0	0	0	49	0	0	**672**
C066	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	**168**
C067	0	0	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	66	39	0	0	**290**
C068	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	**63**
C069	0	0	35	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	22	0	362	0	0	**491**
C070	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	0	**67**
C071	0	0	0	0	0	0	25	105	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	372	**862**
TOTAL	**757**	**308**	**2217**	**204**	**1149**	**338**	**776**	**868**	**1262**	**2524**	**745**	**673**	**485**	**833**	**1559**	**551**	**306**	**703**	**845**	**802**	**285**	**342**	**332**	**893**	**185**	**985**	**69695**

Matrix 29

O/D Trip Estimated Matrix for year 2019, Tuesday (all day), without trip end data. Trips made by residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	TOTAL
Q001	282	281	2740	58	1145	435	1	75	439	1883	18	61	281	890	33	71	168	0	0	0	11	7	294	33	246	57	17	129	0	17	1924	2	235	0	26	23	20	1269	721	336	0	83	173	152	322	801	55	85	0	20	0	133	0	0	**16049**
Q002	76	9	11	35	4	49	0	93	913	254	24	15	0	53	74	45	95	222	0	0	1011	1322	144	32	41	0	64	0	0	0	385	0	0	0	0	0	12	9	0	9	10	0	0	734	0	0	0	0	0	363	0	14	13	0	**6134**
Q003	709	180	983	294	529	223	1	0	68	869	47	0	670	61	0	75	209	414	0	0	0	369	403	84	67	42	51	250	0	0	29	0	216	0	22	58	76	55	0	0	21	78	1	18	0	0	400	0	0	0	19	0	0	88	**7682**
Q004	12	33	20	617	141	300	1	196	3	519	172	778	209	51	103	0	0	778	0	0	1	0	74	478	41	58	132	0	0	0	1	0	0	0	730	0	0	466	0	0	0	65	0	0	0	0	61	0	0	0	0	0	0	180	**6221**
Q005	463	33	359	299	334	405	1	186	5	0	272	415	532	49	379	0	231	0	0	0	0	3	175	174	170	159	0	239	0	0	7	0	0	0	0	397	663	56	0	29	0	0	0	1	1	0	0	0	0	0	19	0	0	909	**6965**
Q006	368	63	136	148	363	1277	3	1167	7	487	87	0	342	553	92	421	376	1387	2	1	95	6	144	0	264	49	166	95	0	299	5	11	29	0	0	282	170	238	69	22	0	160	0	0	0	0	464	0	0	0	0	0	0	0	**9847**
Q007	318	25	52	44	24	201	1087	785	2121	62	21	14	0	80	0	121	111	202	1227	0	0	1	19	0	5	69	44	326	118	90	308	0	0	0	35	6	466	357	0	0	23	16	612	555	0	240	58	83	172	0	0	0	5	0	**10106**
Q008	101	51	0	45	139	366	7	1185	0	23	0	0	38	0	55	51	502	217	2	5	125	17	0	22	15	143	0	3	530	0	16	0	19	2	0	0	1	180	0	0	50	0	388	2	3	3	34	0	0	0	0	0	4	0	**4343**
Q009	435	24	108	56	16	12	1495	0	363	222	69	87	0	0	0	0	272	0	0	0	98	290	187	72	10	1	356	1	30	0	203	0	958	315	161	0	71	53	30	116	0	0	101	40	15	88	0	353	14	20	0	0	0	161	**6900**
Q010	1723	664	163	1366	0	288	0	19	220	1579	120	755	65	50	27	0	0	0	0	0	76	69	740	50	23	0	0	0	0	0	545	0	36	0	278	0	0	373	44	86	0	0	12	19	0	0	0	0	0	0	13	15	0	94	**9513**
Q011	41	0	17	907	94	50	0	0	27	54	619	766	354	466	501	0	24	182	0	0	0	43	32	759	340	0	0	19	0	0	39	0	34	0	198	89	147	118	0	0	0	0	0	11	0	0	0	16	0	0	104	0	0	65	**6114**
Q012	134	283	22	50	0	0	0	0	2	19	1510	1608	244	86	0	666	40	0	0	0	3	286	2	1092	0	171	42	71	0	0	0	0	0	99	92	231	97	379	0	0	0	61	0	1	0	0	0	0	0	107	0	0	0	0	**7398**
Q013	60	0	590	351	690	94	0	163	0	1	8	101	1309	203	256	0	0	0	0	0	0	1	0	723	708	328	0	0	0	36	0	0	0	0	71	0	0	410	323	58	67	0	0	0	0	74	46	0	0	0	98	0	0	0	**6769**
Q014	296	174	50	11	201	588	1	0	0	4	99	143	444	2563	442	214	0	0	0	1	0	0	2	140	47	65	158	278	0	563	1	10	0	0	0	92	107	20	22	0	0	718	0	0	90	0	243	498	0	0	0	38	37	0	**8362**
Q015	39	148	0	3	98	143	0	0	0	22	1022	0	78	642	872	468	0	60	171	0	0	7	0	89	148	294	0	92	38	0	0	0	0	0	89	0	0	0	27	0	0	20	0	94	0	0	18	59	0	0	41	0	47	0	**4830**
Q016	58	56	44	0	0	235	2	156	0	0	0	214	0	234	184	378	821	0	253	84	21	0	67	25	87	431	690	0	0	0	306	23	0	162	0	0	0	140	0	0	173	0	224	0	0	0	158	0	0	0	0	236	0	267	**5727**
Q017	106	72	96	0	155	291	2043	688	74	0	30	0	0	177	70	406	1239	10	22	22	0	0	53	408	14	128	31	684	12	0	0	0	0	0	66	0	76	294	0	0	0	0	8	0	85	0	46	94	0	0	0	0	0	0	**7502**
Q018	257	190	94	166	0	534	606	342	0	0	117	0	0	0	71	0	63	308	781	1443	47	22	100	23	86	57	56	122	74	0	32	0	0	0	94	0	0	0	0	84	0	0	0	0	0	0	0	42	0	0	0	0	0	0	**5810**
Q019	0	0	0	13	0	19	1118	0	0	0	0	0	10	22	160	69	81	160	762	282	53	0	257	0	175	201	18	199	76	0	3	0	0	0	0	0	46	181	39	0	80	83	43	0	0	0	26	0	0	51	0	0	0	41	**4269**
Q020	32	0	0	0	0	20	0	222	0	0	9	0	11	0	0	57	78	214	272	872	14	29	15	0	328	0	0	34	200	0	0	0	18	0	81	0	0	0	0	211	0	30	0	0	0	0	53	121	130	0	0	0	0	0	**3051**
Q021	46	1259	0	45	0	46	0	251	223	213	0	21	11	24	0	16	0	68	2	1	2344	160	210	5	14	0	0	0	62	11	91	175	709	0	14	36	0	722	0	0	0	0	24	0	0	0	0	33	21	0	0	0	0	0	**6856**
Q022	337	1192	76	0	0	106	0	38	140	179	47	161	116	122	161	0	0	30	0	2	294	2318	0	17	68	0	0	0	40	0	157	0	446	99	0	0	0	21	0	60	0	67	0	0	0	0	28	0	0	0	0	0	0	22	**6346**
Q023	742	416	538	1440	447	473	1	0	204	1125	146	435	81	221	0	73	154	0	65	1	57	0	1760	100	0	127	0	0	0	0	496	0	133	0	91	29	101	191	41	0	21	15	0	0	0	49	13	0	8	0	35	0	0	67	**9897**
C002	1	1	1	9	109	0	0	27	0	0	11	388	623	113	61	10	631	11	0	0	0	0	609	3564	885	0	23	0	22	0	410	0	0	0	99	64	113	261	95	46	0	0	0	0	47	49	0	0	0	0	0	83	0	101	**8467**
C003	206	87	19	1	72	559	0	78	2	19	733	0	228	90	157	149	164	483	116	15	32	3	179	245	2899	28	0	69	0	0	41	0	0	0	29	0	65	411	112	26	0	40	0	0	0	32	0	0	0	0	0	0	46	0	**7439**
C004	96	0	56	3	89	106	68	116	2	0	0	449	141	167	453	265	99	14	61	0	0	0	384	0	32	1954	14	24	0	0	44	0	75	0	0	43	0	26	0	0	30	22	0	0	0	0	20	0	0	0	0	0	0	0	**4853**
C005	17	105	51	125	0	212	122	0	213	0	0	60	0	74	0	287	68	39	40	0	0	0	0	32	0	41	373	32	0	0	0	0	31	0	0	0	0	0	40	76	0	27	0	0	0	0	134	29	0	0	0	0	0	0	**2228**
C006	99	12	130	0	242	63	109	121	8	0	28	53	0	67	191	0	538	45	225	40	0	0	0	0	119	35	17	2752	206	0	0	0	0	0	0	47	0	33	0	0	0	202	0	0	0	0	52	155	0	0	0	0	0	0	**5590**
C007	14	0	0	0	0	0	54	398	64	0	0	1	0	0	40	0	33	9	86	189	171	117	0	39	0	0	0	159	1428	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2859**
C008	57	0	0	0	0	173	2	0	0	0	0	0	46	381	0	0	0	0	0	0	74	0	0	0	0	0	0	0	0	504	47	0	0	0	0	0	0	0	0	0	0	0	181	0	0	0	0	0	39	0	0	0	0	0	**1504**
C009	1441	19	42	43	27	14	167	37	328	1291	76	36	75	28	0	459	0	47	0	0	216	167	346	73	17	16	0	0	0	7	2668	0	1065	0	16	67	37	28	48	0	0	0	88	80	34	113	0	0	0	164	51	82	26	36	**9574**
C010	9	0	0	0	0	8	0	0	0	0	0	0	0	9	0	19	0	0	0	0	189	0	0	0	0	0	0	0	0	0	0	389	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**634**
C011	700	0	91	0	0	0	0	50	842	80	64	20	0	0	0	0	0	0	0	1	640	538	325	0	0	42	9	0	0	0	506	0	1023	23	20	25	45	0	19	0	0	0	0	0	0	22	0	0	0	53	0	267	0	20	**5428**
C012	0	0	0	0	0	0	0	3	137	18	0	0	0	0	0	530	0	0	0	0	0	64	0	0	0	0	0	0	0	0	0	0	25	194	15	0	0	13	0	0	0	0	0	0	0	0	0	0	0	18	21	24	47	0	**1107**
C013	136	0	152	114	0	0	1	0	8	17	0	223	414	0	115	0	47	21	0	16	4	0	253	45	30	0	0	0	0	0	40	0	23	34	924	487	174	78	0	0	0	0	0	24	0	0	0	0	0	0	0	94	0	59	**3536**
C014	57	0	46	0	337	938	0	0	0	0	198	260	0	133	0	0	0	0	0	0	5	0	38	14	0	18	0	14	0	0	80	1	13	0	208	1166	332	112	0	18	0	0	1	14	0	61	0	0	1	0	0	32	0	92	**4186**
C015	66	171	79	0	748	210	4	0	2	0	432	144	0	206	0	0	33	0	20	0	0	0	174	32	43	0	0	0	9	0	59	0	32	0	108	413	1650	165	0	0	0	0	10	0	0	0	13	0	0	0	0	0	0	149	**4972**
C016	1280	177	138	64	22	538	7	58	5	14	498	812	142	35	0	0	185	0	113	0	765	79	613	106	387	21	0	18	0	0	64	0	17	26	69	215	210	2910	239	104	0	0	23	0	0	0	0	0	0	0	34	38	0	23	**10049**
C017	1114	0	0	0	0	112	0	0	1	11	0	0	72	36	28	26	0	0	22	0	0	0	93	35	121	0	11	0	0	0	0	0	0	0	0	0	0	239	917	83	0	0	0	0	0	26	0	0	0	0	0	0	0	0	**2946**
C018	554	29	0	0	17	56	0	0	7	7	0	0	25	0	0	0	0	24	0	54	0	4	0	27	36	0	31	0	0	0	0	0	0	0	0	48	0	149	129	1126	100	0	0	0	0	0	0	0	0	0	0	0	0	0	**2423**
C019	219	25	25	0	0	0	21	18	0	0	0	0	2	0	0	111	0	0	56	0	0	0	57	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	78	562	0	0	0	0	0	0	0	0	0	0	0	0	0	**1200**
C020	38	0	201	42	0	141	31	0	70	0	0	60	0	229	54	0	70	0	84	47	0	24	87	0	91	42	19	268	38	0	0	0	0	0	0	0	0	0	0	0	0	853	0	0	0	0	262	184	0	0	0	0	0	41	**2975**
C021	174	0	408	0	44	0	6	383	183	78	0	0	0	0	0	48	18	0	28	0	57	0	0	14	0	0	0	0	0	79	207	0	0	0	0	12	57	88	0	0	0	0	3734	70	135	160	0	0	166	33	41	0	0	0	**6221**
C022	193	67	101	0	5	5	577	10	186	87	42	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	0	0	0	18	23	0	0	0	0	0	0	57	296	19	40	0	0	0	0	0	0	0	0	**1942**
C023	226	0	0	0	3	0	0	16	29	0	0	0	0	116	0	0	220	0	0	0	0	0	0	9	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	144	10	43	13	0	0	0	0	0	0	0	0	**865**
C024	580	0	0	0	0	0	339	18	176	0	0	0	185	0	0	0	0	0	0	0	0	0	59	10	14	0	0	0	0	0	123	0	11	0	0	56	0	0	14	0	0	0	177	23	14	481	0	0	0	0	0	23	0	0	**2302**
C064	39	0	287	41	71	425	117	27	0	0	0	0	40	81	51	47	72	0	40	23	0	10	82	0	0	40	96	72	0	0	0	0	0	0	0	0	47	0	0	0	0	273	0	0	0	0	1581	28	20	0	0	0	0	0	**3610**
C065	54	0	0	0	0	0	149	0	69	0	28	19	0	148	152	0	132	19	123	175	0	0	0	0	0	0	18	191	0	0	0	0	0	0	0	0	0	0	0	0	0	171	0	0	0	0	25	1418	0	0	0	67	0	0	**2960**
C066	0	148	0	0	0	0	2	0	26	0	0	0	0	0	0	0	0	0	0	88	52	0	39	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	200	0	0	0	30	0	106	0	0	0	0	0	**701**
C067	53	27	0	0	0	0	0	0	58	0	0	158	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	257	0	36	26	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	379	97	71	38	0	**1275**
C068	0	0	24	0	36	0	0	0	0	18	172	0	200	0	19	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	45	0	0	17	0	0	0	13	0	0	0	0	37	0	0	0	0	0	0	55	327	0	0	0	**997**
C069	222	41	0	0	0	0	0	0	0	22	0	0	0	45	0	670	0	0	0	0	0	0	0	14	0	0	0	0	0	0	130	0	71	44	36	26	0	16	0	0	0	0	0	0	0	20	0	13	0	44	0	1508	30	0	**2952**
C070	0	48	0	0	0	0	0	6	0	0	0	0	0	56	29	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	32	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	38	386	0	**703**
C071	28	0	95	18	1395	0	0	0	5	4	198	0	0	0	0	111	0	0	18	0	0	60	118	29	0	0	0	0	0	0	58	0	15	0	38	125	154	16	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	1163	**3660**
TOTAL	**14307**	**6110**	**8044**	**6408**	**7596**	**9715**	**8143**	**6933**	**7231**	**9181**	**6918**	**8260**	**6988**	**8561**	**4920**	**5861**	**6773**	**4967**	**4615**	**3362**	**6454**	**6015**	**8169**	**8613**	**7596**	**4648**	**2435**	**6141**	**2885**	**1607**	**9520**	**612**	**5272**	**1093**	**3628**	**4082**	**4993**	**10090**	**2928**	**2567**	**1138**	**2998**	**6290**	**2145**	**807**	**2274**	**3819**	**3211**	**677**	**1337**	**901**	**2762**	**678**	**3580**	**276.851**

Matrix 30

O/D Trip Estimated Matrix for year 2019, time range: 07-09, with trip end data. Trips made by residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C067	C068	C069	C070	C071	TOTAL
Q001	173	150	0	0	64	31	0	8	0	366	0	7	0	53	0	0	0	0	0	0	0	0	151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106	284	0	0	0	0	0	0	0	0	0	1391
Q002	0	0	0	0	0	0	0	0	431	0	0	17	0	0	0	0	0	129	0	0	0	240	9	39	58	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	115	0	0	0	0	0	0	0	0	0	1074
Q003	185	0	0	0	0	229	0	0	0	0	0	0	0	0	0	0	185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	208	0	0	0	0	0	11	818
Q004	9	0	6	650	91	239	0	0	0	144	0	0	37	27	0	0	0	0	0	0	0	0	0	221	0	104	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1652
Q005	48	0	60	163	0	91	0	0	0	0	15	0	75	41	84	0	63	0	0	0	0	0	0	0	0	81	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	691	1470
Q006	13	0	0	0	118	134	0	488	0	49	0	0	0	0	0	60	112	579	0	0	0	0	0	0	114	0	0	0	0	0	0	0	0	0	0	0	0	168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1836
Q007	326	0	0	0	28	90	273	35	350	0	0	7	0	0	0	28	26	45	299	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	497	92	0	0	0	26	0	0	0	0	0	2139
Q008	92	145	0	0	0	0	0	286	0	0	0	0	0	0	0	12	0	0	88	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	647
Q009	0	0	99	0	0	0	0	0	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112	0	0	0	0	0	289	0	0	0	0	0	0	132	0	0	33	0	0	97	0	0	0	0	0	0	8	848
Q010	1000	174	0	0	0	81	0	0	0	700	51	21	0	0	0	0	0	0	0	0	0	0	43	62	35	0	0	0	0	0	120	0	0	0	0	0	0	186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2474
Q011	9	0	0	0	0	12	0	0	0	24	115	100	199	0	407	0	9	0	0	0	0	0	0	462	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1339
Q012	52	0	23	28	0	0	0	0	0	1	441	958	0	98	0	628	0	0	0	0	0	0	3	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	2277
Q013	29	0	121	54	0	0	0	187	0	0	1	0	155	0	156	0	0	0	0	0	0	0	0	350	294	0	0	0	0	0	0	0	0	0	0	0	0	221	192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1759
Q014	63	57	77	9	82	225	0	0	0	0	51	0	100	669	100	0	0	0	0	0	0	0	18	114	0	0	0	0	0	0	0	0	0	0	0	171	135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1872
Q015	0	53	0	0	75	0	0	0	0	135	0	0	0	151	372	185	0	0	214	0	0	0	0	0	0	96	0	122	19	0	0	0	0	0	125	0	0	0	0	0	0	0	0	0	0	0	0	101	0	0	0	0	0	1650
Q016	4	0	0	0	0	114	1	0	0	0	0	0	0	0	68	89	340	0	101	0	0	0	71	0	128	120	377	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	1447
Q017	6	0	0	0	0	93	877	0	14	0	0	0	0	87	54	54	205	0	0	0	0	0	0	106	0	0	0	240	0	0	0	0	0	0	0	0	0	135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1871
Q018	632	15	99	0	0	0	0	32	0	0	23	0	0	0	26	0	0	0	0	266	0	0	91	0	0	0	29	0	0	0	21	0	0	0	0	0	0	0	0	84	0	0	0	0	0	0	0	0	0	0	0	0	0	1318
Q019	0	0	0	17	0	0	171	0	0	0	0	0	0	0	0	0	78	26	0	211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	504
Q020	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	21	39	14	244	231	0	0	0	0	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68	0	0	0	0	0	0	0	234	0	0	0	0	0	928
Q021	0	0	0	1	0	0	0	0	586	73	0	0	0	0	0	0	0	0	0	0	281	66	0	0	0	0	0	0	63	0	407	0	0	0	0	0	0	351	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	1847
Q022	2	0	0	0	0	0	0	0	363	118	0	187	0	0	0	0	0	58	0	0	0	644	0	0	1	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	1447
Q023	237	0	265	0	112	0	0	0	0	74	40	0	0	0	0	0	108	0	74	0	0	0	491	75	0	66	0	0	0	0	0	0	0	0	0	0	86	183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1810
C002	0	0	0	0	0	0	0	46	0	0	0	20	36	9	0	11	140	0	0	0	0	0	142	210	69	0	0	0	0	0	82	0	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	826
C003	81	0	0	0	21	114	0	0	0	0	343	0	50	42	0	0	0	0	16	2	0	0	0	50	221	0	0	18	0	0	31	0	0	0	0	0	0	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1096
C004	3	0	41	0	21	0	41	0	0	0	0	52	0	85	0	30	50	6	0	0	0	0	197	0	0	134	0	33	0	0	58	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	787
C005	1	0	74	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	33	0	0	0	0	0	0	30	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	283
C006	5	0	147	0	60	0	13	1	1	0	0	0	0	0	30	0	0	0	70	0	0	0	0	0	0	0	20	660	58	0	0	0	0	0	0	0	0	44	0	0	0	86	0	0	0	0	0	0	0	0	0	0	0	1194
C007	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	59	0	28	28	0	0	0	0	0	0	198	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	334
C008	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	122
C009	0	0	0	237	2	1	0	0	30	97	0	0	0	0	0	0	0	0	0	0	0	2	0	7	0	0	0	0	0	0	189	0	445	0	0	0	0	9	0	0	0	0	0	2	0	0	0	0	11	0	0	0	0	1031
C010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74
C011	868	0	49	0	0	0	0	0	28	0	9	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	65	0	100	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	15	0	0	1167
C012	0	0	0	0	0	0	0	0	48	10	0	0	0	0	0	104	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	12	148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	356
C013	19	0	8	10	0	0	0	0	0	0	0	0	0	0	0	0	66	0	0	0	0	0	0	0	66	0	0	0	0	0	0	0	25	78	328	60	0	49	0	0	0	0	0	0	0	0	0	0	0	0	49	0	0	758
C014	4	0	5	0	103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	0	0	0	0	0	0	0	87	0	0	0	82	413	54	86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	911
C015	0	0	11	0	114	99	24	0	0	0	49	0	0	22	0	0	42	0	25	0	0	0	86	25	42	0	0	0	0	0	48	0	0	0	30	151	149	64	0	0	0	0	0	0	0	0	26	0	0	0	0	0	2	1006
C016	348	120	22	6	58	87	33	1	0	0	93	76	69	0	0	0	0	0	45	0	0	0	75	23	189	0	0	0	0	0	43	0	14	43	0	34	52	715	0	74	0	0	0	0	0	0	0	0	0	0	0	0	0	2220
C017	286	0	0	0	0	109	0	0	0	0	0	0	29	49	17	0	0	0	19	0	0	0	127	20	32	0	11	0	0	0	0	0	0	0	0	0	0	119	168	31	0	0	0	0	0	0	0	0	0	0	0	0	0	1016
C018	163	11	0	0	29	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	29	0	152	32	0	0	0	0	0	0	0	0	0	0	0	0	475
C019	0	0	31	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	48	0	0	0	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	100	0	0	0	0	0	0	0	0	0	0	0	0	296
C020	2	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	72	17	0	0	0	0	59	32	0	39	30	0	0	0	0	0	0	0	0	0	0	0	0	85	0	0	0	0	71	38	0	0	0	0	0	455
C021	67	0	222	0	0	0	0	216	50	8	0	0	0	0	0	4	0	0	31	0	16	0	0	0	0	0	0	0	0	0	174	0	0	0	0	0	0	6	0	0	0	0	488	0	0	122	0	0	48	0	0	0	0	1451
C022	45	0	77	0	0	2	0	0	89	199	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	16	20	0	0	0	0	0	0	9	6	0	0	0	0	0	0	0	0	0	526
C023	62	0	0	0	2	0	0	0	44	0	0	0	0	18	0	0	24	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	40	0	0	0	0	0	0	0	0	247
C024	84	0	0	0	0	0	226	0	56	0	0	0	44	0	0	0	0	0	0	0	0	0	89	0	21	0	0	0	0	0	77	0	0	0	0	39	0	0	0	0	0	0	23	3	25	299	0	0	0	0	0	0	0	987
C064	3	0	125	53	58	0	78	1	0	0	0	0	0	47	0	0	55	0	30	3	0	0	99	0	0	0	19	37	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	385	29	0	0	0	0	0	1059
C065	5	0	0	0	0	0	23	0	0	0	18	16	0	53	0	0	123	4	0	17	0	0	0	0	0	0	21	83	0	0	0	0	0	0	0	0	0	0	0	0	0	88	0	0	0	0	0	503	0	0	0	0	0	954
C066	0	0	0	0	0	0	60	0	48	0	0	0	0	0	0	0	0	0	0	0	31	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	11	0	0	0	0	0	0	287
C067	29	64	0	0	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	0	12	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	343
C068	0	0	32	0	0	0	0	0	0	9	38	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	34	0	0	0	23	0	0	0	0	0	0	0	0	0	0	30	64	0	0	0	324
C069	87	0	0	0	0	0	0	0	0	13	0	0	0	24	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	156	0	50	0	0	43	0	0	0	0	0	0	0	0	0	54	0	0	44	0	271	33	0	804
C070	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	220
C071	0	0	0	0	145	0	0	0	0	0	0	0	0	0	0	29	0	0	33	0	0	114	0	0	0	0	0	0	0	0	0	0	0	0	38	99	116	41	0	0	0	40	0	0	0	0	0	0	0	0	0	0	26	681
TOTAL	**5053**	**812**	**1593**	**1229**	**1182**	**1758**	**1822**	**1303**	**2227**	**2022**	**1284**	**1493**	**886**	**1535**	**1326**	**1254**	**1673**	**861**	**1499**	**747**	**357**	**1139**	**1855**	**1812**	**1442**	**662**	**832**	**1312**	**367**	**69**	**1789**	**75**	**949**	**430**	**636**	**1091**	**592**	**2571**	**360**	**578**	**132**	**399**	**1363**	**501**	**65**	**595**	**736**	**950**	**162**	**64**	**335**	**157**	**773**	**56.708**

Matrix 31

O/D Trip Estimated Matrix for year 2019, time range: 17-20:30, with trip end data. Trips made by residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	**TOTAL**
Q001	141	162	713	20	104	168	1	0	0	513	79	88	83	204	76	165	116	1	0	0	1	0	63	55	97	75	0	79	0	0	376	0	120	0	18	0	19	287	127	137	0	74	9	0	81	107	65	60	0	11	0	51	0	0	**4549**
Q002	144	54	49	0	0	0	0	104	0	74	12	0	0	0	0	0	69	25	0	0	360	0	0	0	13	0	0	0	0	0	262	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	145	0	5	0	0	**1328**
Q003	177	0	314	0	105	0	0	0	0	0	88	0	120	8	0	0	0	308	0	0	0	0	0	21	35	29	68	90	0	0	0	0	0	0	0	86	20	24	0	0	0	89	0	0	0	0	66	0	0	0	27	0	0	27	**1703**
Q004	0	0	4	534	60	50	0	0	0	0	145	181	0	9	23	0	0	260	0	0	0	0	0	151	19	0	0	0	0	0	0	0	0	0	78	0	0	182	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	**1796**
Q005	120	0	0	287	364	154	0	0	0	0	121	0	0	0	288	0	0	0	0	0	0	1	73	0	165	0	0	0	0	0	0	0	0	0	0	0	317	0	0	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1929**
Q006	484	0	168	0	149	90	0	159	0	0	68	0	0	265	118	288	196	0	1	0	9	1	88	0	67	42	0	0	0	81	0	2	48	0	0	0	58	35	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2449**
Q007	0	9	0	42	0	16	402	173	0	0	0	0	0	94	0	29	45	205	0	0	0	0	0	0	0	63	0	89	118	0	0	0	0	0	0	11	35	83	0	0	42	0	0	0	0	0	17	17	81	0	0	0	12	0	**1583**
Q008	13	0	0	0	0	33	0	778	0	0	0	0	42	0	0	0	166	63	0	0	86	0	0	0	0	28	0	0	83	0	0	0	6	0	0	0	0	34	0	0	13	0	287	0	0	2	0	0	0	0	0	0	4	0	**1640**
Q009	0	68	68	0	0	0	0	0	328	136	60	26	0	0	0	0	0	0	0	0	287	508	0	66	0	1	0	0	20	0	141	0	164	104	5	0	0	13	6	0	0	0	63	28	0	24	0	0	0	12	0	0	0	14	**2142**
Q010	277	0	187	299	0	40	0	0	0	1151	20	86	0	0	10	0	0	0	0	0	42	68	85	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	16	17	0	0	4	0	0	0	0	0	0	0	5	0	0	20	**2359**
Q011	0	0	0	170	12	0	0	0	3	31	447	503	204	0	0	0	0	0	0	0	0	0	5	51	0	0	0	11	0	0	33	0	6	0	154	0	51	62	0	0	0	0	0	0	0	0	0	0	0	0	74	0	0	68	**1886**
Q012	4	218	0	46	0	0	0	0	0	7	467	783	0	0	0	0	22	0	0	0	0	144	0	339	0	154	0	0	0	0	0	0	0	50	0	0	0	62	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	**2343**
Q013	0	0	0	0	335	0	0	8	0	0	6	0	602	14	0	0	0	0	0	0	0	0	0	152	56	0	0	0	0	4	0	0	0	0	50	0	0	0	0	0	92	0	0	0	0	89	0	0	0	0	0	0	0	0	**1409**
Q014	0	33	0	0	0	120	0	0	0	0	0	156	236	352	81	105	0	0	0	0	0	0	0	0	0	27	109	154	0	51	1	1	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	242	0	0	0	28	0	0	**1716**
Q015	0	29	0	0	0	0	0	0	0	0	498	0	0	0	67	0	0	15	0	0	0	0	0	51	19	98	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	16	0	38	0	0	0	0	0	0	22	0	36	0	**907**
Q016	0	0	0	0	0	0	1	56	0	0	0	0	0	178	0	144	430	0	0	55	6	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0	0	120	0	0	0	0	125	0	49	**1215**
Q017	61	0	39	0	38	0	730	99	0	0	0	0	0	0	0	83	130	0	0	0	0	0	42	97	9	45	0	33	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	13	0	27	52	0	0	0	0	0	0	**1537**
Q018	26	0	0	0	0	0	259	0	0	0	0	0	0	0	0	0	0	245	175	270	14	22	0	14	0	20	10	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	**1081**
Q019	0	0	0	0	0	6	448	0	0	0	0	0	8	18	178	0	0	151	0	0	21	0	228	0	0	63	0	89	64	0	1	0	0	0	0	0	43	51	45	0	157	122	103	0	0	0	0	0	0	0	0	0	0	56	**1850**
Q020	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	415	3	0	0	0	56	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	133	0	0	0	0	0	**700**
Q021	4	293	0	0	0	0	0	81	0	0	0	10	0	27	0	0	0	0	0	0	506	0	75	4	0	0	0	0	16	0	0	203	173	0	4	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	**1424**
Q022	83	508	0	0	0	0	0	65	0	0	0	26	0	0	0	0	0	0	0	0	228	0	0	10	0	0	0	0	0	0	54	0	87	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	**1087**
Q023	135	200	79	0	76	47	0	0	49	83	0	0	45	188	0	0	0	0	0	0	0	0	507	64	0	44	0	0	0	0	378	0	61	0	33	68	32	38	68	0	57	30	0	0	0	120	24	0	2	0	0	0	0	129	**2558**
C002	0	0	0	15	137	0	0	0	0	0	2	99	162	11	0	0	0	0	0	0	0	0	219	1030	238	0	31	0	0	0	69	0	0	0	39	0	41	49	0	47	0	0	0	0	60	0	0	0	0	0	0	0	0	0	**2248**
C003	0	40	0	0	80	95	0	0	0	9	0	0	188	0	30	86	0	351	184	0	7	1	0	57	596	40	0	0	0	0	0	0	0	0	27	0	28	139	0	31	0	27	0	0	0	52	0	0	0	0	0	0	61	0	**2130**
C004	0	0	0	1	0	0	0	22	0	0	0	0	101	0	246	147	52	0	0	0	0	0	136	0	0	678	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	**1426**
C005	0	57	0	255	0	102	0	0	134	0	0	81	0	0	0	0	0	43	0	0	0	0	0	0	0	0	95	0	0	0	0	0	0	0	0	0	0	0	36	74	0	0	0	0	0	0	53	0	0	0	0	0	0	0	**931**
C006	0	0	0	0	139	0	0	13	0	0	0	0	0	0	0	0	230	27	0	0	0	0	0	0	63	0	0	523	41	0	0	0	0	0	0	54	0	0	0	0	0	51	0	0	0	0	23	44	0	0	0	0	0	0	**1209**
C007	0	0	0	0	0	0	21	0	0	0	0	0	0	0	44	0	0	0	43	260	0	0	0	0	0	0	0	84	413	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**912**
C008	0	0	0	0	0	0	0	0	0	0	0	0	0	272	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	**293**
C009	298	0	0	0	3	0	0	0	182	436	6	0	4	0	0	0	0	23	0	0	287	0	81	30	17	21	0	0	0	0	636	0	175	0	0	33	29	18	0	0	0	0	36	102	47	56	0	0	0	14	22	42	31	22	**2648**
C010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**123**
C011	48	0	0	0	0	0	0	0	51	0	11	0	0	0	0	0	0	0	0	0	319	161	171	0	0	31	14	0	0	0	68	0	229	18	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	114	0	0	**1254**
C012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	107	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	**182**
C013	0	0	94	0	0	0	0	0	19	15	0	0	0	0	0	0	0	0	0	22	0	0	79	0	0	0	0	0	0	0	0	0	0	0	248	92	90	0	0	0	0	0	0	96	0	0	0	0	0	0	0	59	0	0	**816**
C014	0	0	0	0	0	873	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	6	132	22	13	0	7	0	0	0	12	0	21	0	0	0	0	0	0	0	30	**1134**
C015	2	0	0	0	0	0	0	0	0	0	0	160	0	56	0	0	0	0	0	0	0	0	129	0	27	0	0	0	0	0	0	0	0	0	26	102	274	119	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	64	**969**
C016	0	0	0	0	0	67	0	0	0	16	0	450	71	0	0	0	185	0	140	0	228	0	116	43	101	0	0	23	0	0	0	0	0	0	21	182	44	999	139	51	0	0	16	0	0	0	0	0	0	0	29	0	0	0	**2920**
C017	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	33	38	0	0	0	0	0	0	0	0	0	0	0	0	78	183	37	0	0	0	0	0	62	0	0	0	0	0	0	0	0	**443**
C018	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	36	193	63	0	0	0	0	0	0	0	0	0	0	0	0	0	**388**
C019	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	10	65	0	0	0	0	0	0	0	0	0	0	0	0	0	**449**
C020	0	0	0	0	0	0	19	0	0	0	0	70	0	259	0	0	0	0	0	0	0	0	0	0	0	0	22	61	0	0	0	0	0	0	0	0	0	0	0	0	0	225	0	0	0	0	89	94	0	0	0	0	0	0	**839**
C021	0	0	0	0	0	0	14	0	241	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	171	23	0	0	0	0	0	32	0	0	0	0	0	912	64	41	0	0	0	57	0	0	0	0	0	**1556**
C022	0	53	0	0	0	0	271	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	27	138	17	19	0	0	0	0	0	0	0	0	**563**
C023	0	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	39	0	0	0	0	0	0	0	0	0	**163**
C024	208	0	0	0	0	0	0	0	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	22	0	145	0	0	0	0	0	13	0	0	**532**
C064	0	0	197	0	0	228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102	0	0	0	0	362	0	12	0	0	0	0	0	**935**
C065	0	0	0	0	0	0	67	0	0	0	0	0	0	0	138	0	0	0	0	0	0	0	0	0	0	0	0	106	0	0	0	0	0	0	0	0	0	0	0	0	0	67	0	0	0	0	0	250	0	0	0	49	0	0	**677**
C066	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	0	0	0	0	0	0	0	0	0	0	0	**167**
C067	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	70	36	0	0	**300**
C068	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	0	0	0	**64**
C069	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	22	0	360	0	0	**497**
C070	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0	**65**
C071	0	0	56	62	0	0	0	0	12	3	0	0	0	0	0	145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	112	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	393	**837**
TOTAL	**2585**	**1724**	**1966**	**1731**	**1603**	**2088**	**2236**	**1579**	**1149**	**2486**	**2030**	**2718**	**1864**	**2047**	**1300**	**1210**	**1642**	**1757**	**543**	**1137**	**2527**	**910**	**2097**	**2303**	**1615**	**1464**	**395**	**1357**	**786**	**325**	**2199**	**207**	**1068**	**330**	**766**	**872**	**1231**	**2455**	**724**	**654**	**489**	**829**	**1602**	**563**	**297**	**698**	**847**	**809**	**284**	**349**	**353**	**883**	**194**	**985**	**68863**

Matrix 32

O/D Trip Estimated Matrix for year 2019, Tuesday (all day), with trip end data. Trips made by residents of Piedmont in the Metropolitan Area of Turin.

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	TOTAL
Q001	354	259	2579	48	581	672	0	23	522	1937	26	100	159	533	51	111	263	0	0	0	5	5	268	50	150	88	26	180	0	6	1380	1	239	0	40	35	31	1196	653	315	0	121	51	105	263	610	76	124	0	17	0	114	0	0	**14364**
Q002	86	6	16	16	3	25	0	67	770	178	18	13	0	29	37	23	48	202	0	0	801	1026	89	26	23	0	32	0	0	0	349	0	0	0	0	0	10	7	0	5	5	0	0	642	0	0	0	0	0	324	0	8	8	0	**4892**
Q003	855	120	1164	175	536	248	2	0	66	646	48	0	599	54	0	85	236	473	0	0	0	371	399	92	65	47	57	252	0	0	30	0	159	0	25	64	84	63	0	0	24	82	1	18	0	0	400	0	0	0	18	0	0	102	**7659**
Q004	11	32	21	1388	156	288	1	183	2	400	149	654	193	49	99	0	0	764	0	0	0	0	63	511	43	55	129	0	0	0	1	0	0	0	585	0	0	375	0	0	0	59	0	0	0	0	52	0	0	0	0	0	0	148	**6412**
Q005	427	28	326	751	409	415	1	155	4	0	210	388	576	54	406	0	199	0	0	0	0	1	133	183	199	169	0	184	0	0	6	0	0	0	0	341	577	61	0	32	0	0	0	1	1	0	0	0	0	0	14	0	0	831	**7081**
Q006	567	50	120	348	330	1277	3	1136	6	325	65	0	347	593	93	428	380	1420	1	0	129	4	106	0	289	48	168	86	0	309	5	14	19	0	0	227	169	243	67	23	0	151	0	0	0	0	416	0	0	0	0	0	0	0	**9960**
Q007	297	23	64	119	26	230	1567	568	1804	58	22	18	0	98	0	142	129	214	1043	0	0	2	19	0	7	66	51	265	92	69	281	0	0	0	41	7	317	250	0	0	23	17	429	489	0	233	60	90	126	0	0	0	5	0	**9360**
Q008	106	57	0	129	153	443	7	1269	0	33	0	0	46	0	67	63	535	297	1	3	187	25	0	26	20	177	0	1	584	0	25	0	21	3	0	0	1	230	0	0	63	0	402	3	5	5	45	0	0	0	0	0	5	0	**5039**
Q009	689	23	169	44	22	17	821	0	459	288	92	69	0	0	0	0	193	0	0	0	127	367	169	103	13	2	253	0	46	0	276	0	914	306	122	0	52	40	22	87	0	0	144	52	23	127	0	235	21	27	0	0	0	125	**6537**
Q010	1940	604	239	779	0	311	0	16	263	1934	69	564	64	38	27	0	0	0	0	0	74	65	632	48	25	0	0	0	0	0	699	0	43	0	198	0	0	267	30	61	0	0	12	24	0	0	0	0	0	0	11	12	0	69	**9118**
Q011	44	0	20	539	96	57	0	0	30	68	621	907	398	395	556	0	27	210	0	0	0	50	45	827	413	0	0	19	0	0	51	0	43	0	224	97	161	133	0	0	0	0	0	14	0	0	0	17	0	0	110	0	0	76	**6248**
Q012	129	291	24	58	0	0	0	0	3	25	1383	1739	250	88	0	725	42	0	0	0	2	305	3	1087	0	172	44	67	0	0	1	0	0	89	95	230	97	393	0	0	0	59	0	1	0	0	0	0	0	99	0	0	0	0	**7500**
Q013	61	0	503	290	796	89	0	151	0	1	11	108	1333	208	258	0	0	0	0	0	0	1	0	714	780	328	0	0	0	35	0	0	0	0	72	0	0	421	319	59	69	0	0	0	0	74	49	0	0	0	94	0	0	0	**6825**
Q014	335	145	45	12	241	615	1	0	0	5	106	160	470	2873	463	228	0	0	0	0	0	0	3	144	54	68	124	195	0	607	1	14	0	0	0	94	111	21	22	0	0	524	0	0	99	0	169	365	0	0	0	37	37	0	**8388**
Q015	55	108	0	3	104	132	0	0	0	26	1175	0	73	632	803	437	0	51	176	0	0	4	0	80	149	268	0	91	37	0	0	0	0	0	83	0	0	0	24	0	0	20	0	77	0	0	17	61	0	0	36	0	41	0	**4765**
Q016	105	52	45	0	0	275	2	177	0	0	0	220	0	294	216	450	973	0	251	82	33	0	58	29	111	371	606	0	0	0	222	35	0	139	0	0	0	124	0	0	152	0	248	0	0	0	123	0	0	0	0	210	0	242	**5846**
Q017	160	56	99	0	138	283	2496	469	74	0	27	0	0	185	68	401	1221	9	24	24	0	0	46	328	15	104	30	602	12	0	0	0	0	0	55	0	62	247	0	0	0	0	7	0	58	0	40	87	0	0	0	0	0	0	**7429**
Q018	249	151	84	329	0	451	904	256	0	0	89	0	0	0	84	0	75	338	687	1256	49	22	75	22	79	56	67	131	60	0	35	0	0	0	96	0	0	0	0	85	0	0	0	0	0	0	0	47	0	0	0	0	0	0	**5779**
Q019	0	0	0	29	0	19	1360	0	0	0	0	0	10	23	158	91	106	143	844	309	45	0	249	0	190	197	22	210	78	0	3	0	0	0	0	0	45	182	37	0	81	92	42	0	0	0	27	0	0	46	0	0	0	42	**4679**
Q020	25	0	0	0	0	19	0	136	0	0	8	0	11	0	0	75	103	191	301	955	12	24	13	0	394	0	0	36	204	0	0	0	11	0	91	0	0	0	0	236	0	33	0	0	0	0	62	134	130	0	0	0	0	0	**3201**
Q021	43	1010	0	26	0	50	0	240	231	214	0	25	12	28	0	17	0	82	1	0	2482	166	187	6	17	0	0	0	76	14	101	176	553	0	16	38	0	476	0	0	0	0	28	0	0	0	0	41	26	0	0	0	0	0	**6382**
Q022	310	976	100	0	0	43	0	37	148	183	52	210	48	53	66	0	0	38	0	1	318	2451	0	20	30	0	0	0	51	0	179	0	355	82	0	0	0	26	0	25	0	86	0	0	0	0	33	0	0	0	0	0	0	28	**5951**
Q023	620	281	347	461	246	287	0	0	143	807	47	183	45	93	0	45	95	0	119	0	41	0	2821	161	0	206	0	0	0	0	750	0	190	0	151	47	164	319	66	0	34	27	0	0	0	79	23	0	7	0	55	0	0	113	**9074**
C002	2	1	1	12	125	0	0	25	0	1	17	414	632	115	61	10	639	10	0	0	0	0	598	3503	970	0	27	0	23	0	380	0	0	0	100	62	112	267	93	47	0	0	0	0	50	48	0	0	0	0	0	76	0	105	**8527**
C003	265	82	19	2	97	663	0	90	2	29	1090	0	274	115	186	180	196	587	103	14	52	2	140	191	2521	22	0	59	0	0	30	0	0	0	23	0	51	333	88	21	0	36	0	0	0	25	0	0	0	0	0	0	35	0	**7626**
C004	147	0	50	3	101	106	84	72	2	0	0	371	142	178	452	268	100	13	69	0	0	0	375	0	35	1931	17	25	0	0	41	0	66	0	0	42	0	27	0	0	31	24	0	0	0	0	21	0	0	0	0	0	0	0	**4793**
C005	23	74	48	259	0	188	135	0	193	0	0	57	0	70	0	258	61	32	39	0	0	0	0	28	0	36	396	30	0	0	0	0	24	0	0	0	0	0	35	68	0	27	0	0	0	0	126	29	0	0	0	0	0	0	**2235**
C006	147	7	133	0	211	61	129	72	7	0	24	55	0	69	184	0	523	39	242	43	0	0	0	0	125	33	19	2839	205	0	0	0	0	0	0	44	0	33	0	0	0	217	0	0	0	0	53	167	0	0	0	0	0	0	**5683**
C007	11	0	0	0	0	0	66	378	55	0	0	1	0	0	52	0	44	8	96	208	149	100	0	42	0	0	0	169	1459	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2900**
C008	54	0	0	0	0	189	2	0	0	0	0	0	51	446	0	0	0	0	0	0	66	0	0	0	0	0	0	0	0	540	44	0	0	0	0	0	0	0	0	0	0	0	177	0	0	0	0	0	40	0	0	0	0	0	**1610**
C009	1088	16	56	29	32	18	66	30	359	1449	40	25	68	19	0	156	0	50	0	0	199	150	355	75	20	17	0	0	0	8	2582	0	1191	0	17	69	39	30	50	0	0	0	89	75	38	116	0	0	0	156	51	79	26	39	**8970**
C010	8	0	0	0	0	9	0	0	0	0	0	0	0	10	0	20	0	0	0	0	195	0	0	0	0	0	0	0	0	0	0	380	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**634**
C011	697	0	118	0	0	0	0	36	656	87	32	13	0	0	0	0	0	0	0	0	510	419	391	0	0	51	13	0	0	0	574	0	1098	25	25	30	55	0	23	0	0	0	0	0	0	27	0	0	0	59	0	302	0	26	**5269**
C012	0	0	0	0	0	0	0	2	98	9	0	0	0	0	0	502	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	25	196	17	0	0	15	0	0	0	0	0	0	0	0	0	0	0	19	23	25	51	0	**1011**
C013	104	0	132	106	0	0	1	0	8	18	0	192	338	0	119	0	49	20	0	19	2	0	258	46	35	0	0	0	0	0	39	0	21	31	974	494	179	83	0	0	0	0	0	23	0	0	0	0	0	0	0	90	0	64	**3446**
C014	44	0	40	0	331	803	0	0	0	0	145	225	0	109	0	0	0	0	0	0	2	0	39	14	0	19	0	15	0	0	77	1	12	0	220	1189	342	119	0	19	0	0	0	13	0	63	0	0	0	0	0	31	0	99	**3972**
C015	50	138	68	0	724	216	3	0	2	0	312	123	0	167	0	0	35	0	23	0	0	0	175	32	48	0	0	0	10	0	56	0	29	0	112	415	1680	173	0	0	0	0	11	0	0	0	14	0	0	0	0	0	0	160	**4777**
C016	1336	141	117	58	38	545	5	37	4	14	354	683	218	58	0	0	190	0	128	0	705	66	610	105	429	22	0	20	0	0	60	0	16	23	71	213	211	3012	237	107	0	0	23	0	0	0	0	0	0	0	33	36	0	24	**9951**
C017	1134	0	0	0	0	110	0	0	1	11	0	0	107	56	28	26	0	0	24	0	0	0	90	34	131	0	13	0	0	0	0	0	0	0	0	0	0	241	890	83	0	0	0	0	0	25	0	0	0	0	0	0	0	0	**3006**
C018	567	23	0	0	28	56	0	0	7	7	0	0	38	0	0	0	0	22	0	60	0	3	0	26	39	0	37	0	0	0	0	0	0	0	0	47	0	151	126	1138	101	0	0	0	0	0	0	0	0	0	0	0	0	0	**2476**
C019	223	20	22	0	0	0	26	11	0	0	0	0	3	0	0	111	0	0	62	0	0	0	55	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	78	565	0	0	0	0	0	0	0	0	0	0	0	0	0	**1201**
C020	53	0	196	90	0	129	35	0	66	0	0	59	0	226	50	0	65	0	86	48	0	19	78	0	92	38	21	264	36	0	0	0	0	0	0	0	0	0	0	0	0	875	0	0	0	0	256	189	0	0	0	0	0	39	**3011**
C021	172	0	242	0	14	0	5	388	167	69	0	0	0	0	0	56	26	0	33	0	53	0	0	13	0	0	0	0	0	88	202	0	0	0	0	11	66	106	0	0	0	0	3831	66	150	166	0	0	178	32	41	0	0	0	**6176**
C022	171	67	160	0	7	8	266	10	240	115	26	0	0	0	111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	0	0	0	23	28	0	0	0	0	0	0	68	326	24	48	0	0	0	0	0	0	0	0	**1842**
C023	188	0	0	0	4	0	0	18	34	0	0	0	0	105	0	0	82	0	0	0	0	0	0	10	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	195	11	53	15	0	0	0	0	0	0	0	0	**753**
C024	462	0	0	0	0	0	170	19	203	0	0	0	161	0	0	0	0	0	0	0	0	0	63	10	17	0	0	0	0	0	125	0	10	0	0	60	0	0	15	0	0	0	230	22	16	522	0	0	0	0	0	23	0	0	**2131**
C064	56	0	288	91	61	402	138	16	0	0	0	0	39	82	48	45	69	0	42	25	0	8	76	0	0	37	109	73	0	0	0	0	0	0	0	0	44	0	0	0	0	288	0	0	0	0	1592	30	19	0	0	0	0	0	**3678**
C065	76	0	0	0	0	0	171	0	65	0	23	19	0	146	140	0	123	16	127	178	0	0	0	0	0	0	20	188	0	0	0	0	0	0	0	0	0	0	0	0	0	176	0	0	0	0	25	1462	0	0	0	57	0	0	**3011**
C066	0	103	0	0	0	0	1	0	23	0	0	0	0	0	0	0	0	0	0	102	47	0	30	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	203	0	0	0	37	0	112	0	0	0	0	0	**669**
C067	29	24	0	0	0	0	0	0	65	0	0	139	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	252	0	34	24	0	0	0	0	0	0	0	0	66	0	0	0	0	0	0	365	97	69	39	0	**1229**
C068	0	0	11	0	13	0	0	0	0	9	134	0	174	0	21	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	47	0	0	17	0	0	0	15	0	0	0	0	48	0	0	0	0	0	0	55	345	0	0	0	**924**
C069	126	19	0	0	0	0	0	0	0	11	0	0	0	39	0	619	0	0	0	0	0	0	0	16	0	0	0	0	0	0	133	0	69	43	40	28	0	18	0	0	0	0	0	0	0	22	0	16	0	44	0	1545	32	0	**2820**
C070	0	21	0	0	0	0	0	3	0	0	0	0	0	47	31	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	32	0	0	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	38	395	0	**674**
C071	21	0	79	16	1300	0	0	0	5	4	138	0	0	0	0	111	0	0	20	0	0	49	114	28	0	0	0	0	0	0	53	0	13	0	38	121	151	17	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	1198	**3489**
TOTAL	**14722**	**5010**	**7746**	**6209**	**6922**	**9748**	**8470**	**6088**	**6789**	**8958**	**6550**	**7732**	**6877**	**8376**	**4935**	**5682**	**6828**	**5230**	**4572**	**3329**	**6285**	**5736**	**8865**	**8631**	**7553**	**4655**	**2283**	**6004**	**2975**	**1676**	**9301**	**620**	**5156**	**1029**	**3555**	**4056**	**4872**	**9715**	**2798**	**2488**	**1147**	**2928**	**6307**	**1962**	**780**	**2204**	**3718**	**3093**	**659**	**1272**	**928**	**2754**	**674**	**3530**	**270.981**

Appendix L – Differences between Matrices

Matrix 33

Relative Difference Matrix between 2013 Prior Matrix and 2019 Estimated Matrix with trip end data, for the morning peak hour (expressed in %)

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C067	C068	C069	C070	C071	TOTAL
Q001	-17	-7	-	-	-62	-29	-	74	-	57	-	-47	-	-50	-	-	-	-88	-	-	-	-	250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	152	276	-	-	-	-	-	-	-	-	-	**25**
Q002	-	-	-	-	-	-	-77	-	139	-	-	-52	-	-	-	-	-	78	-	-	-	148	-30	-87	6	-	-52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	-	-	-	-	-	-	-	**9**
Q003	-36	-	-	-	-	67	-63	-	-	-	-	-	-	-	-	-	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-26	-	-	-	-	-	-7	**-11**
Q004	-77	-	-78	57	29	57	-65	-	-	-55	-	-	83	-11	-	-	-	-	-	-	-	-	-	1	-	20	-27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-5**
Q005	-74	-	-29	25	-	1	-	-	-	-	-61	-	0	-29	10	-	-39	-	-	-	-	-	-	-	-	-4	-	-68	-	-	-91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	274	**-17**
Q006	8	-	-	-	-22	12	-75	-32	-91	-78	-	-	-	-	-	-12	1	403	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3**
Q007	15	-	-	-	-31	0	94	-6	159	-	-	-26	-	-	-	-21	-10	-25	-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-15	-	-	-	-	-	-	-	36	74	-	-	-	-57	-	-	-	-	-	**8**
Q008	58	-50	-	-	-	-	-	32	-	-	-	-	-	-	-	-47	-	-	67	-	-	-53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Q009	-	-	22	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-22	-	-	-	-	-	277	-	-	-	-	-	-	-45	-	-	-11	-	-	8	-	-	-	-	-	-	-73	**-3**
Q010	64	199	-	-	-	-63	-	-	-	98	-47	-56	-	-	-	-	-	-	-	-	-	-	-25	-82	-83	-	-	-	-	-	40	-	-	-	-	-	-	-50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**7**
Q011	-57	-	-	-	-	-62	-91	-	-	-35	62	114	-57	-	-53	-	-65	-	-	-	-	-	-	-42	-	-	-	-	-	-	-	-	-66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-39**
Q012	-71	-	-73	-46	-	-	-	-	-88	-82	11	45	-	12	-	207	-	-	-	-	-	-	-61	-	-	-	-	-88	-	-	-	-	-	-	-	-	-	-	-	-	-	-88	-	-92	-	-	-	-	-	-	-	-	-	**-31**
Q013	-62	-	-10	-71	-	-	-	-39	-	-	20	-	26	-	39	-	-	-	-90	-89	-	-	-29	71	63	-	-	-	-	-	-	-	-	-	-	-	-	32	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-11**
Q014	-54	-48	-31	-83	0	21	-73	-	-	-	120	-	-3	9	7	-	-	-	-	-	-	-	29	32	-	-	-	-	-	-	-	-	-	-	-	16	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-6**
Q015	-	-48	-	-	-1	-	-	-	-	33	-	-	-	7	5	-7	-	-	8	-	-	-	-	-	-	-8	-	19	-60	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	**-1**
Q016	12	-	-	-	-	17	-74	-	-	-	-	-	-	-	3	-9	5	-	0	-	-	-	-51	-	21	145	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75	**-2**
Q017	28	-	-	-	-	33	158	-	-38	-	-	-	-	20	18	4	20	-	-	-	-	-	-	-32	-	-	-	-38	-	-	-	-	-	-	-	-	-	-48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**7**
Q018	41	-57	88	-	-	-	-	14	-	-	3	-	-	-	7	-	-	-	-	13	-	-	13	-	-	-	-43	-	-	-	-44	-	-	-	-	-	-	-	-	-37	-	-	-	-	-	-	-	-	-	-	-	-	-	**4**
Q019	-	-	-	-40	-	-	14	-	-	-	-	-	-	-	-	-	-3	-55	-	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-4**
Q020	-	-	-	-	-	-49	-	-	-	-	-	-	-	-	-	-27	-16	-62	39	42	-	-	-	-	-55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-52	-	-	-	-	-	-	-	42	-	-	-	-	-	**-10**
Q021	-56	-	-	-25	-	-	-	-64	28	-31	-	-85	-85	-	-	-	-	-	-54	-	11	0	-	-	-81	-	-	-	31	-	39	-	-	-	-	-80	-	302	-	-	-	-	-	-	-	-	-	-59	-	-	-	-	-	**-9**
Q022	-76	-	-	-	-	-	-93	-	30	-30	-	7	-	-	-	-	-	-27	-	-52	-	1	-	-	-83	-	-	-	-	-	-	-	-	36	-	-	-	-	-	-	-	-	-	-	-	-	-57	-	-	-	-	-	-	**-20**
Q023	17	-	12	-	-25	-	-	-	-	-76	54	-	-	-	-	-	-3	-	7	-	-	-	13	30	-	-8	-	-	-	-	-	-	-	-	-	-	3	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-1**
C002	-71	16	-73	-	-	-	-	-43	-	-	-	7	16	-17	-	-28	31	-	-	-	-	-	40	58	51	-	-	-	-	-	44	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-2**
C003	-49	-	-	-	12	35	-	-	-91	-	456	-	8	22	-	-	-	-	-8	-67	-	-	-	12	6	-	-	3	-	-	-1	-	-	-	-	-	-	-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**
C004	21	-	-39	-	6	-	-11	-	-93	-	-	64	-	14	-	0	14	-66	-	-	-	-	19	-	-	-2	-	24	-	-	25	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-2**
C005	9	-	20	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-11	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	-	**9**
C006	20	-85	31	-	-11	-	-21	-61	-82	-	-	-	-	-	13	-	-	-	13	-	-	-	-	-	-	-	26	25	17	-	-	-	-	-	-	-	-	4	-	-	-	28	-	-	-	-	-	-	-	-	-	-	-	**7**
C007	-51	-	-	-	-	-	-	-	-	-	-	-69	-	-	-	-	-32	-	15	-	-3	-11	-	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-7**
C008	-	-	-	-	-	-	-	-	-	-	-	-	-	-34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-8	-	-	-	-	-	-	-	-	-	-	**-9**
C009	-	-	-	570	-83	-76	-	-80	62	147	-	-	-	-	-	-	-	-	-75	-	-	-46	-	-15	-	-	-	-	-	-	-25	-	165	-	-	-	-	-35	-	-	-	-	-	-52	-	-	-	-	-27	-	-	-	-	**18**
C010	-43	-	-	-	-	-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-25**
C011	26	-	14	-	-	-	-	-38	114	-	-59	-	-	-	-	-	-	-	-	-	-	67	-	-	-	-	-	-	-	-	7	-	-21	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-6	-	-	**0**
C012	-	-	-	-	-	-	-	-45	82	-81	-	-	-	-	-	155	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-34	-23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-14	-	**1**
C013	-63	-	-66	-32	-	-	-	-	-85	-77	-	-	-	-	-	-	27	-	-	-	7	-	-	-	47	-	-	-	-	-	-	-	2	18	20	36	-	19	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	**-10**
C014	-71	-	-73	-	223	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	8	-22	-	-	-7	6	-5	-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4**
C015	-	-	-71	-	246	-17	-48	-71	-88	-	16	-	-	16	-	-	5	-	5	-	-	-	13	27	21	-	-	-	-	-	14	-	-	-	0	14	2	-1	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-34	**-1**
C016	126	22	-72	-43	28	-18	-48	-60	-88	-	17	52	24	-	-	-	-	-	7	-	-	-	14	31	22	-	-	-	-	-	15	-	-14	-2	-	14	2	-1	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	**-2**
C017	118	-	-	-	-	-20	-	-	-88	-82	-	-	22	37	2	-	-	-	4	-	-	-	8	26	17	-	16	-	-	-	-	-	-	-	-	-	-	-4	-6	28	-	-	-	-	-	-	-	-	-	-	-	-	-	**4**
C018	126	-63	-	-	29	-	-	-	-88	-81	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	2	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-	**9**
C019	-	-	-40	-	-	-	-	-58	-	-	-	-	-	-	-	-	-	-	13	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37	3	-	-	-	-	-	-	-	-	-	-	-	-	**-1**
C020	13	-	-	-	-	-	-	-	-46	-	-	-	-	-	-	-	-	-	5	7	-	-	-	-	19	-11	-	16	10	-	-	-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	11	7	-	-	-	-	-	**6**
C021	61	-	205	-	-91	-	-	34	2	-44	-	-	-	-	-	-46	-	-	3	-	-12	-	-	-97	-	-	-	-	-	-	11	-	-	-	-	-84	-	-74	-	-	-	-	-14	-	-	6	-	-	6	-	-	-	-	**-3**
C022	3	-	117	-	-	-72	-	-	87	191	-	-	-	-	-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-13	-	-	-	-24	-14	-	-	-	-	-	-	-32	-46	-	-	-	-	-	-	-	-	-	**20**
C023	14	-	-	-	-79	-	-	-	108	-	-	-	-	-3	-	-	-30	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74	-	-4	-	-	-	-	-	-	-	-	**11**
C024	18	-	-	-	-	-	292	-41	111	-	-	-	38	-	-	-	-	-	-	-	-	-	-5	-	2	-	-	-	-	-	-2	-	-	-	-	-3	-	-	-	-	-	-	76	-40	-4	-7	-	-	-	-	-	-	-	**16**
C064	19	-	30	24	-14	-	-13	-57	-	-	-	-	-	14	-	-	14	-	11	-59	-	-	17	-	-	-	27	26	-	-	-	-	-	-	-	-	-	-	-	-	-	27	-	-	-	-	18	16	-	-	-	-	-	**10**
C065	13	-	-	-	-	-	-19	-	-	-	-34	-12	-	6	-	-	6	-68	-	8	-	-	-	-	-	-	19	17	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	9	-	-	-	-	-	**5**
C066	-	-	-	-	-	-	285	-	9	-	-	-	-	-	-	-	-	-	-	-	-7	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-83	-	-	-	-	-	-	-9	-	-	-	-68	-	-	-	-	-	-	**14**
C067	-1	94	-	-	-	-	-	-	-	-	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-2	-	-28	-18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-5	-	-	-	-	**6**
C068	-	-	1	-	-	-	-	-	-	-78	8	-	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-11	-	-	-	-11	-	-	-	-	-	-	-	-	-	-	1	-1	-	-	-	**-4**
C069	14	-	-	-	-	-	-	-	-	-76	-	-	-	16	-	-	-	-	-	-	-	-	-	27	-	-	-	-	-	-	14	-	-16	-	-	13	-	-	-	-	-	-	-	-	-	7	-	-	10	-	0	5	-	**1**
C070	-	99	-	-	-	-	-78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	**4**
C071	-	-	-	-	215	-	-	-	-89	-	-	-	-	-	-	-16	-	-	-3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-9	5	-5	-10	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-39	**-14**
TOTAL	**-11**	**2**	**-7**	**-5**	**3**	**-5**	**-28**	**-7**	**-1**	**-17**	**21**	**8**	**5**	**-1**	**0**	**6**	**0**	**7**	**-1**	**-2**	**5**	**10**	**-3**	**-8**	**-6**	**6**	**-5**	**-5**	**-3**	**2**	**-4**	**8**	**9**	**3**	**2**	**-3**	**1**	**2**	**4**	**-9**	**3**	**-6**	**7**	**18**	**-4**	**-2**	**-3**	**-2**	**-3**	**-1**	**2**	**-1**	**22**	**-2**

Matrix 34

Relative Difference Matrix between 2013 Prior Matrix and 2019 Estimated Matrix with trip end data, for the afternoon peak hour (expressed in %)

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	TOTAL
Q001	-8	-9	42	-19	-9	-2	-65	-	-	29	-7	-15	4	22	-9	-7	-13	-79	-	-	-29	-	95	-80	-8	-2	-	-51	-86	-	128	-35	-19	-	-18	-	-19	167	170	167	-	-55	119	-	94	116	-54	-54	-	77	-	90	-	-	**4**
Q002	-29	-19	-22	-	-	-	-	118	-	-53	-60	-	-	-	-	-	-31	53	-	-	247	-	-	-	-28	-	-	-	-	-	197	-	-	-	-	-	-	-	-	-31	-	-	-	-	-	-	-	-	-	125	-	-31	-	-	**18**
Q003	-47	-	29	-	14	-	-83	-	-	-	19	-	20	-58	-	-	-	104	-	-	-	-	-	-74	6	24	-43	-39	-	-	-	-	-	-	-	15	4	9	-	-	-	-42	-66	-	-	-	-42	-	-	-	85	-	-	4	**-5**
Q004	-	-	-84	2	-1	3	-	-	-	-	-3	123	-	-64	-4	-	-	68	-	-	-86	-	-	-19	-6	-	-	-	-	-	-82	-	-	-	115	-	-	123	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	112	**0**
Q005	-73	-	-	33	28	5	-92	-	-	-	-40	-	-	-	24	-	-	-	-	-	-	-75	-9	-	22	-	-	-	-	-	-	-	-	-	-	-	175	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-13**
Q006	246	-	-26	-	7	19	-84	-38	-	-	-32	-	-	43	10	13	5	-	-92	-92	-78	-52	3	-	8	19	-	-	-	-18	-88	-79	-75	-	-	-	-2	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-6**
Q007	-	-59	-	-1	-	-1	96	26	-	-	-	-	-	18	-	-6	-13	17	-	-	-	-	-	-	-	-52	-	-19	-22	-	-	-	-	-	-	-10	151	169	-	-	-50	-	-	-	-	-	-55	-54	47	-	-	-	49	-	**11**
Q008	-37	-	-	-	-	-54	-	39	-	-	-	-	-53	-	-	-	112	-2	-	-68	-50	-	-	-	-	-60	-	-75	65	-	-	-	-40	-	-	-	-	-65	-	-	-58	-	55	-	-	-62	-	-	-	-	-	-	-32	-	**-10**
Q009	-	10	19	-	-	-	-	-	25	53	8	-57	-	-	-	-	-	-	-	-	50	62	-	-77	-	-83	-	-83	14	-	21	-	78	77	-58	-	-	-57	-57	-	-	-	7	16	-	14	-	-	-	-8	-	-	-	-58	**1**
Q010	29	-	40	93	-	-65	-95	-	-	81	-35	-48	-	-	-83	-	-	-	-	-	72	86	-38	-	-	-	-	-	-	-	-	-	-	-	-50	-	-	-	-48	-48	-	-	24	-	-	-	-	-	-	-	-36	-	-	-51	**-2**
Q011	-	-	-	18	-81	-	-	-	-75	-76	34	24	-70	-	-	-	-	-	-	-	-	-	-37	-71	-	-	-	-89	-	-	-81	-	-85	-	19	-	17	26	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	18	**-17**
Q012	-77	-4	-	-26	-	-	-97	-	-	-81	40	29	-	-	-	-	-80	-	-	-	-80	-21	-	46	-	49	-	-	-99	-	-	-	-	24	-	-	-	28	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	**-16**
Q013	-	-	-	-	45	-	-	-77	-	-95	-42	-	54	-47	-	-	-	-	-	-	-	-	-	50	39	-	-	-	-	-69	-96	-	-	-	27	-	-	-	-	-	58	-	-	-	-	50	-	-	-	-	-	-	-	-	**-13**
Q014	-	-55	-	-	-	10	-	-	-	-	-	-5	11	31	1	3	-	-	-	-92	-	-	-	-	-	10	59	79	-	-25	-73	-81	-	-	-	-	-11	-	-	-	-	-	-	-	-	-	-	71	-	-	-	-5	-	-	**-1**
Q015	-	-61	-	-	-	-	-	-	-	-	103	-	-	-	-13	-	-	-66	-	-	-	-	-	-8	-14	-6	-	-	-	-	-	-	-	-	-	-	-	-	-17	-	-	-12	-	-6	-	-	-	-	-	-	-14	-	-11	-	**3**
Q016	-	-	-	-	-	-	-84	-38	-	-	-	-	-	42	-	12	5	-	-	28	-78	-	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-32	-	-	-	82	-	-	-	-	155	-	222	**-4**
Q017	175	-	-3	-	-14	-	89	65	-	-	-	-	-	-	-	-10	-16	-	-	-	-	-	36	-54	-13	-53	-	-52	-	-	-	-	-	-	-	-	-	-60	-	-	-	-	-	-	-14	-	-55	-55	-	-	-	-	-	-	**10**
Q018	20	-	-	-	-	-	155	-	-	-	-	-	-	-	-	-	-	53	30	34	-42	-37	-	-38	-	-37	-43	-35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-39	-	-	-	-	-	-	**21**
Q019	-	-	-	-	-	-42	14	-	-	-	-	-	-41	-31	44	-	-	-31	-	-	-74	-	38	-	-	56	-	56	53	-	-79	-	-	-	-	-	26	36	36	-	63	43	46	-	-	-	-	-	-	-	-	-	-	28	**-4**
Q020	-53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-40	-	76	-77	-	-	-	-27	-	-	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	34	-	-	-	-	-	**4**
Q021	-58	31	-	-	-	-	-	-6	-	-	-	-46	-	-63	-	-	-	-	-	-78	50	-	93	-88	-	-	-	-	14	-	-	40	78	-	-49	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	**0**
Q022	-45	25	-	-	-	-	-	-11	-	-	-	-4	-	-	-	-	-	-	-	-	43	-	-	-78	-	-	-	-	-	-	15	-	70	-	-	-	-	-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-9	**-2**
Q023	-8	61	-30	-	-39	-31	-91	-	-76	-70	-	-	-64	27	-	-	-	-	-	-95	-	-	15	28	-	31	-	-	-	-	36	-	7	-	9	19	7	14	12	-	34	19	-	-	-	30	22	-	-7	-	-	-	-	8	**-10**
C002	-	-	-92	-83	23	-	-	-	-	-96	-51	12	32	-54	-	-	-	-	-	-	-	-	14	27	16	-	19	-	-	-	37	-	-	-	8	-	5	11	-	14	-	-	-95	-	17	-	-	-	-	-	-	-	-	-	**-10**
C003	-	-53	-	-	8	14	-	-	-	-79	-	-	16	-	6	7	-	85	44	-	-79	-54	-	12	3	14	-	-	-	-	-	-	-	-	-5	-	-8	-2	-	-2	-	4	-	-	-	12	-	-	-	-	-	-	6	-	**-2**
C004	-	-	-	-82	-	-	-	-56	-	-	-	-	14	-	3	5	-3	-	-	-	-	-	-1	-	-	11	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	**-3**
C005	-	-49	-	23	-	23	-	-	-42	-	-	7	-	-	-	-	-	-55	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	8	7	-	-	-	-	-	-	17	-	-	-	-	-	-	-	**-8**
C006	-	-	-	-	-2	-	-	-48	-	-	-	-	-	-	-	-	-3	-60	-	-	-	-	-	-	0	-	-	11	8	-	-	-	-	-	-	0	-	-	-	-	-	1	-	-	-	-	5	6	-	-	-	-	-	-	**-1**
C007	-	-	-	-	-	-	-22	-	-	-	-	-	-	-	19	-	-	-	32	35	-	-	-	-	-	-	-	6	2	-	-	-	-	-	-	-	-48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**8**
C008	-	-	-	-	-	-	-	-	-	-	-	-	-	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-16	-	-	-	-	-	-	-	-	-	-	-	**25**
C009	229	-	-	-	-68	-	-	-	156	212	13	-	-68	-	-	-	-	-51	-	-	12	-	-23	-15	-22	-13	-	-	-	-	-9	-	93	-	-	-22	-29	-26	-	-	-	-	-19	-14	-23	-13	-	-	-	-31	-20	-26	-19	-29	**20**
C010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**34**
C011	-7	-	-	-	-	-	-	-	102	-	-53	-	-	-	-	-	-	-	-	-	141	164	-13	-	-	-1	-11	-	-	-	3	-	-19	-19	-	-	-	-	-13	-	-	-	-	-	-	-	-	-	-	-	-	-15	-	-	**4**
C012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-14	-	-	-	-11	-	-	-	-	-	-	-	-	-	-	-	-	-5	-	-	-	**-12**
C013	-	-	-65	-	-	-	-95	-	-76	-71	-	-	-	-	-	-	-	-	-	-48	-	-	41	-	-	-	-	-	-	-	-	-	-	-	32	45	29	-	-	-	-	-	-	59	-	-	-	-	-	-	-	34	-	-	**-22**
C014	-	-	-	-	-	382	-	-	-	-	-	-	-	-46	-	-	-	-	-	-	-79	-	-	5	-	-	-	-	-	-	-	-	-	-	-11	-3	-12	-8	-	-8	-	-	-	7	-	6	-	-	-84	-	-	-	-	-11	**-6**
C015	-75	-	-	-	-	-	-	-	-	-	-	41	-	-43	-	-	-	-	-	-	-	-	-2	-	1	-	-	-	-	-	-	-	-	-	-6	1	-9	-4	-	-	-	-	-74	-	-	-	-	-	-	-	-	-	-	-7	**-13**
C016	-	-	-	-	-	-10	-	-	-	-80	-	38	13	-	-	-	-3	-	40	-	-31	-	-2	8	0	-	-	10	-	-	-	-	-	-	-8	0	-9	-5	-4	-4	-	-	-74	-	-	-	-	-	-	-	0	-	-	-	**-8**
C017	-	-	-	-	-	-	-	-	-	-78	-	-	-	-	-	-	-	-	-	-	-	-	-	17	9	-	-	-	-	-	-	-	-	-	-	-	-	3	4	5	-	-	-	-	-	17	-	-	-	-	-	-	-	-	**-11**
C018	-	-	-	-	-	-	-	-	-81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	9	8	29	-	-	-	-	-	-	-	-	-	-	-	-	-	**-14**
C019	605	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-30	-	-	-	-	-	-	-	-	-	-26	-	-	-	-	-	-	-	-	-	-	-	-	-	-35	-23	-	-	-	-	-	-	-	-	-	-	-	-	-	**16**
C020	-	-	-	-	-	-	-36	-	-	-	-	-8	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-3	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-2	-	-	-	-	0	2	-	-	-	-	-	-	**0**
C021	-	-	-	-	-	-	114	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	10	-	-	-	-	-	-49	-	-	-	-	-	-3	3	-7	-	-	-	2	-	-	-	-	-	**7**
C022	-	134	-	-	-	-	5	-26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-7	-	-	-	-	-	-	-	-	-	-	-	-15	-11	-19	-12	-	-	-	-	-	-	-	-	**17**
C023	-	-	-	-	-	-	-	-	-	-	-	-	-	-29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	26	-	-	-	-	-	-	-	-	-	**-5**
C024	174	-	-	-	-	-	-	-	118	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	85	-26	-	-27	-	-	-	-	-	-37	-	-	**20**
C064	-	-	16	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-83	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	7	-	-72	-	-	-	-	-	**-3**
C065	-	-	-	-	-	-	-32	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	8	-	-	-	-4	-	-	**1**
C066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-4	-	-	-	-	-	-	-	-	-	-	-	**20**
C067	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-18	-5	-12	-	-	**-8**
C068	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-4	-	-	-	**-4**
C069	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-15	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-19	-	-11	-	-	**-10**
C070	-	-	-	-	-	-	-	-	-	-	-	-	-	-32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	**-5**
C071	-	-	-72	-11	-	-	-	-	-81	-77	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	14	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	**-16**
TOTAL	**1**	**1**	**-2**	**-1**	**1**	**-1**	**-27**	**-2**	**-5**	**-12**	**1**	**5**	**-2**	**-9**	**2**	**1**	**4**	**-9**	**-11**	**-12**	**-12**	**-15**	**4**	**-1**	**3**	**-1**	**2**	**-2**	**-1**	**-6**	**-4**	**-9**	**7**	**7**	**7**	**2**	**7**	**5**	**5**	**5**	**-3**	**2**	**2**	**-1**	**4**	**-1**	**1**	**0**	**-1**	**9**	**2**	**5**	**2**	**6**	**-2**

Matrix 35

Relative Difference Matrix between 2013 Prior Matrix and 2019 Estimated Matrix with trip end data, for the entire day (expressed in %)

	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011	Q012	Q013	Q014	Q015	Q016	Q017	Q018	Q019	Q020	Q021	Q022	Q023	C002	C003	C004	C005	C006	C007	C008	C009	C010	C011	C012	C013	C014	C015	C016	C017	C018	C019	C020	C021	C022	C023	C024	C064	C065	C066	C067	C068	C069	C070	C071	TOTAL
Q001	16	5	89	-4	-50	-5	-88	-71	3	53	-31	-27	-47	-38	-9	-17	-14	-94	-	-92	-88	-39	193	-77	-44	-19	-40	-41	-94	-18	268	-87	-5	-	-16	-13	-19	562	576	628	-	-43	-13	182	223	230	-43	-42	-	179	-	174	-	-	**6**
Q002	14	-38	-14	-44	-92	-43	-86	28	438	-49	-60	-58	-	-39	-45	-50	-48	70	-	-	147	119	-1	-86	-44	-	-64	-37	-	-	530	-	-	-	-	-	-53	-57	-	-49	-52	-	-	393	-	-	-	-	-	456	-	-7	4	-	**20**
Q003	-22	32	8	21	1	18	-72	-	-1	90	-13	-	-2	-54	-	5	7	255	-	-	-	121	11	-71	3	1	-24	-26	-	-	15	-	19	-	5	8	2	-6	-	-	-2	-28	-64	-9	-	-	-29	-	-	-	14	-	-	1	**-1**
Q004	-71	-50	-85	-3	-6	1	-76	-26	-81	-53	-27	155	89	-57	-3	-	-	203	-86	-	-83	-	-6	8	-3	-14	-36	-	-	-	-77	-	-	-	195	-	-	165	-	-	-	-39	-	-	-	-	-41	-	-	-	-	-	-	181	**0**
Q005	-45	-59	-23	26	21	6	-80	-38	-84	-	-39	230	18	-45	24	-	-24	-	-	-	-	-71	-22	22	25	11	-	-48	-	-	-81	-	-	-	-	292	268	2	-	12	-	-	-75	-85	-83	-	-	-	-	-	-17	-	-	266	**-8**
Q006	-58	-24	-7	25	9	28	-69	-5	-80	-52	-26	-	17	37	23	13	16	287	-82	-80	-60	-55	-5	-	24	9	-19	-21	-	169	-77	-58	-70	-	-	282	10	2	5	11	-	-23	-	-	-	-	-23	-	-	-	-	-	-	-	**-6**
Q007	1	-51	-24	-20	-30	-17	41	4	384	-61	-40	-36	-	-12	-	-27	-26	-30	-17	-	-	-69	-23	-	-21	-55	-48	-23	-28	193	480	-	-	-	-27	-25	520	480	-	-	-56	-51	211	343	-	412	-50	-50	215	-	-	-	-20	-	**15**
Q008	-10	-49	-	-7	-18	-4	6	20	-	-58	-	-	-12	-	-7	-16	156	59	-37	-32	-49	-55	-	-9	-8	2	-	-43	279	-	-56	-	-19	-33	-	-	-79	-6	-	-	-1	-	260	-66	-61	-61	13	-	-	-	-	-	-15	-	**2**
Q009	84	0	9	20	-84	-81	88	-	-2	44	-13	-47	-	-	-	-	-16	-	-	-	35	20	-27	-71	-83	-84	-41	-66	8	-	17	-	112	112	-39	-	-40	-46	-45	-40	-	-	3	-9	4	5	-	-44	5	3	-	-	-	-41	**-2**
Q010	49	118	12	231	-	-47	-87	12	1	48	-48	-45	-79	-31	-78	-	-	-	-	-	115	91	-25	-78	-78	-	-	-	-	-	20	-	-7	-	-37	-	-	-43	-42	-38	-	-	65	-6	-	-	-	-	-	-	-22	-29	-	-39	**0**
Q011	-49	-	-73	81	-75	-71	-93	-	-65	-62	30	37	-58	39	-55	-	-74	-12	-	-96	-	-23	-24	-56	-55	-	-	-82	-	-	-69	-	-76	-	58	64	52	42	-	-	-	-	-	-76	-	-	-	-83	-	-	73	-	-	50	**-25**
Q012	-54	-21	-76	-56	-	-	-94	-	-83	-75	16	23	46	-33	-	223	-77	-	-	-	-73	-31	-50	51	-	37	-83	-84	-97	-	-79	-	-84	22	42	45	39	27	-	-	-	-84	-	-84	-	-	-	-	-	37	-	-	-	-	**-22**
Q013	-60	-	-10	-66	43	-40	-	-55	-	-86	-14	18	39	-35	47	-	-	-	-91	-91	-	-79	-72	44	47	31	-	-	-	28	-88	-	-	-	36	-	-	21	24	31	27	-	-	-	-	34	45	-	-	-	44	-	-	-	**-14**
Q014	-27	-34	-34	-87	4	12	-73	-	-	-42	252	-14	2	19	7	-2	-	-	-	-83	-	-	16	6	7	-5	80	79	-	135	-53	-64	-	-	-	1	-4	-11	-8	-	-	72	-	-	-4	-	74	74	-	-	-	-4	8	-	**1**
Q015	-66	-38	-	-87	-2	-25	-	-	-	-32	308	-	-4	12	1	-8	-	-63	11	-	-	-63	-	-1	1	-10	-	2	-63	-	-	-	-	-	-7	-	-	-	-14	-	-	0	-	-20	-	-	-1	-1	-	-	0	-	1	-	**-2**
Q016	-68	-41	-28	-	-	0	-76	-27	-	-	-	152	-	6	-5	-13	-10	-	5	14	-69	-	-27	-5	-4	119	62	-	-	-	106	-68	-	150	-	-	-	104	-	-	114	-	118	-	-	-	55	-	-	-	-	184	-	119	**3**
Q017	-62	-30	7	-	-1	17	99	418	-31	-	-14	-	-	25	12	3	5	-59	-52	-48	-	-	9	-29	14	-37	-25	-27	-59	-	-	-	-	-	-34	-	-37	-41	-	-	-	-	-60	-	118	-	-29	-29	-	-	-	-	-	-	**3**
Q018	32	-42	49	59	-	64	84	36	-	-	20	-	-	-	3	-	-3	-8	9	18	-42	-49	53	-35	58	-42	-32	-33	-7	-	-50	-	-	-	-39	-	-	-	-	-40	-	-	-	-	-	-	-	-35	-	-	-	-	-	-	**10**
Q019	-	-	-	-39	-	-37	7	-	-	-	-	-	-42	-33	27	58	62	-46	39	51	-66	-	22	-	28	12	29	28	20	-	-71	-	-	-	-	-	12	5	9	-	10	24	16	-	-	-	22	-	-	14	-	-	-	11	**4**
Q020	-24	-	-	-	-	-38	-	-21	-	-	-54	-	-43	-	-	58	61	-47	39	50	-67	-70	-41	-	10	-	-	30	20	-	-	-	-47	-	2	-	-	-	-	0	-	22	-	-	-	-	8	24	16	-	-	-	-	-	**-3**
Q021	-48	32	-	-37	-	-45	-	-31	-4	9	-	-52	-50	-41	-	-52	-	-9	-64	-61	32	18	110	-85	-47	-	-	-	6	-6	14	36	107	-	-45	-43	-	285	-	-	-	-	0	-	-	-	-	-36	2	-	-	-	-	-	**2**
Q022	-21	37	10	-	-	-61	-82	-29	-1	13	-12	-8	-64	-58	-62	-	-	-5	-	-60	37	22	-	-70	-61	-	-	-	9	-	18	-	114	80	-	-	-	-6	-	-65	-	-34	-	-	-	-	-34	-	-	-	-	-	-	1	**-3**
Q023	6	55	-8	524	-15	1	-76	-	-81	-72	-1	3	-60	31	-	-12	-9	-	31	-85	53	-	14	18	-	6	-	-	-88	-	22	-	-6	-	10	14	7	-1	1	-	2	16	-	-	-	10	15	-	17	-	20	-	-	6	**-6**
C002	-72	-52	-86	-78	18	-	-	-63	-81	-88	-29	-3	15	-47	21	-56	13	-56	-	-	-84	-58	16	19	22	-	26	-	-56	-	24	-	-	-	12	15	9	0	3	11	-	-	-87	-	11	11	-	-	-	-	-	9	-	8	**-8**
C003	-20	-28	-29	-85	13	21	-71	-12	-85	-22	372	-	10	29	16	7	9	263	4	-57	-62	-58	-10	-7	-5	-15	-	-5	-	-	-4	-	-	-	-13	-	-16	-22	-20	-15	-	-7	-	-	-	-14	-	-	-	-	-	-	-6	-	**3**
C004	-62	-	-40	-86	8	-18	-19	-40	-87	-	-	96	6	23	11	2	4	-60	22	-	-	-	6	-	13	-1	16	11	-	-	14	-	-12	-	-	6	-	-10	-	-	-3	8	-	-	-	-	10	-	-	-	-	-	-	-	**-6**
C005	-62	-31	7	13	-	16	-19	-	-32	-	-	-10	-	23	-	2	6	-59	22	-	-	-	-	11	-	1	15	13	-	-	-	-	-13	-	-	-	-	-	-4	1	-	11	-	-	-	-	9	10	-	-	-	-	-	-	**-1**
C006	-63	-70	5	-	-3	13	-7	-31	-79	-	-16	-12	-	22	9	-	3	-60	21	33	-	-	-	-	10	-4	13	11	4	-	-	-	-	-	-	4	-	-10	-	-	-	8	-	-	-	-	7	8	-	-	-	-	-	-	**1**
C007	-39	-	-	-	-	-	-15	182	-14	-	-	-62	-	-	37	-	29	-58	11	19	20	6	-	-14	-	-	-	2	-5	-	-	-	-	-	-	-	-22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**5**
C008	91	-	-	-	-	104	123	-	-	-	-	-	88	119	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-22	-5	-	-	-	-	-	-	-	-	-	-	-	-17	-	-	-	-	-	-17	-	-	-	-	-	**6**
C009	178	130	150	183	-62	-55	31	-51	128	234	19	25	-52	55	-	22	-	-35	-75	-	-6	-16	-24	-22	-21	-29	-	-	-	-31	-19	-	147	-	-28	-25	-30	-34	-33	-	-	-	-28	-37	-29	-27	-	-	-	-28	-21	-29	-21	-30	**15**
C010	-40	-	-	-	-	-36	-	-	-	-	-	-	-	-31	-	-44	-	-	-	-	53	-	-	-	-	-	-	-	-	-	-	57	-	-	-	-35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**10**
C011	26	-	-6	-	-	-	-	23	70	26	-56	-54	-	-	-	-	-	-	-	-31	134	108	-5	-	-	-11	1	-	-	-	1	-	-22	-23	-9	-6	-12	-	-15	-	-	-	-	-	-	-9	-	-	-	-11	-	-12	-	-13	**-4**
C012	-	-	-	-	-	-	-	-38	59	-78	-	-	-	-	-	331	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-27	-27	-14	-	-	-24	-	-	-	-	-	-	-	-	-	-	-	-17	-8	-16	-8	-	**-4**
C013	-23	-	-60	-25	-	-	-89	-	-71	-57	-	109	147	-	19	-	12	-57	-	-45	-55	-	14	17	20	-	-	-	-	-	20	-	-6	-6	9	13	6	-1	-	-	-	-	-	-5	-	-	-	-	-	-	-	6	-	4	**-8**
C014	-34	-	-66	-	398	425	-	-	-	-	69	76	-	-3	-	-	-	-	-	-	-61	-	-3	-1	-	-10	-	2	-	-	3	-60	-21	-	-7	-5	-10	-17	-	-9	-	-	-70	-19	-	-7	-	-	-70	-	-	-9	-	-11	**-3**
C015	-34	17	-65	-	404	-24	-7	-80	-75	-	69	81	-	-1	-	-	-5	-	11	-	-	-	-2	1	2	-	-	-	-62	-	4	-	-20	-	-6	-3	-9	-15	-	-	-	-	-64	-	-	-	0	-	-	-	-	-	-	-9	**-4**
C016	31	18	-64	-33	26	-21	-3	-44	-74	-62	75	85	23	45	-	-	-1	-	16	-	26	3	1	4	6	-8	-	5	-	-	8	-	-16	-17	-2	0	-6	-13	-11	-4	-	-	-63	-	-	-	-	-	-	-	4	-5	-	-7	**-8**
C017	33	-	-	-	-	-21	-	-	-74	-61	-	-	24	48	8	-1	-	-	19	-	-	-	1	5	7	-	11	-	-	-	-	-	-	-	-	-	-	-12	-10	-3	-	-	-	-	-	-3	-	-	-	-	-	-	-	-	**-6**
C018	43	-48	-	-	36	-15	-	-	-72	-58	-	-	32	-	-	-	-	-58	-	-47	-	-70	-	15	15	-	18	-	-	-	-	-	-	-	-	9	-	-5	-2	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	**-9**
C019	33	-52	-43	-	-	-	-22	-42	-	-	-	-	5	-	-	-1	-	-	19	-	-	-	2	-	-	-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-2	-7	-	-	-	-	-	-	-	-	-	-	-	-	-	**-7**
C020	-63	-	5	12	-	14	-21	-	-33	-	-	-11	-	22	11	-	4	-	21	30	-	-78	4	-	11	-3	15	12	5	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	8	9	-	-	-	-	-	-3	**0**
C021	109	-	11	-	-71	-	144	179	-14	-1	-	-	-	-	-	94	29	-	10	-	17	-	-	-86	-	-	-	-	-	-15	3	-	-	-	-	-49	-23	-28	-	-	-	-	-9	-21	-10	-8	-	-	-9	-11	-1	-	-	-	**0**
C022	173	132	150	-	-62	-55	29	-51	127	237	17	-	-	-	-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-20	-	-	-	-27	-25	-	-	-	-	-	-	-29	-38	-29	-27	-	-	-	-	-	-	-	-	**8**
C023	146	-	-	-	-66	-	-	46	105	-	-	-	-	-33	-	-	13	-	-	-	-	-	-	-30	-	-	-	-	-	-	-29	-	-	-	-	-	-	-	-	-	-	-	113	-44	-37	-36	-	-	-	-	-	-	-	-	**20**
C024	170	-	-	-	-	-	320	57	122	-	-	-	58	-	-	-	-	-	-	-	-	-	-26	-25	-23	-	-	-	-	-	-21	-	-39	-	-	-27	-	-	-36	-	-	-	133	-39	-32	-29	-	-	-	-	-	-32	-	-	**15**
C064	-63	-	4	9	-5	13	-21	-41	-	-	-	-	5	23	10	0	3	-	18	-49	-	-78	3	-	-	-2	12	11	-	-	-	-	-	-	-	-	-3	-	-	-	-	7	-	-	-	-	6	8	-62	-	-	-	-	-	**1**
C065	-63	-	-	-	-	-	-21	-	-33	-	-18	-12	-	21	9	-	3	-61	19	30	-	-	-	-	-	-	12	10	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	7	7	-	-	-	-2	-	-	**3**
C066	-	18	-	-	-	-	145	-	-13	-	-	-	-	-	-	-	-	-	-	20	18	-	88	-	-	-	-	-	-	-	-	-	-	-	-	-49	-	-	-	-	-	-	-9	-	-	-	-16	-	-8	-	-	-	-	-	**7**
C067	-19	163	-	-	-	-	-	-	160	-	-	56	-	-	-	-	-	-	-2	-	-	-	-	-	-	-	-	-	-	-	-8	-	-29	-30	-	-	-	-	-	-	-	-	170	-	-	-	-	-	-	-18	-11	-20	-10	-	**1**
C068	-	-	-27	-	-31	-	-	-	-	-78	61	-	95	-	-5	-	-	-	-	-	-	-	-8	-	-	-	-	-	-	-	-2	-	-	-25	-	-	-	-22	-	-	-	-	189	-	-	-	-	-	-	-14	-5	-	-	-	**1**
C069	-10	33	-	-	-	-	-	-	-	-76	-	-	-	-2	-	373	-	-	-	-	-	-	-	1	-	-	-	-	-	-	4	-	-20	-20	-7	-3	-	-15	-	-	-	-	-	-	-	-7	-	1	-	-8	-	-9	0	-	**-5**
C070	-	40	-	-	-	-	-79	-29	-	-	-	-	-	4	8	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	9	-	-	-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3	-	-6	6	-	**-1**
C071	-37	-	-67	-39	381	-	-	-	-76	-64	61	-	-	-	-	-10	-	-	6	-	-	-5	-7	-3	-	-	-	-	-	-	0	-	-24	-	-11	-7	-12	-20	-	-	-	-5	-	-	-	-	-	-	-	-	-	-	-	-13	**-3**
TOTAL	**-11**	**4**	**1**	**-2**	**0**	**-3**	**-23**	**-3**	**5**	**-11**	**11**	**8**	**1**	**-6**	**-1**	**2**	**1**	**4**	**-5**	**-8**	**-8**	**-4**	**0**	**-1**	**-2**	**4**	**-3**	**-2**	**1**	**5**	**-2**	**-9**	**9**	**9**	**2**	**1**	**3**	**7**	**6**	**3**	**5**	**-1**	**3**	**9**	**3**	**2**	**0**	**-1**	**2**	**3**	**-1**	**4**	**-1**	**4**	**-1**

Table 39

Zones with relative difference in row and column totals higher than 10%

ORIGINS			DESTINATIONS		
07-09	17-20.30	Tuesday	07-09	17-20.30	Tuesday
Q001	-	-	Q001	-	Q001
-	Q002	Q002	-	-	-
Q003	-	-	-	-	-
-	-	-	-	-	-
Q005	Q005	-	-	-	-
-	-	-	-	-	-
-	Q007	Q007	Q007	Q007	Q007
-	Q008	-	-	-	-
-	-	-	-	-	-
-	-	-	Q010	Q010	Q010
Q011	Q011	Q011	Q011	-	Q011
Q012	Q012	Q012	-	-	-
Q013	Q013	Q013	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	Q018	Q018	-	-	-
-	-	-	-	Q019	-
-	-	-	-	Q020	-
-	-	-	-	Q021	-
Q022	-	-	Q022	Q022	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	C008	-	-	-	-
C009	C009	C009	-	-	-
C010	C010	-	-	-	-
-	-	-	-	-	-
-	C012	-	-	-	-
-	C013	-	-	-	-
-	-	-	-	-	-
-	C015	-	-	-	-
-	-	-	-	-	-
-	C017	-	-	-	-
-	C018	-	-	-	-
-	C019	-	-	-	-

ORIGINS			DESTINATIONS		
07-09	17-20.30	Tuesday	07-09	17-20.30	Tuesday
-	-	-	-	-	-
-	-	-	-	-	-
C022	C022	-	C022	-	-
C023	-	C023	-	-	-
C024	C024	C024	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
C066	C066	-	C066	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	C069	-	-	-	-
-	-	-	-	-	-
C071	C071	-	C071	-	-

OmniTRANS reports

Differences between IMQ 2013 and the Estimated Matrix for the year 2019 without the trip end constraint

07-09 Rows

without trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
1	1367	2399	1032	75
2	1101	1329	228	21
3	791	811	20	3
4	1694	1633	-61	-4
5	1632	1459	-173	-11
6	1725	1737	12	1
7	2040	2454	414	20
8	607	546	-61	-10
9	844	976	132	16
10	2202	2657	455	21
11	1401	1334	-67	-5
12	2567	2241	-326	-13
13	1751	1734	-17	-1
14	1900	1862	-38	-2
15	1684	1643	-41	-2
16	1489	1566	77	5
17	1725	1866	141	8
18	1220	1428	208	17
19	517	464	-53	-10
20	981	922	-59	-6
21	1962	1811	-151	-8
22	1619	1400	-219	-14
23	1706	1824	118	7
24	818	815	-3	0
25	1100	1112	12	1
26	771	768	-3	0
27	292	289	-3	-1
28	1225	1209	-16	-1
29	359	335	-24	-7
30	131	114	-17	-13
31	1009	1065	56	6
32	101	74	-27	-27
33	1029	1162	133	13
34	358	380	22	6
35	755	752	-3	0
36	911	902	-9	-1
37	1009	1000	-9	-1
38	2185	2196	11	1
39	975	983	8	1
40	470	472	2	0
41	292	292	0	0
42	474	463	-11	-2
43	1514	1375	-139	-9
44	505	513	8	2

07-09 Rows

without trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
45	254	237	-17	-7
46	961	903	-58	-6
47	1065	1049	-16	-2
48	993	975	-18	-2
49	291	252	-39	-13
50	344	353	9	3
51	318	338	20	6
52	778	816	38	5
53	219	228	9	4
54	709	700	-9	-1
1485	**56740**	**58217**	**1478**	**63**

07-09 Columns

without trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
1	5305	4711	-594	-11
2	798	899	101	13
3	1651	1496	-155	-9
4	1217	1278	61	5
5	1159	1126	-33	-3
6	1774	1777	3	0
7	1905	1625	-280	-15
8	1329	1547	218	16
9	2160	2446	286	13
10	2127	2167	40	2
11	1223	1358	135	11
12	1421	1509	88	6
13	870	888	18	2
14	1523	1535	12	1
15	1318	1328	10	1
16	1262	1200	-62	-5
17	1686	1642	-44	-3
18	900	875	-25	-3
19	1476	1577	101	7
20	725	812	87	12
21	348	358	10	3
22	1097	1266	169	15
23	1888	2145	257	14
24	1806	1767	-39	-2
25	1446	1483	37	3
26	661	686	25	4
27	794	970	176	22
28	1298	1309	11	1
29	359	367	8	2
30	67	69	2	3
31	1791	1781	-10	-1
32	68	75	7	10
33	949	1010	61	6
34	428	415	-13	-3
35	635	636	1	0
36	1089	1090	1	0
37	591	595	4	1
38	2597	2607	10	0
39	360	362	2	1
40	569	583	14	2
41	132	132	0	0
42	395	392	-3	-1
43	1333	1650	317	24
44	471	763	292	62

07-09 Columns

without trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
45	65	62	-3	-4
46	596	583	-13	-2
47	728	741	13	2
48	938	949	11	1
49	0	0	0	0
50	162	162	0	0
51	65	64	-1	-1
52	338	338	0	0
53	158	159	1	1
54	689	849	160	23
1485	**56740**	**58217**	**1474**	**226**

17-20.30 Rows

without trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
1	4587	4797	210	5
2	1285	1380	95	7
3	1662	1696	34	2
4	1768	1752	-16	-1
5	1955	1882	-73	-4
6	2464	2489	25	1
7	1510	1768	258	17
8	1933	1214	-719	-37
9	2032	2180	148	7
10	2306	2346	40	2
11	1949	1817	-132	-7
12	2422	2278	-144	-6
13	1445	1401	-44	-3
14	1756	1691	-65	-4
15	920	906	-14	-2
16	1222	1217	-5	0
17	1441	1587	146	10
18	974	1049	75	8
19	1791	1731	-60	-3
20	681	696	15	2
21	1348	1543	195	14
22	1061	1185	124	12
23	2577	2754	177	7
24	2299	2220	-79	-3
25	2145	2088	-57	-3
26	1443	1443	0	0
27	927	887	-40	-4
28	1246	1237	-9	-1
29	912	918	6	1
30	266	321	55	21
31	2617	2775	158	6
32	111	123	12	11
33	1220	1202	-18	-1
34	188	180	-8	-4
35	837	822	-15	-2
36	1143	1280	137	12
37	999	1009	10	1
38	2996	2999	3	0
39	459	439	-20	-4
40	402	385	-17	-4
41	464	605	141	30
42	872	841	-31	-4
43	1488	1579	91	6
44	562	678	116	21

17-20.30 Rows

without trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
45	167	175	8	5
46	524	588	64	12
47	964	931	-33	-3
48	700	672	-28	-4
49	163	168	5	3
50	304	290	-14	-5
51	64	63	-1	-2
52	505	491	-14	-3
53	65	67	2	3
54	855	862	7	1
1485	**68996**	**69695**	**701**	**113**

17-20.30 Columns

without trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
1	2652	2978	326	12
2	1715	1842	127	7
3	1985	1993	8	0
4	1768	1698	-70	-4
5	1592	1686	94	6
6	2086	2241	155	7
7	2339	2114	-225	-10
8	1475	2182	707	48
9	1183	1122	-61	-5
10	2531	2517	-14	-1
11	2008	2015	7	0
12	2676	2884	208	8
13	1854	1836	-18	-1
14	2042	2080	38	2
15	1293	1293	0	0
16	1207	1202	-5	0
17	1662	1575	-87	-5
18	1847	1543	-304	-16
19	538	522	-16	-3
20	1145	1073	-72	-6
21	2616	2419	-197	-8
22	936	861	-75	-8
23	2107	1972	-135	-6
24	2291	2301	10	0
25	1597	1617	20	1
26	1463	1461	-2	0
27	389	395	6	1
28	1336	1344	8	1
29	783	757	-26	-3
30	328	308	-20	-6
31	2185	2217	32	1
32	213	204	-9	-4
33	1063	1149	86	8
34	326	338	12	4
35	756	776	20	3
36	868	868	0	0
37	1210	1262	52	4
38	2434	2524	90	4
39	716	745	29	4
40	645	673	28	4
41	488	485	-3	-1
42	816	833	17	2
43	1619	1559	-60	-4
44	559	551	-8	-1

17-20.30 Columns

without trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
45	296	306	10	3
46	693	703	10	1
47	832	845	13	2
48	795	802	7	1
49	290	285	-5	-2
50	345	342	-3	-1
51	353	332	-21	-6
52	879	893	14	2
53	194	185	-9	-5
54	977	985	8	1
1485	**68996**	**69695**	**697**	**31**

Tuesdays Rows

without trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
1	14201	16049	1848	13
2	4615	6134	1519	33
3	7568	7682	114	1
4	6320	6221	-99	-2
5	7056	6965	-91	-1
6	9889	9847	-42	0
7	8984	10106	1122	12
8	5642	4343	-1299	-23
9	6464	6900	436	7
10	9179	9513	334	4
11	6359	6114	-245	-4
12	7792	7398	-394	-5
13	6912	6769	-143	-2
14	8409	8362	-47	-1
15	4830	4830	0	0
16	5854	5727	-127	-2
17	6991	7502	511	7
18	5447	5810	363	7
19	4537	4269	-268	-6
20	3269	3051	-218	-7
21	6453	6856	403	6
22	6011	6346	335	6
23	9002	9897	895	10
24	8598	8467	-131	-2
25	7593	7439	-154	-2
26	4746	4853	107	2
27	2242	2228	-14	-1
28	5780	5590	-190	-3
29	3005	2859	-146	-5
30	1646	1504	-142	-9
31	9154	9574	420	5
32	623	634	11	2
33	5182	5428	246	5
34	1010	1107	97	10
35	3462	3536	74	2
36	3999	4186	187	5
37	4846	4972	126	3
38	9948	10049	101	1
39	2971	2946	-25	-1
40	2499	2423	-76	-3
41	1185	1200	15	1
42	3045	2975	-70	-2
43	6335	6221	-114	-2
44	1892	1942	50	3

Tuesdays Rows

without trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
45	774	865	91	12
46	2177	2302	125	6
47	3716	3610	-106	-3
48	3063	2960	-103	-3
49	687	701	14	2
50	1258	1275	17	1
51	930	997	67	7
52	2766	2952	186	7
53	676	703	27	4
54	3548	3660	112	3
1485	**271140**	**276851**	**5709**	**98**

Tuesday Columns

without trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
1	15111	14307	-804	-5
2	4745	6110	1365	29
3	7838	8044	206	3
4	6319	6408	89	1
5	6920	7596	676	10
6	9822	9715	-107	-1
7	8914	8143	-771	-9
8	5777	6933	1156	20
9	6730	7231	501	7
10	8982	9181	199	2
11	6457	6918	461	7
12	7594	8260	666	9
13	6844	6988	144	2
14	8401	8561	160	2
15	4933	4920	-13	0
16	5724	5861	137	2
17	6927	6773	-154	-2
18	5449	4967	-482	-9
19	4537	4615	78	2
20	3303	3362	59	2
21	6352	6454	102	2
22	5808	6015	207	4
23	9003	8169	-834	-9
24	8600	8613	13	0
25	7528	7596	68	1
26	4683	4648	-35	-1
27	2242	2435	193	9
28	5946	6141	195	3
29	2941	2885	-56	-2
30	1646	1607	-39	-2
31	9218	9520	302	3
32	623	612	-11	-2
33	5148	5272	124	2
34	1009	1093	84	8
35	3527	3628	101	3
36	4032	4082	50	1
37	4846	4993	147	3
38	9695	10090	395	4
39	2780	2928	148	5
40	2466	2567	101	4
41	1154	1138	-16	-1
42	2911	2998	87	3
43	6268	6290	22	0
44	1923	2145	222	12

Tuesday Columns

without trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
45	774	807	33	4
46	2177	2274	97	4
47	3681	3819	138	4
48	3062	3211	149	5
49	655	677	22	3
50	1258	1337	79	6
51	930	901	-29	-3
52	2767	2762	-5	0
53	676	678	2	0
54	3484	3580	96	3
1485	**271140**	**276851**	**5718**	**148**

OmniTRANS reports

Differences between IMQ 2013 and the Estimated Matrix for the year 2019 with the trip end constraint

07-09 Rows

with trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
1	1367	1700	333	24
2	1101	1200	99	9
3	791	705	-86	-11
4	1694	1612	-82	-5
5	1632	1358	-274	-17
6	1725	1780	55	3
7	2040	2204	164	8
8	607	615	8	1
9	844	816	-28	-3
10	2202	2346	144	7
11	1401	859	-542	-39
12	2567	1781	-786	-31
13	1751	1558	-193	-11
14	1900	1794	-106	-6
15	1684	1661	-23	-1
16	1489	1453	-36	-2
17	1725	1853	128	7
18	1220	1266	46	4
19	517	494	-23	-4
20	981	885	-96	-10
21	1962	1777	-185	-9
22	1619	1299	-320	-20
23	1706	1692	-14	-1
24	818	797	-21	-3
25	1100	1124	24	2
26	771	754	-17	-2
27	292	319	27	9
28	1225	1317	92	7
29	359	334	-25	-7
30	131	119	-12	-9
31	1009	1188	179	18
32	101	76	-25	-25
33	1029	1028	-1	0
34	358	361	3	1
35	755	682	-73	-10
36	911	942	31	3
37	1009	1001	-8	-1
38	2185	2143	-42	-2
39	975	1010	35	4
40	470	510	40	9
41	292	290	-2	-1
42	474	504	30	6
43	1514	1475	-39	-3
44	505	602	97	19

07-09 Rows

with trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
45	254	279	25	10
46	961	1120	159	17
47	1065	1167	102	10
48	993	1043	50	5
49	291	332	41	14
50	344	365	21	6
51	318	308	-10	-3
52	778	787	9	1
53	219	228	9	4
54	709	612	-97	-14
1485	**56740**	**55526**	**-1215**	**-42**

07-09 Columns

with trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
1	5305	4743	-562	-11
2	798	815	17	2
3	1651	1542	-109	-7
4	1217	1154	-63	-5
5	1159	1193	34	3
6	1774	1686	-88	-5
7	1905	1367	-538	-28
8	1329	1240	-89	-7
9	2160	2143	-17	-1
10	2127	1756	-371	-17
11	1223	1483	260	21
12	1421	1535	114	8
13	870	910	40	5
14	1523	1513	-10	-1
15	1318	1321	3	0
16	1262	1333	71	6
17	1686	1676	-10	-1
18	900	966	66	7
19	1476	1466	-10	-1
20	725	711	-14	-2
21	348	367	19	6
22	1097	1212	115	10
23	1888	1835	-53	-3
24	1806	1654	-152	-8
25	1446	1354	-92	-6
26	661	701	40	6
27	794	753	-41	-5
28	1298	1236	-62	-5
29	359	350	-9	-2
30	67	68	1	2
31	1791	1717	-74	-4
32	68	74	6	9
33	949	1038	89	9
34	428	440	12	3
35	635	648	13	2
36	1089	1052	-37	-3
37	591	597	6	1
38	2597	2662	65	3
39	360	372	12	3
40	569	518	-51	-9
41	132	136	4	3
42	395	371	-24	-6
43	1333	1427	94	7
44	471	554	83	18

07-09 Columns

with trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
45	65	62	-3	-4
46	596	585	-11	-2
47	728	707	-21	-3
48	938	921	-17	-2
49	0	0	0	0
50	162	158	-4	-3
51	65	64	-1	-1
52	338	343	5	1
53	158	156	-2	-1
54	689	841	152	22
1485	**56740**	**55526**	**-1214**	**4**

17-20.30 Rows

with trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
1	4587	4784	197	4
2	1285	1512	227	18
3	1662	1575	-87	-5
4	1768	1766	-2	0
5	1955	1700	-255	-13
6	2464	2325	-139	-6
7	1510	1677	167	11
8	1933	1733	-200	-10
9	2032	2044	12	1
10	2306	2263	-43	-2
11	1949	1613	-336	-17
12	2422	2038	-384	-16
13	1445	1258	-187	-13
14	1756	1744	-12	-1
15	920	948	28	3
16	1222	1174	-48	-4
17	1441	1580	139	10
18	974	1180	206	21
19	1791	1716	-75	-4
20	681	712	31	5
21	1348	1348	0	0
22	1061	1036	-25	-2
23	2577	2331	-246	-10
24	2299	2072	-227	-10
25	2145	2103	-42	-2
26	1443	1400	-43	-3
27	927	851	-76	-8
28	1246	1233	-13	-1
29	912	981	69	8
30	266	331	65	25
31	2617	3135	518	20
32	111	149	38	34
33	1220	1261	41	3
34	188	165	-23	-12
35	837	650	-187	-22
36	1143	1079	-64	-6
37	999	872	-127	-13
38	2996	2761	-235	-8
39	459	407	-52	-11
40	402	347	-55	-14
41	464	539	75	16
42	872	877	5	1
43	1488	1596	108	7
44	562	654	92	16

17-20.30 Rows

with trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
45	167	159	-8	-5
46	524	629	105	20
47	964	934	-30	-3
48	700	706	6	1
49	163	195	32	20
50	304	279	-25	-8
51	64	61	-3	-5
52	505	454	-51	-10
53	65	62	-3	-5
54	855	717	-138	-16
1485	**68996**	**67716**	**-1280**	**-21**

17-20.30 Columns

with trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
1	2652	2688	36	1
2	1715	1727	12	1
3	1985	1937	-48	-2
4	1768	1747	-21	-1
5	1592	1601	9	1
6	2086	2055	-31	-1
7	2339	1717	-622	-27
8	1475	1448	-27	-2
9	1183	1126	-57	-5
10	2531	2215	-316	-12
11	2008	2032	24	1
12	2676	2803	127	5
13	1854	1814	-40	-2
14	2042	1864	-178	-9
15	1293	1318	25	2
16	1207	1218	11	1
17	1662	1728	66	4
18	1847	1688	-159	-9
19	538	479	-59	-11
20	1145	1008	-137	-12
21	2616	2306	-310	-12
22	936	797	-139	-15
23	2107	2186	79	4
24	2291	2271	-20	-1
25	1597	1642	45	3
26	1463	1443	-20	-1
27	389	399	10	2
28	1336	1310	-26	-2
29	783	779	-4	-1
30	328	309	-19	-6
31	2185	2108	-77	-4
32	213	193	-20	-9
33	1063	1138	75	7
34	326	349	23	7
35	756	805	49	7
36	868	889	21	2
37	1210	1297	87	7
38	2434	2549	115	5
39	716	749	33	5
40	645	674	29	5
41	488	472	-16	-3
42	816	831	15	2
43	1619	1645	26	2
44	559	553	-6	-1

17-20.30 Columns

with trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
45	296	306	10	3
46	693	684	-9	-1
47	832	838	6	1
48	795	796	1	0
49	290	288	-2	-1
50	345	375	30	9
51	353	361	8	2
52	879	925	46	5
53	194	197	3	1
54	977	1040	63	6
1485	**68996**	**67716**	**-1279**	**-49**

Tuesday Rows

with trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
1	14201	15065	864	6
2	4615	5539	924	20
3	7568	7499	-69	-1
4	6320	6297	-23	0
5	7056	6468	-588	-8
6	9889	9329	-560	-6
7	8984	10367	1383	15
8	5642	5770	128	2
9	6464	6331	-133	-2
10	9179	9138	-41	0
11	6359	4763	-1596	-25
12	7792	6086	-1706	-22
13	6912	5922	-990	-14
14	8409	8501	92	1
15	4830	4717	-113	-2
16	5854	6017	163	3
17	6991	7173	182	3
18	5447	6004	557	10
19	4537	4726	189	4
20	3269	3183	-86	-3
21	6453	6570	117	2
22	6011	5827	-184	-3
23	9002	8441	-561	-6
24	8598	7918	-680	-8
25	7593	7820	227	3
26	4746	4455	-291	-6
27	2242	2222	-20	-1
28	5780	5848	68	1
29	3005	3143	138	5
30	1646	1739	93	6
31	9154	10525	1371	15
32	623	682	59	9
33	5182	4994	-188	-4
34	1010	972	-38	-4
35	3462	3170	-292	-8
36	3999	3898	-101	-3
37	4846	4635	-211	-4
38	9948	9196	-752	-8
39	2971	2787	-184	-6
40	2499	2285	-214	-9
41	1185	1107	-78	-7
42	3045	3034	-11	0
43	6335	6356	21	0
44	1892	2050	158	8

Tuesday Rows

with trip ends

Centroid	Prior Mx Row Total	Est Mx Row Total	Difference	Relative Difference (%)
45	774	927	153	20
46	2177	2505	328	15
47	3716	3743	27	1
48	3063	3146	83	3
49	687	732	45	7
50	1258	1275	17	1
51	930	941	11	1
52	2766	2641	-125	-5
53	676	667	-9	-1
54	3548	3445	-103	-3
1485	**271140**	**268591**	**-2549**	**-8**

Tuesday Columns
with trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
1	15111	13440	-1671	-11
2	4745	4948	203	4
3	7838	7893	55	1
4	6319	6207	-112	-2
5	6920	6900	-20	0
6	9822	9519	-303	-3
7	8914	6871	-2043	-23
8	5777	5602	-175	-3
9	6730	7069	339	5
10	8982	8017	-965	-11
11	6457	7161	704	11
12	7594	8233	639	8
13	6844	6905	61	1
14	8401	7914	-487	-6
15	4933	4865	-68	-1
16	5724	5863	139	2
17	6927	7022	95	1
18	5449	5655	206	4
19	4537	4296	-241	-5
20	3303	3022	-281	-9
21	6352	5820	-532	-8
22	5808	5597	-211	-4
23	9003	9045	42	0
24	8600	8536	-64	-1
25	7528	7402	-126	-2
26	4683	4856	173	4
27	2242	2183	-59	-3
28	5946	5832	-114	-2
29	2941	2967	26	1
30	1646	1733	87	5
31	9218	8995	-223	-2
32	623	564	-59	-9
33	5148	5626	478	9
34	1009	1101	92	9
35	3527	3601	74	2
36	4032	4069	37	1
37	4846	5013	167	3
38	9695	10368	673	7
39	2780	2942	162	6
40	2466	2533	67	3
41	1154	1210	56	5
42	2911	2896	-15	-1
43	6268	6442	174	3
44	1923	2094	171	9

Tuesday Columns

with trip ends

Centroid	Prior Mx Column Total	Est Mx Column Total	Difference	Relative Difference (%)
45	774	799	25	3
46	2177	2224	47	2
47	3681	3669	-12	0
48	3062	3040	-22	-1
49	655	670	15	2
50	1258	1294	36	3
51	930	919	-11	-1
52	2767	2862	95	3
53	676	669	-7	-1
54	3484	3617	133	4
1485	**271140**	**268591**	**-2550**	**12**