

SINGLE-ROUTE OD MATRIX ESTIMATION USING AUTOMATIC PASSENGER COUNTING DATA: A CASE STUDY IN GENEVA

Bachelor Thesis

Jonas Plačiakis

BSc Civil Engineering

Faculty of Engineering and Technology

2023-07-03

**UNIVERSITY
OF TWENTE.**

Abstract

The advancement and availability of automatic data collection systems (ADCs) have led public transport data collection methods to a new age. The ADC systems, such as automatic passenger counting (APC), automatic fare collection (AFC), and others, can generate an abundant amount of passenger data. This data can then be translated into the origin-destination passenger (OD) matrices, a key concept of public transport planning problems. In this research, two single-route OD modelling approaches, using boarding and alighting counts, are selected and numerically compared using the provided case study of TPG (*Transports Publics Genevois*) Geneva, Switzerland. The selected methods are the Iterative Proportional Fitting (IPF) and Gravity Model (GM). Four cases of four different lines of interest were modelled to obtain an inventory of estimated single-route passenger origin-destination matrices. The inventory of the two modelling approaches is then compared to determine the model choice recommendation for the TPG case study.

The modelled single-route passenger OD matrices can be used directly as input for full-network passenger OD matrix modelling or in other public transport planning applications. It is recommended that TPG use the Iterative Proportional Fitting model for future research as it provides a closer replication of the specific TPG public transport network.

Project supervisor: Alejandro Tirachini

Title: Associate Professor of Civil Engineering at the University of Twente

TPG contact person: Daniel Reck

Title: Transport Engineer at TPG

Table of Contents

Abstract.....	1
List of Tables.....	3
List of Figures	4
1. Introduction	6
1.1. General Approach and Research Motivation	7
1.2. Case Study Introduction.....	7
1.3. Research Objective.....	10
2. Literature Review	12
2.1. General Background.....	12
2.2. Single-Route OD Matrix Estimation Methods	13
3. Methodology.....	15
3.1. Phase 1: Data Preparation.....	15
3.2. Phase 2: Method Application.....	19
3.3. Phase 3: Result Comparison and Recommendations.....	20
4. Geneva Case Study.....	21
4.1. Descriptive APC Data Statistics.....	21
4.2. Case Study Data Preparation.....	29
4.3. IPF Example	32
4.4. GM Example.....	33
4.5. OD Matrix Comparison Example.....	33
5. Results and Discussion	37
6. Summary and Future Research.....	42
Bibliography	43
Appendix Line 1.....	44
Appendix Line 5.....	1
Appendix Line 8.....	1
Appendix Line 11.....	1

List of Tables

Table 1 Case study bus lines together with their initial origin and final destinations	8
Table 2 APC data column explanations	9
Table 3 Descriptive statistics for the whole APC dataset	22
Table 4 Descriptive statistics for Line 1 of the APC dataset	22
Table 5 Descriptive statistics for Line 3 of the APC dataset	22
Table 6 Descriptive statistics for Line 5 of the APC dataset	22
Table 7 Descriptive statistics for Line 7 of the APC dataset	22
Table 8 Descriptive statistics for Line 8 of the APC dataset	23
Table 9 Descriptive statistics for Line 11 of the APC dataset	23
Table 10 Morning and evening peak hours for week and weekend days	25
Table 11 Unbalanced average boardings (o_i) and alightings (d_j) for Line 5, workdays, hour 8, both directions	30
Table 12 Marginal boarding (Q_i) and alighting (Q_j) totals for Line 5 before and after balancing, workdays, hour 8, both directions.....	30
Table 13 Balanced average boardings (o_i) and alightings (d_j) for Line 5, workdays, hour 8, both directions	30
Table 14 Trip length distributions for Line 5, workdays, hour 8, both methods	34
Table 15 Mean and Median of Trip Distances of IPF and GM OD matrices, Line 5, workdays, hour 8	35
Table 16 Cumulative trip length distribution, Line 5, workdays, hour 8, both methods and absolute difference	35
Table 17 Trip distribution, cumulative trip distribution, absolute difference, lines 1, 5, 8 and 11, workday, hour 8.....	37
Table 18 Total modelled passenger trips per line, per modelling method	38
Table 19 Distance decay function sensitivity analysis constant values	40
Table 20 Mean Absolute Error of all cases of interest	41
Table 21 Target boardings and alightings, Line 1, "Aller" direction	44
Table 22 Target boardings and alightings, Line 1, "Retour" direction	46
Table 23 (cumulative) trip length distribution and absolute differences, Line 1	0
Table 24 (cumulative) rip length distribution and absolute differences, Line 5.....	0
Table 25 Target boardings and alightings, Line 8, "Aller" direction	1
Table 26 Target boardings and alightings, Line 8, Retour direction	3
Table 27 (cumulative) trip length distribution and absolute differences, Line 8	0
Table 28 Target boardings and alightings, Line 11, "Aller" direction	1
Table 29 Target boardings and alightings, Line 11, "Retour" direction	2
Table 30 (cumulative) trip distribution and absolute differences, Line 11	0

List of Figures

Figure 1 Lines of interest of the Geneva case study	8
Figure 2 Example of available APC data	9
Figure 3 Research methodology tree	15
Figure 4 Total number of average hourly boardings over OD study period for each hour of each weekday	24
Figure 5 Total number of average hourly alightings over OD study period for each hour of each weekday	25
Figure 6 Workday average hourly boardings of each Line	26
Figure 7 Workday average passenger boardings per scheduled bus	27
Figure 8 Total Stop Boardings, 8AM, Workday	28
Figure 9 Total Stop Alightings, 8AM, Workday	28
Figure 10 Total Stop Boardings, 5PM, Workday	28
Figure 11 Total Stop Alightings, 5PM, Workday	28
Figure 12 Highlighted non-structural zeros of the initial seed matrix of Line 5.....	29
Figure 13 Average bus load of Line 5, workdays, hour 8, in both directions	31
Figure 14 Total estimated hourly passenger trips per distance class for Line 5, workdays, hour 8, both methods	35
Figure 15 Total hourly passenger trips per distance interval, Line 1, workdays, hour 8	38
Figure 16 Total hourly passenger trips per distance interval, Line 5, workdays, hour 8	39
Figure 17 Total hourly passenger trips per distance interval, Line 8, workdays, hour 8	39
Figure 18 Total hourly passenger trips per distance interval, Line 11, workdays, hour 8	40
Figure 19 Total Hourly Passenger Trips per Distance Interval, Line 1, workdays, hour 8, Sensitivity Analysis	41
Figure 20 Updated seed matrix, Line 1	0
Figure 21 Cost matrix, Line 1, costs as kilometers	1
Figure 22 Cost matrix, Line 1, costs as minutes	0
Figure 23 IPF OD matrix, Line 1, workdays, hour 8, pax/h	0
Figure 24 IPF OD matrix, Line 1, workdays, hour 17, pax/h	1
Figure 25 IPF OD matrix, Line 1, Saturday, hour 17, pax/h	2
Figure 26 IPF OD matrix, Line 1, Sunday, hour 17, pax/h	3
Figure 27 GM OD matrix, Line 1, workdays, hour 8, pax/h	4
Figure 28 GM OD matrix, Line 1, workdays, hour 17, pax/h	5
Figure 29 GM OD matrix, Line 1, Saturday, hour 17, pax/h	6
Figure 30 GM OD matrix, Line 1, Sunday, hour 17, pax/h	7
Figure 31 Line 5, average target boardings and alightings, "Aller" direction.....	2
Figure 32 Line 5, average target boardings and alightings, Retour direction	4
Figure 33 Updated seed matrix, Line 5	0
Figure 34 Cost matrix, Line 5, cost as kilometers.....	0
Figure 35 Cost matrix, Line 5, cost as minutes.....	0
Figure 36 IPF OD matrix, Line 5, workdays, hour 8, pax/h	0
Figure 37 IPF OD matrix, Line 5, workdays, hour 17, pax/h	0
Figure 38 IPF OD matrix, Line 5, Saturday, hour 17, pax/h	0
Figure 39 IPF OD matrix, Line 5, Sunday, hour 17, pax/h.....	0

Figure 40 GM OD matrix, Line 5, workdays, hour 8, pax/h	0
Figure 41 GM OD matrix, Line 5, workdays, hour 17, pax/h	0
Figure 42 GM OD matrix, Line 5, Saturday, hour 17, pax/h	0
Figure 43 GM OD matrix, Line 5, Sunday, hour 17, pax/h	0
Figure 44 Updated seed matrix, Line 8	0
Figure 45 Cost matrix, Line 8, cost as kilometers	0
Figure 46 Cost matrix, Line 8, costs as minutes	0
Figure 47 IPF OD matrix, Line 8, workdays, hour 8, pax/h	0
Figure 48 IPF OD matrix, Line 8, workdays, hour 17, pax/h	0
Figure 49 IPF OD matrix, Line 8, Saturday, hour 17	0
Figure 50 IPF OD matrix, Line 8, Sunday, hour 17	0
Figure 51 GM OD matrix, Line 8, workdays, hour 8, pax/h	0
Figure 52 GM OD matrix, Line 8, workdays, hour 17, pax/h	0
Figure 53 GM OD matrix, Line 8, Saturday, hour 17, pax/h	0
Figure 54 GM OD matrix, Line 8, hour 17, pax/h	0
Figure 55 Updated seed matrix, Line 11	0
Figure 56 Cost matrix, Line 11, cost as kilometers	0
Figure 57 Cost matrix, Line 11, cost as minutes	0
Figure 58 IPF OD matrix, Line 11, workdays, hour 8, pax/h	0
Figure 59 IPF OD matrix, Line 11, workdays, hour 17, pax/h	0
Figure 60 IPF OD matrix, Line 11, Saturday, hour 17, pax/h	0
Figure 61 IPF OD matrix, Line 11, Sunday, hour 17, pax/h	0
Figure 62 GM OD matrix, Line 11, workdays, hour 8, pax/h	0
Figure 63 GM OD matrix, Line 11, workdays, hour 17, pax/h	0
Figure 64 GM OD matrix, Line 11, Saturday, hour 17, pax/h	0
Figure 65 GM OD matrix, Line 11, Sunday, hour 17, pax/h	0

1. Introduction

Public transport is a user-driven service that aims to provide modes of transport for the general public. Because of its nature, it requires careful planning and resource optimization at every implementation stage to ensure that it stays an attractive mode of transport compared to personal vehicles or other mobility options. A key concept of common public transport problems is the Origin-Destination (OD) matrix. It provides a spatiotemporal estimation of passenger travel demand, allowing planners to better understand user travel behavior, trip lengths and zones of attraction. The estimated spatiotemporal data can be used in various public transport system design stages, ultimately leading to more efficient transit systems (Gkiotsalitis 2022).

In the public transport context, the origin-destination matrices typically take the form of a model which utilizes available passenger data to estimate the desired OD matrix. Throughout the years, various models requiring different types of input data were developed (Mohammed and Oke 2022). Before the more common use of modern-day automated data collection systems (ADCs), the required data were mainly obtained from onboard surveys and other manual data collection methods. The manual data collection was a complicated and resource-consuming process (Furth, et al. 2006) & (Chan 2007) making it difficult to implement OD models over a more significant part of a public transport network with the desired accuracy. Nowadays, automated data collection systems, such as automatic passenger counting, automatic vehicle location and others, are being primarily implemented in various public transport networks worldwide. Implementing these systems in combination with online surveys provides an extensive database for more accurate OD matrix estimations.

OD matrices can be estimated at single-route or network levels. To what level and accuracy the desired matrices can be modelled depends on available data and the selection of modelling methods. Therefore, for each specific case study, it becomes crucial to understand the available data and select appropriate modelling methods for OD matrix estimations. In this thesis, the case study of Geneva, Switzerland, is considered. The available data, provided by TPG (*Transports Publics Genevois*), is analyzed with descriptive data statistics and later utilized for single-route OD matrix estimations using two selected modelling approaches: Iterative Proportional Fitting (IPF) and Gravity Model (GM). The modelling results are then compared to identify the differences between the two approaches, and modelling choice recommendations are provided for TPG.

The report is structured as follows. The remainder of Section 1 provides additional information about the general approach to OD matrix estimations, elaborates more on research motivation, introduces the case study and determines the research objective of this report. Section 2 provides a relevant literature review about the general use of OD matrix and single-route OD matrix modelling approaches. Section 3 contains the research methodology. In Section 4, the data of the Geneva case study is analyzed using descriptive data statistics, and the two selected modelling approaches, together with necessary data preparation, are applied to one selected line of interest. The results are then discussed in Section 5, and the conclusion of this report is provided in Section 6.

1.1. General Approach and Research Motivation

The introduction mentions that OD matrices can be estimated at two levels: single-route and network. The route-level OD models provide data about passenger movement between their origin and destination on a single line. Besides being one of the main inputs for network OD matrix estimation, route-level OD matrices have also been used in various public transport planning applications (Site and Filippi 1998) & (Tirachini, Cortes and Jara-Diaz 2011). Meanwhile, the network-level OD models provide information about passenger flows between their origin and destination while considering transfers between routes for a selected transport network.

A general approach for network-level OD estimation can be described in three phases (Cui 2006). During phase 1, three types of input data are obtained: (1) a sample of ridership count, typically derived from automatic data collection systems like APC. (2) A seed matrix that can be obtained from various methods such as web surveys, GPS tracking, etc. And (3) transfer flows, typically obtained from AFC and different methods. In phase 2, boarding and alighting totals and the seed matrix for that specific route is used together with the appropriate method to estimate the route-level OD matrices. Finally, during phase 3, the network-level OD matrix can be estimated by inferring route transfer probabilities from AFC data in combination with the route-level OD matrix.

TPG, the leading public transport operator of Geneva, Switzerland, is interested in developing a network origin-destination model to acquire information about user travel behaviors for future network optimization in collaboration with the University of Twente. This collaboration is the lead motivation behind this research. The following chapter will introduce the TPG case study together with its limitations to be used for the subsequent research.

1.2. Case Study Introduction

Like most public transport operators, TPG (*Transports Publics Genevois*) also desires to have a balanced and optimal public transport network that would at least be a competitive alternative to other modes of transportation. As established before, TPG wants to develop a network-level OD matrix to obtain information about user travel behaviors within their system to achieve this goal of a more balanced transport system. Therefore, at the end of 2022, TPG conducted an origin-destination study on their network, and data from six lines of interest (see Table 1 and Figure 1) were made available for the present study. The study started on the 5th of September, 2022 and ended on the 14th of October, 2022. During the mentioned period, data about passenger travel behavior was collected via a web survey and smartphone-based GPS tracking. Both methods combined had over 28000 respondents and provided necessary data for TPG from which route-level origin-destination seed matrices were constructed. These matrices are an essential input of route-level OD matrix estimations, which, as mentioned before, are one of the main inputs for network OD matrix estimations.

TPG Lines of Interest, Geneva, Switzerland

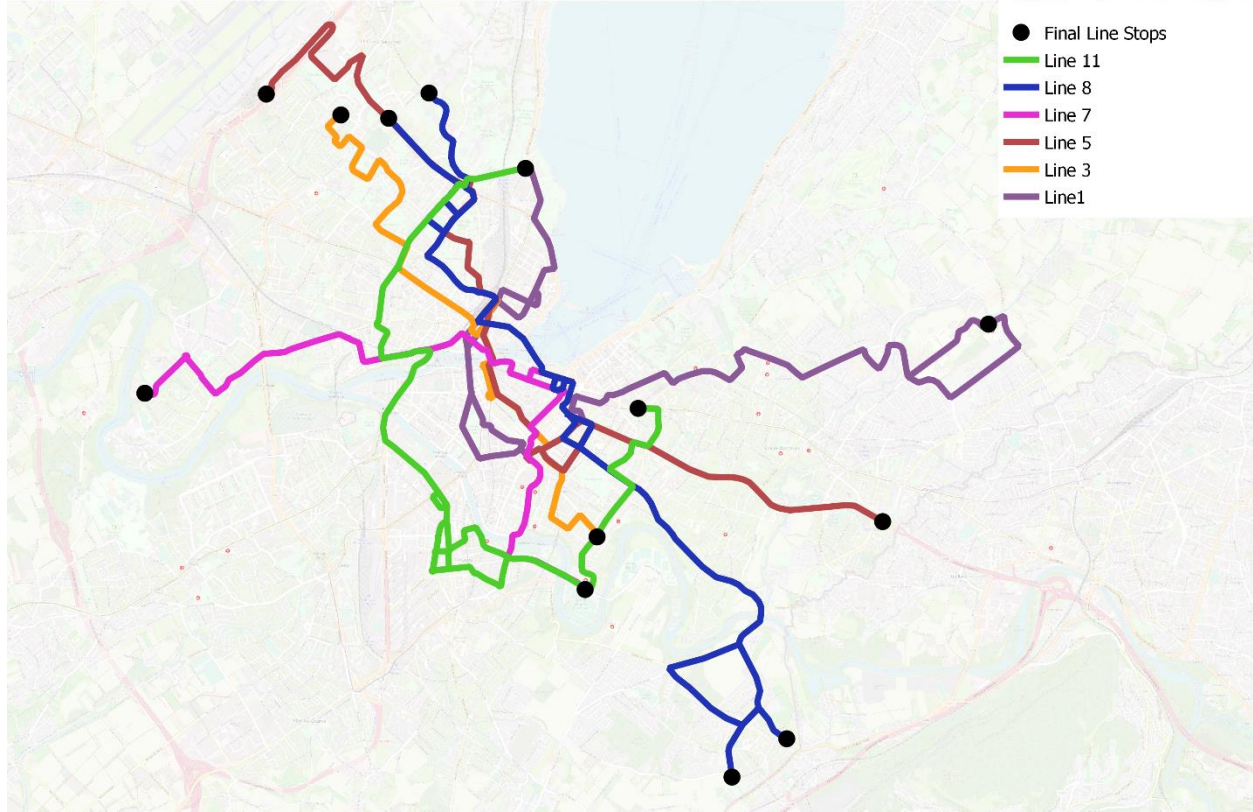


Figure 1 Lines of interest of the Geneva case study

Table 1 Case study bus lines together with their initial origin and final destinations

Line	Origin	Destination
1	Thônex, Hôpital Trois-Chêne	Genève, Jardin Botanique
3	Grand-Saconnex, Gardiol	Genève, Crêts-de-Champel
5	Thônex, Vallard	Genève-Aéroport, Terminal
7	Genève, Bout-du-Monde	Vernier, Lignon-Tours
8	Genève, OMS	Veyrier, douane
11	Genève, Jardin Botanique	Genève-Eaux-Vives, gare

Another available dataset TPG provides for route-level and network-level OD estimation is boarding and alighting data. This dataset was obtained using automatic passenger counting systems (APCs) operating on all buses over the same period as the origin-destination study. It provides information about average hourly passenger boardings and alightings in both route directions for all six lines of interest. It was also mentioned that the available APC counts have an accuracy of 2%. Due to the counting accuracy in this

research, it was decided to estimate the OD matrices with a convergence error ϵ of 0.02. An example of this dataset is presented in Figure 2 with accompanying Table 2 for column explanations.

	A	B	C	D	E	F	G
1	Date	Arrêt	Horaire Tranche Stop Réel	Ligne	Sens Théo.	Nb de Descentes	Nb de Montées
2	05-09-22	31 Décembre		00 1	Aller	1	0
3	05-09-22	31 Décembre		00 1	Retour	2	2
4	05-09-22	31 Décembre		05 1	Aller	4	2
5	05-09-22	31 Décembre		05 1	Retour	0	2
6	05-09-22	31 Décembre		06 1	Aller	6	5
7	05-09-22	31 Décembre		06 1	Retour	5	3
8	05-09-22	31 Décembre		07 1	Aller	33	31
9	05-09-22	31 Décembre		07 1	Retour	10	35
10	05-09-22	31 Décembre		08 1	Aller	52	38
11	05-09-22	31 Décembre		08 1	Retour	26	28
12	05-09-22	31 Décembre		09 1	Aller	13	22
13	05-09-22	31 Décembre		09 1	Retour	13	20
14	05-09-22	31 Décembre		10 1	Aller	23	28
15	05-09-22	31 Décembre		10 1	Retour	16	15
16	05-09-22	31 Décembre		11 1	Aller	15	13
17	05-09-22	31 Décembre		11 1	Retour	8	19
18	05-09-22	31 Décembre		12 1	Aller	31	15

Figure 2 Example of available APC data

Table 2 APC data column explanations

Column A	Date of data collection
Column B	Bus stop name
Column C	An hour on which route took place
Column D	The line number
Column E	Route direction (outward or return)
Column F	Number of average hourly alightings at that stop
Column G	Number of average hourly boardings at that stop

Finally, two additional datasets were presented by TPG: (1) stop locations and (2) route distances. Stop location data contains bus stop coordinates for each study line projected in *Swiss CH1903+ / LV95*. And route distance data indicates the distances between stops for each line in the desired direction.

In short, TPG has provided four types of data for all lines of interest: (1) Seed matrices, (2) APC data, (3) Route distances, and (4) Stop locations. However, the network OD models can't be modelled despite the available data because a key dataset is missing – transfer flow data. Therefore, due to the missing transfer flow dataset, this research has been limited to single-route origin-destination matrix estimations. Nevertheless, the single-route OD matrices are essential for network-level OD modelling and can be used in other planning applications (Site and Filippi 1998)& (Tirachini, Cortes and Jara-Diaz 2011).

Furthermore, another limitation of this research occurs from APC data quality. While examining provided APC data, it was noticed that for lines 1, 3 and 7, information about additional stops (stops that aren't in the schedule) was observed. One way to tackle this problem is not to consider the days or hours when the anomalies were observed for the modelling. This approach, however, is only possible for line 1 as it only contains additional data for one specific date - the 10th of September, 2022. The observed anomalies for lines 3 and 7 were rather extensive, including data for multiple hours and days. Thus, removing the specific

dates from the modelling would cause the integrity of the data to be compromised. Therefore, it was decided not to model lines 3 and 7, and when modelling line 1 – remove the specific date mentioned before.

The final limitations in this case study occur due to time constraints. Modelling each hour of each day of the week would prolong the research drastically. Therefore, it was decided that the origin-destination matrices would be modelled only for morning and evening peak hours derived from descriptive data statistics. It was also decided not to model each day of the week separately and instead combine them into workdays, Saturdays, and Sundays. The reason why Saturdays and Sundays are separate is provided in Chapter 3.1.

To summarize this case study, TPG is interested in developing a partial-network origin-destination matrix for lines 1, 3, 5, 7, 8, and 11. However, due to data and time constraints, this study has been limited to single-route origin-destination modelling for lines 1, 5, 8 and 11 of workdays, Saturday and Sunday peak hours.

1.3. Research Objective

Problem Statement

Several approaches for single-route OD matrix estimation using APC data are currently available. It is only natural that each of them provides different results due to their unique methodologies and assumptions. Research is missing for the specific case study of Geneva, which would investigate the modelled OD matrix impact of different methods using the available boarding and alighting data collected by APC systems.

Research Objective

The main objective of this research is to utilize the available data provided by TPG to estimate, compare and offer recommendations for the single-route OD matrix modelling of the Geneva case study using two selected modelling approaches: Iterative Proportional Fitting and Gravity Model.

Research Questions

The following research questions and sub-questions were derived from the research objective and underlying context.

Due to project time constraints, additional modelling day and hour criteria were imposed. Research question 1 and its sub-questions 1-a and 1-b were derived to determine these criteria.

[1] What are the day and hour criteria?

- a. Which weekdays are considered workdays and weekend days?**
- b. What are the peak hours for work and weekend days?**

Research question 2 and its sub-questions 2-a and 2-b were derived to determine which single-route OD matrix modelling method is recommended for the Geneva case study.

[2] Depending on available data, which of the three methods is recommended for the given Geneva case study?

- a. Using the two selected methods, what are the estimated route-level OD matrices for lines of interest?**
- b. What are the main differences between route-level OD matrices of different estimation methods?**

2. Literature Review

The literature review presented in this chapter focuses on the general concept of origin-destination matrices in the public transport context, including the general use of OD matrices and automatic data collection systems. Furthermore, various single-route passenger OD modelling methods using boarding and alighting data are presented, from which two are selected for this research and are more elaborated.

2.1. General Background

The origin-destination (or OD) matrix is a key concept in the public transport context. It provides planners with the necessary spatiotemporal data about the user travel behavior over a selected route or system of interest. The available data can be used to evaluate alternatives, identify points of attraction, forecast revenues and estimate trip lengths. (Ben-Akiva, Macke and Hsu 1985). The wide range of OD matrix data applications allows the modelled OD matrices to be used in various public transport planning stages, such as transit network design or resource management. (Gkiotsalitis 2022). The desired OD matrices can be modelled at route and network levels. The ability to model them at the desired level depends on available data and selected modelling approaches.

Various modelling approaches have been developed through the years that use different assumptions to model the different level OD matrices utilizing the available data (Mohammed and Oke 2022). The available data in the public transport context typically includes information about user origin, destination and passenger counts. Back in the day, before the use of automatic data collection systems (ADCs), the most common way to collect this type of data was through manual labor methods such as onboard surveys. These methods, however, provided only a small portion of potential data and required a rather extensive amount of resources, thus limiting the modelled OD matrix accuracy (Furth, et al. 2006) & (Chan 2007). The data availability situation changed when automatic data collection systems, such as automatic fare collection (AFC) or automatic vehicle location (AVL), were implemented in various transit networks worldwide. This implementation of ADC systems potentially had the following benefits for OD matrix modelling: increased and less biased sample, reduced modelling costs, more targeted surveys and more frequent OD matrix estimation (Cui 2006).

The beforementioned APC data collection system is one of the possible ADC systems. TPG has installed this system in all their buses of interest to obtain the necessary boarding and alighting data. The installed automatic passenger counters utilize infrared beam technology to count the passenger boardings and alightings at each stop along the route. However, this technology is not ideal, and due to its nature, it has a slight chance of undercounting the boarding and alighting numbers. Therefore, it is common for boarding and alighting count to be undercounted, typically resulting in uneven marginal totals for a one-way bus trip (this issue is addressed in subsection 3.1).

2.2. Single-Route OD Matrix Estimation Methods

As mentioned in the previous subsection, various modelling approaches are available that model the OD matrix at one of the two levels while utilizing the available data. This project considers the single-route OD matrices modelled using available passenger boarding and alighting data. Therefore, the remainder of this subsection focuses only on single-route OD matrix modelling approaches using boarding and alighting data.

The single-route OD matrix modelling methods using boarding and alighting data can be categorized into estimation approaches with and without the base information. Modelling methods with the base information typically require boarding and alighting data and a base matrix. The base matrix is generally acquired from past OD modellings, expert knowledge, or constructed from web surveys. Methods like iterative proportional fitting, maximum likelihood estimation, generalized least squares method and others are characterized as methods with the base information. Meanwhile, methods without base information only require boarding, alighting, and supplementary assumptions to model the desired OD matrix. Tsygalnitsky's method and Li and Cassidy's methods are two of a few modelling methods requiring no base information. Dawei Lu discusses all the beforementioned and additional modelling methods in greater detail in the referenced paper (Lu 2008).

Amongst all the single-route modelling approaches, the following three are considered to be the general methods: iterative proportional fitting method (IPF), entropy maximization method (EM) and gravity model (GM) (Gkiotsalitis 2022). The three mentioned methods were initially considered for this research. However, further investigation found that the entropy maximization method is an analogy to the gravity model (Ortuzar and Willumsen 2011). Therefore, for this research, it was decided to compare the IPF and GM modelling approaches (GM is selected over EM due to a more simplistic modelling procedure). The two chosen estimation methods are elaborated in more detail in the remainder of this subsection.

Iterative Proportional Fitting

The Iterative Proportional Fitting Method is currently considered a state-of-the-art method for OD matrix modelling using boarding and alighting data (Ji, Mishalani and McCord 2014). The iterative cell adjustment method enforces the marginal totals agreements to update the seed matrix into a single-route OD matrix. Therefore, the two required data inputs are (1) seed matrices and (2) target boarding (o_i) and alighting (d_j) data.

The iterative cell adjustment method uses row b_i^k and column a_j^k growth factors to update the respective cells at each iteration k using the following formula:

$$Q_{ij}^{IPF,k} = b_i^k a_j^k q_{ij}^0$$

The growth factors are determined at each iteration via the two formulas below and change from iteration to iteration until the desired convergence, ϵ , between target boarding (o_i) and modelled row total (Q_i) is achieved.

$$b_i^k = \frac{o_i}{\sum_{s=1}^{S=N} Q_{ij}^{IPF,k-1}} \quad a_j^k = \frac{d_j}{\sum_{s=1}^{S=N} Q_{ij}^{IPF,k-1}}$$

Where k – is the iteration number, o_i - is the target number of passenger boardings at stop i , d_j – is the target number of passenger alightings at stop j , N – is the route number of stops, $Q_{ij}^{IPF,k-1}$ – passenger flow between origin i and origin j estimated in iteration $k-1$.

The iterative procedure stops once the desired convergence is observed, indicating that the final form of the single-route OD matrix is determined.

Due to its simplicity, this method has a significant advantage over other matrix estimation methods as it can be computed without sacrificing accuracy. However, it contains two main limitations. The first is the non-structural zeros problem (Ben-Akiva, Macke and Hsu 1985). This problem arises if OD pairs with low flow in the seed matrix are estimated as zero-flow cells. The second problem is that it highly depends on the seed matrix's quality (Liu, Hentenryck and Zhao 2021). However, this research only addresses the first problem of non-structural zeros, as the second one is out of scope. To address the non-structural zeroes problem, a simple solution to add a small positive value to each cell is selected (Lomax and Norman 2016). This approach to overcome the non-structural zeros problem and exact values are further discussed in subsections 3.1 and 4.2 for the specific case of Geneva.

Gravity Model

The selected Gravity Model is an analogy to Newton's gravity law.

$$q_{ij} = a \frac{o_i d_j}{l_{ij}^2}$$

Where q_{ij} is the estimated passenger flow from origin i to destination j , l_{ij} is the distance of travelling from zone i to zone j and o_i and d_j are the generated and attracted trips, respectively.

There are three types of gravity models: uniform, singly constrained and double-constrained. The uniform gravity model is considered the simplest and uses only a distance decay function $f(c_{ij})$ to estimate trips from i to j as a generalization of the original gravity law with the square of the distance as the denominator. The distance decay function typically takes one of the following forms: exponential function, power function or a combination of exponential and power functions. Meanwhile, single and double-constrained models introduce origin (a_i) or destination-specific (b_j) balancing factors. The balancing factors can be expressed using the following equations.

$$\begin{aligned} a_i &= 1 / \sum_j b_j d_j f(c_{ij}) \\ b_j &= 1 / \sum_i a_i o_i f(c_{ij}) \end{aligned}$$

A double-constrained gravity model is selected for this research and can be expressed in the following function using the beforementioned origin and destination-specific balancing factors.

$$q_{ij} = a_i o_i b_j d_j f(c_{ij})$$

Note that the balancing factors are interdependent. Therefore, to determine the final q_{ij} an iterative algorithm of Furness, described in subsection 3.2 is used.

Another essential attribute of this method is the cost matrix c_{ij} , which, in general, could include travel distance, time, fare and so on. This matrix will be determined for the specific case study of Geneva during data preparation in Chapter 4.2.

3. Methodology

The following methodology has been developed to fulfil the desired research objective (see Figure 3). It contains three main phases: (1) data preparation, (2) method application, and (3) result comparison and recommendations. This section elaborates on each methodology phase by defining all the steps needed to reach the desired research outcome.

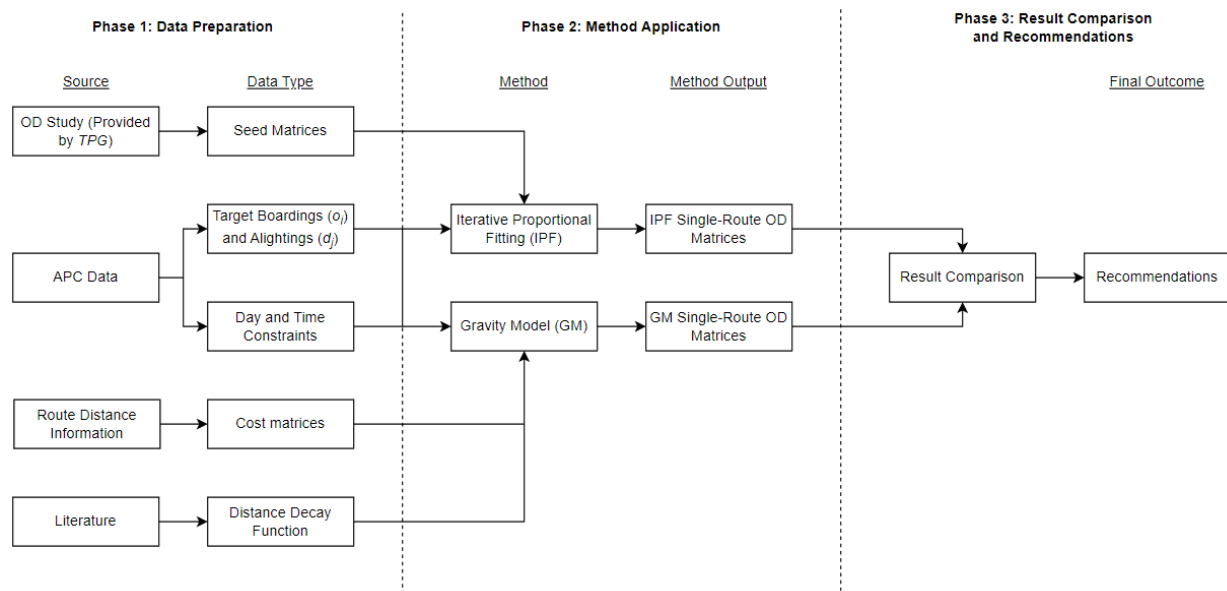


Figure 3 Research methodology tree

3.1. Phase 1: Data Preparation

During phase 1, all the necessary data for single-route OD matrix modelling is obtained. From the literature review, it was found that four types of data are needed for the selected OD matrix modelling methods: target boardings, o_i , and alightings, d_j (for IPF and GM), seed matrices (for IPF), cost matrices, C_{ij} (for GM) and distance decay function, $f(c_{ij})$ (for GM). Additionally to the necessary data inputs for each method, the day and time constraints were added due to project time constraints. The rest of this subsection defines how each data input is obtained.

Day and Time Constraints

The case study introduction mentioned that due to project time constraints, it was decided to model the single-route OD matrices for the workday, Saturday and Sunday peak hours. These are the so-called day and time constraints. To obtain these criteria, the APC dataset's total boardings (and alightings) are plotted separately for each hour (from 00 to 23) of each weekday (from Monday to Sunday). The resulting figure is then visually examined to determine which days of the week to group together or individually and the peak hours of interest.

Target Boardings (o_i) and Alightings (d_j)

Both selected OD matrix modelling approaches require target boarding (o_i) and alighting (d_j) data at each stop along the route. These values are direction specific and constrain the modelled OD matrix to represent reality as closely as possible. In this case, these values are derived from the APC dataset as an average passenger hourly boarding (or alighting) at a particular stop along the route of the selected line for a specific peak hour of a particular weekday(s) for both route directions.

This research focuses on single-route OD matrix modelling, thus indicating that each route begins and ends at its first and final stop. Due to the nature of APC data, some boarding and alighting values may be greater than zero at the first and last stops. Therefore it is important to ensure that no alightings and boardings are counted in the outbound and inbound directions respectfully. If a value greater than zero is observed at the first and final stops, it is replaced as a zero, thus ensuring that the trip starts and ends with zero passengers on board.

Furthermore, average boarding and alighting totals in the same route direction must be equal; otherwise, the desired convergence in both modelling approaches may not be achievable (Gkiotsalitis 2022). Therefore, each specific case's total boardings and alightings are checked to be equal. In the case of unequal totals, a systematic method of proportional corrections is used to distribute the needed corrections for boardings and alightings (Furth, et al. 2006). This method multiplies all the boardings by the correction factor $f=T_{on}^*/T_{on}$ and all the alightings by the correction factor $f=T_{off}^*/T_{off}$. Where, T_{on}^*, T_{off}^* are the targeted boarding and alighting totals. In this research, it was decided to balance the obtained average boarding and alighting counts with the observed whole number of total boardings.

After achieving a balanced line, the calculated loads may be negative at one or more stops along the route. To deal with this issues, we follow the procedure suggested by Furth et al. (2006). The departing load and through-load (departing load minus boardings) is checked along the route to address this issue. Negative loads indicate stops at which correction is needed. If multiple negative loads are observed, the one with the highest negative load is corrected first. A trip is split at that stop into two new sub-blocks: block one ends at the selected stop, and block two begins at it. The new sub-blocks are then balanced with the algorithm described in the previous paragraph. After balancing both blocks, the negative loads are rechecked using departing and through loads. The correction procedure is complete if no negative loads are present along the route (Furth, et al. 2006).

Seed Matrices

The seed matrices are the second and final input required for the IPF modelling method. As mentioned in the case study introduction (Section 1.2), the seed matrices were constructed by TPG using an online survey and smartphone-based GPS tracking and were provided for this research. However, two important aspects must be considered when preparing seed matrices.

The first aspect is the structural zeros problem. In this research, the origin-destination matrices are modelled for a single route, meaning transfers are not included. Therefore it is essential to ensure that each seed matrix pair q_{ij} , where $i = j$, contains a zero value (structural zero). It is possible that due to the nature of provided seed matrices, some q_{ij} values, where $i = j$, are larger than zero. If such a value is observed, it is then replaced as a zero value to ensure that the modelled OD matrices only provide single-route spatiotemporal data

The second aspect considered in this research is the common problem of non-structural zeros (Ben-Akiva, Macke and Hsu 1985). This problem occurs when non-structural OD pairs ($i \neq j$) with low flow values are estimated as zeros as no trips were observed on those OD pairs when constructing the seed matrix. If there are too many zeros, around 30%, it might prevent modelling convergence. Therefore, to address this issue, each non-structural zero-cell value is replaced by a constant smaller than the desired convergence error, ϵ (Lomax and Norman 2016).

Cost Matrices

Like the IPF method, the Gravity Model requires a base matrix called the cost matrix, C_{ij} . In this research, cost matrices cost are considered in minutes to fit the selected distance decay function $f(c_{ij})$ presented further.

The desired cost matrices are determined from the kilometer cost matrix by dividing each cell value by an average bus speed, $v_{average}$. The kilometer cost matrices are constructed from the available route distance information provided by TPG. Each cell in the kilometer cost matrix represents the bus travelled distance along a route from stop i to stop j . Meanwhile, the average bus speed, $v_{average}$, of the selected lines of interest was determined to be 0.24 km/min or roughly 14.5 km/h. This value, however, may seem small. The reason behind it is that it was determined from the actual bus travel times obtained from the official TPG planning website (<https://www.tpg.ch/>). The average bus speed was determined by selecting various bus travel times from the route origin to the route destination and dividing them by the total route distance (available from route distance data). This approach gives the advantage of modelling more realistic OD matrices as the selected bus travels times include the additional traffic and bus stop times.

Distance Decay Function

The third and final input required for the Gravity Model is the distance decay function $f(c_{ij})$. During the literature review, it was found that the distance decay function typically takes one of the three following forms (Gkiotsalitis 2022):

$$f(c_{ij}) = \exp(-\beta c_{ij}) \quad (\text{exponential function})$$

$$f(c_{ij}) = c_{ij}^{-n} \quad (\text{power function})$$

$$f(c_{ij}) = c_{ij}^n \cdot \exp(-\beta c_{ij}) \quad (\text{combined function})$$

These functions are of the most basic form. Additional constraints, such as points of attraction, can be added to increase modelling accuracy (Schatzmann, Sarlas and Axhausen, 2019). However, this research doesn't consider the additional constraints as they are out of scope.

An important aspect of the distance decay function is the selection of constant values or parameters (n or β). These values fit the selected function to the specific location. For the case study of this report, the

location selected is Switzerland. The literature review found that the most common distance decay function used in public transport modelling in Switzerland is a power function where $n = -1.537$ (Schatzmann, Sarlas and Axhausen, 2018).

3.2. Phase 2: Method Application

As mentioned, two modelling approaches were selected for this research: Iterative Proportional Fitting (IPF) and Gravity Model (GM). This subsection defines the required inputs and steps of the application for each method.

Iterative Proportional Fitting

The Iterative Proportional Fitting modelling method changes the seed matrix into a single-route OD matrix by applying a cell adjustment method that enforces the agreement of marginal totals. Hence, the two required data inputs for this approach are (1) seed matrices and (2) target boarding (o_i) and alighting (d_j) data.

The cell adjustment method is an iterative procedure where each iteration k , uses a row factor b_i^k and column factor a_j^k to update the respective cells using the following function.

$$Q_{ij}^{IPF,k} = b_i^k a_j^k q_{ij}^0$$

The growth factors b_i^k and a_j^k change from iteration to iteration until the desired convergence, ϵ , is achieved. The growth factors are the ratio between the observed boardings (alightings) and the estimated number of boardings (alightings) from the previous iteration. The following equations are used to compute the row and column factors for each iteration k .

$$b_i^k = \frac{q_i}{\sum_{s=1}^{s=N} Q_{ij}^{IPF,k-1}} \quad a_j^k = \frac{q_j}{\sum_{s=1}^{s=N} Q_{ij}^{IPF,k-1}}$$

Where k – is the iteration number, q_i - is the observed number of passenger boardings at stop i , q_j - the observed number of passenger alightings at stop j , N – is the route number of stops, $Q_{ij}^{IPF,k-1}$ – passenger flow between origin i and origin j estimated in iteration $k-1$.

The final form of the single-route OD matrix is achieved once the difference between the observed and estimated boardings is smaller or equal to the selected convergence level.

Gravity Method

The second method to be considered in this research is the Gravity Model. To be more precise, a doubly-constrained Gravity Model is used. The two constraints are the average (target) boarding and alighting values at each stop along the route. The following two balancing factors, a_i and b_j , are introduced to ensure that the origin and destination constraints (target boarding and alighting values) are met.

$$a_i = 1 / \sum_j b_j d_j f(c_{ij})$$

$$b_j = 1 / \sum_i a_i o_i f(c_{ij})$$

Where a_i is the origin-specific balancing row factor, b_j is the destination-specific balancing column factor, d_j is the alighting target value, o_i is the target boarding value and $f(c_{ij})$ is the respective distance decay

function value. This research shows the selected distance decay function with the corresponding constant value below (Schatzmann, Sarlas and Axhausen, 2018).

$$f(c_{ij}) = c_{ij}^{-n} \quad n = -1.532$$

The following formula is then used with the beforementioned balancing factors, target boarding and alighting values and distance decay function to determine the final form of the modelled OD matrix.

$$q_{ij} = a_i o_i b_j d_j f(c_{ij})$$

Note that the balancing factors are interdependent. Therefore, to determine the final q_{ij} an iterative algorithm of Furness is used (Gkiotsalitis 2022). This algorithm is described below.

- [1] Set convergence error ε , iteration $k=0$ and $b_j=1$
- [2] **Repeat**
- [3] Calculate a_i using the beforementioned formula
- [4] Calculate b_j using the beforementioned formula
- [5] **Repeat** steps 3 and 4 until the values of a_i and b_j from iteration to iteration are less than or equal to the convergence error ε . The final a_i and b_j are the ones of the latest iteration once the desired convergence is observed.

3.3. Phase 3: Result Comparison and Recommendations

The trip length distribution is used to compare the modelled single-route OD matrices. This distribution can be obtained by assigning distance values to the corresponding modelled OD matrix pairs and computing the cumulative proportions. Considering the longest route distance in this case study of 12,6 kilometers, the cumulative proportions in this research are selected to be the distance from 0 to 14 kilometers with the interval value of 2 km. Additionally, the absolute difference between the cumulative distributions is determined from the calculated area differences between the modelled matrices. Finally, the mean absolute error is determined to further quantify the differences between the two modelling approaches.

4. Geneva Case Study

The following chapter contains five subchapters: (1) descriptive APC data statistics, (2) data preparation, (3) IPF application, (4) GM application and (5) result comparison. Subchapter 1 applies descriptive statistics to the available APC dataset. From the descriptive statistics, two main outputs are obtained: days of the week that belong to work or weekend days and peak hours of interest. Furthermore, subchapter 2 illustrates the data preparation for OD matrix modelling. However, the approach to data preparation is identical for each line of interest. Therefore, Subchapter 2 only describes the data preparation for one selected line of interest – Line 5. The complete data preparation results of Line 5 and the other lines of interest are provided in respective line appendices. Finally, subchapters 3 to 5 illustrate the application of OD matrix modelling methods and the estimated result comparison for Line 5 of the specific case of workdays, peak hour 8, and "Aller" direction only. Only one particular case of interest is described in the last three subchapters for the same reason as in Subchapter 2 – the modelling and estimated OD matrix result comparison approaches are identical for each line case of interest.

4.1. Descriptive APC Data Statistics

First, the descriptive statistics were determined for the whole APC dataset obtained from TPG and are presented in Table 3. TPG noted that the APC data was balanced with a counting error of 2%. The descriptive statistics show that the difference between total boardings and alightings is only 0.002%. This difference can occur due to rounding errors as the boarding and alighting data are presented as the average number of passengers per hour. Furthermore, we can observe that the total number of data points is 310062, with a mean of 14 passengers per hour for both boardings and alightings equally. The standard deviation for boardings is 25 and 24 passengers per hour for alightings. This statistic indicates that the data is spread out with variance degrees of 622 and 558 for boardings and alightings, respectively. Both minimum values are 0, indicating no negative boardings or alightings occurred. Finally, the maximum value for boardings is 561 and 452 for alightings. These maximum values are relatively high but can be explained by the fact that the boardings and alightings are hourly averages, meaning that multiple buses were passing at that exact stop in that particular hour for a specific line. To be more precise: the highest value of 561 for average boardings per hour was recorded on the 5th of October, 2022 (Wednesday), hour 18 for Line 1, in the inbound ("Retour") direction at stop Genève, Gare Cornavin. During that hour, four buses of Line 1 are scheduled to pass that stop. Furthermore, the highest value of 452 for average alightings per hour was recorded on the 12th of October, 2022 (Wednesday), hour 17 for Line 5, in the "Retour" direction at the same stop as the highest boarding value. During that hour, seven buses of Line 5 are scheduled to pass that stop. Assuming that every bus attracts an equal amount of boardings, converting passengers/hour to passengers/hour-bus is possible simply by dividing the average number of boardings/hour by the number of scheduled busses. The resulting values are 140 pax/h-bus for boardings and 65 pax/h-bus for alightings.

Table 3 Descriptive statistics for the whole APC dataset

Full APC Sample									
Variable	Total (Pax/h)	Diff. (%)	N	Mean (Pax/h)	St. Dev. (Pax/h)	Var. (Pax/h)	Min. (Pax/h)	Max. (Pax/h)	Max. (Pax/h-bus)
Boardings	4436262.45	0.002	310062	14	25	622	0	561	140
Alightings	4436261.65		310062	14	24	558	0	452	65

The same descriptive statistics were determined separately for all lines in the full APC dataset: Lines 1, 3, 5, 7, 8 and 11. The results are presented in Tables 4-9, respectively. An important statistic is the difference between total boardings and alightings which varies from 0.009% to 0.52%. This difference is still relatively low and can be explained in the same way as the difference in total boardings and total alightings – rounding errors. The rest of the descriptive statistics do not indicate anomalies from the full APC dataset.

Table 4 Descriptive statistics for Line 1 of the APC dataset

Line 1 Sample									
Variable	Total (Pax/h)	Diff. (%)	N	Mean (Pax/h)	St. Dev. (Pax/h)	Var. (Pax/h)	Min. (Pax/h)	Max. (Pax/h)	Max. (Pax/h-bus)
Boardings	664774,27	0,009	64989	10	19	358	0	561	140
Alightings	664773,65		64989	10	17	301	0	341	85

Table 5 Descriptive statistics for Line 3 of the APC dataset

Line 3 Sample									
Variable	Total (Pax/h)	Diff. (%)	N	Mean (Pax/h)	St. Dev. (Pax/h)	Var. (Pax/h)	Min. (Pax/h)	Max. (Pax/h)	Max. (Pax/h-bus)
Boardings	902636,04	0,034	42801	21	29	873	0	442	44
Alightings	902632,96		42801	21	30	832	0	325	41

Table 6 Descriptive statistics for Line 5 of the APC dataset

Line 5 Sample									
Variable	Total (Pax/h)	Diff. (%)	N	Mean (Pax/h)	St. Dev. (Pax/h)	Var. (Pax/h)	Min. (Pax/h)	Max. (Pax/h)	Max. (Pax/h-bus)
Boardings	688098	0.52	46716	13	23	535	0	420	60
Alightings	688134		46716	13	21	435	0	452	60

Table 7 Descriptive statistics for Line 7 of the APC dataset

Line 7 Sample									
Variable	Total (Pax/h)	Diff. (%)	N	Mean (Pax/h)	St. Dev. (Pax/h)	Var. (Pax/h)	Min. (Pax/h)	Max. (Pax/h)	Max. (Pax/h-bus)
Boardings	468430,2	0,018	45556	10	18	330	0	222	28
Alightings	468429,3		45556	10	17	282	0	196	25

Table 8 Descriptive statistics for Line 8 of the APC dataset

Line 8 Sample									
Variable	Total (Pax/h)	Diff. (%)	N	Mean (Pax/h)	St. Dev. (Pax/h)	Var. (Pax/h)	Min. (Pax/h)	Max. (Pax/h)	Max. (Pax/h-bus)
Boardings	848703	0.46	55015	15	32	1039	0	493	82
Alightings	848664		55015	15	29	856	0	324	54

Table 9 Descriptive statistics for Line 11 of the APC dataset

Line 11 Sample									
Variable	Total (Pax/h)	Diff. (%)	N	Mean (Pax/h)	St. Dev. (Pax/h)	Var. (Pax/h)	Min. (Pax/h)	Max. (Pax/h)	Max. (Pax/h-bus)
Boardings	863625	0.009	48177	18	24	599	0	321	36
Alightings	863626		48177	18	24	585	0	365	41

Other essential attributes determined from APC data is how demand is spread along a day for both workdays and weekends, including the existence of morning and evening peak hours. These attributes were determined by calculating the total passenger boardings and alightings over the whole study period for each hour (00-23) of each weekday (Monday-Sunday) separately. The results are plotted as diagrams in Figures 4 and 5.

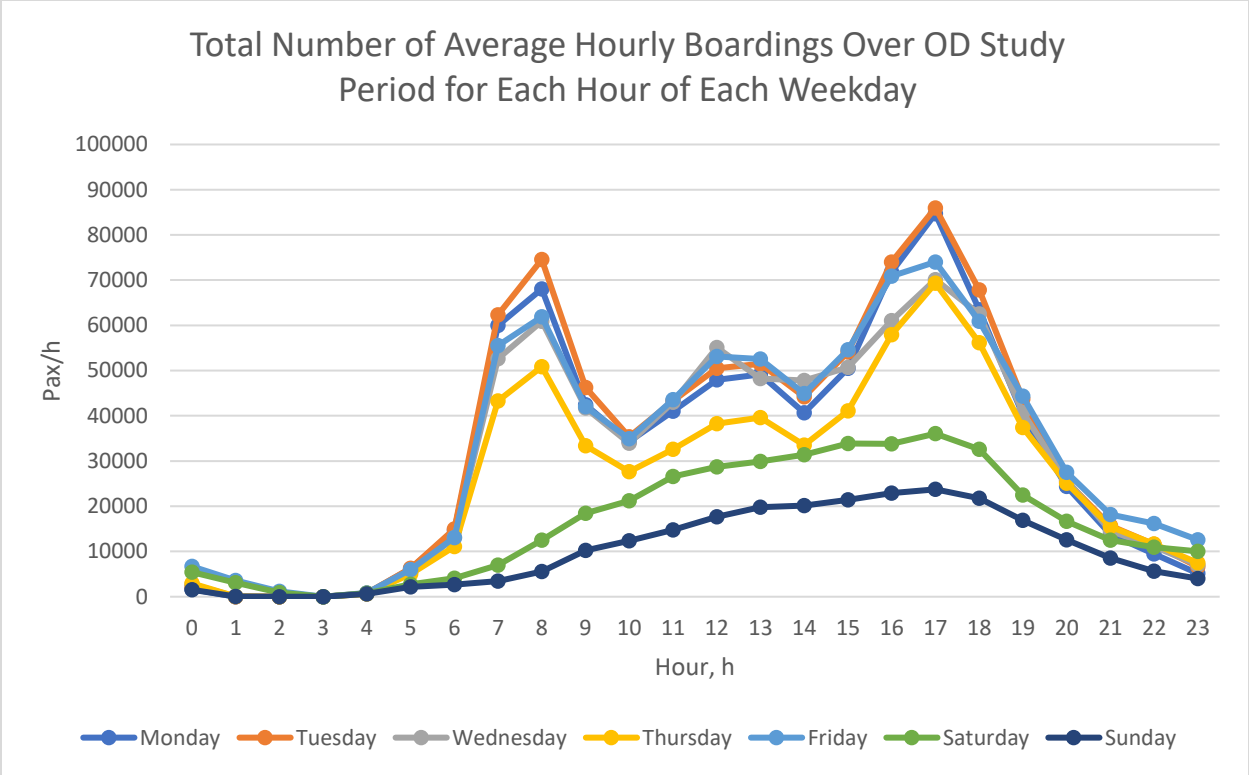


Figure 4 Total number of average hourly boardings over OD study period for each hour of each weekday

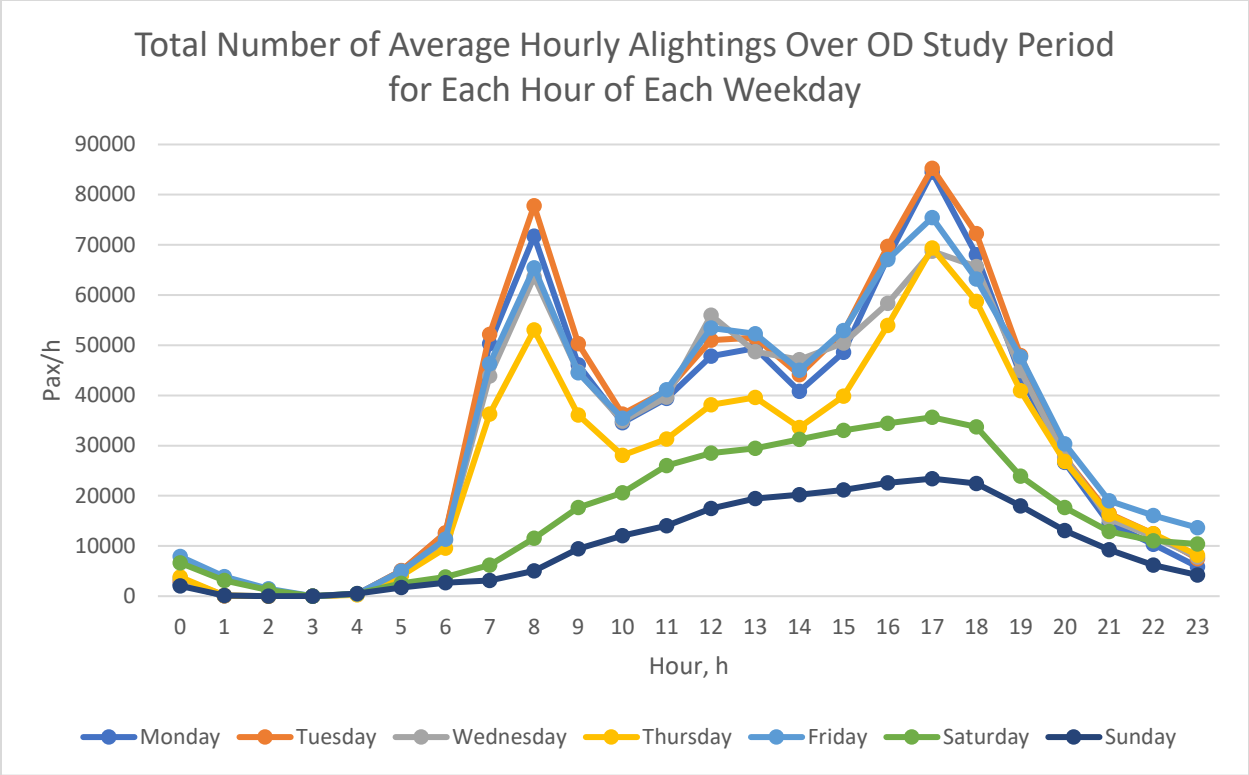


Figure 5 Total number of average hourly alightings over OD study period for each hour of each weekday

The two figures above show that the graphs for Monday, Tuesday, Wednesday, Thursday and Friday are similar in shape, having two main peaks – morning and afternoon, and a third lunch-time peak, that is smaller. The morning peak period is roughly from 7:00 to 9:00 and the evening peak period is between 16:00 and 19:00. Meanwhile, Saturday and Sunday graphs differ from the previous weekdays as they are much smoother and don't contain clear peak hours but are alike. Public transport demand is the largest at around 16:00 to 18:00 on weekends. However, since the chart of Saturday has a clear distinction from Sunday in terms of the total number of passengers, they are considered as two separate datasets in this research. Therefore in the remainder of this research, three different datasets will be used: workdays (Monday, Tuesday, Wednesday, Thursday and Friday combined), Saturday and Sunday.

If we restrict ourselves to one hour of operation, from the figures it is also possible to identify morning and evening peak hours for workdays and evening peak hours for Saturday-Sunday by identifying the most active hours (hours with the highest total average pax/h of boardings and alightings). The results are presented in Table 10 below.

Table 10 Morning and evening peak hours for week and weekend days

	Morning Peak Hour	Evening Peak Hour
Weekdays	8	17
Saturday	-	17
Sunday	-	17

Furthermore, by plotting hourly average passenger boardings for each line over an average workday, it is possible to observe which lines receive the most passenger load. Graphs like this for each line are plotted in Figure 6 below. Figure 6 shows that Line 1 has the highest average passenger boarding during the morning peak hour. Meanwhile, Line 11 has the highest number of average boardings for the evening peak hour.

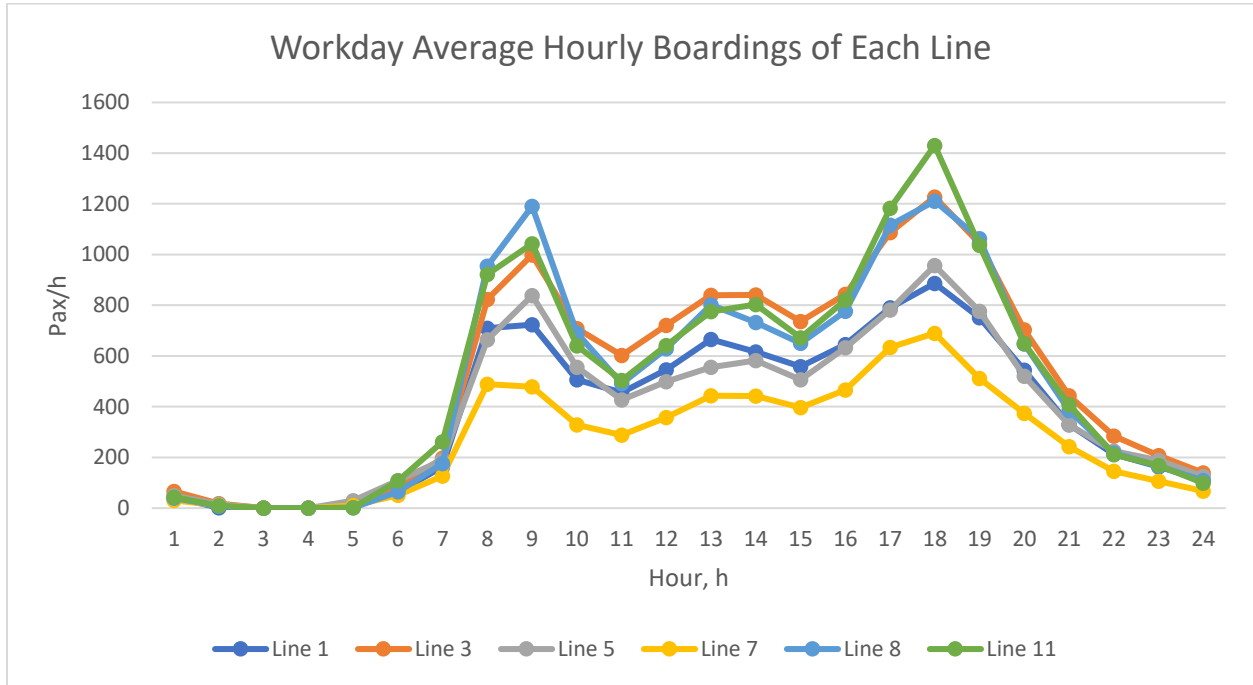


Figure 6 Workday average hourly boardings of each Line

To continue, under the simplifying assumption that each scheduled bus is equally attractive to passengers at each hour, it is possible to determine the average hourly passenger boarding per bus. This is presented in Figure 7 below, where the highest passenger boarding per bus is observed for Line 1 and Line 8. It is worth noting that Figure 7 presents the total number of passengers using a bus along the whole line, it is not the observed load of a bus, which is smaller than the total boarding demand.

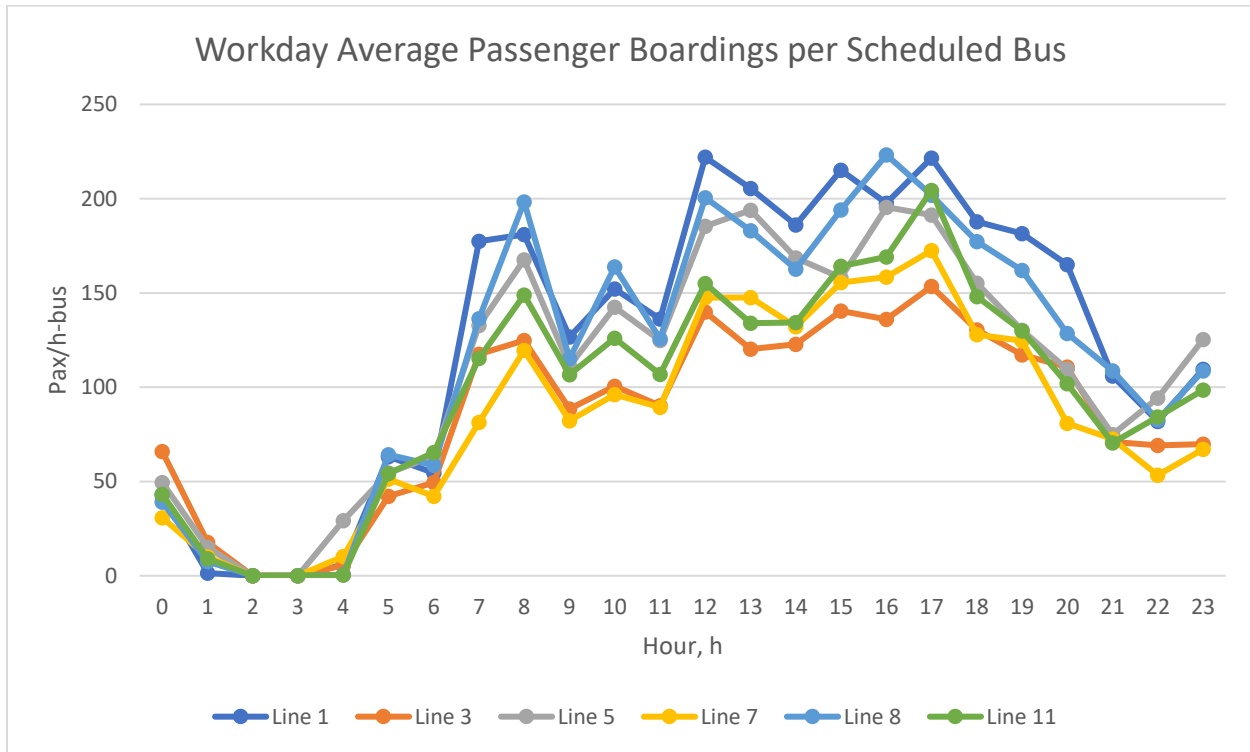


Figure 7 Workday average passenger boardings per scheduled bus

Finally, to conclude the descriptive data statistics for the Automated Passenger Count dataset, total hourly boardings and alightings at each stop for workday peak hours 8 AM and 5 PM are compared in Figures 8-11. Each bus stop recorded in APC data is presented as a coloured circle where darker colour indicates more boardings or alighting at that stop during that hour. At a first glance, it is hard to determine people's movements within Geneva city. However, it is visible that during the morning rush hour, more boardings occur on the outskirts of Geneva, thus indicating that in the morning, people tend to move towards the centre of Geneva. Meanwhile, during the evening peak hour, more alightings are observed on the outskirts of Geneva, thus indicating the opposite people movement to the one of the morning rush hour.



Figure 8 Total Stop Boardings, 8AM, Workday

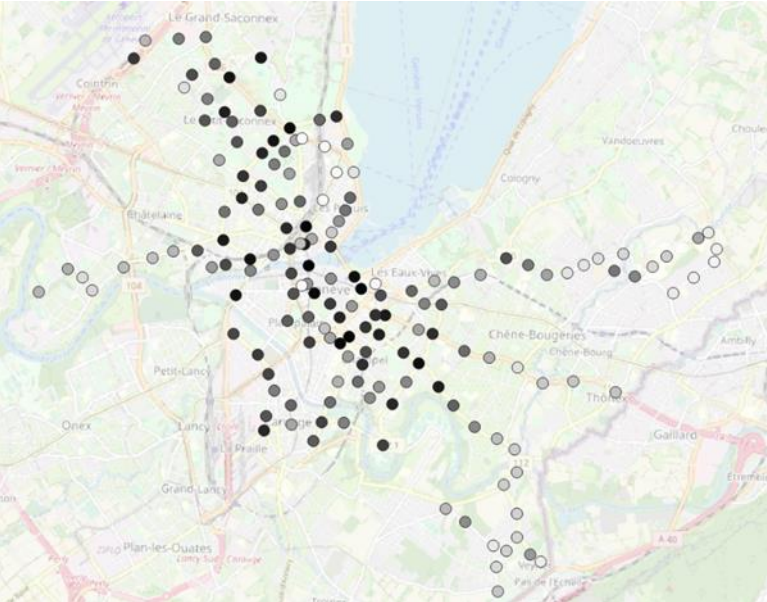


Figure 9 Total Stop Alightings, 8AM, Workday

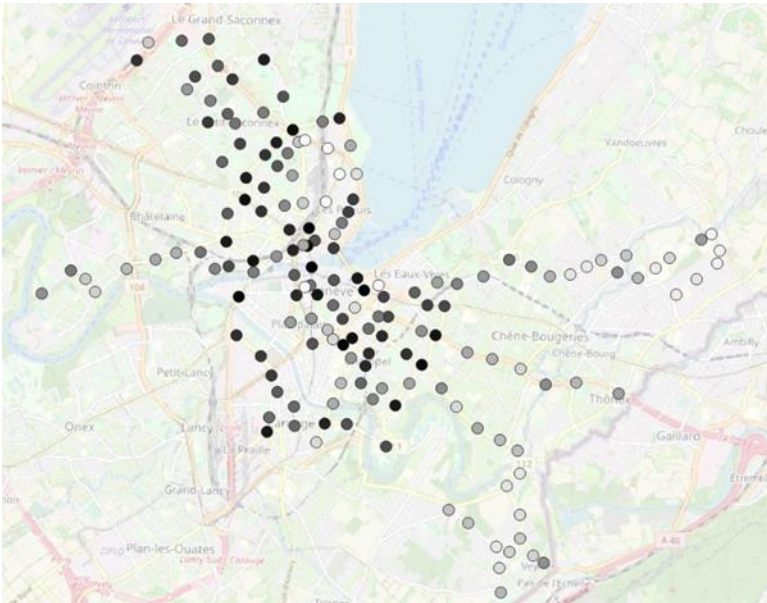


Figure 10 Total Stop Boardings, 5PM, Workday

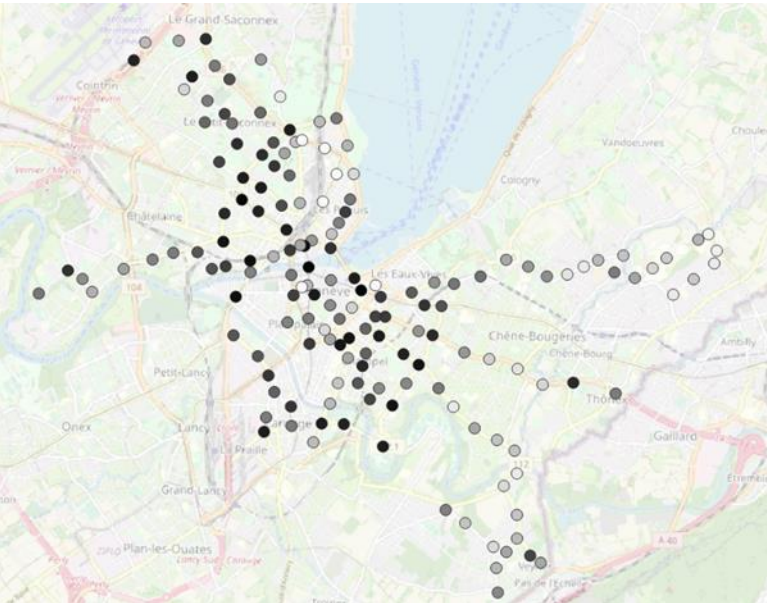


Figure 11 Total Stop Alightings, 5PM, Workday

4.2. Case Study Data Preparation

In Chapter 3, four types of required modelling data were mentioned: (1) seed matrices, (2) generated boardings (o_i) and alightings (d_j), (3) cost matrices and (4) distance decay function. This subchapter illustrates how each required dataset for OD matrix modelling is obtained. As mentioned in the Chapter 4 introduction, the procedures are only described for Line 5 as they are identical for each line of interest. Complete results of this subchapter are provided in respective line appendices.

Seed Matrices

In the methodology subsection 3.1, it was mentioned that two important aspects need to be considered for the preparation of available seed matrices: structural zeros and non-structural zeros problems. The structural zeros problem refers to matrix pairs q_{ij} where, i , and j are equal. It is essential to ensure that these matrix pairs are zero values. If a value greater than zero is observed, it is replaced with a zero value.

The second aspect considered in this research for seed matrix preparation is the non-structural zeroes problem (Ben-Akiva, Macke and Hsu 1985). In short, this problem occurs when non-structural OD pairs ($i \neq j$) with low flow demand values are estimated as zero values, because no trips were observed there when estimating the seed matrix. In Figure 12, the non-structural zero-value cells of the same initial seed matrix for Line 5 are highlighted in green. Noticeably, about 50% of the data contains non-structural zero-value cells. If the cell values are left as zeroes, it will cause difficulties during IPF application. Each zero-value cell will remain with zero estimated passenger flows after the IPF application, even if the OD pair is a legitimate choice for passengers. In Chapter 3.1, it was briefly mentioned that in this research, a small constant value is added to each cell in the seed matrix to overcome the non-structural zeroes issue. The constant value should be smaller than the selected convergence test value of 0.02 and higher than zero (Lomax and Norman 2016). Therefore, in this research, the constant value to overcome the non-structural zeros issues is determined as half of the convergence test value and is equal to 0.01. The updated and final seed matrix for Line 5 and other lines of interest can be found in the respective line appendices.

Figure 12 Highlighted non-structural zeros of the initial seed matrix of Line 5

Generated boardings (o_i) and alightings (d_j)

To obtain the generated target boardings (o_i) and alightings (d_j) for each route direction, the average boardings and alightings were determined for each bus line stop over the whole data period in both route directions for a

specific peak hour. The portion of obtained workday average boardings and alightings for both route directions at hour 8 is provided in Table 11 below.

Table 11 Unbalanced average boardings (o_i) and alightings (d_j) for Line 5, workdays, hour 8, both directions

Stop name	"Aller", Boardings (pax/h)	"Aller", Alightings (pax/h)	"Retour", Boardings (pax/h)	"Retour", Alightings (pax/h)
01 Thônex, Vallard	71	0	0	14
02 Thônex, Sous-Moulin	152	5	1	8
03 Chêne-Bougeries, Coll. Claparède	11	6	1	7
...
32 Grand-Saconnex, Palexpo	7	32	21	9
33 Grand-Saconnex, Arena-Halle 7	3	14	17	1
34 Genève-Aéroport, Terminal	0	93	80	0

Furthermore, for all three modelling approaches, the total generated boardings (o_i) and alightings (d_j) must be equal; otherwise, convergence is not achievable. Table 12 contains marginal boarding and alighting totals for Line 5, workdays, for morning peak hour 8 in both route directions before and after balancing with respecting balancing factors used. It can be observed that the unbalanced total boardings in "Aller" direction, 934, do not match the unbalanced total alightings, 942, in the same direction. Therefore a balancing procedure, as described in Section 2.3 of this report, is performed over the average unbalanced boarding and alighting data. It was decided to balance the alighting data to match the total boardings up to a whole number, hence the balancing factors for boardings. The respective balancing factors were applied for each stop to obtain the balanced totals. A portion of the balanced totals is provided in Table 13.

Table 12 Marginal boarding (Q_i) and alighting (Q_j) totals for Line 5 before and after balancing, workdays, hour 8, both directions

	"Aller", Boardings (pax/h)	"Aller", Alightings (pax/h)	"Retour", Boardings (pax/h)	"Retour", Alightings (pax/h)
Unbalanced Totals	934	942	804	848
Balancing Factor (f)	1.000246	0.991425	1.000067	0.948516
Balanced Totals	934	934	804	804

Table 13 Balanced average boardings (o_i) and alightings (d_j) for Line 5, workdays, hour 8, both directions

Stop name	"Aller", Boardings (pax/h)	"Aller", Alightings (pax/h)	"Retour", Boardings (pax/h)	"Retour", Alightings (pax/h)
01 Thônex, Vallard	71	0	0	13
02 Thônex, Sous-Moulin	152	5	1	7
03 Chêne-Bougeries, Coll. Claparède	11	6	1	6
...
32 Grand-Saconnex, Palexpo	7	31	21	8

33 Grand-Saconnex, Arena-Halle 7	3	14	17	1
34 Genève-Aéroport, Terminal	0	92	80	0

The balanced target boarding and alighting data are also checked to ensure no negative loads are observed on the bus along the route. Figure 13 presents the average bus load of Line 5 in "Aller" and "Retour" directions throughout the route for workdays, hour 8 (note the direction of the route). No negative loads occur throughout the route; therefore, no balancing procedure must be done, and the balanced values are considered final.

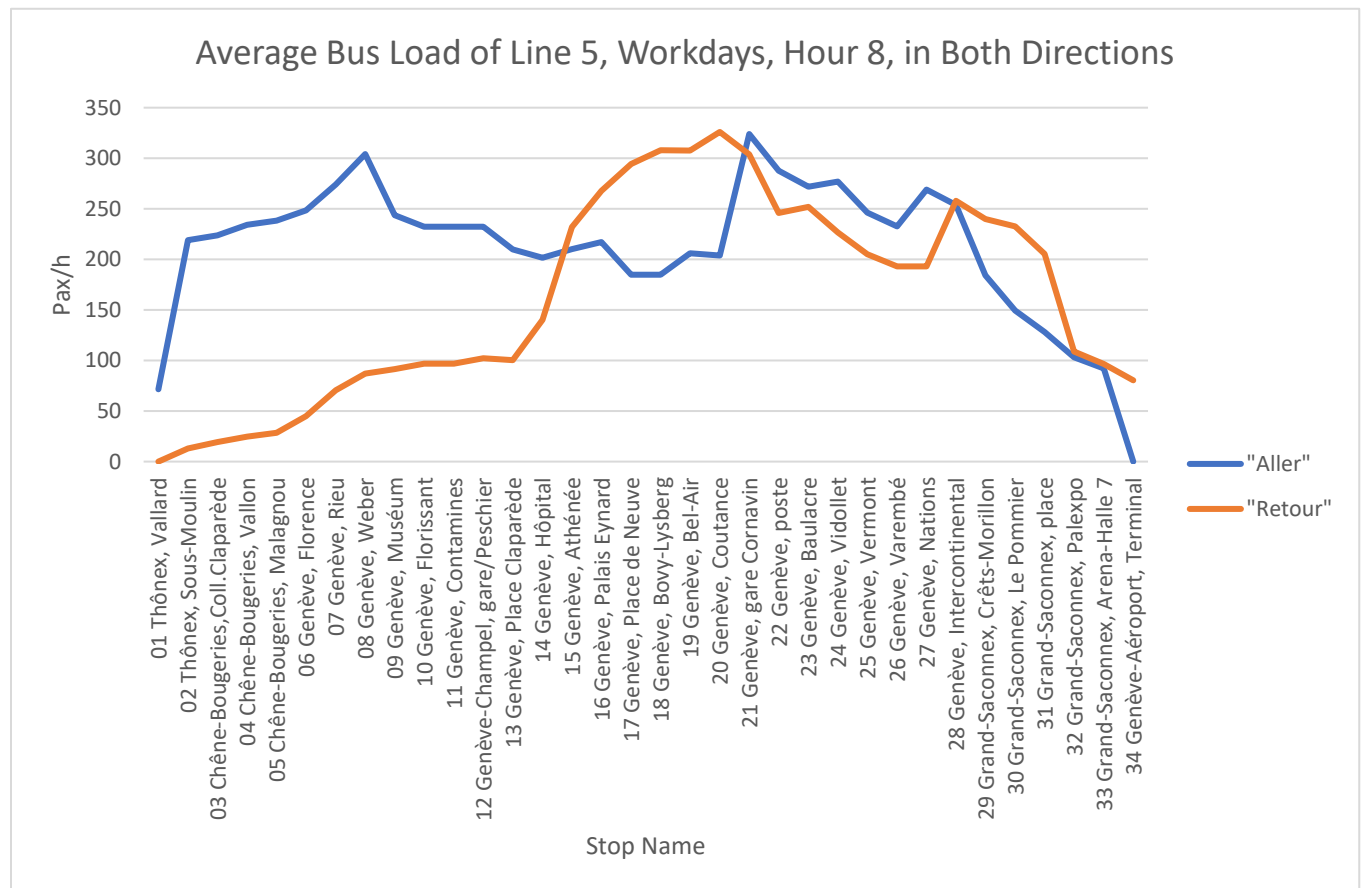


Figure 13 Average bus load of Line 5, workdays, hour 8, in both directions

Cost Matrices (C_{ij})

In this research, the variable used for cost matrices is travel time and the unit is minutes. Each cell in the cost matrix represents the average time in minutes for a bus to travel from a particular origin i to a specific destination j along the route. The kilometer cost values were first calculated based on bus travel distances between stops provided by TPG. Since each bus route varies per direction, the matrices obtained aren't symmetrical. The constructed cost matrix with kilometer values for Line 5 is presented in Figure 34, Appendix Line 5. In the presented matrix, stops that can be reached only in one direction are highlighted in green and yellow. The green indicates stops that can only be reached in the "Aller" direction; meanwhile, the yellow indicates stops that can only be reached in the "Retour" direction. Noticeably, highlighted cells

and OD pairs with the same stop name are left empty. This is done because the research doesn't consider bus transfers, thus making the stops unreachable from a certain route direction. To transform the kilometer cost matrices, each cell was divided by the beforementioned (see section 3.1) average bus travel speed $v_{average} = 0.24$ km/min. The final cost matrix for Line 5, where cost values are minutes is presented in Figure 35, Appendix Line 5.

Distance Decay Function $f(c_{ij})$

In Subchapter 3.1, it was mentioned that for this research, the following distance decay power function is selected with the constant value $n = 1.537$ (Schatzmann, Sarlas and Axhausen, 2018).

$$f(c_{ij}) = c_{ij}^{-n}$$

4.3. IPF Example

This subsection illustrates OD matrix modelling using the Iterative Proportional Fitting approach for Line 5 in the case of workdays, hour 8:00-9:00, and “Aller” direction. The procedure is implemented in Microsoft Excel.

Step 1 of the method is to obtain the required data: seed matrix, target boardings (o_i) and alightings (d_j). The data used in this specific case is the “Aller” direction seed matrix of Line 5 and the target boarding and alighting data of Line 5, workdays, hour 8, can be found in Appendix Line 5.

Step 2 starts the iterative cell adjustment method containing the following three steps.

a) Determine the row factors b_i^k for each row, i , using the formula $b_i^k = \frac{q_i}{\sum_{s=1}^N Q_{ij}^{IPF,k-1}}$ for iteration, k , and update each cell with the respective estimated row factor. After this step, the updated row totals match the target boardings (o_i) but not the column totals. Therefore the next step is to adjust the column totals to match the targeted alightings (d_j).

b) To adjust the column totals, the column factors a_j^k for each column, j , are determined using the formula $a_j^k = \frac{q_j}{\sum_{s=1}^N Q_{ij}^{IPF,k-1}}$. After obtaining the column factors, each matrix cell is updated with the respective column factor. This step matches column totals but compromises the row totals.

c) In theory, steps a and b should be repeated until the desired convergence is observed. To determine when the desired convergence is achieved, this step is used. It calculates the maximum convergence after each iteration cycle k . The maximum convergence is determined by calculating the convergence of each row via the following formula and then returning the maximum value.

$$\varepsilon_i = \left| 1 - \frac{o_i}{Q_i} \right|$$

Where ε_i is the convergence value of row i , o_i is the targeted boarding and Q_i is the updated row totals.

The maximum convergence value is then checked against the desired convergence of 0.02. Suppose the maximum convergence value is higher than the desired convergence. In that case, the iterative cell adjustment cycle starts from the beginning (step a) with the latest updated matrix. The process is then

repeated until the expected convergence of 0.02 is observed as a maximum convergence value for the specific case. Note – sometimes, the division by 0 may occur when determining the row convergence, as some stops are direction specific. In those cases, the convergence is updated manually to 0.

The resulting OD matrix of this particular case was achieved after seven iterations and is presented in Figure 36, Appendix Line 5.

4.4. GM Example

This subsection illustrates the second OD matrix modelling approach – Gravity Model - for Line 5 in the case of workdays, hour 8, and “Aller” direction. This approach was applied in Microsoft Excel. Figure 35, Appendix Line 5 shows the resulting cost matrix C_{ij} used

In Subchapter 3.2, the algorithm of Furness was described for the Gravity Model. The steps of that algorithm for the specific case are applied below.

Step 1 sets the desired convergence error $\epsilon=0.02$ and destination-specific row factor $b_j=1$ for iteration $k=0$.

Step 2 starts the iterative loop, during which steps 3 and 4 are repeated.

Steps 3 & 4 use the following formulas to determine the row and column specific factors for each iteration k . Note that since the goal is to model single-route OD matrices, it is essential to ensure that at each iteration k , cells representing possible passenger flow from the other direction are perceived as 0 values.

$$a_i = 1 / \sum_j b_j d_j f(c_{ij})$$

$$b_j = 1 / \sum_i a_i o_i f(c_{ij})$$

After each iterative loop iteration, the maximum convergence is tested in Step 5 between the current and previous iterations balancing factors using the formulas below. If the observed maximum convergence of both balancing factors is higher than the desired convergence error $\epsilon=0.02$, steps 3-5 are repeated.

$$\epsilon_{ai} = \left| 1 - \frac{a_i^k}{a_i^{k-1}} \right|$$

$$\epsilon_{bj} = \left| 1 - \frac{b_j^k}{b_j^{k-1}} \right|$$

The procedure stops when the highest observed convergence error is equal or smaller than the desired convergence error of 0.02. For the specific case of Line 5, workdays, hour 8, and “Aller” direction, the desired convergence was observed after 5 iterations.

4.5. OD Matrix Comparison Example

As mentioned in the methodology, trip length distribution is used to compare the difference between two modelled OD matrices. Note that since estimated matrices are single-route, they do not have overlapping

cells (cells where $i = j$), and the trip length distributions can be modelled from the full single-route OD matrix. In this section, an example of the trip length distribution is obtained for the case of Line 5, workdays, hour 8. The two flowing figures (Figure 36 and Figure 40, Appendix Line 5) represent this case's estimated single route OD matrices.

For both IPF and GM-modelled OD matrices, the trip distance to each cell value is assigned from the kilometer cost matrix presented in Figure 34, Appendix Line 5. The trip distance values are then transformed into trip length distribution.

The resulting trip length distributions for IPF and GM methods of the specific case considered are provided in Table 14 below. The distance column indicates the considered route distance; meanwhile, the IPF and GM columns represent the portion of passengers with the trip lengths within the selected interval. For example, the value of 0.401 in the IPF column indicates that 40.1% of total passenger trips were estimated to have a distance larger than 2 kilometers but smaller than 4. Using the total number of estimated passenger trips for the specific case (1738 for IPF and 1738 for GM), it is possible to visualize the differences between the number of estimated passenger trips per distance class, see Figure 14. Additionally, the average and median of trip distances were determined for both modelling approaches (see Table 15).

Table 14 Trip length distributions for Line 5, workdays, hour 8, both methods

Distance	IPF	GM
2 km	0.414	0.571
4 km	0.401	0.203
6 km	0.141	0.110
8 km	0.030	0.056
10 km	0.009	0.031
12 km	0.003	0.023
14 km	0.002	0.006

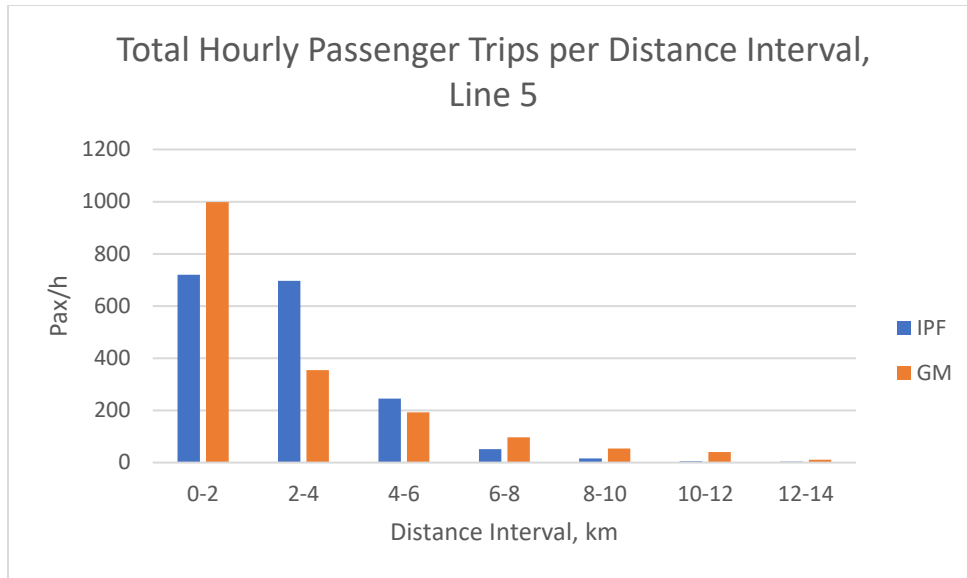


Figure 14 Total estimated hourly passenger trips per distance class for Line 5, workdays, hour 8, both methods

Table 15 Mean and Median of Trip Distances of IPF and GM OD matrices, Line 5, workdays, hour 8

	IPF	GM
Mean Trip Distance, km	2.68	2.75
Median Trip Distance, km	2.42	2.31

Figure 14 shows that the GM modelling approach estimated more long-distance trips (for distance intervals 12-14, 10-12, 6-8) and substantially more shortest-distance trips. Meanwhile, the IPF model estimated more medium-distance trips for 2-4 and 4-6 intervals. The nature of each modelling approach can explain the differences. As mentioned, the IPF method requires a seed matrix, which was constructed from the origin-destination study and GPS tracking by TPG in the Geneva case study. Furthermore, the Gravity Model highly depends on the selected distance decay function. Therefore, the estimated passenger trips using the IPF method are more specific to the actual situation, assuming that provided seed matrices are of high quality, of the selected line of interest, and the Gravity Model results represent a situation which would be more general for the whole of Switzerland.

To further quantify the differences, using the cumulative proportions, the trip length distributions can be transformed into cumulative trip length distributions. The results are presented in Table 15, where each cell value represents the cumulative proportion of passenger trips with a smaller distance than the respective row distance. The absolute differences between the cumulative trip length distributions can be determined by computing the areas between the curves.

Table 16 Cumulative trip length distribution, Line 5, workdays, hour 8, both methods and absolute difference

Distance	IPF	GM	Absolute Difference
2 km	0.414	0.571	0.157
4 km	0.815	0.774	0.041
6 km	0.956	0.884	0.072
8 km	0.986	0.940	0.046

10 km	0.995	0.971	0.024
12 km	0.998	0.994	0.004
14 km	1.000	1.000	0.000

Finally, the mean absolute difference, ε_{MAE} , is calculated using the equation. The mean absolute difference for the case of Line 5, workdays, hour 8 is observed to be equal to 1.1326.

$$\varepsilon_{MAE} = \frac{\sum_{i=1, j=1}^n |q_{ij}^{IPF} - q_{ij}^{GM}|}{n}$$

Where ε_{MAE} is the mean absolute difference, n is the total number of cells in a matrix, q_{ij}^{IPF} and q_{ij}^{GM} , are the modelled passenger trips for ij OD pairs of the respective modelling approaches.

5. Results and Discussion

The final modelled single-route origin-destination matrices for all lines and cases of interest are provided in the according appendices. To compare the Iterative Proportional Fitting and Gravity Model matrices, the (cumulative) trip distribution functions and absolute differences were computed like in the example subsection 4.5. In this section, however, only the case of interest for workdays, peak hour 8, is discussed for all four lines of interest. The reason is that the results between different line cases of interest only vary in numerical values. Therefore, the further discussion of this chapter can be applied to all cases discussed in this report.

Using the respective modelled OD matrices in combination with the route distance information, the following (cumulative) trip distributions and absolute differences were determined for lines 1, 5, 8 and 11 for the case of workdays, peak hour 8.

Table 17 Trip distribution, cumulative trip distribution, absolute difference, lines 1, 5, 8 and 11, workday, hour 8

Distance interval (km)	Trip Distribution		Cumulative Trip Distribution		Absolute Difference
	IPF	GM	IPF	GM	
Line 1					
0-2	0.615	0.657	0.615	0.657	0.043
2-4	0.240	0.169	0.855	0.827	0.028
4-6	0.092	0.075	0.947	0.902	0.046
6-8	0.039	0.051	0.986	0.953	0.033
8-10	0.010	0.033	0.996	0.986	0.010
10-12	0.003	0.013	0.999	0.999	0.000
12-14	0.000	0.001	1.000	1.000	0.000
Line 5					
0-2	0.414	0.571	0.414	0.571	0.157
2-4	0.401	0.203	0.814	0.774	0.041
4-6	0.141	0.110	0.956	0.884	0.072
6-8	0.030	0.056	0.985	0.940	0.046
8-10	0.009	0.031	0.995	0.971	0.024
10-12	0.003	0.023	0.998	0.994	0.004
12-14	0.002	0.006	1.000	1.000	0.000
Line 8					
0-2	0.476	0.575	0.476	0.575	0.098
2-4	0.352	0.221	0.828	0.796	0.032
4-6	0.125	0.097	0.953	0.893	0.061
6-8	0.040	0.060	0.993	0.952	0.040
8-10	0.004	0.025	0.997	0.978	0.020
10-12	0.002	0.022	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000
Line 11					
0-2	0.603	0.687	0.603	0.687	0.085
2-4	0.307	0.177	0.910	0.864	0.046

4-6	0.075	0.070	0.985	0.935	0.050
6-8	0.014	0.033	0.998	0.968	0.031
8-10	0.001	0.022	1.000	0.990	0.010
10-12	0.000	0.010	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000

Together with the total estimated average hourly passenger trips (see Table 18), the derived trip distribution functions can be converted into the total estimated passenger hourly passenger trips per selected distance interval. The results were plotted in the following four figures.

Table 18 Total modelled passenger trips per line, per modelling method

Line	Total modelled passenger trips per line per modelling method (pax)	
	IPF	GM
Line 1	1529	1529
Line 5	1738	1738
Line 8	2493	2493
Line 11	2214	2214

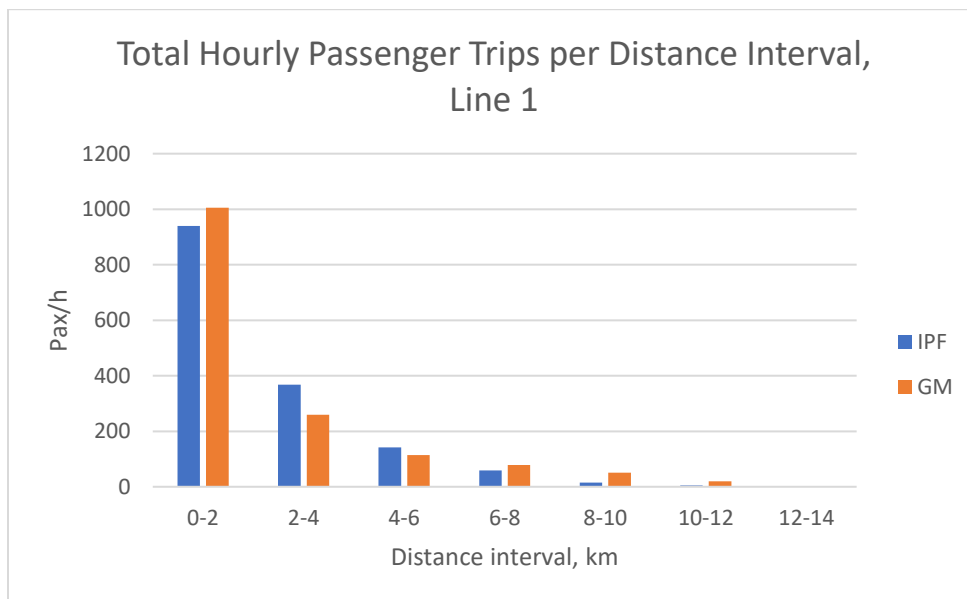


Figure 15 Total hourly passenger trips per distance interval, Line 1, workdays, hour 8

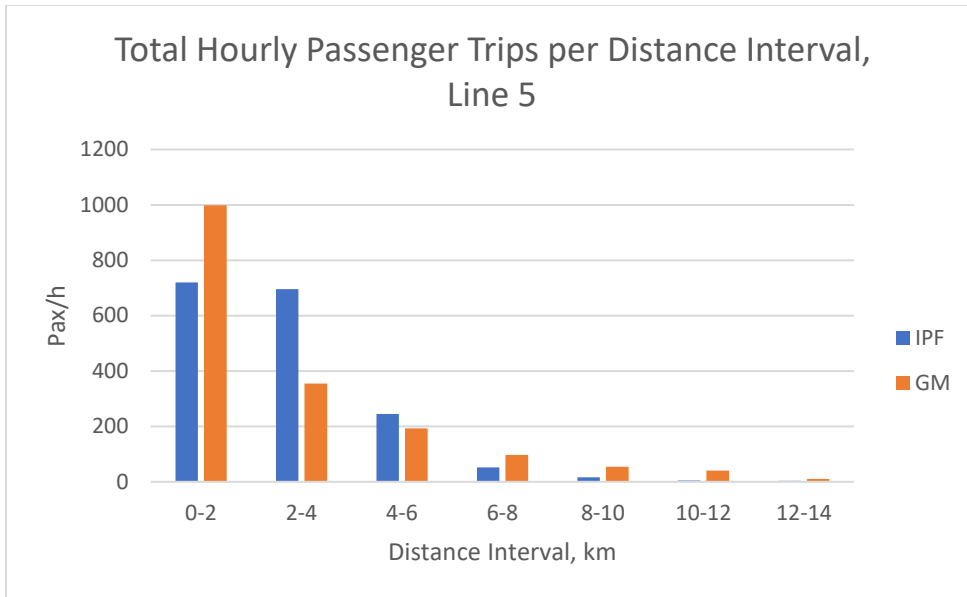


Figure 16 Total hourly passenger trips per distance interval, Line 5, workdays, hour 8

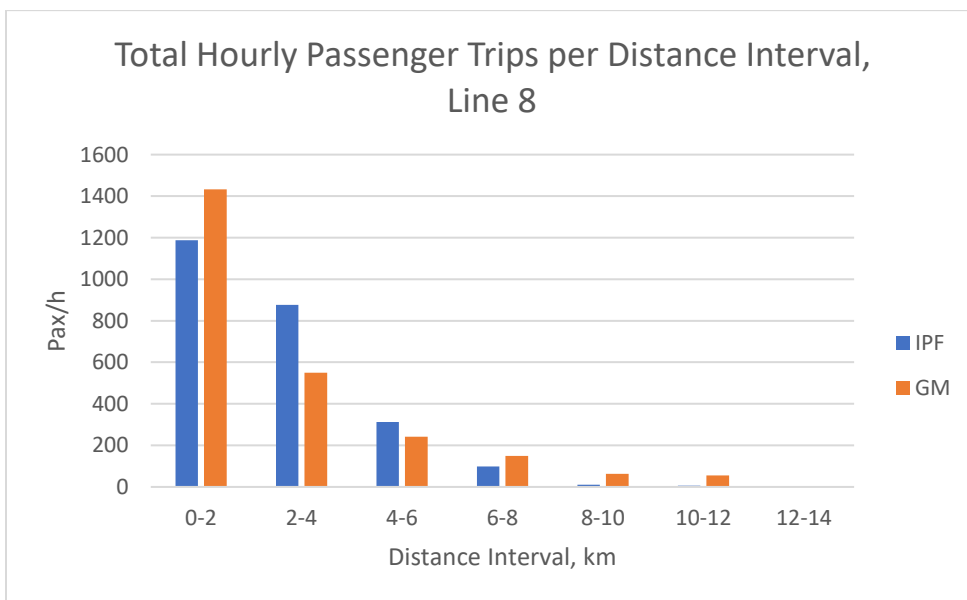


Figure 17 Total hourly passenger trips per distance interval, Line 8, workdays, hour 8

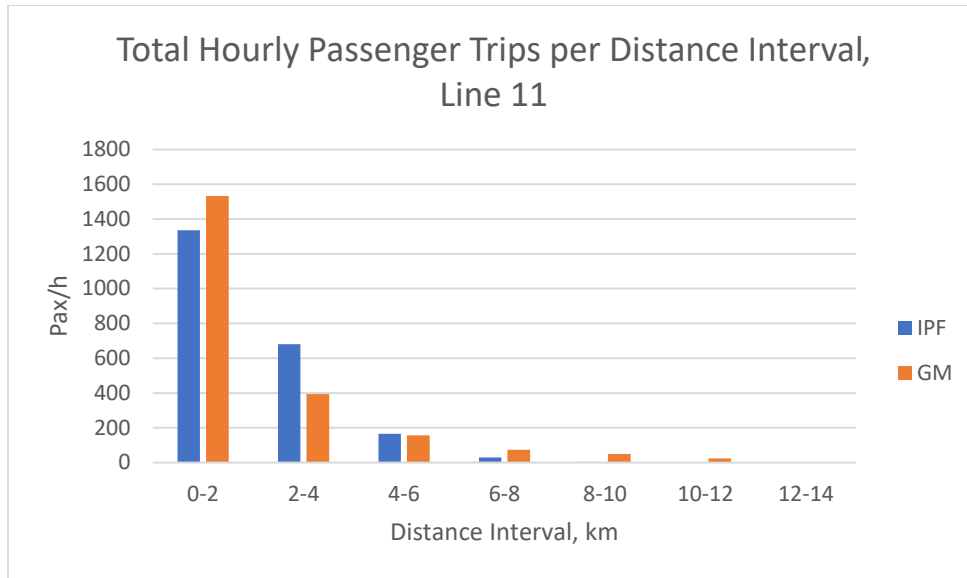


Figure 18 Total hourly passenger trips per distance interval, Line 11, workdays, hour 8

As discussed in subsection 4.5, the modelled result of the Iterative Proportional Fitting highly depends on the available seed matrix, and the gravity model estimation approach highly depends on the selected distance decay function. From the graph observations, it is visible that in all four modelled cases, the gravity model estimates a larger passenger count on the shortest-distance trips (0 to 2 km) and for all trips larger than 6 kilometers. The distribution of gravity model columns also fits the negative power function used during the modelling approach. This fit again shows that the modelled results of the gravity model highly depend on the selected distance decay function.

To further show that the Gravity Model modelled OD matrices highly depend on the selected distance decay function, a simple sensitivity analysis was performed for the case of Line 1, workdays, hour 8. Four different constant values of the same negative power distance decay function were compared with the IPF method, see Table 19. The mean absolute error with respect to the modelled IPF matrix is provided in the same table. It can be observed that when changing the constant value, n , of the distance decay function, the mean absolute error increases. Additionally, Figure 19 illustrates the modelled trip distributions for the IPF and different variations of the Gravity Model. In the figure, the change in modelled trips per distance interval can be observed. This sensitivity analysis proves once more that the resulting OD matrices highly depend on the selected distance decay function when using the Gravity Model approach.

Table 19 Distance decay function sensitivity analysis constant values

Figure Reference	Constant value n	Mean Absolute Error (Gx compared to IPF)
G0	-1.537	0.5143
G1	-1.037	0.6156
G2	-2.037	0.7519
G3	-2.537	0.8065

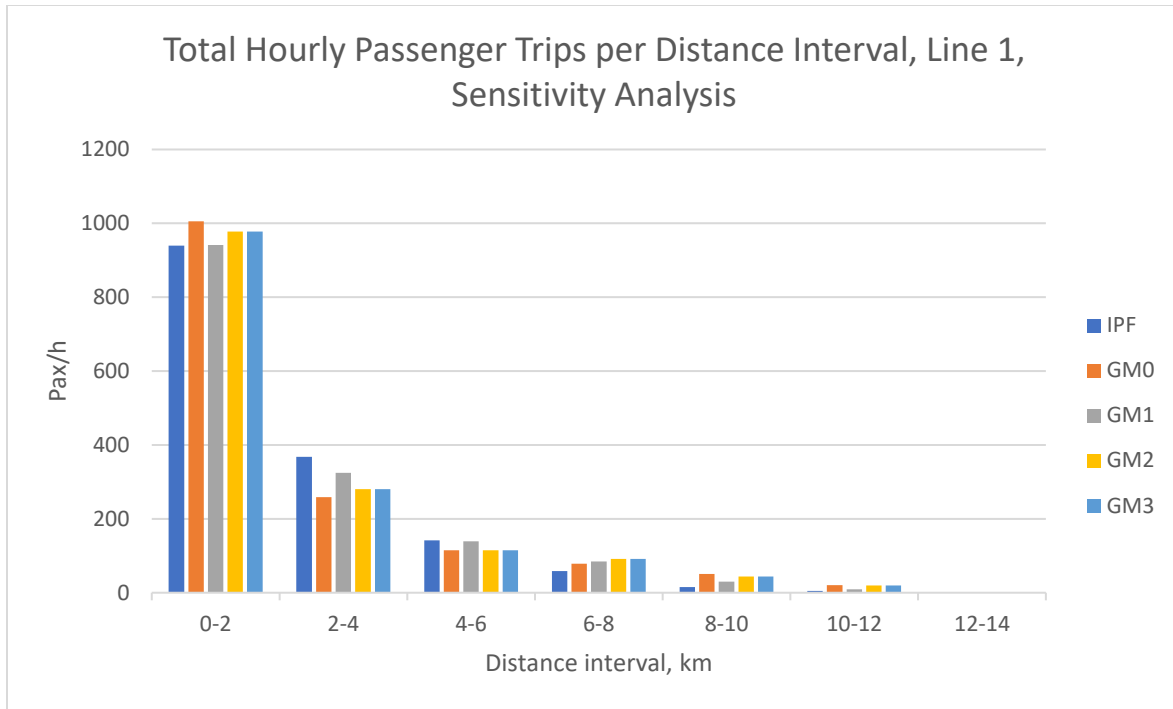


Figure 19 Total Hourly Passenger Trips per Distance Interval, Line 1, workdays, hour 8, Sensitivity Analysis

Furthermore, in all four figures, it is observed that the IPF estimation method estimates more passenger trips for intervals 2-4 and 4-6 than the compared gravity model. The nature of IPF can explain this difference, as the modelled OD matrices are a direct product of the iterative cell adjustment method performed on the seed matrices.

Finally, the mean absolute error for all cases of interest (see Table 20 below) was computed to further quantify the difference between the methods. The mean absolute error for each case of interest ranges from 0.2425 to 2.1839. Noticeably, the observed errors for weekend peak hours are almost half the workday peak hour errors. This indicates that the matrices modelled with lower passenger demand (Saturday-Sunday) are more similar between the two methods than the ones modelled with higher passenger demand (workdays hours 8 and 17).

Table 20 Mean Absolute Error of all cases of interest

	Workdays, Hour 8	Workdays, Hour 17	Saturday, Hour 17	Sunday, Hour 17
Line 1	0.5143	0.6321	0.2844	0.2425
Line 5	1.1326	1.2697	0.6104	0.5225
Line 8	1.1103	1.0496	0.5251	0.3305
Line 11	1.5694	2.1839	0.9471	0.6557

Considering the discussed differences, it can be concluded that due to the modelling nature of the OD matrix estimation approaches, the single route OD matrices modelled with the Iterative Proportional Fitting method represent the current network situation more realistically. That is because the Gravity Model is estimated with the distance decay function of general public transport use in Switzerland rather

than the Geneva distance decay function, which is more specific to the actual TPG network situation. Therefore the recommended modelling approach for TPG is the Iterative Proportional Fitting method.

It is worth noting that the desired goal of TPG is to construct the network-level OD matrix, thus combining the modelled single-route OD matrices. Some lines may be missing the seed matrices for the IPF modelling approach. In those cases, it is possible to model the single-route OD matrices using the Gravity Model. However, a more comprehensive sensitivity analysis should be performed to identify the appropriate distance decay function representing the real network situation closest. The sensitivity analysis should be performed on one of the lines modelled by the IPF modelling approach, assuming that the used seed matrices were of high quality.

6. Summary and Future Research

To summarize this research, from the available passenger boarding and alighting count data obtained from APC systems, it was found that weekdays from Monday to Friday have a similar pattern of passenger hourly boarding data with two peak hours: morning hour 8 and evening hour 17. Therefore the five workdays can be grouped to estimate an average workday single-route OD matrix. Furthermore, an average hourly boarding count showed that the weekend days, Saturday and Sunday have a similar hourly distribution. However, unlike the workdays, they should be considered separately with one evening peak hour – 17, as the total hourly Saturday boardings are around half the time smaller than Saturday hourly boardings. To continue, it was found that line 8 receives the highest hourly boarding on an average workday during morning rush hour and line 11 during evening rush hour. Finally, the available APC data provided by TPG showed that during the morning rush hour on a workday, more boardings occur at the outskirts of Geneva and during the evening rush hour - more alightings. Thus, on an average workday, the morning rush hour traffic is directed towards the city centre and, during the evening peak hour, away from the Geneva city centre.

Furthermore, using the available APC, route distance and seed matrix data, the single-route OD matrices were modelled using Gravity Model and the Iterative Proportional Fitting estimation approach for the Geneva case study. In the Geneva case study, four lines of interest (1, 5, 8 and 11) of the TPG public transport network were modelled for four selected cases of interest. Case 1 – average workday, morning peak hour 8; case 2 – average workday, evening peak hour 17; case 3 – Saturday evening peak hour 17, and case 4 – Sunday evening peak hour 17. The obtained matrix values are average passenger hourly trips and can be found in the corresponding line appendices. After comparing the obtained OD matrices, it was decided to recommend using Iterative Proportional Fitting for the specific case study of Geneva to better represent the reality of the TPG public transport network.

This research's single-route passenger OD matrix outputs and the additional transfer flow data can be used as input for the network-level passenger OD matrix modelling. Furthermore, the obtained matrices can already be used in various public transport problems, such as resource scheduling. Additionally, future research could include more complex distance decay functions for the Gravity Model and OD matrix estimation for each workday and analyze under which conditions both approaches provide more similar results.

Bibliography

- Ben-Akiva, Moshe, Peter P Macke, and Poh Ser Hsu. 1985. *Alternative Methods for Estimating RouteLevel Trip Tables and Expand On-Board Surveys*. Transportation Research Board, 1-11.
- Chan, Joanne S. M. 2007. *Rail transit OD matrix estimation and journey time reliability metric using automated fare data*. Cambridge: Massachusetts Institute of Technology.
- Cui, Alex. 2006. *Bus Passenger Origin-Destination Matrix Estimation using Automated Data Collection Systems*. MSc Thesis, Cambridge: Massachusetts Institute of Technology.
- Furth, Peter G., Brendon Hemily, Theo H. J. Muller, and James G. Strathman. 2006. *Using Archived AVL-APC Data to Improve Transit Performance and Management*. Washington, D.C.: National Academies Press.
- Gkiotsalitis, Konstantinos. 2022. "Strategic Planning of Public Transport Services." In *Public Transport Optimization*, 377-383. Enschede: Springer imprint.
- Ji, Yuxiong, Rabi G. Mishalani, and Mark R. McCord. 2014. "Estimating Transit Route OD Flow Matrices from APC Data on Multiple Bus Trips using the IPF Method with an Iteratively Improved Base: Method and Empirical Evaluation." *Transport Engineering* Volume 140.
- Liu, Xinyu, Pascal Van Hentenryck, and Xilei Zhao. 2021. "Optimization Models for Estimating Transit Network Origin-Destination Flows with Big Transit Data." *Journal of Big Data Analytics in Transportation* 247-262.
- Lomax, Nik, and Paul Norman. 2016. "Estimating Population Attribute Values in a Table: "Get Me Started in" Iterative Proportional Fitting." *The Professional Geographer, Volume 68* 451-461.
- Lu, Dawei. 2008. "Route Level Bus Transit Passenger Origin-Destination Flow Estimation Using APC data: Numerical and Empirical investigation."
- Mohammed, Mohammed, and Jimi Oke. 2022. "Origin-destination inference in public transportation systems: a comprehensive review." *International Journal of Transportation Science and Technology*.
- Ortuzar, Juan de Dios, and Luis Pilo Willumsen. 2011. *Modelling Transport, Fourth Edition*. Chichester: John Wiley & Sons, Ltd.
- Schatzmann, Thomas, Georgios Sarlas, and Kay W. Axhausen. 2018. "Spatial modelling of origin-destination commuting flows in Switzerland." Athens, Greece.
- . 2019. *Spatial modelling of origin-destination commuting flows in Switzerland*. Transportation Research Board.
- Site, Paolo Delle, and Francesco Filippi. 1998. "Service optimization for bus corridors with short-turn strategies and variable vehicle size." In *Transportation Research Part A-Policy and Practice*, 19-38.
- Tirachini, Alejandro, Christian E. Cortes, and Sergio R. Jara-Diaz. 2011. "Optimal design and benefits of a short turning strategy for a bus corridor." 169-189.

Appendix Line 1

Balanced Target Boardings (o_i) and Alightings (d_j)

Table 21 Target boardings and alightings, Line 1, "Aller" direction

Stop name	Workdays, "Aller", Hour 8, Boardings	Workdays, "Aller", Hour 8, Alightings	Workdays, "Aller", Hour 17, Boardings	Workdays, "Aller", Hour 17, Alightings	Saturday, "Aller", Hour 17, Boardings	Saturday, "Aller", Hour 17, Alightings	Sunday, "Aller", Hour 17, Boardings	Sunday, "Aller", Hour 17, Alightings
01 Thônex, Hôpital Trois- Chêne	12	0	33	0	27	0	20	0
02 Thônex, Pont-Bochet	0	0	2	0	0	0	1	0
03 Thônex, Jumelles	2	0	2	0	2	0	2	0
04 Thônex, Belle-Terre Pl. Araire	2	0	3	0	3	0	1	0
05 Thônex, Belle-Terre Pl. Turin	9	1	5	1	7	2	5	0
06 Thônex, Belle-Terre école	3	0	2	0	0	0	1	0
07 Thônex, Belle-Idée centre	14	1	9	1	4	0	5	2
08 Thônex, Belle-Idée réception	2	0	4	0	0	0	0	0
09 Chêne- Bourg, Petit- Bel-Air	17	5	14	3	9	1	5	2
10 Chêne- Bougeries, Seymaz	13	2	12	1	5	1	2	0
11 Chêne- Bougeries, Montagne	40	3	28	5	14	2	12	1
12 Chêne- Bougeries, Castan	23	1	11	1	6	0	4	0

13	Chêne-Bougeries, Coq-d'Inde	3	0	3	1	2	0	0	0
14	Chêne-Bougeries, Fourches	6	1	4	1	1	0	2	0
15	Chêne-Bougeries, Ch. de l'Eperon	31	21	16	7	7	3	7	2
16	Cognoy, Clos du Môlan	36	22	26	8	9	2	9	1
17	Cognoy, Gradelle	11	5	43	5	3	2	2	1
18	Cognoy, Pré-Picot	34	6	26	20	7	3	6	4
19	Genève-Eaux-Vives, gare/Vadier	26	19	17	36	5	5	8	4
20	Genève-Eaux-Vives, gare/Bloch	29	7	17	19	9	6	9	4
21	Genève, 31-Décembre	42	29	30	37	14	16	9	14
22	Genève, Terrassière	30	34	23	47	14	26	7	12
23	Genève, Tranchées	24	39	17	38	5	13	7	9
24	Genève, Florissant	14	32	13	18	4	7	2	2
25	Genève, Muséum	0	0	0	0	0	0	0	0
26	Genève, Contamines	0	0	0	0	0	0	0	0
27	Genève-Champel, gare/Peschier	0	0	0	0	0	0	0	0
28	Genève, Place Claparède	12	51	25	36	4	13	4	9
29	Genève, Hôpital	29	59	76	34	22	14	25	12
30	Genève, Lombard	0	0	0	0	0	0	0	0
31	Genève, Pont-d'Arve	0	0	0	0	0	0	0	0
32	Genève, Ecole-de-Médecine	0	0	0	0	0	0	0	0

33 Genève, Philosophes	13	13	15	8	5	3	2	2
34 Genève, Plainpalais	24	56	35	49	18	18	9	18
35 Genève, Cirque	35	25	62	36	35	8	33	8
36 Genève, Stand	21	20	36	20	11	7	15	7
37 Genève, Mercier	0	0	0	0	0	0	0	0
38 Genève, Goulart	10	14	26	26	21	16	7	13
39 Genève, gare Cornavin	124	52	109	114	102	64	75	55
40 Genève, Alpes	0	0	0	0	0	0	0	0
41 Genève, Monthoux	10	29	6	35	5	28	3	30
42 Genève, Navigation	14	42	9	73	9	49	5	35
43 Genève, Gautier	8	49	4	43	1	31	3	18
44 Genève, De-Châteaubriand	1	3	1	4	0	3	2	10
45 Genève, Perle du Lac	0	29	1	20	4	33	2	16
46 Genève, Jardin Botanique	0	51	0	16	0	23	0	17

Table 22 Target boardings and alightings, Line 1, "Retour" direction

Stop name	Workdays, "Retour", Hour 8, Boardings	Workdays, "Retour", Hour 8, Alightings	Workdays, "Retour", Hour 17, Boardings	Workdays, "Retour", Hour 17, Alightings	Saturday, "Retour", Hour 17, Boardings	Saturday, "Retour", Hour 17, Alightings	Sunday, "Retour", Hour 17, Boardings	Sunday, "Retour", Hour 17, Alightings
01 Thônex, Hôpital Trois-Chêne	0	25	0	24	0	19	0	12
02 Thônex, Pont-Bochet	0	2	0	1	0	2	0	0
03 Thônex, Jumelles	0	0	0	2	0	2	0	1
04 Thônex, Belle-Terre Pl. Araire	0	0	0	4	0	2	0	1

05 Thônex, Belle-Terre Pl. Turin	1	1	1	12	1	3	0	3
06 Thônex, Belle-Terre école	0	2	0	4	0	1	0	2
07 Thônex, Belle-Idée centre	0	7	0	12	0	6	1	5
08 Thônex, Belle-Idée réception	0	6	1	10	0	0	0	1
09 Chêne- Bourg, Petit- Bel-Air	4	27	8	27	2	16	2	10
10 Chêne- Bougeries, Seymaz	1	5	2	17	1	6	1	5
11 Chêne- Bougeries, Montagne	3	38	11	46	6	18	0	8
12 Chêne- Bougeries, Castan	1	5	1	23	0	10	0	7
13 Chêne- Bougeries, Coq- d'Inde	1	3	1	4	0	3	0	2
14 Chêne- Bougeries, Fourches	1	3	2	6	0	3	0	2
15 Chêne- Bougeries,Ch.de l'Eperon	4	6	7	33	1	19	1	11
16 Cologny, Clos du Môlan	4	20	15	25	2	15	1	10
17 Cologny, Gradelle	4	55	13	22	4	12	0	5
18 Cologny, Pré- Picot	6	16	9	36	3	24	2	15
19 Genève- Eaux-Vives, gare/Vadier	23	13	26	16	11	8	11	4
20 Genève- Eaux-Vives, gare/Bloch	12	6	14	19	8	9	7	6
21 Genève, 31- Décembre	28	20	41	32	27	15	12	9

22 Genève, Terrassière	34	28	64	40	40	18	15	14
23 Genève, Tranchées	0	0	0	0	0	0	0	0
24 Genève, Florissant	0	0	0	0	0	0	0	0
25 Genève, Muséum	13	12	20	13	7	6	4	6
26 Genève, Contamines	18	28	18	30	5	10	6	9
27 Genève- Champel, gare/Peschier	27	17	22	22	9	19	5	15
28 Genève, Place Claparède	8	46	25	33	8	12	5	10
29 Genève, Hôpital	25	78	51	39	18	17	17	18
30 Genève, Lombard	5	23	9	31	3	15	4	14
31 Genève, Pont-d'Arve	72	71	78	99	54	57	30	43
32 Genève, Ecole-de- Médecine	34	54	32	48	15	28	12	40
33 Genève, Philosophes	0	0	0	0	0	0	0	0
34 Genève, Plainpalais	0	0	0	0	0	0	0	0
35 Genève, Cirque	48	35	53	55	19	26	15	24
36 Genève, Stand	27	44	36	35	14	13	12	10
37 Genève, Mercier	34	12	42	25	18	15	8	8
38 Genève, Goulart	0	0	0	0	0	0	0	0
39 Genève, gare Cornavin	182	76	143	172	112	106	98	91
40 Genève, Alpes	9	11	20	20	12	6	11	8
41 Genève, Monthoux	33	3	45	12	28	5	25	8
42 Genève, Navigation	67	3	84	16	63	6	56	12
43 Genève, Gautier	46	1	91	8	28	3	22	3

44 Genève, De- Châteaubriand	2	1	6	3	6	1	13	1
45 Genève, Perle du Lac	14	0	27	2	14	1	12	0
46 Genève, Jardin Botanique	14	0	62	0	18	0	43	0

Table with 47 columns (Line 1, Saturday, Hour 17, IPF) and 46 rows (01 Thônex 02 Thônex to 46 Genève, Jardin Botanique). Each cell contains a numerical value representing the IPF matrix.

Figure 25 IPF OD matrix, Line 1, Saturday, hour 17, pax/h

(Cumulative) trip length distribution and absolute differences

Table 23 (cumulative) trip length distribution and absolute differences, Line 1

Distance interval (km)	Trip Distribution		Cumulative Trip Distribution		Absolute Difference
	IPF	GM	IPF	GM	
Line 1, workdays, hour 8					
0-2	0.615	0.657	0.615	0.657	0.043
2-4	0.240	0.169	0.855	0.827	0.028
4-6	0.092	0.075	0.947	0.902	0.046
6-8	0.039	0.051	0.986	0.953	0.033
8-10	0.010	0.033	0.996	0.986	0.010
10-12	0.003	0.013	0.999	0.999	0.000
12-14	0.000	0.001	1.000	1.000	0.000
Line 1, workdays, hour 17					
0-2	0.658	0.704	0.658	0.704	0.045
2-4	0.218	0.143	0.876	0.847	0.029
4-6	0.085	0.070	0.961	0.917	0.043
6-8	0.028	0.043	0.988	0.960	0.028
8-10	0.008	0.025	0.996	0.986	0.011
10-12	0.003	0.013	0.999	0.998	0.001
12-14	0.001	0.001	1.000	1.000	0.000
Line 1, Saturday, hour 17					
0-2	0.634	0.682	0.634	0.682	0.049
2-4	0.197	0.134	0.831	0.817	0.014
4-6	0.098	0.071	0.929	0.887	0.042
6-8	0.046	0.055	0.975	0.943	0.032
8-10	0.018	0.036	0.993	0.979	0.014
10-12	0.006	0.020	0.999	0.999	0.000
12-14	0.001	0.001	1.000	1.000	0.000
Line 1, Sunday, hour 17					
0-2	0.625	0.670	0.625	0.670	0.046
2-4	0.215	0.152	0.840	0.822	0.017
4-6	0.088	0.065	0.927	0.887	0.040
6-8	0.044	0.050	0.972	0.937	0.035
8-10	0.020	0.038	0.992	0.975	0.017
10-12	0.007	0.023	0.999	0.997	0.001
12-14	0.002	0.003	1.000	1.000	0.000

Appendix Line 5

Balanced Target Boardings (o) and Alightings (d)

Stop name	Workdays, "Aller", Hour 8, Boardings	Workdays, "Aller", Hour 8, Alightings	Workdays, "Aller", Hour 17, Boardings	Workdays, "Aller", Hour 17, Alightings	Saturday, "Aller", Hour 17, Boardings	Saturday, "Aller", Hour 17, Alightings	Sunday, "Aller", Hour 17, Boardings	Sunday, "Aller", Hour 17, Alightings
01 Thônex, Vallard	71	0	30	0	20	0	24	0
02 Thônex, Sous-Moulin	152	5	19	4	14	1	18	1
03 Chêne- Bougeries,Coll.Claparède	11	6	29	3	1	0	6	0
04 Chêne-Bougeries, Vallon	11	1	8	1	3	1	3	0
05 Chêne-Bougeries, Malagnou	7	3	21	3	3	1	1	0
06 Genève, Florence	31	21	16	8	8	1	7	1
07 Genève, Rieu	38	13	51	17	11	4	6	4
08 Genève, Weber	43	13	25	7	10	4	15	5
09 Genève, Muséum	22	82	17	31	7	9	9	8
10 Genève, Florissant	15	27	15	8	3	2	5	4
11 Genève, Contamines	0	0	0	0	0	0	0	0
12 Genève-Champel, gare/Peschier	0	0	0	0	0	0	0	0
13 Genève, Place Claparède	14	36	25	22	5	4	3	2
14 Genève, Hôpital	48	56	111	47	19	6	18	8
15 Genève, Athénée	13	4	20	3	7	1	6	0
16 Genève, Palais Eynard	12	5	17	2	8	4	2	2
17 Genève, Place de Neuve	20	53	31	35	24	10	29	10
18 Genève, Bovy-Lysberg	0	0	0	0	0	0	0	0

19 Genève, Bel-Air	73	52	111	63	84	16	59	13
20 Genève, Coutance	30	32	52	63	58	21	13	9
21 Genève, gare Cornavin	165	45	146	109	137	58	134	37
22 Genève, poste	7	43	6	13	6	12	7	11
23 Genève, Baulacre	7	23	10	51	8	38	7	25
24 Genève, Vidollet	21	16	13	38	14	39	15	21
25 Genève, Vermont	9	40	8	18	2	11	3	6
26 Genève, Varembe	10	23	14	17	6	11	6	6
27 Genève, Nations	55	18	89	12	40	15	30	7
28 Genève, Intercontinental	12	27	15	32	9	30	11	24
29 Grand-Saconnex, Crêts-Morillon	10	80	15	45	5	36	7	32
30 Grand-Saconnex, Le Pommier	6	40	15	42	5	29	6	16
31 Grand-Saconnex, place	11	32	11	94	7	70	15	42
32 Grand-Saconnex, Palexpo	7	31	13	20	10	15	11	23
33 Grand-Saconnex, Arena-Halle 7	3	14	3	21	1	11	5	74
34 Genève-Aéroport, Terminal	0	92	0	128	0	75	0	86

Figure 31 Line 5, average target boardings and alightings, "Aller" direction

Stop name	Workdays, "Retour", Hour 8, Boardings	Workdays, "Retour", Hour 8, Alightings	Workdays, "Retour", Hour 17, Boardings	Workdays, "Retour", Hour 17, Alightings	Saturday, "Retour", Hour 17, Boardings	Saturday, "Retour", Hour 17, Alightings	Sunday, "Retour", Hour 17, Boardings	Sunday, "Retour", Hour 17, Alightings
01 Thônex, Vallard	0	13	0	52	0	20	0	23
02 Thônex, Sous-Moulin	1	7	3	115	0	23	1	18
03 Chêne- Bougeries,Coll.Claparède	1	6	11	7	0	4	0	2
04 Chêne-Bougeries, Vallon	0	4	2	5	1	5	0	2

05 Chêne-Bougeries, Malagnou	0	17	3	8	1	5	1	3
06 Genève, Florence	3	28	10	28	1	9	2	11
07 Genève, Rieu	6	22	17	25	5	12	6	6
08 Genève, Weber	9	13	12	31	5	17	9	14
09 Genève, Muséum	9	14	15	18	3	8	4	7
10 Genève, Florissant	0	0	0	0	0	0	0	0
11 Genève, Contamines	7	13	9	21	4	12	3	6
12 Genève-Champel, gare/Peschier	17	15	16	25	7	17	3	15
13 Genève, Place Claparède	6	46	26	26	9	9	5	9
14 Genève, Hôpital	34	126	53	54	12	28	12	27
15 Genève, Athénée	5	40	6	15	1	7	2	2
16 Genève, Palais Eynard	4	31	6	19	1	12	2	11
17 Genève, Place de Neuve	24	38	41	37	22	17	14	18
18 Genève, Bovy-Lysberg	15	15	26	9	6	3	2	2
19 Genève, Bel-Air	37	56	46	88	24	49	11	36
20 Genève, Coutance	52	30	58	49	29	25	14	13
21 Genève, gare Cornavin	148	90	130	190	67	118	71	82
22 Genève, poste	2	8	6	10	4	5	1	7
23 Genève, Baulacre	30	5	18	9	11	6	11	4
24 Genève, Vidollet	30	8	25	25	16	12	14	11
25 Genève, Vermont	18	7	46	11	16	5	4	4
26 Genève, Varembe	0	0	0	0	0	0		0

27 Genève, Nations	6	70	26	49	7	21	10	15
28 Genève, Intercontinental	29	11	31	15	14	5	9	5
29 Grand-Saconnex, Crêts-Morillon	43	36	65	10	21	8	14	7
30 Grand-Saconnex, Le Pommier	41	13	53	9	7	7	6	7
31 Grand-Saconnex, place	108	11	60	17	56	17	33	10
32 Grand-Saconnex, Palexpo	21	8	50	8	33	8	26	7
33 Grand-Saconnex, Arena-Halle 7	17	1	9	1	6	1	2	1
34 Genève-Aéroport, Terminal	80	0	105	0	104	0	90	0

Figure 32 Line 5, average target boardings and alightings, Retour direction

(Cumulative) trip length distribution and absolute differences

Table 24 (cumulative) trip length distribution and absolute differences, Line 5

Distance interval (km)	Trip Distribution		Cumulative Trip Distribution		Absolute Difference
	IPF	GM	IPF	GM	
Line 5, workdays, hour 8					
0-2	0.414	0.571	0.414	0.571	0.157
2-4	0.401	0.203	0.814	0.774	0.041
4-6	0.141	0.110	0.956	0.884	0.072
6-8	0.030	0.056	0.985	0.940	0.046
8-10	0.009	0.031	0.995	0.971	0.024
10-12	0.003	0.023	0.998	0.994	0.004
12-14	0	0	1.000	1.000	0.000
Line 5, workdays, hour 17					
0-2	0.440	0.590	0.440	0.590	0.150
2-4	0.366	0.178	0.806	0.768	0.038
4-6	0.155	0.119	0.961	0.887	0.073
6-8	0.030	0.049	0.990	0.936	0.054
8-10	0.006	0.031	0.996	0.967	0.029
10-12	0.002	0.027	0.998	0.994	0.004
12-14	0.002	0.006	1.000	1.000	0.000
Line 5, Saturday, hour 17					
0-2	0.391	0.537	0.391	0.537	0.146
2-4	0.354	0.187	0.744	0.724	0.020
4-6	0.199	0.147	0.944	0.871	0.073
6-8	0.043	0.062	0.987	0.933	0.054
8-10	0.008	0.030	0.995	0.963	0.031
10-12	0.003	0.027	0.998	0.990	0.008
12-14	0.002	0.010	1.000	1.000	0.000
Line 5, Sunday, hour 17					
0-2	0.305	0.470	0.305	0.470	0.165
2-4	0.374	0.192	0.679	0.662	0.017
4-6	0.236	0.176	0.914	0.837	0.077
6-8	0.057	0.077	0.972	0.914	0.058
8-10	0.015	0.036	0.987	0.950	0.037
10-12	0.006	0.032	0.993	0.982	0.011
12-14	0.007	0.018	1.000	1.000	0.000

Appendix Line 8

Balanced Target Boardings (o) and Alightings (d)

Table 25 Target boardings and alightings, Line 8, "Aller" direction

Stop name	Workdays, "Aller", Hour 8, Boardings	Workdays, "Aller", Hour 8, Alightings	Workdays, "Aller", Hour 17, Boardings	Workdays, "Aller", Hour 17, Alightings	Saturday, "Aller", Hour 17, Boardings	Saturday, "Aller", Hour 17, Alightings	Sunday, "Aller", Hour 17, Boardings	Sunday, "Aller", Hour 17, Alightings
01 Genève, OMS	19	0	90	0	0	0	0	0
02 Grand- Saconnex, Crêts-Morillon	0	0	0	0	0	0	0	0
03 Genève, Intercontinental	0	0	0	0	0	0	0	0
05 Genève, Appia	10	3	77	3	13	0	6	0
06 Genève, Nations	12	5	47	27	26	4	18	2
07 Genève, UIT	26	4	64	8	9	0	7	0
08 Genève, Motta	60	8	48	14	20	3	14	3
09 Genève, Vidollet	44	2	32	9	27	2	16	2
10 Genève, Canonnière	125	7	88	46	47	8	34	6
11 Genève, Grottes	31	10	30	28	14	9	10	4
12 Genève, gare Cornavin	328	123	251	212	165	77	164	54
13 Genève, Chantepoulet	81	24	82	35	53	17	28	8
14 Genève, Mont-Blanc	40	15	60	23	39	14	21	12
15 Genève, Métropole	39	141	52	95	41	66	18	31
16 Genève, Rive	169	165	283	158	238	98	69	67
17 Genève, Tranchées	26	62	40	53	16	38	8	26
18 Genève, Florissant	21	37	29	40	12	28	7	9

19 Genève, Muséum	0	0	0	0	0	0	0	0
20 Genève, Contamines	40	43	50	63	15	48	9	23
21 Genève, Krieg	22	80	42	114	27	88	8	29
22 Genève, Aubert	38	108	69	116	30	74	10	42
23 Genève, Velours	6	73	13	46	3	28	4	15
24 Chêne- Bougeries, C.- Florissant	1	49	1	5	0	1	1	2
25 Chêne- Bougeries, Conches place	3	31	4	25	1	12	1	9
26 Chêne- Bougeries, Calandrini	3	11	8	14	1	12	1	5
27 Chêne- Bougeries, Villette	2	8	10	17	0	11	1	6
28 Veyrier, Pont de Sierne	1	12	2	4	0	3	0	1
29 Veyrier, Sierne	2	7	4	7	2	5	1	3
30 Vessy, Stand de Tir	1	13	3	44	1	23	1	13
31 Veyrier, Bois- Gourmand	1	32	5	17	0	4	1	2
32 Veyrier, Le Reposoir	0	3	0	8	0	3	1	2
33 Veyrier, La Salésienne	0	8	1	28	0	9	0	11
34 Veyrier, Rasses	0	6	1	23	0	9	0	6
35 Veyrier, Tournettes	0	12	0	44	0	24	0	19
36 Veyrier, Les Quibières	0	7	1	15	0	6	0	5
37 Veyrier, Petit-Veyrier	0	7	1	21	0	10	0	4
38 Veyrier, village	0	29	0	89	0	75	0	38
39 Veyrier, douane	0	4	0	38	0	0	0	0

Table 26 Target boardings and alightings, Line 8, Retour direction

Stop name	Workdays, "Retour", Hour 8, Boardings	Workdays, "Retour", Hour 8, Alightings	Workdays, "Retour", Hour 17, Boardings	Workdays, "Retour", Hour 17, Alightings	Saturday, "Retour", Hour 17, Boardings	Saturday, "Retour", Hour 17, Alightings	Sunday, "Retour", Hour 17, Boardings	Sunday, "Retour", Hour 17, Alightings
01 Genève, OMS	0	198	0	32	0	0	0	0
02 Grand- Saconnex, Crêts-Morillon	9	81	10	26	0	0	0	0
03 Genève, Intercontinental	5	40	2	12	0	0	0	0
05 Genève, Appia	0	0	0	0	0	0	0	0
06 Genève, Nations	9	48	3	14	1	16	1	13
07 Genève, UIT	23	87	7	26	1	20	1	11
08 Genève, Motta	36	67	11	43	1	26	1	20
09 Genève, Vidollet	7	20	3	33	0	29	1	22
10 Genève, Canonnière	69	79	16	111	10	74	5	48
11 Genève, Grottes	20	21	13	51	4	38	3	21
12 Genève, gare Cornavin	290	135	172	196	128	155	80	100
13 Genève, Chantepoulet	0	0	0	0	0	0	0	0
14 Genève, Mont-Blanc	22	79	29	80	29	37	18	23
15 Genève, Métropole	76	68	99	47	64	27	33	20
16 Genève, Rive	91	184	91	150	59	86	31	46
17 Genève, Tranchées	0	0	0	0	0	0	0	0
18 Genève, Florissant	0	0	0	0	0	0	0	0

19 Genève, Muséum	65	40	32	28	20	13	15	9
20 Genève, Contamines	56	57	39	42	23	14	14	16
21 Genève, Krieg	63	15	71	20	35	13	18	6
22 Genève, Aubert	99	34	143	36	45	20	30	12
23 Genève, Velours	36	70	27	7	11	2	8	2
24 Chêne-Bougeries, C.-Florissant	7	4	7	0	1	0	0	1
25 Chêne-Bougeries, Conches place	21	3	22	2	13	1	8	2
26 Chêne-Bougeries, Calandrini	12	3	12	3	16	0	3	0
27 Chêne-Bougeries, Vilette	10	1	10	1	8	0	4	1
28 Veyrier, Pont de Sierne	4	0	4	1	4	0	4	0
29 Veyrier, Sierne	5	3	2	1	2	1	3	1
30 Vessy, Stand de Tir	37	1	17	2	17	2	12	1
31 Veyrier, Bois-Gourmand	17	3	17	2	3	0	3	2
32 Veyrier, Le Reposoir	6	0	5	0	2	0	2	0
33 Veyrier, La Salésienne	14	0	11	1	7	0	6	1
34 Veyrier, Rasses	16	0	7	0	5	1	4	0
35 Veyrier, Tournettes	28	0	24	0	17	0	15	0
36 Veyrier, Les Quibières	22	0	6	2	2	0	1	0
37 Veyrier, Petit-Veyrier	22	1	12	1	1	0	3	0
38 Veyrier, village	19	0	11	0	5	0	4	0
39 Veyrier, douane	130	0	40	0	39	0	42	0

(Cumulative) trip length distribution and absolute differences

Table 27 (cumulative) trip length distribution and absolute differences, Line 8

Distance interval (km)	Trip Distribution		Cumulative Trip Distribution		Absolute Difference
	IPF	GM	IPF	GM	
Line 8, workdays, hour 8					
0-2	0.476	0.575	0.476	0.575	0.098
2-4	0.352	0.221	0.828	0.796	0.032
4-6	0.125	0.097	0.953	0.893	0.061
6-8	0.040	0.060	0.993	0.952	0.040
8-10	0.004	0.025	0.997	0.978	0.020
10-12	0.002	0.022	1.000	1.000	0.000
12-14	0	0	1.000	1.000	0.000
Line 8, workdays, hour 17					
0-2	0.555	0.632	0.555	0.632	0.077
2-4	0.273	0.166	0.828	0.798	0.030
4-6	0.120	0.092	0.948	0.890	0.058
6-8	0.047	0.073	0.994	0.962	0.032
8-10	0.004	0.026	0.998	0.988	0.010
10-12	0.002	0.012	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000
Line 8, Saturday, hour 17					
0-2	0.588	0.645	0.588	0.645	0.057
2-4	0.233	0.150	0.821	0.795	0.025
4-6	0.130	0.099	0.950	0.895	0.056
6-8	0.044	0.076	0.995	0.971	0.024
8-10	0.004	0.028	0.999	0.999	0.000
10-12	0.000	0.001	0.999	1.000	0.001
12-14	0.000	0.000	0.999	1.000	0.001
Line 8, Sunday, hour 17					
0-2	0.509	0.587	0.509	0.587	0.078
2-4	0.265	0.167	0.775	0.754	0.021
4-6	0.134	0.093	0.908	0.847	0.061
6-8	0.080	0.108	0.988	0.955	0.032
8-10	0.012	0.043	1.000	0.998	0.002
10-12	0.000	0.002	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000

Appendix Line 11

Balanced Target Boardings (o_i) and Alightings (d_j)

Table 28 Target boardings and alightings, Line 11, "Aller" direction

Stop name	Workdays, "Aller", Hour 8, Boardings	Workdays, "Aller", Hour 8, Alightings	Workdays, "Aller", Hour 17, Boardings	Workdays, "Aller", Hour 17, Alightings	Saturday, "Aller", Hour 17, Boardings	Saturday, "Aller", Hour 17, Alightings	Sunday, "Aller", Hour 17, Boardings	Sunday, "Aller", Hour 17, Alightings
01 Genève, Jardin Botanique	25	0	66	0	24	0	34	0
02 Genève- Sécheron, gare	12	0	43	2	12	0	20	2
03 Genève, Nations	24	5	104	9	28	4	20	5
04 Genève, UIT	21	7	64	5	10	0	6	1
05 Genève, Motta	30	6	46	11	23	3	11	4
06 Genève, Grand-Pré	55	6	63	37	21	8	18	8
07 Genève, Servette	90	17	91	81	53	26	29	20
08 Genève, Wendt	64	11	42	45	28	18	20	13
09 Genève, Charmilles	86	48	106	96	58	30	33	17
10 Genève, Miléant	76	29	44	42	21	24	15	18
11 Genève, Délices	64	37	71	28	29	16	21	10
12 Genève, Seujet	10	23	15	25	4	9	3	7
13 Genève, Jonction	97	144	128	157	68	75	35	51
14 Genève, Queue-d'Arve	12	55	36	49	26	30	6	4
15 Genève, Vernets	8	61	26	50	7	16	5	7
16 Genève, Epinettes	44	51	33	57	19	37	8	21

17 Carouge GE, Rue des Mouettes	41	29	34	38	17	17	8	11
18 Carouge GE, Gavard	19	41	18	33	8	23	1	3
19 Carouge GE, Tours	52	70	107	79	67	33	23	24
20 Carouge GE, Marché	48	26	59	48	31	28	17	14
21 Carouge GE, Moraines	12	58	9	20	3	9	0	5
22 Carouge GE, Armes	0	0	0	0	0	0	0	0
23 Carouge GE, Fontenette	24	32	31	67	14	34	12	13
24 Carouge GE, Val-d'Arve	19	19	18	62	11	29	11	12
25 Genève, Bout-du-Monde	9	27	29	54	32	12	39	9
26 Genève, Crêts-de-Champel	39	31	38	52	19	33	8	25
27 Genève, Clinique Générale	10	19	12	21	5	9	3	11
28 Genève, Aubert	21	46	41	46	11	32	7	22
29 Genève, Rieu	18	40	54	45	4	23	4	24
30 Genève, Amandolier	1	56	4	73	0	29	0	24
31 Genève-Eaux-Vives, gare	0	38	0	103	0	42	0	35

Table 29 Target boardings and alightings, Line 11, "Retour" direction

Stop name	Workdays, "Retour", Hour 8, Boardings	Workdays, "Retour", Hour 8, Alightings	Workdays, "Retour", Hour 17, Boardings	Workdays, "Retour", Hour 17, Alightings	Saturday, "Retour", Hour 17, Boardings	Saturday, "Retour", Hour 17, Alightings	Sunday, "Retour", Hour 17, Boardings	Sunday, "Retour", Hour 17, Alightings
01 Genève, Jardin Botanique	0	65	0	30	0	21	0	31
02 Genève-Sécheron, gare	1	53	1	19	0	9	1	8
03 Genève, Nations	11	100	8	38	6	20	6	16

04 Genève, UIT	11	91	4	35	1	12	1	7
05 Genève, Motta	20	71	5	54	2	35	1	20
06 Genève, Grand-Pré	42	36	9	44	4	28	4	11
07 Genève, Servette	109	47	48	132	29	60	17	33
08 Genève, Wendt	56	36	30	76	15	35	11	27
09 Genève, Charmilles	97	120	77	156	35	68	21	46
10 Genève, Miléant	0	0	0	0	0	0	0	0
11 Genève, Délices	61	81	71	159	23	58	13	51
12 Genève, Seujet	22	14	33	20	14	8	20	2
13 Genève, Jonction	177	63	225	148	105	88	74	46
14 Genève, Queue-d'Arve	14	14	76	24	44	14	14	3
15 Genève, Vernets	9	22	70	21	20	8	13	6
16 Genève, Epinettes	36	20	60	41	37	12	17	12
17 Carouge GE, Rue des Mouettes	39	11	38	31	17	17	9	7
18 Carouge GE, Gavard	15	19	41	15	23	7	4	5
19 Carouge GE, Tours	52	51	99	99	48	50	25	27
20 Carouge GE, Marché	0	0	0	0	0	0	0	0
21 Carouge GE, Moraines	0	0	0	0	0	0	0	0
22 Carouge GE, Armes	27	53	61	98	27	22	17	27
23 Carouge GE, Fontenette	39	29	68	48	37	15	16	8
24 Carouge GE, Val-d'Arve	32	11	45	39	20	15	26	9

25 Genève, Bout-du- Monde	8	32	25	54	36	8	36	12
26 Genève, Crêts-de- Champel	31	35	42	64	11	30	12	14
27 Genève, Clinique Générale	17	18	18	21	5	8	6	6
28 Genève, Aubert	50	47	94	41	32	14	18	7
29 Genève, Rieu	40	42	118	27	14	9	13	7
30 Genève, Amandolier	89	2	80	2	26	2	14	1
31 Genève- Eaux-Vives, gare	77	0	90	0	43	0	35	0

Updated Seed Matrix

V1	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève	0		1.01	2.01	6.01	6.01	20.01	4.01	8.01	1.01	1.01	0.01	5.01	0.01	0.01	0.01	1.01	2.01	1.01	1.01	1.01	0.01	2.01	0.01	1.01	0.01	0.01	0.01	0.01	0.01	0.01
02 Genève	2.01	0	2.01	4.01	6.01	6.01	5.01	5.01	11.01	1.01	3.01	0.01	4.01	0.01	1.01	0.01	1.01	0.01	2.01	0.01	2.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.01	0.01
03 Genève	4.01	6.01	0	1.01	2.01	17.01	23.01	7.01	14.01	5.01	6.01	1.01	7.01	3.01	3.01	0.01	1.01	1.01	2.01	2.01	0.01	0.01	0.01	3.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
04 Genève	2.01	2.01	0.01	0	0.01	8.01	10.01	6.01	15.01	2.01	3.01	0.01	11.01	2.01	1.01	0.01	7.01	2.01	7.01	1.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
05 Genève	4.01	4.01	3.01	2.01	0	5.01	15.01	3.01	10.01	5.01	3.01	3.01	12.01	2.01	6.01	2.01	2.01	1.01	2.01	2.01	0.01	1.01	1.01	0.01	0.01	1.01	0.01	0.51	0.01	0.01	0.01
06 Genève	4.01	5.01	12.01	4.01	4.01	0	4.01	5.01	17.01	10.01	4.01	4.01	25.01	9.01	7.01	8.01	5.01	6.01	10.01	5.01	0.01	0.01	1.01	2.01	0.01	1.01	0.01	1.01	0.01	0.01	1.01
07 Genève	20.01	12.01	25.01	19.01	22.01	8.01	0	3.01	14.51	9.01	8.01	3.01	25.51	17.01	15.01	7.01	7.01	8.01	5.01	1.01	0.01	1.01	0.01	1.01	2.01	0.01	0.01	0.01	0.01	1.01	1.01
08 Genève	5.01	3.01	11.01	8.01	14.01	4.01	15.01	0	3.01	7.01	7.01	3.01	37.01	4.01	6.01	9.01	4.01	6.01	9.01	7.01	1.01	2.01	4.01	0.01	2.01	1.01	1.01	0.01	0.01	0.01	0.01
09 Genève	10.01	10.01	13.01	9.01	12.01	14.01	15.51	11.01	0	4.01	3.01	9.343333	53.51	12.01	15.01	15.34333	14.51	11.01	14.01	9.01	0.01	1.01	4.01	3.01	1.01	1.01	0.01	0.01	1.01	0.01	0.01
10 Genève	0.01	0.01	2.01	0.01	2.01	2.01	3.01	0.01	1.01	0	6.01	1.01	36.01	8.01	10.01	6.01	1.01	8.01	6.01	8.01	0.01	0.01	0.01	0.01	0.01	2.01	1.01	0.01	2.01	0.01	0.01
11 Genève	0.01	4.01	5.01	2.01	4.01	3.01	12.01	9.01	5.01	0.01	0	6.01	41.01	11.01	16.01	5.01	4.01	9.01	11.01	12.01	0.01	0.01	6.01	2.01	1.01	0.01	1.01	1.01	0.01	0.01	0.01
12 Genève	0.01	1.01	3.01	1.01	3.01	6.01	1.01	3.01	6.343333	0.01	3.01	0	6.01	1.01	2.01	1.01	1.01	0.01	2.01	1.01	0.01	2.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
13 Genève	4.01	6.01	10.01	9.01	14.01	17.01	31.01	44.01	57.67667	10.01	55.01	5.01	0	10.34333	14.01	20.34333	21.01	18.01	26.01	17.01	5.01	6.01	13.01	8.01	4.01	6.01	3.01	8.01	0.01	1.01	2.01
14 Genève	1.01	1.01	3.01	3.01	1.01	2.01	16.01	4.01	12.01	2.01	12.01	2.01	15.67667	0	2.01	6.01	6.01	7.01	6.01	6.01	1.01	0.01	2.01	1.01	1.01	4.01	0.01	2.01	2.01	4.01	3.01
15 Genève	0.01	1.01	0.01	0.01	5.01	5.01	12.01	9.01	19.01	1.01	21.01	13.01	2.01	0	3.01	4.01	2.01	8.01	4.01	0.01	0.01	2.01	1.01	1.01	2.01	2.01	3.01	0.01	0.01	0.01	0.01
16 Genève	0.01	0.01	0.01	0.01	1.01	4.01	8.01	10.01	12.34333	2.01	12.01	0.01	21.34333	4.01	3.01	0	4.01	4.01	12.01	6.01	2.01	0.01	3.01	3.01	2.01	1.01	1.01	1.01	0.01	2.01	1.01
17 Caroug	1.01	0.01	3.01	5.01	2.01	5.01	7.01	4.01	14.01	1.01	7.01	1.01	20.01	1.01	5.01	3.01	0	3.01	16.01	4.01	2.01	0.01	1.01	3.01	0.01	0.01	0.01	3.01	8.01	2.01	3.01
18 Caroug	1.01	1.01	1.01	0.01	2.01	1.01	6.01	3.01	15.01	3.01	12.01	1.01	14.01	3.01	1.01	5.01	2.01	0	9.01	2.01	2.01	0.01	5.01	1.01	2.01	6.01	4.01	7.01	7.01	5.01	5.01
19 Caroug	3.01	3.01	1.01	5.01	5.01	6.01	7.01	18.01	17.01	0.01	17.01	5.01	30.34333	7.01	12.01	16.01	14.01	10.01	0	13.01	7.01	1.01	27.01	10.01	5.01	12.01	3.01	22.01	12.01	8.01	7.01
20 Caroug	0.01	0.01	0.01	0.01	0.01	1.01	0.01	2.01	3.01	3.01	5.01	0.01	5.01	1.01	0.01	1.01	0.01	0.01	1.01	0	4.01	0.343333	4.01	6.01	5.01	8.51	4.01	12.01	10.01	6.01	5.01
21 Caroug	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0.01	1.01	2.01	1.01	2.01	0.01	1.01	2.01	0.01	0.01
22 Caroug	0.01	1.01	1.01	2.01	2.01	0.01	5.01	4.01	9.01	1.01	9.01	2.01	15.01	8.01	4.01	3.01	0.01	5.01	12.01	0.343333	0.01	0	0.01	2.01	0.01	2.51	1.01	3.01	5.01	2.01	2.01
23 Caroug	2.01	0.01	0.01	0.01	1.01	2.01	0.01	3.01	5.01	0.01	5.01	2.01	18.01	4.01	3.01	3.01	3.01	6.01	23.01	0.01	0.01	7.01	0	0.01	0.01	13.01	1.01	8.01	6.01	19.01	11.01
24 Caroug	0.01	0.01	3.01	1.01	1.01	2.01	1.01	1.01	2.01	0.01	1.01	0.01	9.01	2.01	0.01	5.01	1.01	3.01	14.01	1.01	0.01	9.01	0.01	0	1.01	3.01	0.01	2.01	4.01	2.01	2.01
25 Genève	1.01	0.01	0.01	0.01	0.01	0.01	2.01	2.01	0.01	0.01	1.01	0.01	3.01	0.01	0.01	2.01	0.01	0.01	6.01	1.01	1.01	4.01	1.01	0.01	0	5.01	1.01	6.01	1.01	5.01	8.01
26 Genève	0.01	0.01	0.01	0.01	1.01	0.01	0.01	1.01	0.01	0.01	1.01	0.01	5.01	6.01	2.01	2.01	0.01	6.01	11.01	1.51	0.01	14.51	9.01	4.01	3.01	0	3.01	20.01	9.01	16.01	17.01
27 Genève	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.01	0.01	0.01	0.01	1.01	3.01	1.01	1.01	0.01	0.01	3.01	7.01	0.01	0.01	6.01	2.01	0.01	3.01	9.01	0	5.01	6.01	9.01	8.01
28 Genève	1.01	0.01	0.01	0.01	0.51	0.01	1.01	1.01	0.01	0.01	1.01	0.01	9.01	1.01	5.01	2.01	3.01	4.01	19.01	3.01	0.01	13.01	7.01	6.01	4.01	20.01	5.01	0	3.01	22.01	15.01
29 Genève	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	3.01	1.01	1.01	0.01	1.01	5.01	0.01	1.01	6.01	4.01	17.01	1.01	0.01	13.01	9.01	1.01	2.01	6.01	3.01	5.01	0	11.01	21.01
30 Genève	0.01	0.01	0.01	0.01	0.01	0.01	1.01	0.01	0.01	0.01	0.01	1.01	2.01	1.01	0.01	1.01	1.01	3.01	8.01	0.01	0.01	5.01	20.01	4.01	4.01	12.01	13.01	22.01	10.01	0	2.01
31 Genève	0.01	2.01	0.01	0.01	0.01	0.01	0.01	1.01	0.01	0.01	0.01	0.01	1.01	3.01	1.01	1.01	1.01	4.01	8.01	2.01	0.01	8.01	11.01	4.01	12.01	29.01	13.01	19.01	23.01	1.01	0

Figure 55 Updated seed matrix, Line 11

IPF results

Line 11, Workdays, Hour 8, IPF	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	0.2	2.8	3.1	3.7	1.1	4.6	1.3	3.6	0.5	0.5	0.0	1.6	0.0	0.0	0.0	0.2	0.5	0.2	0.1	1.0	0.0	0.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
02 Genève-Sécheron, gare	1.2	0.0	2.3	2.6	1.5	0.4	0.5	0.7	2.0	0.2	0.7	0.0	0.5	0.0	0.1	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	0.1	0.0
03 Genève, Nations	4.8	5.8	0.0	1.2	1.0	2.4	4.1	1.7	4.9	1.8	2.5	0.4	1.7	0.9	0.8	0.0	0.2	0.2	0.4	0.2	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
04 Genève, UII	5.7	4.6	0.0	0.0	0.0	1.3	2.1	1.8	6.3	0.9	1.5	0.0	3.2	0.7	0.3	0.0	1.3	0.4	1.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
05 Genève, Motta	6.0	4.8	4.9	4.5	0.0	1.1	4.3	1.2	5.7	2.9	2.1	1.7	4.8	1.0	2.6	0.9	0.5	0.3	0.6	0.3	0.0	0.0	0.3	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0
06 Genève, Grand-Pré	5.3	5.4	17.5	8.1	4.8	0.0	1.2	2.1	10.2	6.1	2.9	2.4	10.5	4.6	3.2	3.7	1.3	1.9	3.0	0.9	0.0	0.0	0.3	0.5	0.0	0.2	0.0	0.2	0.0	0.0	0.1
07 Genève, Servette	19.4	9.4	26.5	27.9	19.4	4.9	0.0	1.9	13.1	8.3	8.7	2.7	16.1	12.9	10.4	4.8	2.7	3.8	2.3	0.3	0.0	0.0	0.0	0.3	1.5	0.0	0.0	0.0	0.3	0.2	
08 Genève, Wendt	5.1	2.4	12.1	12.2	12.8	2.6	8.0	0.0	2.4	5.7	6.8	2.4	20.7	2.7	3.7	5.5	1.4	2.5	3.6	1.6	1.8	0.0	1.5	0.0	1.4	0.3	0.6	0.0	0.0	0.0	0.0
09 Genève, Charmilles	12.1	9.7	17.2	16.5	13.2	10.8	10.0	6.6	0.0	3.1	2.7	7.1	28.4	7.6	8.7	8.8	4.8	4.4	5.3	1.9	0.0	0.0	1.4	0.9	0.7	0.3	0.0	0.0	0.3	0.0	0.0
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	1.2	29.6	7.9	9.0	5.4	0.5	5.0	3.5	2.6	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.0	1.0	0.0	0.0
11 Genève, Délices	0.0	5.4	9.1	5.0	6.0	3.2	10.6	7.4	13.3	0.0	0.0	4.8	22.7	7.3	9.7	3.0	1.4	3.8	4.3	2.7	0.0	0.0	2.2	0.6	0.7	0.0	0.6	0.3	0.0	0.0	0.0
12 Genève, Seujet	0.0	0.6	2.5	1.2	2.1	2.9	0.4	1.1	7.7	0.0	3.1	0.0	4.6	0.9	1.7	0.8	0.5	0.0	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
13 Genève, Jonction	2.6	3.1	7.0	8.8	8.2	7.0	10.6	14.0	59.3	0.0	48.2	6.7	0.0	8.2	10.1	14.5	8.5	9.0	12.2	4.5	10.3	0.0	5.7	2.8	3.2	2.3	2.0	2.8	0.0	0.3	0.4
14 Genève, Queue-d'Arve	0.2	0.1	0.6	0.8	0.2	0.2	1.4	0.3	3.2	0.0	2.8	0.7	3.7	0.0	0.7	2.1	1.2	1.7	1.4	0.8	1.0	0.0	0.4	0.2	0.4	0.7	0.0	0.3	0.4	0.6	0.3
15 Genève, Vernets	0.0	0.1	0.0	0.0	0.4	0.3	0.5	0.4	2.6	0.0	2.5	0.5	1.6	0.2	0.0	1.2	0.9	0.6	2.1	0.6	0.0	0.0	0.5	0.2	0.5	0.4	0.8	0.6	0.0	0.0	0.0
16 Genève, Epinettes	0.0	0.0	0.0	0.0	0.4	1.0	1.7	2.0	7.8	0.0	6.5	0.0	11.8	2.0	2.8	0.0	3.4	4.1	11.7	3.3	8.5	0.0	2.7	2.2	3.3	0.8	1.4	0.7	0.0	1.3	0.5
17 Carouge GE, Rue des Mouettes	0.4	0.0	1.2	2.8	0.7	1.2	1.4	0.7	8.3	0.0	3.6	0.8	10.4	0.5	4.3	2.2	0.0	2.8	14.2	2.0	7.8	0.0	0.8	2.0	0.0	0.0	0.0	2.0	6.2	1.2	1.2
18 Carouge GE, Gavard	0.2	0.1	0.2	0.0	0.3	0.1	0.5	0.2	4.0	0.0	2.7	0.3	3.2	0.6	0.4	1.6	0.5	0.0	3.0	0.4	3.0	0.0	1.6	0.3	1.2	1.6	1.9	1.8	2.1	1.1	0.8
19 Carouge GE, Tours	0.6	0.5	0.2	1.6	1.0	0.8	0.8	1.9	5.8	0.0	4.9	2.2	9.0	1.9	5.9	6.5	4.7	3.6	0.0	3.0	12.4	0.0	10.2	3.0	3.4	3.9	1.7	6.7	4.2	2.2	1.3
20 Carouge GE, Marché	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	11.7	0.0	2.5	3.0	5.7	4.6	3.8	6.0	5.8	2.7	1.5
21 Carouge GE, Moraines	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	1.3	2.1	2.5	2.3	0.0	1.1	2.5	0.0	0.0
22 Carouge GE, Armes	0.0	0.2	0.3	0.7	0.4	0.0	0.6	0.5	3.3	0.0	2.8	1.0	4.8	2.3	2.1	1.3	0.0	2.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Carouge GE, Fontenette	0.6	0.0	0.0	0.0	0.3	0.4	0.0	0.4	2.2	0.0	1.9	1.2	7.0	1.4	1.9	1.6	1.3	2.8	10.6	0.0	0.0	5.4	0.0	0.0	0.0	6.1	0.8	3.5	3.0	7.4	3.0
24 Carouge GE, Val-d'Arve	0.0	0.0	1.2	0.5	0.3	0.5	0.2	0.2	1.1	0.0	0.5	0.0	4.4	0.9	0.0	3.4	0.6	1.8	8.3	0.0	0.0	8.9	0.0	0.0	2.9	4.1	0.0	2.5	2.9	4.5	1.6
25 Genève, Bout-du-Monde	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.3	0.0	1.0	0.0	0.0	0.9	0.0	0.0	2.4	0.0	0.0	2.7	0.5	0.0	0.0	2.0	0.7	2.2	0.4	1.6	1.8
26 Genève, Crêts-de-Champel	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.3	0.0	1.6	1.7	1.0	0.9	0.0	2.3	4.1	0.0	0.0	9.0	4.4	2.3	4.0	0.0	3.6	12.6	6.5	8.9	6.6
27 Genève, Clinique Générale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.9	0.3	0.5	0.0	0.0	1.0	2.4	0.0	0.0	3.4	0.9	0.0	3.6	4.2	0.0	1.9	2.7	3.1	1.9
28 Genève, Aubert	0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.3	0.0	2.9	0.3	2.6	0.9	1.1	1.6	7.2	0.0	0.0	8.3	3.5	3.5	5.4	10.5	2.9	0.0	2.2	12.7	6.0
29 Genève, Rieu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.3	0.0	0.3	1.5	0.0	0.4	2.2	1.6	6.6	0.0	0.0	8.5	4.6	0.6	2.8	3.2	1.8	5.7	0.0	7.5	9.9
30 Genève, Amandolier	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.7	0.3	0.0	0.5	0.4	1.3	3.4	0.0	0.0	3.6	11.1	2.6	6.0	7.1	8.3	27.5	17.9	0.0	0.9
31 Genève-Eaux-Vives, gare	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.6	0.4	0.3	0.2	1.0	2.0	0.0	0.0	3.3	3.6	1.5	10.6	10.0	4.9	14.0	24.2	1.6	0.0

Figure 58 IPF OD matrix, Line 11, workdays, hour 8, pax/h

Line 11, Workdays, Hour 17, IPF	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	1.6	3.4	1.7	5.2	5.6	23.0	6.3	9.9	1.2	0.8	0.0	3.6	0.0	0.0	0.0	0.4	0.7	0.5	0.4	0.6	0.0	1.4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	
02 Genève-Sécheron, gare	1.1	0.0	5.3	2.6	4.1	4.3	4.5	6.1	10.6	1.0	1.8	0.0	2.2	0.0	0.4	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
03 Genève, Nations	4.1	3.6	0.0	0.9	1.9	16.8	28.1	11.6	18.4	6.5	4.9	1.0	5.3	2.1	1.8	0.0	0.5	0.4	1.0	0.9	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
04 Genève, UIT	2.2	1.3	0.0	0.0	0.0	7.0	10.8	8.8	17.5	2.3	2.2	0.0	7.4	1.3	0.5	0.0	2.8	0.7	3.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
05 Genève, Motta	1.5	0.9	1.1	1.0	0.0	3.1	11.5	3.1	8.2	4.1	1.5	1.9	5.7	0.9	2.2	0.9	0.6	0.2	0.6	0.6	0.0	0.0	0.5	0.0	0.0	0.3	0.0	0.1	0.0	0.0	0.0
06 Genève, Grand-Pré	1.2	0.9	3.5	1.6	1.7	0.0	2.9	4.9	13.1	7.6	1.9	2.4	11.2	3.7	2.4	3.5	1.3	1.3	3.0	1.3	0.0	0.0	0.4	1.3	0.0	0.3	0.0	0.2	0.0	0.0	0.2
07 Genève, Servette	8.0	2.8	9.6	9.8	12.4	4.3	0.0	4.3	16.6	10.2	5.7	2.7	16.9	10.5	7.6	4.5	2.8	2.6	2.3	0.4	0.0	0.0	0.0	0.9	2.7	0.0	0.0	0.0	0.0	0.3	0.3
08 Genève, Wendt	1.7	0.6	3.5	3.5	6.6	1.8	11.8	0.0	2.0	4.7	3.0	1.6	14.5	1.5	1.8	3.4	0.9	1.2	2.4	1.6	0.3	0.0	1.5	0.0	1.6	0.3	0.3	0.0	0.0	0.0	0.0
09 Genève, Charmilles	5.9	3.5	7.3	6.8	9.9	11.1	21.2	10.0	0.0	4.7	2.2	8.8	36.9	7.7	7.9	10.2	6.0	3.8	6.6	3.6	0.0	0.0	2.7	2.9	1.4	0.5	0.0	0.0	0.4	0.0	0.0
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.7	19.5	4.0	4.2	3.1	0.3	2.1	2.2	2.5	0.0	0.0	0.0	0.0	0.0	0.7	0.5	0.0	0.6	0.0	0.0
11 Genève, Délices	0.0	2.2	4.5	2.4	5.3	3.8	26.4	13.2	12.5	0.0	0.0	5.3	26.8	6.7	8.0	3.2	1.6	2.9	4.9	4.6	0.0	0.0	3.8	1.9	1.3	0.0	0.6	0.3	0.0	0.0	0.0
12 Genève, Seujet	0.0	0.4	1.8	0.8	2.7	5.2	1.5	3.0	10.7	0.0	6.2	0.0	7.0	1.1	1.8	1.1	0.7	0.0	1.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
13 Genève, Jonction	1.6	1.4	3.8	4.6	7.9	9.2	28.9	27.3	60.8	0.0	70.6	6.6	0.0	9.1	10.1	18.5	11.8	8.4	16.6	9.4	3.8	0.0	11.9	10.7	7.5	3.9	2.4	3.0	0.0	0.4	0.9
14 Genève, Queue-d'Arve	0.4	0.2	1.1	1.5	0.6	1.1	14.8	2.5	12.6	0.0	15.3	2.6	22.4	0.0	1.5	5.8	3.5	3.4	4.0	3.5	0.8	0.0	1.9	1.4	2.0	2.7	0.0	0.8	1.1	1.5	1.5
15 Genève, Vernets	0.0	0.2	0.0	0.0	2.1	2.0	8.3	4.1	14.8	0.0	20.0	3.0	13.9	1.5	0.0	3.2	2.6	1.1	6.0	2.6	0.0	0.0	2.1	1.6	2.2	1.5	1.9	1.3	0.0	0.0	0.0
16 Genève, Epinettes	0.0	0.0	0.0	0.0	0.4	1.5	5.3	4.4	9.3	0.0	11.0	0.0	21.9	2.8	2.5	0.0	2.4	2.0	8.2	3.6	1.6	0.0	3.0	4.3	4.0	0.7	0.9	0.4	0.0	0.8	0.5
17 Carouge GE, Rue des Mouettes	0.2	0.0	0.5	1.2	0.5	1.2	3.0	1.1	6.7	0.0	4.1	0.6	13.1	0.5	2.7	2.6	0.0	1.7	12.3	2.7	1.8	0.0	1.1	4.8	0.0	0.0	0.0	1.3	5.1	0.9	1.7
18 Carouge GE, Gavard	0.2	0.1	0.2	0.0	0.6	0.3	2.8	0.9	7.9	0.0	7.7	0.7	10.1	1.5	0.6	4.8	2.0	0.0	2.9	0.6	0.8	0.0	2.3	0.7	1.9	2.0	1.6	1.3	1.9	0.9	1.2
19 Carouge GE, Tours	0.6	0.3	0.2	1.2	1.4	1.6	3.1	5.4	8.6	0.0	10.5	3.2	21.0	3.4	6.8	14.7	13.5	3.5	0.0	8.4	6.1	0.0	28.8	15.6	11.0	9.0	2.8	9.6	7.4	3.4	3.8
20 Carouge GE, Marché	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	3.8	0.0	4.6	10.0	11.7	6.9	4.0	5.6	6.6	2.8	2.9
21 Carouge GE, Moraines	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	1.0	2.9	2.0	1.4	0.0	0.4	1.1	0.0	0.0
22 Carouge GE, Armes	0.0	0.1	0.2	0.6	0.7	0.0	2.9	1.5	5.9	0.0	7.2	1.7	13.4	4.9	2.9	3.6	0.0	2.3	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Carouge GE, Fontenette	0.4	0.0	0.0	0.0	0.3	0.6	0.0	1.0	2.8	0.0	3.4	1.4	13.7	2.1	1.9	3.0	3.2	2.3	21.2	0.0	0.0	11.3	0.0	0.0	0.0	9.2	0.9	3.3	3.5	7.7	5.6
24 Carouge GE, Val-d'Arve	0.0	0.0	0.6	0.3	0.3	0.6	0.5	0.3	1.1	0.0	0.7	0.0	6.6	1.0	0.0	4.9	1.0	1.1	12.5	0.0	0.0	14.1	0.0	0.0	4.2	4.3	0.0	1.7	2.4	3.3	2.1
25 Genève, Bout-du-Monde	0.3	0.0	0.0	0.0	0.0	0.0	1.2	0.8	0.0	0.0	0.8	0.0	2.8	0.0	0.0	2.5	0.0	0.0	6.8	0.0	0.0	7.9	1.6	0.0	0.0	7.4	1.9	5.2	1.2	4.2	8.6
26 Genève, Crêts-de-Champel	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.3	0.0	1.9	1.6	0.6	1.0	0.0	1.2	5.1	0.0	0.0	11.8	6.0	7.3	5.8	0.0	3.2	9.8	6.3	7.7	10.4
27 Genève, Clinique Générale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.8	0.2	0.2	0.0	0.0	0.4	2.4	0.0	0.0	3.6	1.0	0.0	4.2	5.2	0.0	1.8	3.1	3.2	3.6
28 Genève, Aubert	0.1	0.0	0.0	0.0	0.1	0.0	0.3	0.2	0.0	0.0	0.5	0.0	4.6	0.4	2.1	1.4	2.2	1.0	11.9	0.0	0.0	14.3	6.3	14.7	10.3	21.1	4.0	0.0	3.9	19.7	17.0
29 Genève, Rieu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.9	0.0	1.0	3.3	0.0	1.3	7.9	1.9	19.7	0.0	0.0	26.3	15.0	4.6	9.5	11.7	4.4	10.9	0.0	15.5	37.7
30 Genève, Amandolier	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.7	0.3	0.0	0.5	0.5	0.6	3.5	0.0	0.0	3.9	12.7	6.9	7.2	8.9	7.2	18.2	9.8	0.0	4.2
31 Genève-Eaux-Vives, gare	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.6	0.2	0.4	0.4	0.6	2.7	0.0	0.0	4.8	5.4	5.4	16.8	16.7	5.6	12.2	17.5	2.3	0.0

Figure 59 IPF OD matrix, Line 11, workdays, hour 17, pax/h

Line 11, Saturday, Hour 17, IPF	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	0.1	1.9	0.1	1.6	1.7	8.7	3.1	3.5	0.6	0.4	0.0	1.5	0.0	0.0	0.0	0.1	0.4	0.2	0.2	0.2	0.0	0.5	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
02 Genève-Sécheron, gare	0.2	0.0	2.0	0.1	0.9	0.9	1.2	2.1	2.6	0.4	0.7	0.0	0.7	0.0	0.1	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	0.1	0.0
03 Genève, Nations	3.5	2.2	0.0	0.0	0.4	3.5	7.4	3.9	4.4	2.3	1.8	0.2	1.6	0.8	0.3	0.0	0.1	0.1	0.2	0.3	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
04 Genève, UIT	0.8	0.3	0.0	0.0	0.0	0.9	1.7	1.8	2.5	0.5	0.5	0.0	1.3	0.3	0.1	0.0	0.4	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
05 Genève, Motta	0.8	0.3	0.4	0.2	0.0	1.2	5.6	2.0	3.7	2.7	1.1	0.8	3.1	0.6	0.7	0.6	0.3	0.2	0.3	0.3	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0
06 Genève, Grand-Pré	0.7	0.4	1.6	0.4	1.0	0.0	0.9	1.9	3.7	3.2	0.8	0.6	3.8	1.6	0.5	1.4	0.4	0.6	0.8	0.5	0.0	0.0	0.1	0.3	0.0	0.1	0.0	0.1	0.0	0.0	0.1
07 Genève, Servette	6.0	1.5	5.7	3.5	9.0	2.9	0.0	3.0	8.1	7.4	4.3	1.2	10.0	7.6	2.8	3.1	1.3	2.0	1.1	0.2	0.0	0.0	0.0	0.4	0.6	0.0	0.0	0.0	0.0	0.2	0.2
08 Genève, Wendt	1.1	0.3	1.9	1.1	4.3	1.1	5.1	0.0	1.1	3.9	2.5	0.8	9.7	1.2	0.7	2.7	0.5	1.0	1.3	1.1	0.1	0.0	0.8	0.0	0.4	0.2	0.2	0.0	0.0	0.0	0.0
09 Genève, Charmilles	3.6	1.5	3.5	2.0	5.9	6.2	8.3	3.9	0.0	3.3	1.6	3.6	20.8	5.3	2.7	6.8	2.8	2.7	2.9	2.1	0.0	0.0	1.2	1.3	0.3	0.3	0.0	0.0	0.2	0.0	0.0
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.2	9.1	2.3	1.2	1.7	0.1	1.3	0.8	1.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.3	0.0	0.0
11 Genève, Délices	0.0	0.7	1.7	0.5	2.4	1.6	8.0	4.0	3.4	0.0	0.0	1.6	11.5	3.5	2.1	1.6	0.6	1.6	1.7	2.0	0.0	0.0	1.3	0.6	0.2	0.0	0.2	0.1	0.0	0.0	0.0
12 Genève, Seujet	0.0	0.2	0.9	0.3	1.7	3.0	0.6	1.2	4.1	0.0	1.9	0.0	2.1	0.4	0.3	0.4	0.2	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
13 Genève, Jonction	1.3	0.8	2.4	1.7	6.0	6.6	14.7	13.8	28.2	0.0	26.1	2.7	0.0	6.5	3.6	12.8	5.7	6.3	7.7	5.7	1.5	0.0	5.6	4.9	1.6	2.3	1.0	2.0	0.0	0.2	0.7
14 Genève, Queue-d'Arve	0.4	0.2	0.9	0.7	0.5	0.9	9.0	1.5	7.0	0.0	6.8	1.3	14.9	0.0	0.7	5.2	2.2	3.4	2.4	2.8	0.4	0.0	1.2	0.8	0.6	2.1	0.0	0.7	0.8	1.2	1.4
15 Genève, Vernets	0.0	0.1	0.0	0.0	0.9	0.8	2.4	1.2	4.0	0.0	4.3	0.7	4.4	0.6	0.0	1.1	0.7	0.4	1.4	0.8	0.0	0.0	0.5	0.4	0.2	0.5	0.4	0.5	0.0	0.0	0.0
16 Genève, Epinettes	0.0	0.0	0.0	0.0	0.4	1.4	3.3	2.7	5.3	0.0	5.0	0.0	14.8	2.3	1.3	0.0	1.4	1.8	4.7	2.6	0.8	0.0	1.7	2.4	1.1	0.5	0.4	0.3	0.0	0.6	0.4
17 Caroug GE, Rue des Mouettes	0.1	0.0	0.3	0.4	0.4	0.8	1.4	0.5	2.9	0.0	1.4	0.2	6.7	0.3	1.0	0.6	0.0	1.2	5.4	1.5	0.7	0.0	0.5	2.1	0.0	0.0	0.0	0.8	2.6	0.5	1.1
18 Caroug GE, Gavard	0.2	0.1	0.1	0.0	0.5	0.2	1.7	0.6	4.5	0.0	3.5	0.3	6.8	1.2	0.3	1.5	1.6	0.0	1.3	0.3	0.3	0.0	1.0	0.3	0.4	1.1	0.6	0.8	1.0	0.5	0.8
19 Caroug GE, Tours	0.5	0.2	0.1	0.5	1.0	1.1	1.6	2.7	4.0	0.0	3.9	1.3	11.5	2.2	2.8	3.9	8.7	1.9	0.0	6.4	3.1	0.0	17.1	9.0	3.0	6.7	1.5	8.0	5.1	2.7	3.5
20 Caroug GE, Marché	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	1.6	0.0	2.4	5.0	2.8	4.4	1.8	4.1	4.0	1.9	2.3
21 Caroug GE, Moraines	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	0.3	0.9	0.3	0.6	0.0	0.2	0.4	0.0	0.0
22 Caroug GE, Armes	0.0	0.1	0.1	0.2	0.5	0.0	1.3	0.7	2.4	0.0	2.4	0.6	6.6	3.0	1.1	0.8	0.0	1.1	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Caroug GE, Fontenette	0.4	0.0	0.0	0.0	0.3	0.5	0.0	0.6	1.5	0.0	1.5	0.7	8.8	1.6	0.9	0.9	2.4	1.5	12.3	0.0	0.0	3.0	0.0	0.0	0.0	3.9	0.3	1.6	1.4	3.4	2.9
24 Caroug GE, Val-d'Arve	0.0	0.0	0.4	0.1	0.2	0.4	0.3	0.2	0.5	0.0	0.3	0.0	3.9	0.7	0.0	1.4	0.7	0.7	6.6	0.0	0.0	3.3	0.0	0.0	1.0	2.8	0.0	1.2	1.4	2.3	1.7
25 Genève, Bout-du-Monde	0.8	0.0	0.0	0.0	0.0	0.0	2.3	1.5	0.0	0.0	1.1	0.0	5.7	0.0	0.0	2.4	0.0	0.0	12.6	0.0	0.0	6.6	2.5	0.1	0.0	7.5	1.3	5.9	1.2	4.5	10.7
26 Genève, Crêts-de-Champel	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.8	0.8	0.2	0.2	0.0	0.5	1.9	0.0	0.0	1.9	1.8	2.6	0.8	0.0	1.0	5.1	2.7	3.7	5.9
27 Genève, Clinique Générale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.0	0.0	0.2	0.8	0.0	0.0	0.6	0.3	0.0	0.5	2.1	0.0	0.8	1.1	1.3	1.8
28 Genève, Aubert	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.0	2.0	0.2	0.7	0.3	1.1	0.5	4.6	0.0	0.0	2.5	2.0	5.5	1.5	9.8	1.5	0.0	0.9	5.0	5.1
29 Genève, Rieu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.1	0.0	0.2	0.6	0.0	0.1	1.5	0.3	2.9	0.0	0.0	1.7	1.8	0.6	0.5	2.0	0.6	1.3	0.0	1.0	2.9
30 Genève, Amandolier	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.1	0.3	0.2	1.4	0.0	0.0	0.7	4.1	2.6	1.0	4.2	2.7	6.0	2.4	0.0	0.2
31 Genève-Eaux-Vives, gare	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.5	0.1	0.1	0.3	0.4	1.7	0.0	0.0	1.3	2.7	3.1	3.7	12.1	3.3	6.2	6.6	1.6	0.0

Figure 60 IPF OD matrix, Line 11, Saturday, hour 17, pax/h

Line 11, Sunday, Hour 17, IPF	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	1.7	2.2	0.3	2.0	2.3	10.2	3.5	3.3	1.0	0.5	0.0	2.4	0.0	0.0	0.0	0.4	0.2	0.5	0.4	0.6	0.0	1.1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
02 Genève-Sécheron, gare	0.8	0.0	3.2	0.4	1.4	1.6	1.8	3.1	3.2	0.7	1.1	0.0	1.4	0.0	0.1	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
03 Genève, Nations	4.0	1.6	0.0	0.1	0.3	2.6	4.7	2.5	2.3	2.1	1.3	0.2	1.4	0.1	0.2	0.0	0.1	0.0	0.4	0.3	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
04 Genève, UIT	1.1	0.3	0.0	0.0	0.0	0.5	0.9	0.9	1.1	0.4	0.3	0.0	0.9	0.0	0.0	0.0	0.4	0.0	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
05 Genève, Motta	0.7	0.2	0.2	0.1	0.0	0.6	2.2	0.8	1.2	1.5	0.5	0.5	1.7	0.1	0.3	0.4	0.2	0.0	0.3	0.2	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.1	0.0	0.0	0.0
06 Genève, Grand-Pré	1.2	0.4	1.3	0.3	0.5	0.0	0.6	1.2	2.0	3.0	0.6	0.7	3.5	0.3	0.4	1.5	0.5	0.2	1.4	0.6	0.0	0.0	0.2	0.5	0.0	0.3	0.0	0.2	0.0	0.0	0.3
07 Genève, Servette	7.0	1.1	3.2	1.5	3.4	0.7	0.0	1.3	3.1	4.8	2.2	0.9	6.4	1.0	1.4	2.4	1.3	0.4	1.3	0.2	0.0	0.0	0.0	0.4	1.0	0.0	0.0	0.0	0.0	0.4	0.5
08 Genève, Wendt	2.1	0.3	1.7	0.7	2.6	0.4	2.9	0.0	0.4	2.6	1.3	0.7	6.4	0.2	0.4	2.1	0.5	0.2	1.6	1.0	0.2	0.0	0.8	0.0	0.7	0.3	0.5	0.0	0.0	0.0	0.0
09 Genève, Charmilles	5.3	1.4	2.5	1.1	2.8	1.8	3.8	2.2	0.0	1.8	0.7	2.4	11.0	0.6	1.2	4.3	2.1	0.5	2.9	1.6	0.0	0.0	0.9	1.0	0.4	0.4	0.0	0.0	0.6	0.0	0.0
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2	6.3	0.3	0.7	1.4	0.1	0.3	1.1	1.2	0.0	0.0	0.0	0.0	0.0	0.7	0.5	0.0	1.0	0.0	0.0
11 Genève, Délices	0.0	0.8	1.4	0.3	1.3	0.5	4.2	2.6	2.1	0.0	0.0	1.5	8.1	0.5	1.2	1.4	0.6	0.4	2.2	2.0	0.0	0.0	1.3	0.7	0.4	0.0	0.6	0.3	0.0	0.0	0.0
12 Genève, Seujet	0.0	0.5	1.9	0.4	2.3	2.4	0.8	2.0	6.0	0.0	3.6	0.0	1.3	0.1	0.2	0.3	0.2	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
13 Genève, Jonction	2.4	0.9	2.2	1.2	3.6	2.4	8.5	10.0	19.0	0.0	23.2	0.8	0.0	0.5	1.1	5.6	3.0	0.8	5.3	2.9	1.2	0.0	2.9	2.7	1.6	2.2	1.7	2.1	0.0	0.3	0.8
14 Genève, Queue-d'Arve	0.4	0.1	0.4	0.2	0.2	0.2	2.7	0.6	2.4	0.0	3.1	0.2	3.6	0.0	0.1	0.9	0.5	0.2	0.6	0.5	0.1	0.0	0.2	0.2	0.2	0.8	0.0	0.3	0.6	0.6	0.6
15 Genève, Vernets	0.0	0.1	0.0	0.0	0.6	0.3	1.5	1.0	2.9	0.0	4.2	0.2	2.3	0.1	0.0	0.6	0.4	0.1	1.1	0.5	0.0	0.0	0.3	0.2	0.3	0.5	0.8	0.5	0.0	0.0	0.0
16 Genève, Epinettes	0.0	0.0	0.0	0.0	0.2	0.4	1.6	1.6	3.0	0.0	3.7	0.0	5.8	0.3	0.6	0.0	0.5	0.1	2.0	0.8	0.4	0.0	0.5	0.8	0.7	0.3	0.5	0.2	0.0	0.5	0.3
17 Carouge GE, Rue des Mouettes	0.2	0.0	0.2	0.2	0.2	0.3	0.7	0.3	1.7	0.0	1.1	0.1	2.8	0.0	0.5	0.3	0.0	0.1	1.9	0.4	0.3	0.0	0.1	0.6	0.0	0.0	0.0	0.5	2.6	0.3	0.7
18 Carouge GE, Gavad	0.1	0.0	0.0	0.0	0.1	0.0	0.3	0.1	0.9	0.0	0.9	0.0	1.0	0.1	0.1	0.3	0.2	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.1	0.1
19 Carouge GE, Tours	0.9	0.2	0.1	0.3	0.6	0.4	0.9	2.0	2.7	0.0	3.5	0.4	5.5	0.3	1.6	2.4	2.8	0.8	0.0	1.3	1.0	0.0	3.5	2.0	1.2	2.6	1.0	3.5	3.9	1.4	1.7
20 Carouge GE, Marché	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	0.7	0.0	0.6	1.5	1.4	2.3	1.7	2.3	4.0	1.3	1.5
21 Carouge GE, Moraines	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	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0
22 Carouge GE, Armes	0.0	0.1	0.2	0.2	0.4	0.0	1.0	0.7	2.3	0.0	2.9	0.2	4.3	0.6	0.9	0.7	0.0	0.6	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Carouge GE, Fontenette	0.8	0.0	0.0	0.0	0.2	0.2	0.0	0.4	1.1	0.0	1.4	0.2	4.4	0.2	0.6	0.6	0.8	0.6	3.2	0.0	0.0	1.6	0.0	0.0	0.0	2.8	0.3	1.2	1.9	3.2	2.6
24 Carouge GE, Val-d'Arve	0.0	0.0	1.1	0.2	0.5	0.5	0.5	0.4	1.2	0.0	0.7	0.0	6.0	0.3	0.0	2.7	0.7	0.9	5.3	0.0	0.0	5.4	0.0	0.0	0.9	2.5	0.0	1.2	2.5	2.6	1.8
25 Genève, Bout-du-Monde	3.2	0.0	0.0	0.0	0.0	0.0	2.9	2.4	0.0	0.0	2.3	0.0	6.1	0.0	0.0	3.3	0.0	0.0	6.9	0.0	0.0	7.4	1.0	0.0	0.0	7.9	2.4	6.8	2.4	6.2	13.6
26 Genève, Crêts-de-Champel	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.3	0.0	1.2	0.3	0.4	0.4	0.0	0.6	1.5	0.0	0.0	3.1	1.1	1.9	1.2	0.0	0.6	1.8	1.7	1.6	2.3
27 Genève, Clinique Générale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.7	0.1	0.2	0.0	0.0	0.3	0.9	0.0	0.0	1.2	0.2	0.0	1.1	1.5	0.0	0.4	1.0	0.8	1.0
28 Genève, Aubert	0.3	0.0	0.0	0.0	0.1	0.0	0.2	0.1	0.0	0.0	0.2	0.0	1.9	0.1	0.8	0.3	0.7	0.4	2.3	0.0	0.0	2.5	0.7	2.5	1.4	3.1	0.8	0.0	0.8	3.2	3.0
29 Genève, Rieu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.3	0.0	0.2	0.3	0.0	0.2	1.6	0.4	2.3	0.0	0.0	2.8	1.1	0.5	0.8	1.0	0.6	0.7	0.0	1.2	3.1
30 Genève, Amandolier	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.1	0.2	0.2	0.8	0.0	0.0	0.8	1.8	1.4	1.2	1.6	1.9	2.4	1.5	0.0	0.4
31 Genève-Eaux-Vives, gare	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.2	0.2	0.3	0.3	0.5	1.4	0.0	0.0	2.2	1.7	2.4	6.0	6.5	3.2	3.5	5.7	0.6	0.0

Figure 61 IPF OD matrix, Line 11, Sunday, hour 17, pax/h

GM results

Line 11, Workdays, Hour 8, GM	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	0.2	2.6	0.8	0.3	0.6	0.5	0.2	1.1	0.6	0.6	0.4	4.1	1.1	1.6	1.5	0.4	0.7	1.3	0.3	0.5	0.0	0.5	0.2	0.5	0.8	0.3	0.8	0.7	1.1	0.9
02 Genève-Sécheron, gare	1.2	0.0	2.4	0.6	0.2	0.3	0.2	0.1	0.5	0.2	0.2	0.2	1.6	0.4	0.6	0.6	0.2	0.3	0.5	0.1	0.2	0.0	0.2	0.1	0.2	0.3	0.1	0.3	0.3	0.4	0.3
03 Genève, Nations	3.8	7.3	0.0	5.6	1.2	1.0	0.7	0.3	1.1	0.6	0.5	0.4	3.4	0.9	1.3	1.1	0.3	0.5	1.0	0.2	0.4	0.0	0.3	0.2	0.3	0.5	0.2	0.5	0.5	0.7	0.6
04 Genève, UIT	1.0	1.3	8.5	0.0	4.6	1.3	0.8	0.3	1.2	0.5	0.5	0.3	3.2	0.8	1.1	1.0	0.3	0.5	0.8	0.2	0.3	0.0	0.3	0.1	0.3	0.4	0.2	0.4	0.4	0.6	0.5
05 Genève, Motta	2.1	2.1	6.6	10.1	0.0	3.1	1.7	0.5	2.2	1.0	1.0	0.6	5.6	1.4	2.0	1.7	0.5	0.8	1.5	0.4	0.6	0.0	0.5	0.2	0.5	0.8	0.3	0.8	0.7	1.1	0.9
06 Genève, Grand-Pré	3.9	3.5	8.9	10.2	16.0	0.0	12.9	1.9	5.6	2.1	1.8	1.1	9.2	2.2	3.0	2.5	0.7	1.2	2.1	0.5	0.8	0.0	0.7	0.3	0.6	1.0	0.4	1.0	0.9	1.4	1.2
07 Genève, Servette	11.6	9.6	22.0	22.7	23.1	22.0	0.0	7.4	15.1	4.8	3.9	2.2	18.4	4.2	5.6	4.8	1.4	2.2	3.8	0.9	1.4	0.0	1.3	0.6	1.2	1.8	0.6	1.8	1.6	2.5	2.1
08 Genève, Wendt	4.9	3.9	8.4	8.1	6.7	3.9	21.2	0.0	21.5	4.2	3.0	1.6	12.1	2.6	3.4	2.8	0.8	1.3	2.2	0.5	0.8	0.0	0.7	0.3	0.6	1.0	0.3	1.0	0.9	1.4	1.1
09 Genève, Charmilles	10.1	7.5	15.2	13.8	9.9	4.5	14.0	24.2	0.0	15.4	7.7	3.3	23.6	4.7	5.8	4.8	1.3	2.1	3.6	0.8	1.3	0.0	1.1	0.5	1.0	1.5	0.5	1.5	1.3	2.1	1.7
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	4.4	24.9	4.2	4.9	3.9	1.1	1.6	2.8	0.6	1.0	0.0	0.8	0.4	0.7	1.1	0.4	1.1	0.9	1.4	1.2
11 Genève, Délices	2.3	1.7	3.3	2.9	1.9	0.8	2.1	2.6	44.4	0.0	0.0	8.0	30.8	4.2	4.6	3.6	1.0	1.4	2.4	0.5	0.8	0.0	0.7	0.3	0.6	0.9	0.3	0.8	0.7	1.1	0.9
12 Genève, Seujet	0.9	0.6	1.2	1.0	0.6	0.2	0.6	0.6	6.3	0.0	10.1	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
13 Genève, Jonction	10.5	7.2	13.2	11.2	6.8	2.4	5.7	5.7	49.0	0.0	55.6	13.1	0.0	27.3	20.7	14.0	3.4	4.6	7.4	1.5	2.3	0.0	1.9	0.8	1.5	2.1	0.7	2.0	1.8	2.6	2.1
14 Genève, Queue-d'Arve	0.4	0.3	0.5	0.4	0.2	0.1	0.2	0.2	1.2	0.0	1.1	0.1	9.9	0.0	6.0	2.7	0.5	0.6	0.9	0.2	0.2	0.0	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.2
15 Genève, Vernets	0.3	0.2	0.3	0.3	0.2	0.1	0.1	0.1	0.7	0.0	0.6	0.1	3.9	2.5	0.0	5.5	0.6	0.5	0.7	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1
16 Genève, Epinettes	1.2	0.8	1.4	1.1	0.6	0.2	0.5	0.4	2.8	0.0	2.2	0.2	11.1	3.8	10.3	0.0	16.0	7.7	9.5	1.4	1.8	0.0	1.3	0.5	0.8	1.0	0.3	0.9	0.8	1.1	0.9
17 Caroug GE, Rue des Mouettes	0.6	0.4	0.7	0.6	0.3	0.1	0.2	0.2	1.3	0.0	1.1	0.1	4.9	1.5	3.0	24.3	0.0	15.0	14.5	1.7	2.1	0.0	1.4	0.5	0.8	1.0	0.3	0.9	0.7	1.0	0.8
18 Caroug GE, Gavard	0.5	0.3	0.5	0.4	0.2	0.1	0.2	0.1	0.9	0.0	0.7	0.1	2.8	0.7	1.2	4.0	2.9	0.0	15.3	0.7	0.8	0.0	0.4	0.2	0.2	0.3	0.1	0.2	0.2	0.2	0.2
19 Caroug GE, Tours	1.5	0.9	1.6	1.3	0.7	0.2	0.5	0.4	2.7	0.0	2.1	0.2	8.2	1.9	2.9	8.0	4.6	15.2	0.0	14.7	12.7	0.0	6.4	2.1	2.8	3.1	1.0	2.6	2.1	3.0	2.3
20 Caroug GE, Marché	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	29.4	0.0	6.9	1.7	1.9	1.9	0.6	1.5	1.2	1.6	1.3
21 Caroug GE, Moraines	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	6.2	1.1	1.0	0.9	0.3	0.7	0.5	0.7	0.6
22 Caroug GE, Armes	0.5	0.3	0.5	0.4	0.2	0.1	0.1	0.1	0.8	0.0	0.6	0.0	2.1	0.4	0.6	1.4	0.6	1.0	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Caroug GE, Fontenette	0.7	0.4	0.7	0.6	0.3	0.1	0.2	0.2	1.0	0.0	0.7	0.1	2.5	0.5	0.6	1.2	0.5	0.6	8.5	0.0	0.0	20.0	0.0	8.1	4.4	3.2	0.9	2.2	1.7	2.2	1.7
24 Caroug GE, Val-d'Arve	0.5	0.3	0.5	0.4	0.2	0.1	0.1	0.1	0.7	0.0	0.5	0.0	1.6	0.3	0.4	0.7	0.3	0.3	4.2	0.0	0.0	7.6	14.5	0.0	7.0	3.5	0.9	2.2	1.6	2.0	1.5
25 Genève, Bout-du-Monde	0.2	0.1	0.2	0.2	0.1	0.0	0.1	0.0	0.3	0.0	0.2	0.0	0.6	0.1	0.1	0.2	0.1	0.1	1.2	0.0	0.0	1.7	1.5	1.7	0.0	3.5	0.7	1.6	1.0	1.2	0.9
26 Genève, Crêts-de-Champel	0.8	0.5	0.8	0.6	0.3	0.1	0.2	0.2	1.0	0.0	0.7	0.1	2.1	0.4	0.4	0.8	0.3	0.3	3.4	0.0	0.0	4.3	2.6	2.1	10.2	0.0	9.4	13.7	6.2	5.8	3.9
27 Genève, Clinique Générale	0.3	0.2	0.3	0.2	0.1	0.0	0.1	0.1	0.3	0.0	0.2	0.0	0.7	0.1	0.1	0.2	0.1	0.1	1.1	0.0	0.0	1.3	0.8	0.6	2.3	8.5	0.0	6.9	1.4	1.0	0.6
28 Genève, Aubert	1.0	0.6	1.0	0.8	0.4	0.1	0.3	0.2	1.2	0.0	0.9	0.1	2.6	0.4	0.5	0.9	0.3	0.3	3.6	0.0	0.0	4.3	2.3	1.7	5.9	11.5	10.7	0.0	11.9	6.0	3.4
29 Genève, Rieu	0.6	0.4	0.6	0.5	0.3	0.1	0.2	0.1	0.8	0.0	0.5	0.0	1.6	0.3	0.3	0.5	0.2	0.2	2.0	0.0	0.0	2.4	1.2	0.8	2.8	3.7	2.1	19.2	0.0	12.5	5.4
30 Genève, Amandolier	1.7	1.0	1.7	1.3	0.7	0.2	0.4	0.3	2.0	0.0	1.4	0.1	4.1	0.7	0.7	1.3	0.5	0.5	5.0	0.0	0.0	5.6	2.8	1.9	5.6	6.0	2.7	16.1	27.0	0.0	0.9
31 Genève-Eaux-Vives, gare	1.9	1.2	1.9	1.5	0.8	0.2	0.5	0.4	2.3	0.0	1.5	0.1	4.5	0.7	0.8	1.4	0.5	0.5	5.3	0.0	0.0	5.9	2.9	1.9	5.5	5.3	2.3	12.0	15.1	1.6	0.0

Figure 62 GM OD matrix, Line 11, workdays, hour 8, pax/h

Line 11, Workdays, Hour 17, GM	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	1.6	3.6	0.4	0.4	4.2	6.3	2.6	6.8	1.7	1.2	1.0	9.4	1.6	1.9	2.1	1.2	1.2	2.9	0.8	0.2	0.0	1.6	1.5	1.8	1.9	0.5	1.3	1.1	1.7	3.2
02 Genève-Sécheron, gare	1.2	0.0	5.1	0.4	0.4	3.3	4.7	1.8	4.6	1.1	0.7	0.6	5.7	0.9	1.1	1.2	0.7	0.7	1.7	0.5	0.1	0.0	0.9	0.9	1.0	1.0	0.3	0.7	0.6	0.9	1.7
03 Genève, Nations	3.1	4.8	0.0	4.5	3.2	12.0	15.3	5.3	12.5	2.9	1.8	1.5	13.3	2.1	2.4	2.6	1.5	1.4	3.6	1.0	0.3	0.0	1.9	1.8	2.1	2.2	0.6	1.4	1.2	1.9	3.5
04 Genève, UIT	0.3	0.3	2.9	0.0	7.1	8.9	10.3	3.3	7.4	1.6	1.0	0.8	7.2	1.1	1.3	1.4	0.8	0.7	1.8	0.5	0.1	0.0	1.0	0.9	1.1	1.1	0.3	0.7	0.6	1.0	1.8
05 Genève, Motta	0.4	0.3	1.5	2.5	0.0	8.4	9.0	2.7	5.8	1.3	0.8	0.6	5.3	0.8	0.9	1.0	0.6	0.5	1.3	0.4	0.1	0.0	0.7	0.7	0.8	0.8	0.2	0.5	0.4	0.7	1.2
06 Genève, Grand-Pré	0.5	0.4	1.2	1.6	5.6	0.0	35.1	4.7	7.3	1.3	0.7	0.5	4.4	0.6	0.7	0.7	0.4	0.4	0.9	0.3	0.1	0.0	0.5	0.4	0.5	0.5	0.1	0.3	0.3	0.4	0.8
07 Genève, Servette	2.4	1.6	4.8	5.5	12.8	21.3	0.0	24.8	26.6	4.0	2.1	1.4	11.6	1.6	1.7	1.9	1.0	0.9	2.3	0.6	0.2	0.0	1.2	1.1	1.2	1.2	0.3	0.8	0.6	1.0	1.9
08 Genève, Wendt	0.5	0.3	1.0	1.1	2.0	2.0	23.5	0.0	25.4	2.4	1.1	0.7	5.1	0.7	0.7	0.7	0.4	0.4	0.9	0.2	0.1	0.0	0.4	0.4	0.5	0.5	0.1	0.3	0.2	0.4	0.7
09 Genève, Charmilles	2.1	1.2	3.3	3.3	5.4	4.3	28.8	29.8	0.0	26.0	8.3	4.4	30.0	3.6	3.6	3.8	2.0	1.8	4.4	1.1	0.3	0.0	2.1	1.9	2.1	2.1	0.6	1.4	1.1	1.7	3.2
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	3.0	16.2	1.6	1.6	1.6	0.8	0.7	1.7	0.4	0.1	0.0	0.8	0.7	0.8	0.8	0.2	0.5	0.4	0.6	1.1
11 Genève, Délices	1.1	0.6	1.6	1.6	2.4	1.7	9.8	7.3	46.5	0.0	0.0	10.1	37.5	3.1	2.7	2.7	1.4	1.2	2.8	0.7	0.2	0.0	1.2	1.1	1.2	1.2	0.3	0.7	0.6	0.9	1.7
12 Genève, Seujet	0.5	0.3	0.7	0.6	0.9	0.6	3.1	2.0	7.4	0.0	17.3	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
13 Genève, Jonction	4.9	2.7	6.6	6.2	8.5	5.4	26.8	16.2	51.2	0.0	84.6	16.1	0.0	30.4	18.7	16.0	7.5	5.8	13.2	3.1	0.8	0.0	5.0	4.4	4.6	4.3	1.1	2.6	2.1	3.2	5.8
14 Genève, Queue-d'Arve	1.1	0.6	1.4	1.3	1.7	1.0	4.7	2.7	7.3	0.0	9.7	0.9	44.8	0.0	12.7	7.2	2.7	1.7	3.7	0.8	0.2	0.0	1.2	1.0	1.0	0.9	0.2	0.5	0.4	0.6	1.1
15 Genève, Vernets	1.2	0.6	1.5	1.4	1.8	1.1	4.9	2.7	7.1	0.0	8.7	0.7	28.0	11.9	0.0	14.3	3.1	1.5	2.9	0.5	0.1	0.0	0.7	0.6	0.6	0.5	0.1	0.3	0.2	0.3	0.6
16 Genève, Epinettes	1.2	0.6	1.5	1.3	1.7	1.0	4.5	2.4	6.1	0.0	7.1	0.6	18.3	4.2	10.2	0.0	13.9	3.8	6.7	1.1	0.3	0.0	1.4	1.1	1.0	0.8	0.2	0.5	0.4	0.5	1.0
17 Carouge GE, Rue des Mouettes	0.3	0.2	0.4	0.4	0.5	0.3	1.2	0.7	1.6	0.0	1.9	0.1	4.4	0.9	1.6	24.4	0.0	9.7	13.2	1.7	0.4	0.0	1.9	1.4	1.3	1.0	0.2	0.6	0.4	0.7	1.1
18 Carouge GE, Gavard	0.6	0.3	0.7	0.7	0.8	0.5	2.1	1.1	2.7	0.0	3.0	0.2	6.4	1.1	1.6	10.0	9.7	0.0	14.7	0.8	0.1	0.0	0.6	0.4	0.4	0.3	0.1	0.2	0.1	0.2	0.3
19 Carouge GE, Tours	1.8	0.9	2.1	1.9	2.3	1.3	5.9	3.1	7.3	0.0	8.0	0.6	16.3	2.5	3.4	17.6	13.6	12.6	0.0	33.1	5.1	0.0	19.8	12.8	9.9	7.1	1.7	3.9	2.8	4.1	7.2
20 Carouge GE, Marché	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	10.8	0.0	19.4	9.6	6.1	3.9	0.9	2.0	1.4	2.1	3.6
21 Carouge GE, Moraines	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	4.7	1.7	0.9	0.5	0.1	0.3	0.2	0.3	0.4
22 Carouge GE, Armes	0.5	0.3	0.6	0.5	0.7	0.4	1.6	0.8	2.0	0.0	2.1	0.1	3.9	0.5	0.7	2.8	1.8	0.7	41.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Carouge GE, Fontenette	0.5	0.3	0.6	0.5	0.6	0.4	1.6	0.8	1.8	0.0	1.9	0.1	3.3	0.4	0.5	1.8	1.1	0.3	14.6	0.0	0.0	38.0	0.0	17.6	5.4	2.6	0.5	1.2	0.8	1.1	1.9
24 Carouge GE, Val-d'Arve	0.3	0.1	0.3	0.3	0.3	0.2	0.8	0.4	0.9	0.0	1.0	0.1	1.6	0.2	0.2	0.8	0.5	0.1	5.6	0.0	0.0	11.1	21.1	0.0	9.6	3.1	0.6	1.3	0.8	1.1	1.8
25 Genève, Bout-du-Monde	0.2	0.1	0.2	0.2	0.2	0.1	0.6	0.3	0.6	0.0	0.7	0.0	1.1	0.1	0.1	0.5	0.3	0.1	2.8	0.0	0.0	4.5	3.8	8.4	0.0	13.4	2.0	4.0	2.4	2.9	4.6
26 Genève, Crêts-de-Champel	0.4	0.2	0.5	0.4	0.5	0.3	1.2	0.6	1.3	0.0	1.3	0.1	2.1	0.2	0.2	0.8	0.4	0.1	4.2	0.0	0.0	6.0	3.6	5.4	13.2	0.0	9.5	12.1	4.9	4.8	7.1
27 Genève, Clinique Générale	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.4	0.0	0.4	0.0	0.6	0.1	0.1	0.2	0.1	0.0	1.1	0.0	0.0	1.4	0.8	1.1	2.3	8.7	0.0	8.1	1.5	1.1	1.5
28 Genève, Aubert	0.9	0.4	1.0	0.8	1.0	0.5	2.3	1.1	2.5	0.0	2.5	0.1	3.8	0.4	0.4	1.4	0.8	0.2	6.9	0.0	0.0	9.2	4.9	6.6	11.8	23.3	12.2	0.0	19.2	10.0	12.7
29 Genève, Rieu	1.2	0.6	1.3	1.1	1.3	0.7	3.0	1.5	3.3	0.0	3.2	0.2	5.0	0.5	0.6	1.8	1.0	0.2	8.5	0.0	0.0	10.9	5.6	7.3	11.7	16.1	5.1	28.3	0.0	28.0	26.9
30 Genève, Amandolier	0.9	0.4	1.0	0.9	1.0	0.5	2.3	1.1	2.5	0.0	2.4	0.1	3.7	0.4	0.4	1.3	0.7	0.2	5.9	0.0	0.0	7.4	3.6	4.6	6.8	7.4	1.9	6.8	16.2	0.0	4.3
31 Genève-Eaux-Vives, gare	1.2	0.6	1.4	1.2	1.4	0.7	3.1	1.5	3.3	0.0	3.3	0.2	4.9	0.5	0.5	1.7	0.9	0.2	7.6	0.0	0.0	9.4	4.5	5.6	8.0	8.0	1.9	6.1	11.0	2.3	0.0

Figure 63 GM OD matrix, Line 11, workdays, hour 17, pax/h

Line 11, Saturday, Hour 17, GM	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Genève	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	0.1	2.0	0.0	0.2	1.0	2.2	0.7	1.4	0.8	0.5	0.3	4.1	0.8	0.4	1.2	0.4	0.7	1.0	0.3	0.1	0.0	0.6	0.5	0.3	0.8	0.2	0.7	0.5	0.9	1.5
02 Genève-Sécheron, gare	0.2	0.0	1.9	0.0	0.1	0.6	1.1	0.4	0.7	0.4	0.2	0.1	1.8	0.3	0.2	0.5	0.2	0.3	0.4	0.1	0.0	0.0	0.2	0.2	0.1	0.3	0.1	0.3	0.2	0.3	0.6
03 Genève, Nations	3.0	2.9	0.0	0.2	1.1	2.3	4.1	1.1	2.0	1.0	0.7	0.4	4.5	0.8	0.4	1.2	0.4	0.6	0.9	0.3	0.1	0.0	0.5	0.5	0.3	0.7	0.1	0.6	0.5	0.8	1.3
04 Genève, UIT	0.1	0.1	1.0	0.0	1.4	1.0	1.6	0.4	0.7	0.3	0.2	0.1	1.4	0.3	0.1	0.4	0.1	0.2	0.3	0.1	0.0	0.0	0.2	0.1	0.1	0.2	0.0	0.2	0.1	0.2	0.4
05 Genève, Motta	0.3	0.1	0.7	0.7	0.0	3.2	4.6	1.1	1.8	0.8	0.5	0.3	3.5	0.6	0.3	0.9	0.3	0.5	0.7	0.2	0.0	0.0	0.4	0.3	0.2	0.5	0.1	0.4	0.3	0.5	0.9
06 Genève, Grand-Pré	0.3	0.1	0.5	0.4	3.0	0.0	11.8	1.3	1.5	0.6	0.3	0.2	1.9	0.3	0.2	0.4	0.1	0.2	0.3	0.1	0.0	0.0	0.2	0.2	0.1	0.2	0.0	0.2	0.1	0.2	0.4
07 Genève, Servette	1.7	0.7	2.7	1.9	8.8	13.6	0.0	12.7	9.9	3.3	1.8	0.9	9.3	1.5	0.7	2.0	0.6	1.0	1.4	0.4	0.1	0.0	0.8	0.7	0.4	0.9	0.2	0.8	0.6	1.0	1.6
08 Genève, Wendt	0.4	0.1	0.6	0.4	1.4	1.3	11.1	0.0	11.7	2.4	1.1	0.5	5.0	0.8	0.4	1.0	0.3	0.5	0.7	0.2	0.0	0.0	0.4	0.3	0.2	0.4	0.1	0.4	0.3	0.4	0.7
09 Genève, Charmilles	1.3	0.5	1.7	1.0	3.3	2.4	12.2	13.2	0.0	14.8	5.0	1.8	16.6	2.3	1.0	2.8	0.9	1.3	1.9	0.6	0.1	0.0	1.0	0.8	0.4	1.0	0.2	1.0	0.7	1.2	1.9
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	1.1	7.8	0.9	0.4	1.0	0.3	0.5	0.6	0.2	0.0	0.0	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.4	0.6
11 Genève, Délices	0.5	0.2	0.6	0.4	1.1	0.7	3.0	2.3	14.3	0.0	0.0	3.2	15.8	1.5	0.6	1.5	0.4	0.7	0.9	0.3	0.1	0.0	0.4	0.4	0.2	0.4	0.1	0.4	0.3	0.5	0.7
12 Genève, Seujet	0.3	0.1	0.4	0.2	0.6	0.4	1.5	1.0	3.6	0.0	6.2	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
13 Genève, Jonction	3.7	1.2	3.9	2.2	6.1	3.6	13.3	8.4	25.9	0.0	31.8	6.5	0.0	19.7	5.4	11.7	3.2	4.2	5.6	1.5	0.3	0.0	2.4	1.9	0.9	2.1	0.4	1.8	1.4	2.1	3.4
14 Genève, Queue-d'Arve	0.8	0.3	0.8	0.5	1.2	0.7	2.4	1.4	3.8	0.0	3.7	0.4	28.9	0.0	5.7	8.2	1.8	2.0	2.4	0.6	0.1	0.0	0.8	0.7	0.3	0.7	0.1	0.6	0.4	0.6	1.0
15 Genève, Vernets	0.4	0.1	0.4	0.2	0.6	0.3	1.1	0.7	1.7	0.0	1.5	0.1	8.3	4.2	0.0	4.5	0.6	0.5	0.5	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1
16 Genève, Epinettes	1.0	0.3	1.0	0.5	1.4	0.7	2.6	1.4	3.5	0.0	3.1	0.3	13.2	3.7	4.3	0.0	7.2	3.5	3.5	0.7	0.1	0.0	0.8	0.6	0.2	0.5	0.1	0.4	0.3	0.4	0.7
17 Caroug GE, Rue des Mouettes	0.3	0.1	0.3	0.2	0.4	0.2	0.7	0.4	0.9	0.0	0.8	0.1	3.2	0.8	0.7	8.2	0.0	6.6	5.2	0.8	0.1	0.0	0.8	0.6	0.2	0.5	0.1	0.4	0.3	0.4	0.6
18 Caroug GE, Gavard	0.5	0.2	0.5	0.3	0.7	0.4	1.3	0.7	1.6	0.0	1.3	0.1	4.9	1.0	0.7	3.5	5.9	0.0	6.7	0.4	0.1	0.0	0.3	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.2
19 Caroug GE, Tours	1.3	0.4	1.2	0.7	1.6	0.9	2.9	1.6	3.6	0.0	3.0	0.2	10.2	1.9	1.2	5.0	6.8	6.1	0.0	21.5	2.6	0.0	12.2	7.4	2.6	4.7	0.9	3.6	2.5	3.6	5.6
20 Caroug GE, Marché	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	4.8	0.0	10.4	4.9	1.4	2.3	0.4	1.6	1.1	1.6	2.4
21 Caroug GE, Moraines	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	1.5	0.5	0.1	0.2	0.0	0.1	0.1	0.1	0.2
22 Caroug GE, Armes	0.3	0.1	0.3	0.2	0.4	0.2	0.7	0.4	0.9	0.0	0.7	0.1	2.3	0.4	0.2	0.7	0.8	0.3	17.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Caroug GE, Fontenette	0.7	0.2	0.6	0.3	0.8	0.4	1.3	0.7	1.6	0.0	1.2	0.1	3.6	0.6	0.3	0.9	0.9	0.3	11.8	0.0	0.0	10.7	0.0	7.9	1.1	1.3	0.2	0.8	0.5	0.7	1.1
24 Caroug GE, Val-d'Arve	0.3	0.1	0.3	0.1	0.3	0.2	0.6	0.3	0.7	0.0	0.5	0.0	1.5	0.2	0.1	0.3	0.3	0.1	3.8	0.0	0.0	2.6	7.3	0.0	3.0	2.4	0.4	1.4	0.8	1.1	1.7
25 Genève, Bout-du-Monde	0.7	0.2	0.6	0.3	0.8	0.4	1.3	0.7	1.5	0.0	1.1	0.1	3.1	0.4	0.2	0.6	0.6	0.2	6.1	0.0	0.0	3.4	4.2	9.5	0.0	13.0	1.6	5.4	3.0	3.7	5.2
26 Genève, Crêts-de-Champel	0.3	0.1	0.2	0.1	0.3	0.2	0.5	0.3	0.5	0.0	0.4	0.0	1.1	0.2	0.1	0.2	0.2	0.0	1.7	0.0	0.0	0.8	0.7	1.1	2.5	0.0	3.2	7.0	2.7	2.6	3.4
27 Genève, Clinique Générale	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.1	0.1	0.2	3.5	0.0	3.5	0.6	0.5	0.5
28 Genève, Aubert	0.4	0.1	0.4	0.2	0.5	0.2	0.8	0.4	0.8	0.0	0.6	0.0	1.7	0.2	0.1	0.3	0.3	0.1	2.2	0.0	0.0	1.0	0.8	1.1	1.8	12.8	5.3	0.0	5.3	2.8	3.1
29 Genève, Rieu	0.2	0.1	0.2	0.1	0.2	0.1	0.3	0.2	0.4	0.0	0.3	0.0	0.7	0.1	0.0	0.1	0.1	0.0	0.9	0.0	0.0	0.4	0.3	0.4	0.6	3.0	0.7	5.0	0.0	2.2	1.9
30 Genève, Amandolier	0.5	0.1	0.4	0.2	0.5	0.3	0.8	0.4	0.9	0.0	0.6	0.0	1.7	0.2	0.1	0.3	0.2	0.1	2.0	0.0	0.0	0.9	0.6	0.8	1.1	4.2	0.8	3.7	4.4	0.0	0.2
31 Genève-Eaux-Vives, gare	1.0	0.3	0.8	0.4	1.0	0.5	1.6	0.8	1.7	0.0	1.3	0.1	3.3	0.4	0.2	0.5	0.5	0.1	3.8	0.0	0.0	1.6	1.1	1.5	1.9	6.7	1.3	4.9	4.5	1.6	0.0

Figure 64 GM OD matrix, Line 11, Saturday, hour 17, pax/h

Line 11, Sunday, Hour 17, GM	01 Genève	02 Genève	03 Genève	04 Genève	05 Genève	06 Genève	07 Genève	08 Genève	09 Genève	10 Genève	11 Genève	12 Genève	13 Genève	14 Genève	15 Genève	16 Genève	17 Caroug	18 Caroug	19 Caroug	20 Caroug	21 Caroug	22 Caroug	23 Caroug	24 Caroug	25 Genève	26 Genève	27 Genève	28 Genève	29 Genève	30 Genève	31 Genève
01 Genève, Jardin Botanique	0.0	1.7	2.4	0.1	0.5	1.8	2.8	1.1	1.4	1.2	0.6	0.5	5.0	0.2	0.5	1.5	0.6	0.2	2.0	0.6	0.1	0.0	0.6	0.5	0.4	1.0	0.5	1.1	1.3	1.6	2.6
02 Genève-Sécheron, gare	0.8	0.0	3.0	0.1	0.4	1.2	1.9	0.7	0.8	0.7	0.4	0.3	2.7	0.1	0.2	0.8	0.3	0.1	1.0	0.3	0.0	0.0	0.3	0.2	0.2	0.5	0.2	0.5	0.6	0.8	1.2
03 Genève, Nations	3.5	2.2	0.0	0.6	1.4	2.0	2.7	0.9	1.0	0.8	0.4	0.3	2.8	0.1	0.2	0.7	0.3	0.1	1.0	0.3	0.0	0.0	0.3	0.2	0.2	0.4	0.2	0.5	0.6	0.7	1.1
04 Genève, UIT	0.3	0.1	1.1	0.0	1.4	0.7	0.8	0.3	0.3	0.2	0.1	0.1	0.7	0.0	0.1	0.2	0.1	0.0	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.2	0.3
05 Genève, Motta	0.3	0.1	0.5	0.4	0.0	1.9	2.1	0.6	0.6	0.5	0.2	0.2	1.5	0.1	0.1	0.4	0.2	0.1	0.5	0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.1	0.2	0.3	0.3	0.5
06 Genève, Grand-Pré	0.6	0.2	0.6	0.3	2.1	0.0	10.1	1.3	1.0	0.6	0.3	0.2	1.5	0.0	0.1	0.3	0.1	0.1	0.4	0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.3	0.4
07 Genève, Servette	2.7	0.7	2.3	1.2	5.0	5.3	0.0	8.3	4.3	2.1	0.9	0.5	4.8	0.1	0.3	1.0	0.4	0.1	1.2	0.3	0.1	0.0	0.3	0.2	0.2	0.5	0.2	0.5	0.6	0.7	1.2
08 Genève, Wendt	0.7	0.2	0.6	0.3	0.9	0.6	7.6	0.0	7.3	2.2	0.8	0.4	3.7	0.1	0.2	0.7	0.3	0.1	0.8	0.2	0.0	0.0	0.2	0.2	0.1	0.3	0.2	0.3	0.4	0.5	0.8
09 Genève, Charmilles	1.7	0.4	1.2	0.5	1.6	0.8	5.8	9.4	0.0	9.6	2.5	1.1	8.7	0.2	0.5	1.4	0.6	0.2	1.6	0.4	0.1	0.0	0.4	0.3	0.3	0.6	0.3	0.6	0.7	0.9	1.4
10 Genève, Miléant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.9	5.6	0.1	0.3	0.7	0.3	0.1	0.8	0.2	0.0	0.0	0.2	0.1	0.1	0.3	0.1	0.3	0.3	0.4	0.6
11 Genève, Délices	0.6	0.2	0.4	0.2	0.5	0.2	1.4	1.6	8.6	0.0	0.0	2.8	11.5	0.2	0.4	1.1	0.4	0.1	1.1	0.3	0.0	0.0	0.3	0.2	0.2	0.3	0.2	0.3	0.4	0.5	0.8
12 Genève, Seujet	0.9	0.2	0.6	0.2	0.6	0.3	1.5	1.5	4.6	0.0	9.8	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
13 Genève, Jonction	5.4	1.2	3.0	1.3	3.3	1.3	7.0	6.7	17.7	0.0	26.6	1.9	0.0	2.2	3.0	7.0	2.5	0.7	5.5	1.3	0.2	0.0	1.2	0.8	0.7	1.4	0.6	1.4	1.6	1.8	2.9
14 Genève, Queue-d'Arve	0.5	0.1	0.3	0.1	0.3	0.1	0.6	0.5	1.2	0.0	1.4	0.1	8.9	0.0	1.2	1.9	0.5	0.1	0.9	0.2	0.0	0.0	0.2	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.3
15 Genève, Vernets	0.7	0.2	0.4	0.2	0.4	0.1	0.7	0.6	1.3	0.0	1.4	0.0	6.4	1.1	0.0	3.1	0.5	0.1	0.6	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1
16 Genève, Epinettes	1.0	0.2	0.5	0.2	0.5	0.2	0.9	0.8	1.7	0.0	1.8	0.1	6.2	0.6	2.7	0.0	3.3	0.3	2.0	0.3	0.0	0.0	0.2	0.1	0.1	0.2	0.1	0.2	0.2	0.3	0.3
17 Carouge GE, Rue des Mouettes	0.2	0.1	0.1	0.0	0.1	0.0	0.2	0.2	0.4	0.0	0.4	0.0	1.2	0.1	0.3	5.4	0.0	0.9	3.9	0.5	0.1	0.0	0.3	0.2	0.1	0.2	0.1	0.2	0.2	0.3	0.4
18 Carouge GE, Gavard	0.2	0.0	0.1	0.0	0.1	0.0	0.2	0.1	0.3	0.0	0.3	0.0	0.8	0.1	0.2	1.0	0.9	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19 Carouge GE, Tours	1.3	0.3	0.7	0.3	0.6	0.2	1.0	0.9	1.7	0.0	1.7	0.0	4.8	0.3	0.8	4.2	3.0	3.9	0.0	8.8	0.8	0.0	2.8	1.5	0.9	1.4	0.6	1.2	1.3	1.4	2.2
20 Carouge GE, Marché	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	2.9	0.0	4.6	1.8	0.9	1.3	0.5	1.1	1.1	1.2	1.8
21 Carouge GE, Moraines	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	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22 Carouge GE, Armes	0.6	0.1	0.3	0.1	0.3	0.1	0.5	0.4	0.7	0.0	0.7	0.0	1.9	0.1	0.3	1.1	0.6	0.4	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23 Carouge GE, Fontenette	0.6	0.1	0.3	0.1	0.3	0.1	0.4	0.4	0.7	0.0	0.6	0.0	1.6	0.1	0.2	0.7	0.4	0.2	3.0	0.0	0.0	6.9	0.0	4.9	1.2	1.2	0.5	0.9	0.9	0.9	1.4
24 Carouge GE, Val-d'Arve	1.1	0.2	0.5	0.2	0.5	0.2	0.8	0.6	1.2	0.0	1.1	0.0	2.6	0.1	0.3	1.0	0.6	0.2	4.0	0.0	0.0	7.0	4.5	0.0	2.9	2.1	0.7	1.4	1.3	1.3	1.9
25 Genève, Bout-du-Monde	1.8	0.4	0.9	0.3	0.8	0.3	1.2	1.0	1.8	0.0	1.7	0.0	3.9	0.2	0.4	1.4	0.7	0.3	4.5	0.0	0.0	6.4	1.9	6.2	0.0	12.7	3.4	6.1	5.3	4.8	6.8
26 Genève, Crêts-de-Champel	0.6	0.1	0.3	0.1	0.2	0.1	0.4	0.3	0.6	0.0	0.5	0.0	1.1	0.1	0.1	0.4	0.2	0.1	1.0	0.0	0.0	1.3	0.3	0.6	3.8	0.0	2.0	2.3	1.4	1.0	1.3
27 Genève, Clinique Générale	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.2	0.0	0.2	0.0	0.3	0.0	0.0	0.1	0.1	0.0	0.3	0.0	0.0	0.4	0.1	0.1	0.8	3.2	0.0	2.0	0.5	0.3	0.4
28 Genève, Aubert	0.7	0.1	0.3	0.1	0.3	0.1	0.4	0.3	0.6	0.0	0.6	0.0	1.2	0.1	0.1	0.4	0.2	0.1	1.0	0.0	0.0	1.1	0.2	0.4	2.0	4.4	3.8	0.0	3.8	1.5	1.7
29 Genève, Rieu	0.6	0.1	0.3	0.1	0.2	0.1	0.3	0.3	0.5	0.0	0.4	0.0	0.9	0.0	0.1	0.3	0.1	0.0	0.7	0.0	0.0	0.8	0.1	0.3	1.2	1.8	0.9	3.1	0.0	2.3	1.9
30 Genève, Amandolier	0.7	0.1	0.3	0.1	0.3	0.1	0.4	0.3	0.6	0.0	0.5	0.0	1.1	0.0	0.1	0.3	0.2	0.1	0.8	0.0	0.0	0.9	0.1	0.3	1.1	1.3	0.6	1.2	2.9	0.0	0.4
31 Genève-Eaux-Vives, gare	2.1	0.4	0.9	0.4	0.8	0.3	1.2	1.0	1.7	0.0	1.5	0.0	3.2	0.1	0.3	0.9	0.4	0.2	2.2	0.0	0.0	2.4	0.4	0.8	2.8	3.1	1.2	2.3	4.3	0.6	0.0

Figure 65 GM OD matrix, Line 11, Sunday, hour 17, pax/h

(Cumulative) trip length distribution and absolute differences

Table 30 (cumulative) trip distribution and absolute differences, Line 11

Distance interval (km)	Trip Distribution		Cumulative Trip Distribution		Absolute Difference
	IPF	GM	IPF	GM	
Line 11, workdays, hour 8					
0-2	0.603	0.687	0.603	0.687	0.085
2-4	0.307	0.177	0.910	0.864	0.046
4-6	0.075	0.070	0.985	0.935	0.050
6-8	0.014	0.033	0.998	0.968	0.031
8-10	0.001	0.022	1.000	0.990	0.010
10-12	0.000	0.010	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000
Line 11, workdays, hour 17					
0-2	0.576	0.675	0.576	0.675	0.099
2-4	0.326	0.176	0.902	0.851	0.051
4-6	0.081	0.076	0.983	0.928	0.055
6-8	0.015	0.037	0.998	0.965	0.033
8-10	0.002	0.024	1.000	0.989	0.011
10-12	0.000	0.011	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000
Line 11, Saturday, hour 17					
0-2	0.555	0.661	0.555	0.661	0.106
2-4	0.344	0.184	0.899	0.845	0.054
4-6	0.082	0.081	0.981	0.926	0.055
6-8	0.017	0.039	0.998	0.965	0.032
8-10	0.002	0.024	1.000	0.989	0.010
10-12	0.000	0.011	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000
Line 11, Sunday, hour 17					
0-2	0.480	0.610	0.480	0.610	0.130
2-4	0.361	0.184	0.841	0.795	0.046
4-6	0.112	0.092	0.953	0.887	0.067
6-8	0.036	0.055	0.990	0.942	0.048
8-10	0.009	0.036	0.999	0.977	0.021
10-12	0.001	0.023	1.000	1.000	0.000
12-14	0.000	0.000	1.000	1.000	0.000