Transport Modelling LV 209.213

Exercise1

Visum Travel Demand Model

prepared by

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Contents

1 Exercise 1 – Problem statement

1.1 General problem definition

So far we have prepared the travel demand model GM_08_Bus32.ver. This transport model for Graz is unrealistic for various reasons. The travel demand hasthreeparticular deficiencies.

1. The model is too coarse; e.g. the number of internal zones is very small considering the spatial area, the number of residents and the density of the network. However, we work on a simplified network and will not increase the number of zones by splitting them.
2. Employees travel only to work, and students travel only to university; thus the total of internal trips within the 17 Graz zones is too low (total number of trips as the sum of matrices 14 to 17).
3. The result of the trip distribution should include all internal trips conducted by all modes.

The second and third elementary mistakes should be settled, with this corrections:

- internal trips should be raised by the model.
- the mode choice should be part of the travel demand model.

The file **GM_10_Ex1Start.ver** has been prepared and uploaded as a starting point. The zonal data has been extended by an additional attribute OtherOpp. These other traffic relevant opportunities represent the attractiveness for shopping, leisure, and other activities for all residents. Usually, zonal based structural data for each activity and the associated trip rates are provided to separate each trip purpose. This simplification is done to keep your effort in an exercise low.

After generating a new OD-internal you have to calculate the bi-modal split between PuT and PrT. We will neglect bicycle transport and walking mode (except connecting each centroid with a public transport stop by PuTWalk).

The PuT and PrT(only car) matrices have to be assigned to the network. You will have to plan a base case reflecting the current situation. Graz will grow in the future, and we will assume that the growth is limited to additional residents in the zones of Strassgang and Wetzelsdorf and new work places in Liebenau. This will lead to additional travel demand and an extended PuT infrastructure, while not changing the road network. Consider two new metro lines (PuT improvement). You have toanalyze travel demand increase and its impact on the additional infrastructure supply (additional metro).

1.2 Specific tasks

The following list indicates the main tasks, which may be supplemented by additional steps as necessary:

a) Add a trip rate of 0.60 for all trips to other opportunities;eg.In 2023 each residenttravels with 60% probability to one other activity and returns home again.

b) You will receive new demand strata which have to be considered in the LOGIT trip distribution model with c=-0,08.

c) Use a LOGT choice model for mode choice. Use the current travel time for car traffic and the journey time in public transport as utilities. Since students have less access to private cars you should use different c-values;eg. Employees with c=-0.05, students c=-0.02 and residents somewhere in between such as c=-0.04.

d) The current travel times will only be used if you apply a feedback loop between assignment and mode choice (trip generation and trip distribution may not be affected).

e) Conduct private (only car) and public transport assignments and save this version as **base case** 2023.

You may want to use the following assumptions for the planning scenarios. Though, these assumptions are realistic it must be noted, that this is just a student exercise and doesnot reflect the comprehensive planning currently being done within the transport planning administration of Graz.

f) **Reference scenario 2030**: The zones of Wetzelsdorf, Strassgang, Eggenberg and Göstingwill receive 4.000 new residents each until 2030. 40% of the new residents will be employed and have car access. Liebenau and Strassgang will gain 5.000 new workplaces each. Calculate the total travel demand, the mode choice and run multimodal traffic assignment for this reference scenario 2030.

g) **Planning scenario 2030**: The additional travel demand requires investments in thepublic transport infrastructure. Add both metro linesin a reasonable, abstract manner based on Figure 1. Each zone touched by M1 or M2 has to have at least one stop connected via PuTWalk. The total running times are relevant, but alignment and all stops are not required. The Metro is a new Transport System.

h) Calculate mode choice and multimodal traffic assignment as previously done.

i) Calculate the differences between

- BaseCase2023 (extra demand, bimodal choice PrT/PuT),
- RefCase2030(like 2023 plus extra residents and work places) and
- PlanScen1 2030(like RefCase 2030 plus metro)

and analyze your findings with suitable KPIs (key performance indicators) such as total trips per mode, modal split, total distance travelled (PassengerKm) and total time travelled. A report such as this one (or also a master thesis) should contain a final summary table including the scenarios and essential KPIs.

1.3 General remarks:

a) The results should be archived and uploaded via TeachcenterMyFiles. Please name your archive file

Ex1_Visum_<FamilyName1>_<FamiliyName2>.zip.

The upload has to be done until **May31st,2023, 12:00**

b) A report has to be prepared and stored as *.pdf file. You may want to use this template. Document your steps. You may want to prepare a flow chart or other accompanying systematic explanation which you may prepare handwritten and embed as scanned figure.

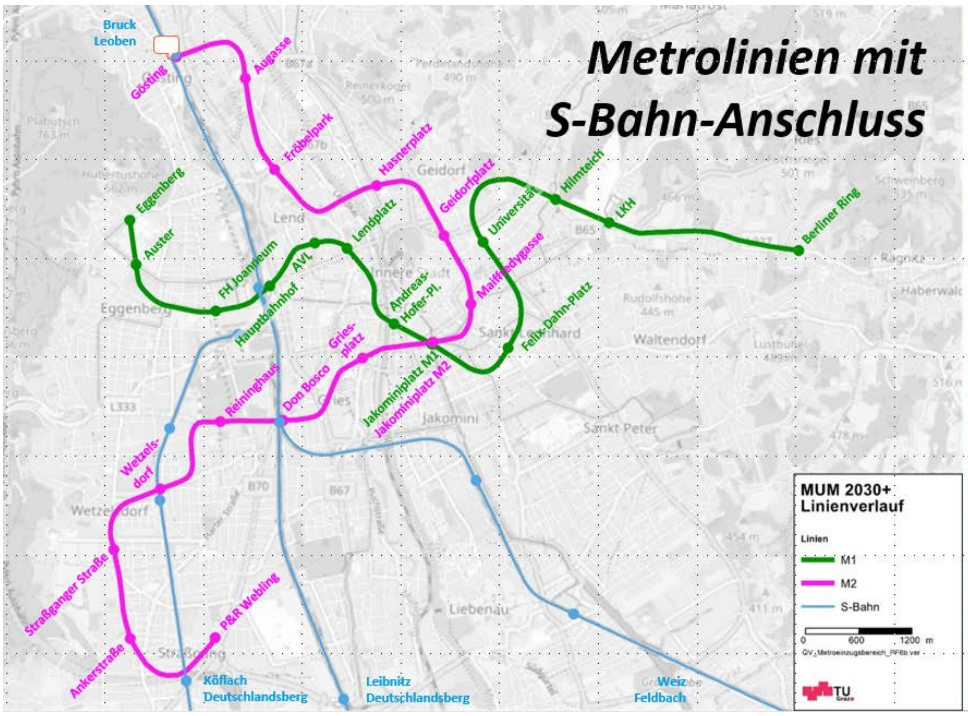
c) All figures should be accompanied by an explanation what is shown and how you prepared it. The figures should be meaningful. Therefore,pleaseconsider carefullythe usage of each item such as colors; annotation of links and the value of objects (disable unnecessary objects).

d) Include Visum *.ver-files and other necessary data such as graphic parameters and filters in your archive.

e) The grading of this exercise contains

- quality of the modelling ability (did you consider the mode choice model, how did add the new public transport lines, how did you add the additional demand)

- quality of the report (separation between description of the technicalities in Visum and the results of your model; quality of figures, writing style)



Stationen	Fahrzeit
Eggenberg	0 min
Auster	1 min
FH Joanneum	3 min
Hauptbahnhof	4 min
AVL	5 min
Lendplatz	7 min
Andreas-Hofer-Platz	8 min
Jakominiplatz	10 min
Felix-Dahn-Platz	11 min
Universität	13 min
Hilmteich	15 min
LKH	17 min
Berliner Ring	20 min
Gösting	0 min
Augasse	1 min
Fröbelpark	3 min
Hasnerplatz	5 min
Geidorfplatz	7 min
Maiffredygasse	8 min
Jakominiplatz	10 min
Griesplatz	11 min
Don Bosco	13 min
Reininghaus	15 min
Wetzelsdorf	17 min
Straßganger Straße	18 min
Ankerstraße	20 min
P&R Webling	22 min

Fig. 1: Metro alignment as of March 2021 for the city of Graz by MUM 2030 GmbH

2 Base Case

In the first task we had to prepare our Base Case, based on the file **GM_10_Ex1Start.ver**, which was provided by the professor.

The following figure shows the model structure that was created for this problem.

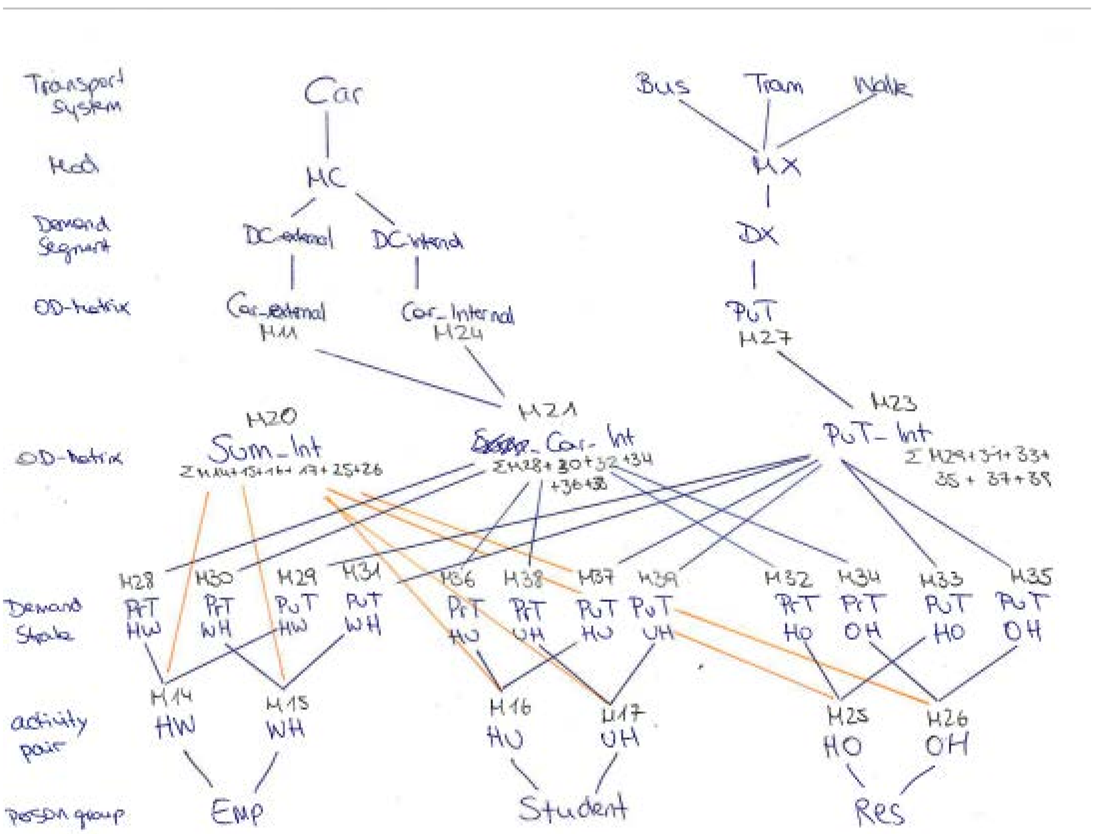


Figure 1: Model structure

2.1 Trip generation

The first step was to create a new person group Residents [RES] with the destination Other Opportunities [OTHEROPP]. Later on, new activity pairs for the new person group weredefined. Those new activity pairs are called Home-Other Opportunities (H-O) and Other Opportunities-Home (O-H).

For defining the production and attraction function we used the trip generation in the procedure sequence. Following the instructions, the functions were adapted with a trip rate of 0.6. This means that 60% of the residents travel from home to the Other Opportunities or from Other Opportunities to home.

Parameters: Trip generation

- [ ] Calculate attributes for active zones only
- [ ] Use 0 to initialize the passive zone attributes
- [ ] Matrix balancing for active zones only
- [ ] Sum up values

	Demand stratum	Matrix balancing	Production function	Attraction function
1	Emp-H-W D-H-W	Mean of both totals	0.695*[EMP] ...	[WP] ...
2	Emp-W-H D-W-H	Mean of both totals	0.556*[WP] ...	[EMP] ...
3	R1-H-O D-H-O	Mean of both totals	0.6*[RES] ...	[OTHEROPP] ...
4	R2-O-H D-O-H	Mean of both totals	[OTHEROPP]*0.6 ...	[RES] ...
5	Stud-H-U D-H-U	Mean of both totals	1.08*[STUD] ...	[UNIFH] ...
6	Stud-U-H D-U-H	Mean of both totals	1.04*[UNIFH] ...	[STUD] ...

Figure 2: Trip generation

2.2 Trip Distribution

The trip distribution describes the allocation of the trips from one origin to a destination. The Gravitation model considers the above built marginal sums from the trip generation and calculates the number of trips from zone i to j using the current travel time as utilization function. This means, the higher the travel time, the lower the number of trips from zone i to j. But also, the bigger the *Productions* and *Attractions* the higher the number of trips. Let's imagine city A with a bigger population than city B. Although city A is farer away from city C than B, people would more likely go to city A, because it has a higher population and therefore a higher attraction.

We used the trip distribution in the procedure sequence. As a first step a skim matrix for private transport PrTwas created, where we used the current travel time(tcur) as a utility. This matrix serves as our utility function for the trip distribution. Following the instructions, the LOGIT functions had a c-value of -0.08. As a result of this procedure, we get two new Distribution matrices (25_Distribuiton R1-H-O und 26_Distribution R2-O-H).

Parameters: Trip distribution

- [ ] For active OD pairs only
- [ ] Exclude OD pairs connecting passive zones
- [x] Set any result demand matrix to 0 prior to calculation
- [ ] Apply estimated parameters

	Demand stratum	Utility function	Function type	a	b	c	Direction parameters
1	Emp-H-W D-H-W	Matrix([NO] = 24) ...	Logit	0	0	-0.1	Productions, Doubly constrained, Scaling: mean value ...
2	Emp-W-H D-W-H	Matrix([NO] = 24) ...	Logit	0	0	-0.1	Productions, Doubly constrained, Scaling: mean value ...
3	R1-H-O D-H-O	Matrix([NO] = 24) ...	Logit	0	0	-0.08	Productions, Doubly constrained, Scaling: mean value ...
4	R2-O-H D-O-H	Matrix([NO] = 24) ...	Logit	0	0	-0.08	Productions, Doubly constrained, Scaling: mean value ...
5	Stud-H-U D-H-U	Matrix([NO] = 24) ...	Logit	0	0	-0.1	Productions, Doubly constrained, Scaling: mean value ...
6	Stud-U-H D-U-H	Matrix([NO] = 24) ...	Logit	0	0	-0.1	Productions, Doubly constrained, Scaling: mean value ...

Figure 3: Trip distribution

2.3 Mode Choice

As a next step the Mode Choice had to be created. For doing this step, we used the matrices that we created before (Person Group: Res M25/M26) and included the matrix of the full system, person group "Emp"(M 14 /M 15) and "Student"(M 16/M 17).
[Hier eingeben]

For generating the mode choice, we should calculate the new PuT skim matrix with the journey time as utility. Then we executed the mode choice giving the new PuT and PrT and we also changed the c-values for each person group. As a result, we obtained new matrices, these are in the range between M28-M39.

	Key	Demand stratum	Mode	Utility function	Function type	a	b	c		Input demand matrix	Input demand matrix
1	Emp-H-W/MC	Emp-H-W D-H-W	MC Car	Matrix([NO] = 24 ...	Logit	0	0	-0.05	...	Matrix(14)	14 Distribution Emp-H-W
2	Emp-H-W/MX	Emp-H-W D-H-W	MX PuT	Matrix([NO] = 27 ...	Logit	0	0	-0.05	...	Matrix(14)	14 Distribution Emp-H-W
3	Emp-W-H/MC	Emp-W-H D-W-H	MC Car	Matrix([NO] = 24 ...	Logit	0	0	-0.05	...	Matrix(15)	15 Distribution Emp-W-H
4	Emp-W-H/MX	Emp-W-H D-W-H	MX PuT	Matrix([NO] = 27 ...	Logit	0	0	-0.05	...	Matrix(15)	15 Distribution Emp-W-H
5	R1-H-O/MC	R1-H-O D-H-O	MC Car	Matrix([NO] = 24 ...	Logit	0	0	-0.04	...	Matrix(25)	25 Distribution R1-H-O
6	R1-H-O/MX	R1-H-O D-H-O	MX PuT	Matrix([NO] = 27 ...	Logit	0	0	-0.04	...	Matrix(25)	25 Distribution R1-H-O
7	R2-O-H/MC	R2-O-H D-O-H	MC Car	Matrix([NO] = 24 ...	Logit	0	0	-0.04	...	Matrix(26)	26 Distribution R2-O-H
8	R2-O-H/MX	R2-O-H D-O-H	MX PuT	Matrix([NO] = 27 ...	Logit	0	0	-0.04	...	Matrix(26)	26 Distribution R2-O-H
9	Stud-H-U/MC	Stud-H-U D-H-U	MC Car	Matrix([NO] = 24 ...	Logit	0	0	-0.02	...	Matrix(16)	16 Distribution Stud-H-U
10	Stud-H-U/MX	Stud-H-U D-H-U	MX PuT	Matrix([NO] = 27 ...	Logit	0	0	-0.02	...	Matrix(16)	16 Distribution Stud-H-U
11	Stud-U-H/MC	Stud-U-H D-U-H	MC Car	Matrix([NO] = 24 ...	Logit	0	0	-0.02	...	Matrix(17)	17 Distribution Stud-U-H
12	Stud-U-H/MX	Stud-U-H D-U-H	MX PuT	Matrix([NO] = 27 ...	Logit	0	0	-0.02	...	Matrix(17)	17 Distribution Stud-U-H

Figure 4: Mode Choice

2.4 Transport Assignment

As the last step, the OD-matrix was defined.It is made by applying a sum of the matrices that the mode choice generated in the step before.

We generated the sum providing the correct matrices for this step, in concrete we sum all the matrices that are Prt and PuT, then we obtained the new matrices, Car_Int and PuT_Int. We used the option Combination of matrices and vector that you can define in Procedure Sequence.

Finally, a loop between the assignments and the mode choice was introduced. This loop was configured for doing 5 iterations. The result of all the steps that we made until this point, serves as the starting model for our future simulations.

The Figure 5 shows the result of all the executed steps.

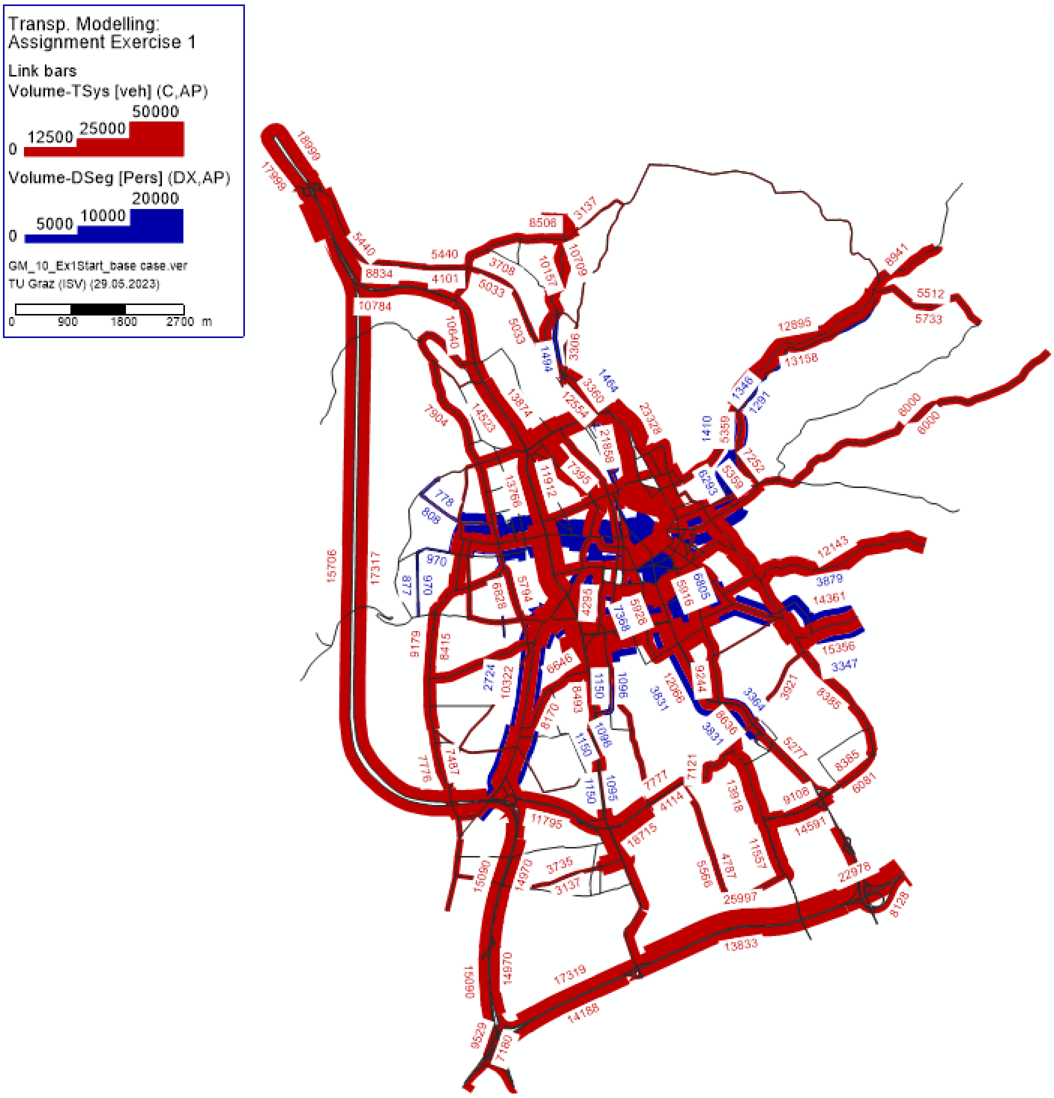


Figure 5: Resultof Base Case

3 Reference Scenario 2030

In this task we had to prepare our reference case, based on the Base Case. In this scenario we will add more residents and workplaces, as consequence of this new configuration we will obtain more possible trips than in the Base Case 2023.

3.1 New Trip Generation

The first step was to add attribute groups, called NEWRES_2030 and NEW_WP2030, we added the new residents and workplaces in the specific zones.

The trip generation was adapted to the current situation of our problem. For doing it, we changed the formulas according to the new scenario that we want to apply to our new model.

	Demand stratum	Matrix balancing	Production function		Attraction function	
1	Emp-H-W D-H-W	Mean of both totals	0.695*([EMP]+0.4*[NEWRES_2030])	...	[WP]+[NEW_WP2030]	...
2	Emp-W-H D-W-H	Mean of both totals	0.556*([WP]+[NEW_WP2030])	...	[EMP]+0.4*[NEWRES_2030]	...
3	R1-H-O D-H-O	Mean of both totals	0.6*([RES]+[NEWRES_2030])	...	[OTHEROPP]	...
4	R2-O-H D-O-H	Mean of both totals	[OTHEROPP]*0.6	...	[RES]+[NEWRES_2030]	...
5	Stud-H-U D-H-U	Mean of both totals	1.08*[STUD]	...	[UNIFH]	...
6	Stud-U-H D-U-H	Mean of both totals	1.04*[UNIFH]	...	[STUD]	...

Figure 6: New trip generation of reference scenario 2030

After running our new model with the new conditions, we obtain the following outcome, which can be seen in Figure 7.

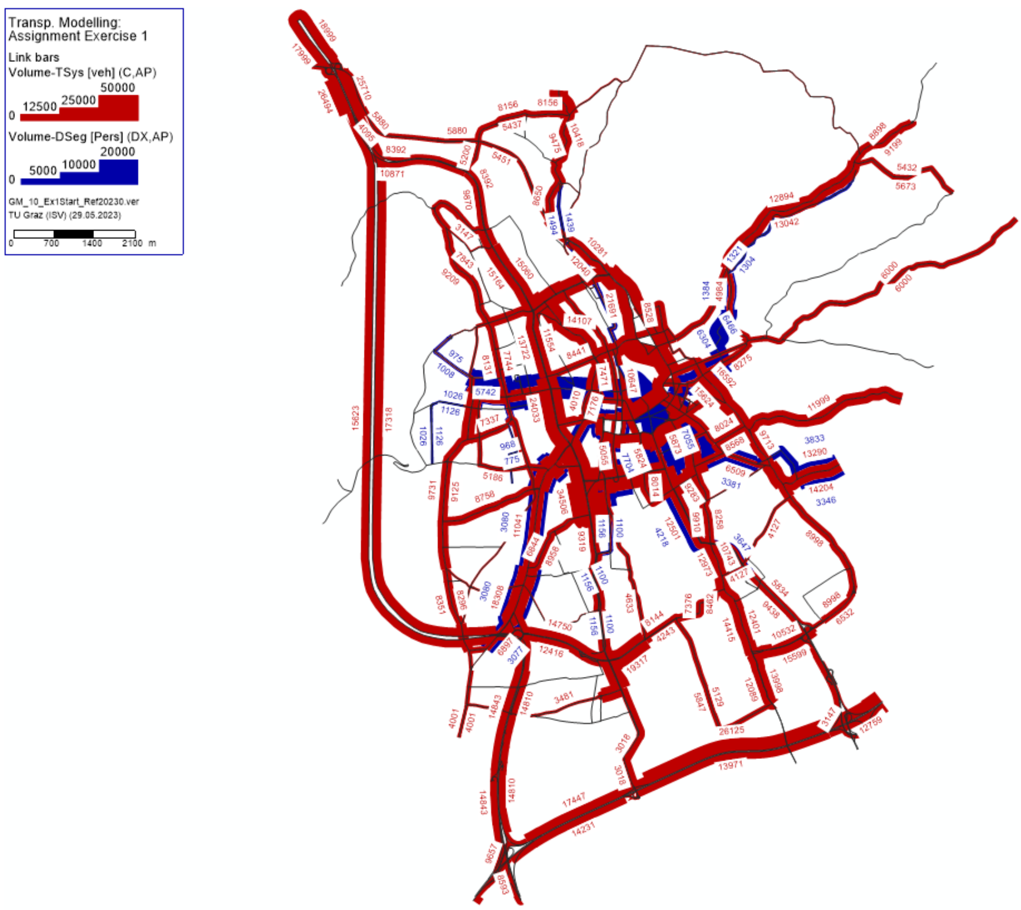


Figure 7: Result of Reference Scenario 2030

4 Planning Scenario 2030

In this scenario we will add a new public transport system (Metro),because of the new travel demand. We will have the same trips that we generated before in the Reference scenario, but the mode choice will be different according to the new transport system.

The figure below shows the updated model structure.

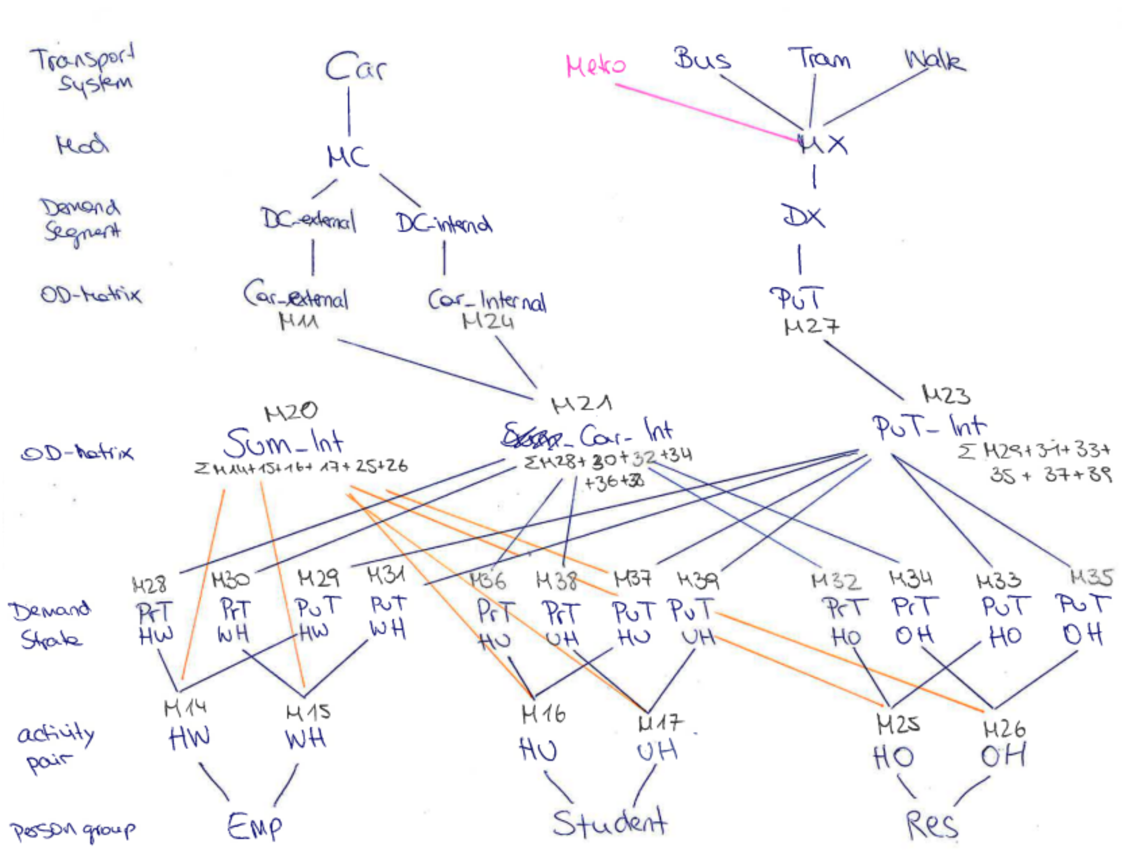


Figure 8: model structure for planning scenario 2030

4.1 New public transport system (Metro)

At the very beginning we constructed a new Transport system called Metro. The next step was to create a stop point in each zone. Therefore, nodes were created if necessary and connected withlinks. To generate trips from people to our stop point, a connector was linked between the zone centroid and the stop point. For the connectors the mode was changed to PuT_Walk and for the links we made a new link type, that only operates for the mode Metro. Then we introduced a new object called Line routes and created four new metro line routes: M1 Eggenberg-Berliner Ring (Zone Eggenberg to Zone Waltendorf) and reverse and also M2 Gösting-P&R Webling(Zone Gösting to Zone Straßgang) and reverse.

The Figure 9 shows the trips generated on the two new metro lines.

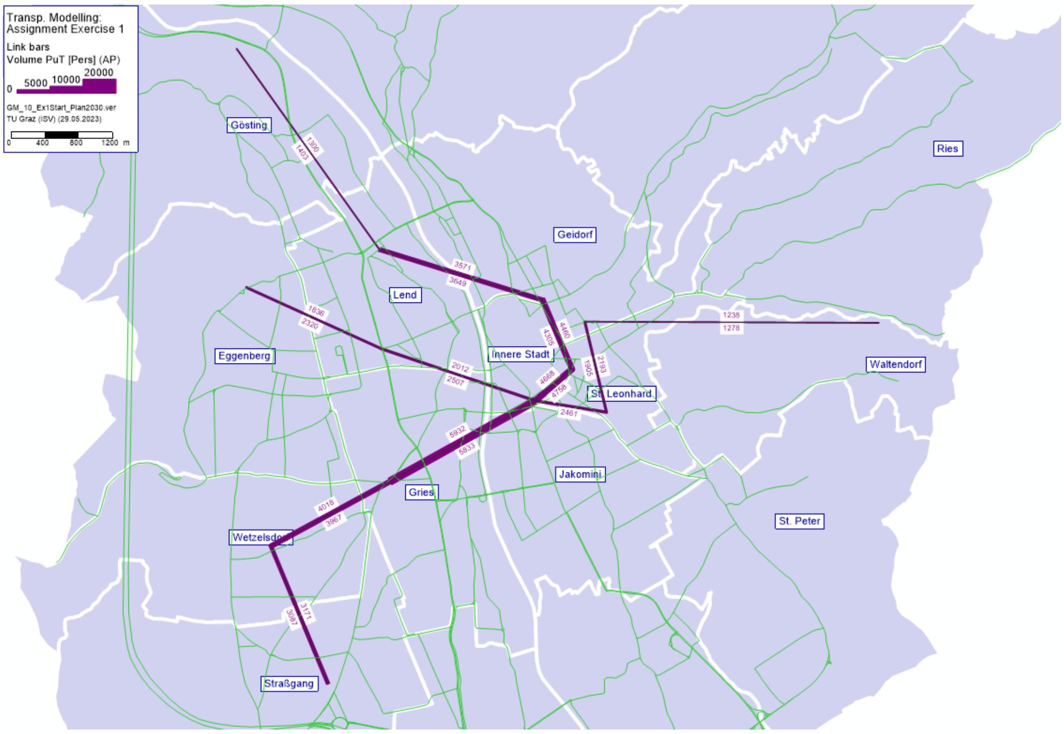


Figure 9: New metro lines

Later on, we defined our times per each stop. As a last step a tabular timetable had to be established. To achieve this, vehicle journeys had to be generated. Therefore, a regular service rate of every ten minutes was set up between 06:00 and 20:00 o'clock.

The figure below shows the new generated trips throughout the city.

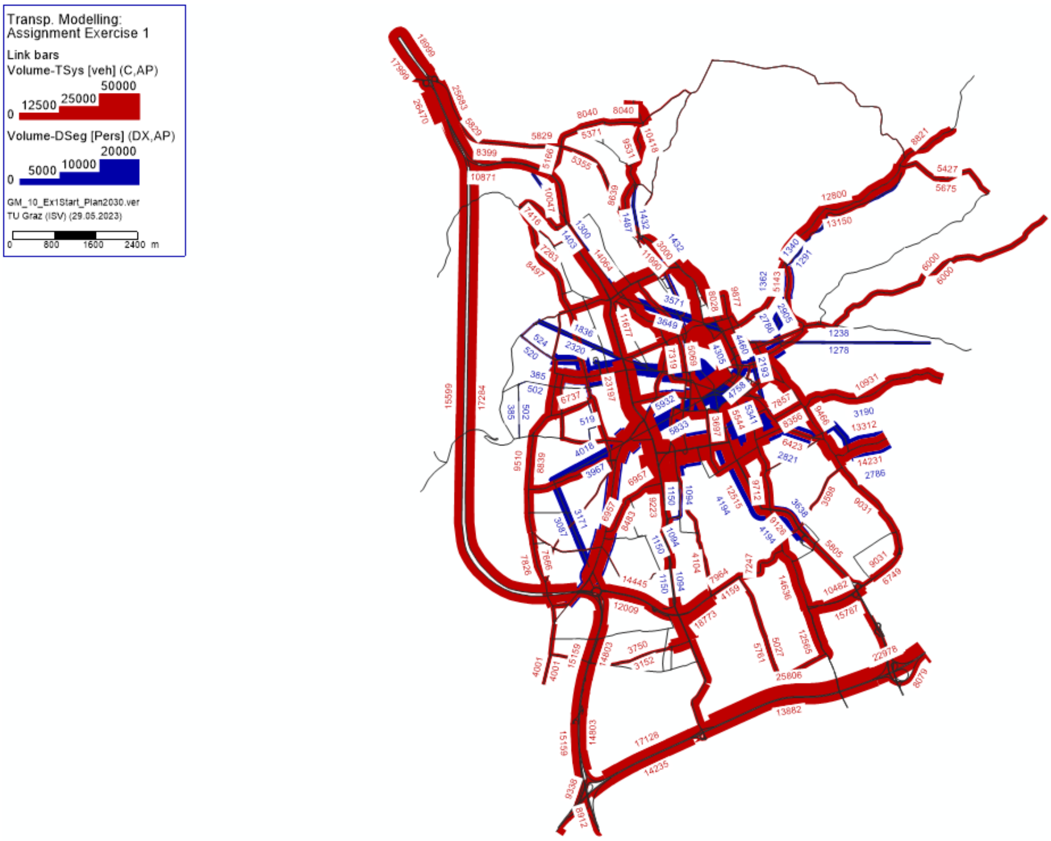


Figure 10: Result of Planning Scenario 2030

5 Comparison between Scenarios

In this chapter, we will compare all the scenarios by different key performance indicators (KPI).

Table 1: Key Performance Indicators of different Scenarios

	Base Case	Ref_2030	Plan_2030
Modal Split Car [%]	70,40	70,14	67,58
Modal Split PuT [%]	29,60	29,86	32,42
Total Trips Car Int	437434	454037	437515
Total TripsPuTInt	183933	193334	209857
Total trips internal	621367	647371	647372

5.1 Difference Base Case 2023 and Reference Scenario 2030

In the picture you can see the difference between PuT and PrT. We also can observe that a positive difference indicates more activity on certain routes. As a general conclusion, we can say that in five years, we will have more activity in specific areas in Graz. In total 26004 more trips were generated.

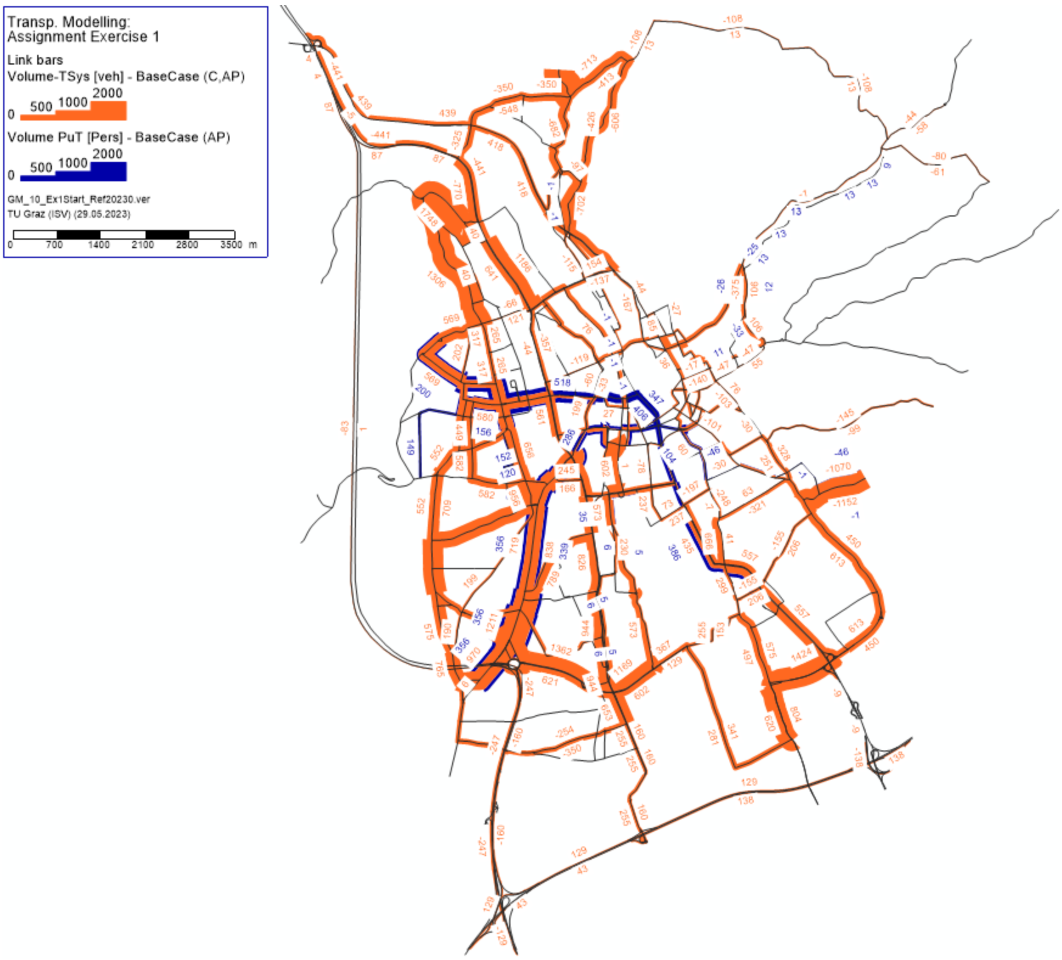


Figure 11: Difference of Reference Scenario 2030 and Base Case 2023

5.2 Difference Reference Scenario 2030 and Planning Scenario 2030

In the following picture we will see the difference between PuT and PrT after we introduced two new metro lines. The figure shows, that a lot of people choose to use the metro instead of their own car. This can be seen in the decrease of volume of TSys [veh] and an increase of volume PuT [pers].

As a general conclusion, we can say that in five years, we will have more activity in specific areas in Graz.

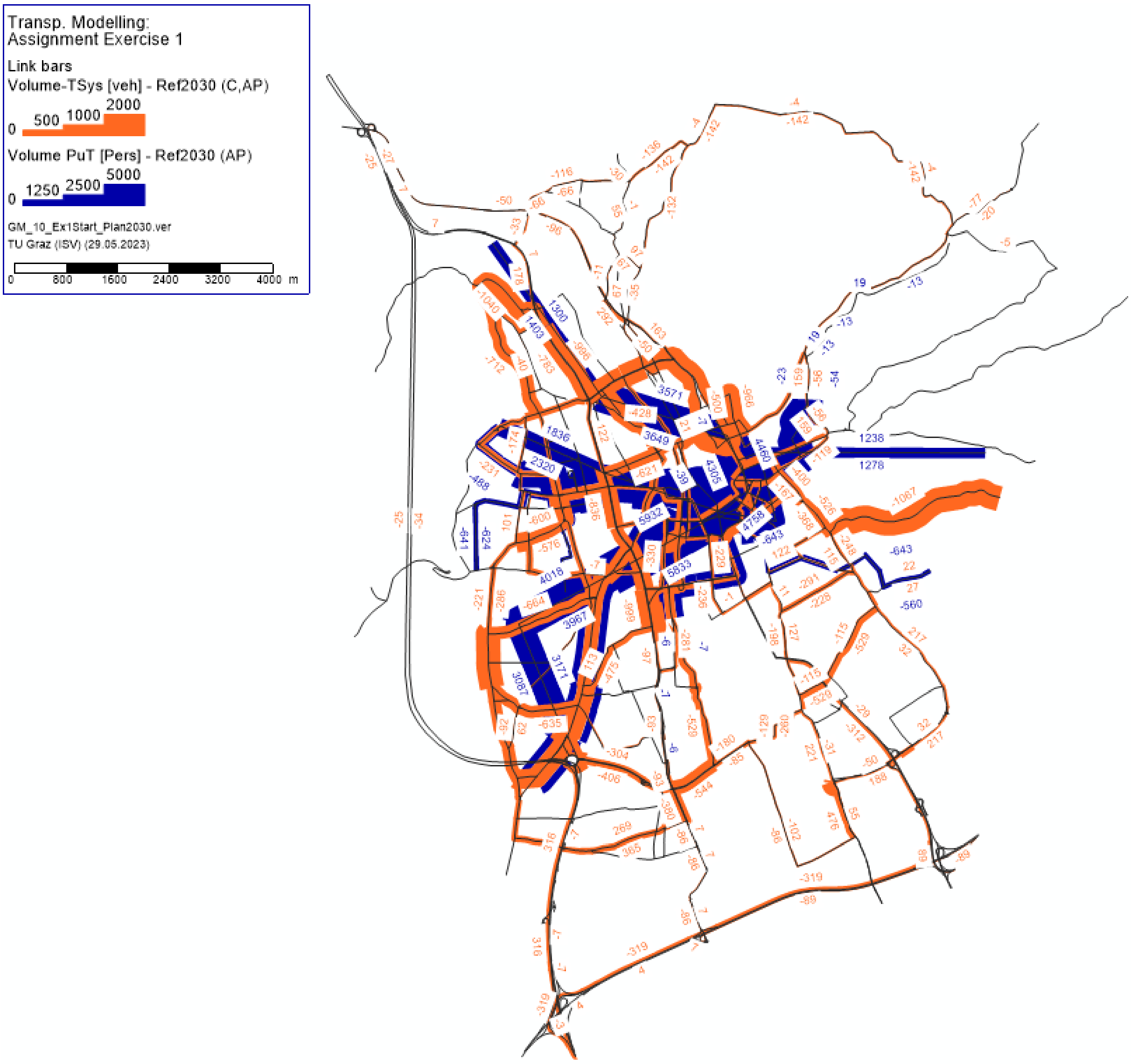


Figure 12: Difference of Planning Scenario 2030 and Reference Scenario 2030

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