Helsinki

Urban Environment Division 2020:08

VISSIM microsimulations of Teollisuuskatu

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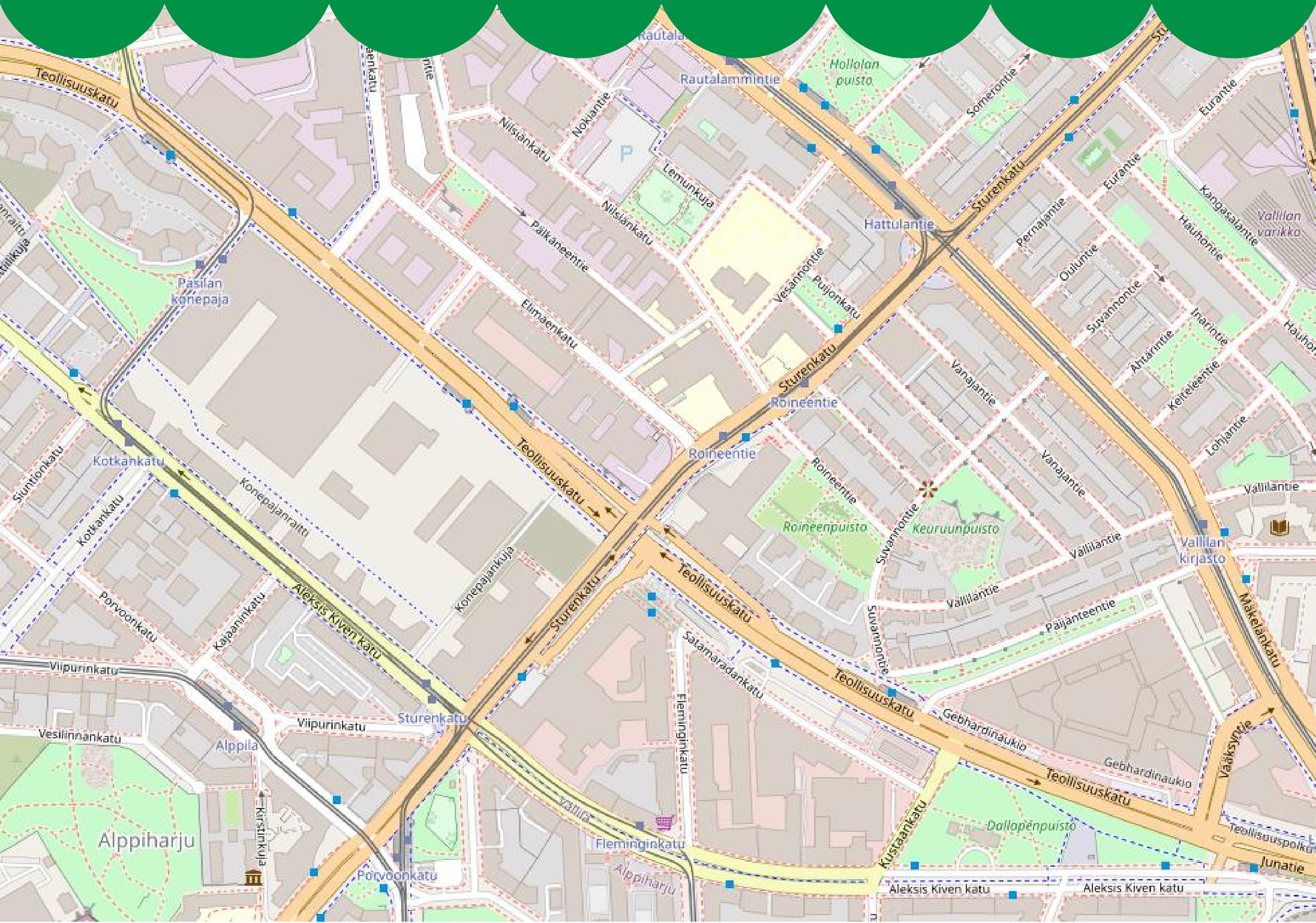


Contents

Content and scope of the work

This model was developed to evaluate two traffic scenarios within morning and evening peak hours in the year 2030. The scope of this microscopic traffic simulation model is Teollisuuskatu, including intersections between Vääksyntie and Jämsänkatu as shown in Figure 1 and Figure 1. The simulation model consists of different transport modes including, Private Motorized Traffic, Non-Motorized Traffic (Bikes and Pedestrians) and Public Transit (trams/trunk buses).

The focus of this simulation model is to evaluate different scenarios for the forecasted motorized traffic of the year **2030**, within 90 second cycle times in all intersections. The model consists of nine signalized intersections, each with 90 seconds cycle. The defined speed for all private and public modes is 40 km/hr. Figure 2 shows details of the model, including labeled intersections from Jämsänkatu to Vääksyntie and a zoomed picture showing more details of the used model elements. Signal controllers numbered (309 – 331) already exist today, moreover, the model consists of two more signalized pedestrian crossings traffic controllers (7 & 8) as shown in Figure 2.

Tram and bus lines are all defined to have an average dwelling time of 20 seconds for all (three) stops shown in Figure 2. At an early planning stage, this is important to allow some understanding of the behavior of tram/bus lines along other traffic users.

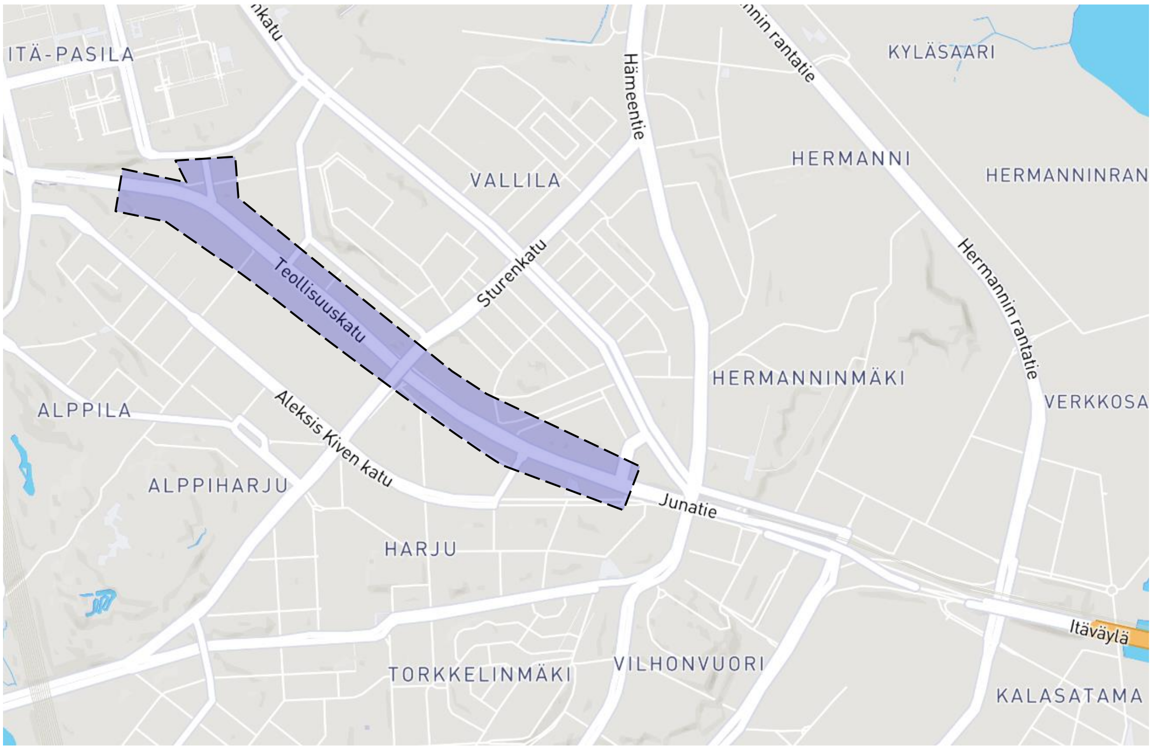


Figure 1. Scope of the simulation model

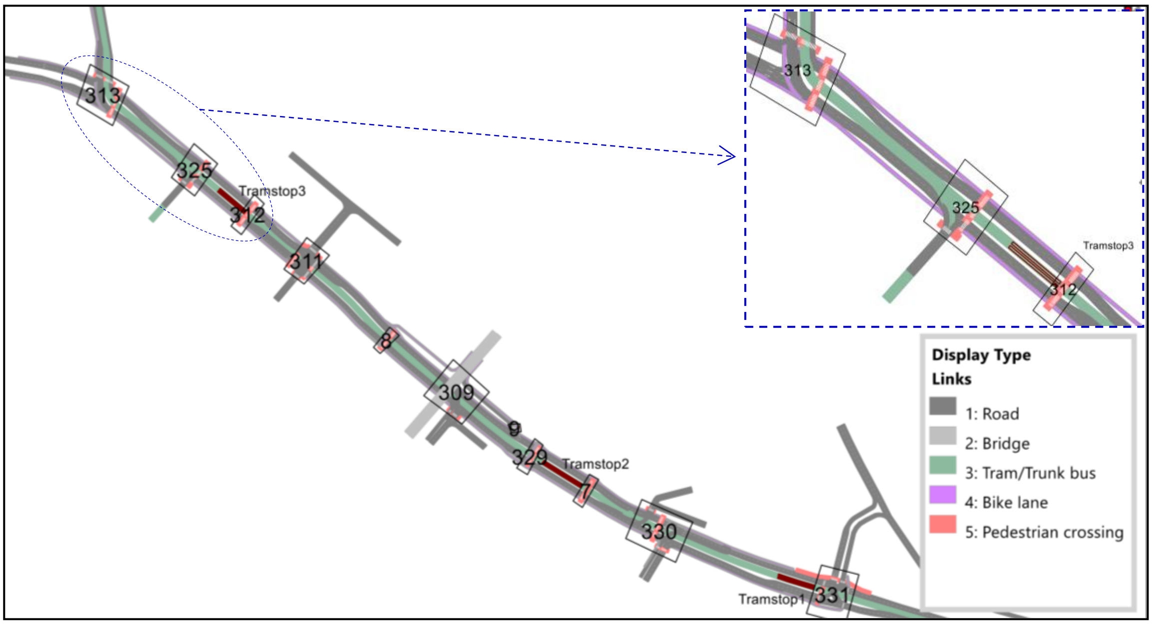


Figure 2. Vissim model of Teollisuuskatu

Teollisuuskatu studied intersections:

- 313: Jämsänkatu
- 325: Traverssikuja
- 312: Töysänkatu (Pedestrian crossing)
- 311: Telekatu
- 8: New pedestrian crossing
- 309: Satamaradankatu
- 7: New pedestrian crossing
- 330: Kustaankatu/Päijänteentie
- 331: Vääksyntie

The work evaluates and compares the functionality of two different street design options during the morning and evening rush hours:

- **Scenario A** (2030):

The number of car lanes in this scenario stays the same as the current situation, two lanes in each direction. A two-way tram/trunk bus line extends all the way from Vääksyntie to Jämsänkatu with a total of three stops, with reserved tracks. The car ramp merging from Sturenkatu is closed for vehicles. Töysänkatu is turned into a pedestrian only zone. Uni-directional bike lane extends throughtout the network for each direction. Two new signalized pedestrian crossings have been added to each side of tram stops 2 and 3. Kustaankatu and Päijänteentie have only right turns, unlike today's situation.

- **Scenario C** (2030):

The same situation applies to this scenario; moreover, the number of car lanes used in this scenario is *one* (only for vehicle traffic going westbound).

Signal controllers

All signal controllers used in this simulation model are coordinated fixed-time controllers. In this model, the signals along the corridor are coordinated to allow a green wave based on the assumption that vehicles travel an average speed of 40 km/hr between intersections. The figures below allow the reader to distinguish the signal groups and their phases on the network as used in the model. In all cases, the signal phases provides the maximum allowed green time for signal groups going through the corridor as most of the traffic demand is in this direction. This may relatively cause some significant delay for turn movements and traffic coming from secondary roads, which will be discussed in the Results and discussion chapter. As mentioned earlier the model consists of nine signalized intersections, each with 90 seconds cycle

For intersections along Teollisuuskatu, it is planned that Jämsänkatu (313) and Traverssikuja (325) are the only intersections that have independent phases for public transit, outlined in red in Figure 3 and Figure 6. However in this simulation and at such early planning phase of traffic management, it was more intuitive not to add those phases in the fixed time signal plans, since the main focus was to measure the traffic demand/capacity of the network. This may have some negative effect on the travel time and delay of public transit in this model; however, it could be better to discard those phase until actuated traffic signals are developed for the model. On that note, it may be relevant here to mention that in this simulation model, there are two transit lines passing through Teollisuuskatu intersections with 3 and 10 minute headways: **1.** Combined trunk lines 500 and 510, and **2.** Tram 9.

- Teollisuuskatu/Jämsänkatu (313)

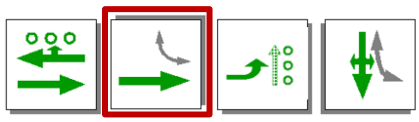


Figure 3. Jämsänkatu signal phases

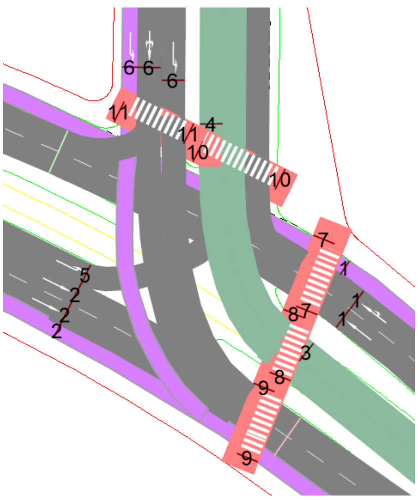


Figure 5. Jämsänkatu vissim model

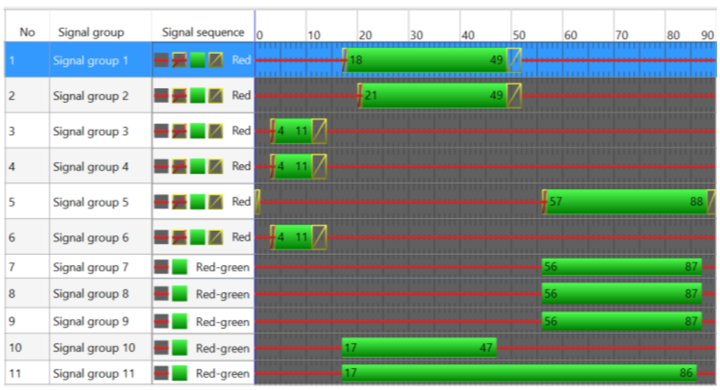


Figure 4. Jämsänkatu signal plan

Phase number 2, outlined in red in Figure 3, is only active when there is a tram/trunk bus coming. However, since this is a fixed-time signal controller. In this simulation, signal groups 1 and 2 continue through out phase and two. Later on, when transit signal priority in the signal controller, signal group 1 would be cut to fit signal groups 3 and 4 in the instance were there is a tram/trunk line coming at Jämsänkatu, as shown in phase 2.

- Teollisuuskatu/Traverssikuja (325)

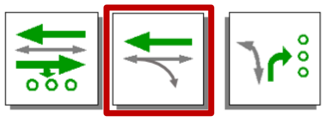


Figure 6. Traverssikuja signal phases

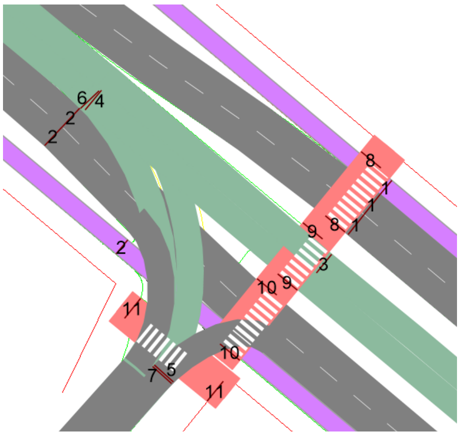


Figure 7. Traverssikuja vissim model

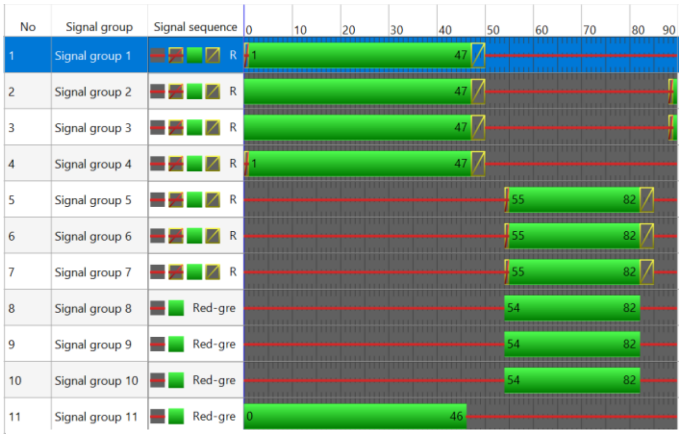


Figure 8. Traverssikuja signal plan

Group number 6 in phase number 2, outlined in red, is only active when there is a tram (9) - headway 10 minutes- coming at the intersection. However, since this is a fixed-time signal controller type, it was more intuitive not to cut signal group 2 in all cycles of the fixed time signal plan. Later on, when transit signal priority in the signal controller, signal groups 2 and 11 would get lower time to fit tram signal groups 3 and 4 in the instance were there is a tram (9) coming at Traverssikuja as shown in phase 2.

- Teollisuuskatu/Töysänkatu (Only Pedestrian Crossing) (312)

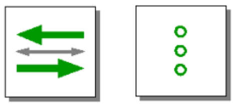


Figure 9. Töysänkatu signal phases

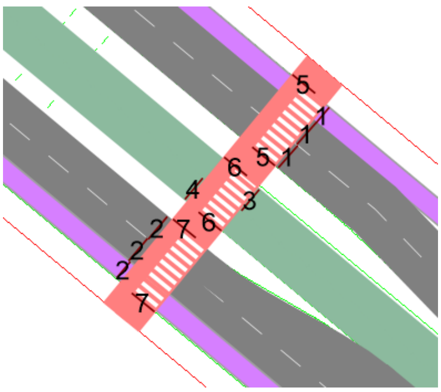


Figure 10. Töysänkatu Crossing

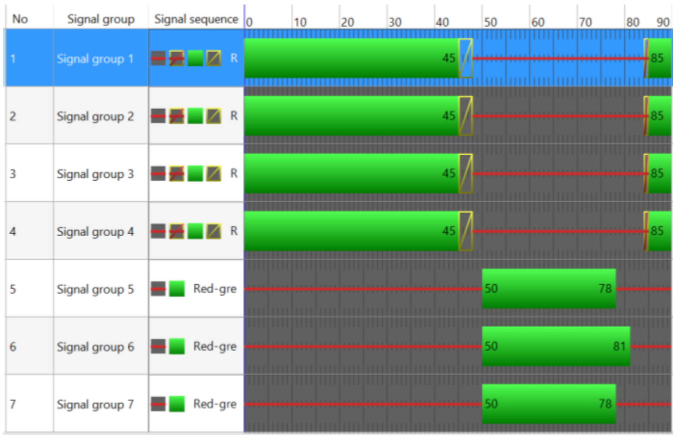


Figure 11. Töysänkatu signal plan

- Teollisuuskatu/Telekatu (311)

Figure 12. Telekatu signal phases

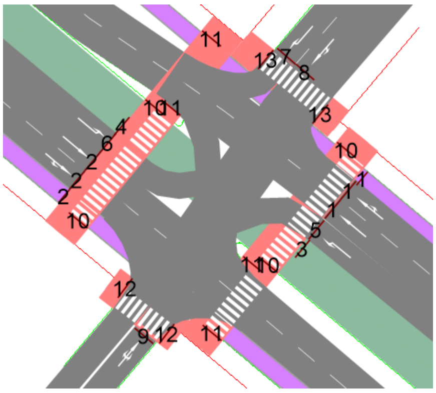


Figure 14. Telekatu vissim model

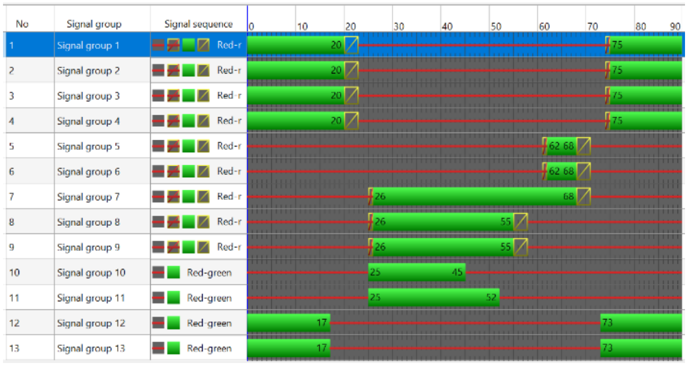


Figure 13. Telekatu signal plan

One more crossing was added to the model on the western side of the intersection. Since the right turn is already on the second and the third phase, there is enough time for the traffic turning right from the northern side to pass through the intersection. Therefore, pedestrian traffic going north/south would also be distributed to both sides of the intersection; allowing less pedestrian and vehicle conflict in phase 2, depicted in signal groups 11 and 8.

- Teollisuuskatu/Pedestrian Crossing (8)

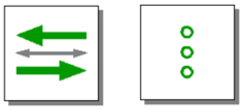


Figure 15. Pedestrian Crossing signal phases

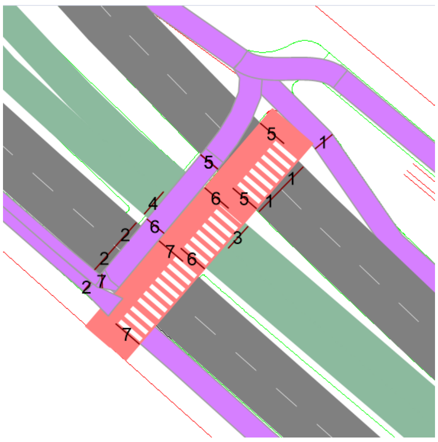


Figure 17. Pedestrian Crossing vissim model

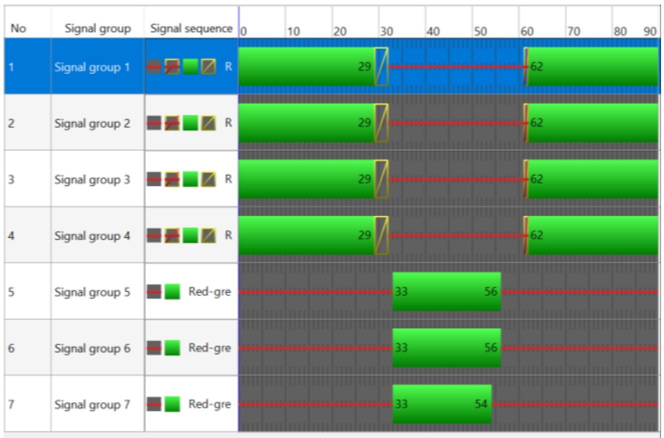


Figure 16. Pedestrian Crossing signal plan

- Teollisuuskatu/Satamaradankatu (309)

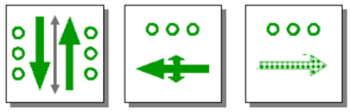


Figure 18. Satamaradankatu signal phases

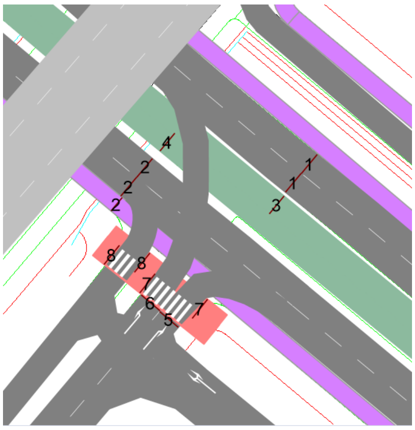


Figure 20. Satamaradankatu vissim model

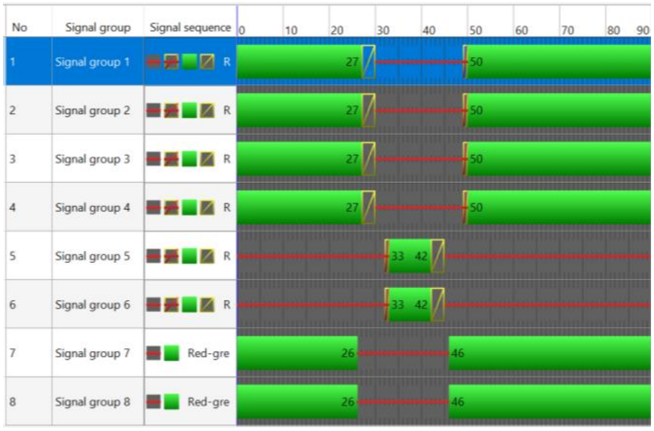


Figure 19. Satamaradankatu signal plan

- Teollisuuskatu/Pedestrian Crossing (329)

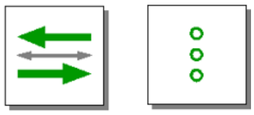


Figure 21. Pedestrian Crossing signal phases

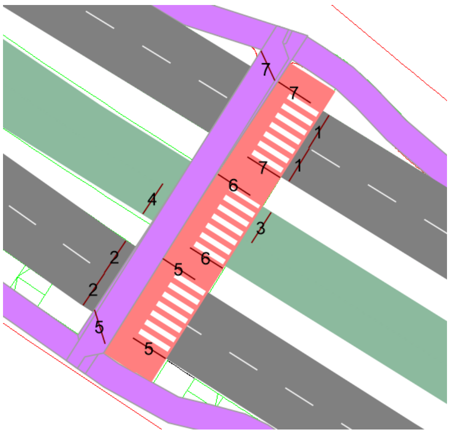


Figure 23. Pedestrian Crossing vissim model

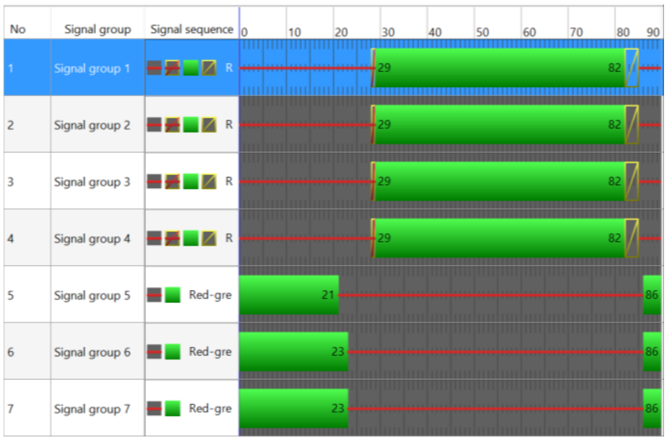


Figure 22. Pedestrian Crossing signal plan

- Teollisuuskatu/Pedestrian Crossing (7)

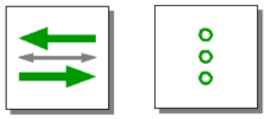


Figure 24. Pedestrian Crossing signal phases

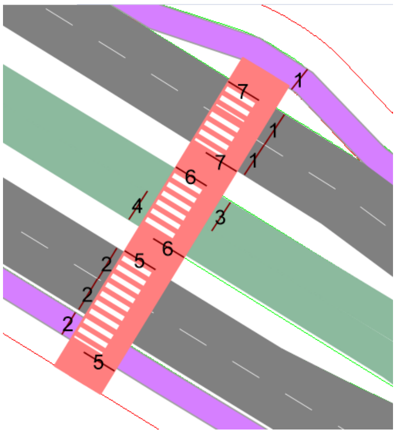


Figure 25. Pedestrian Crossing vissim model

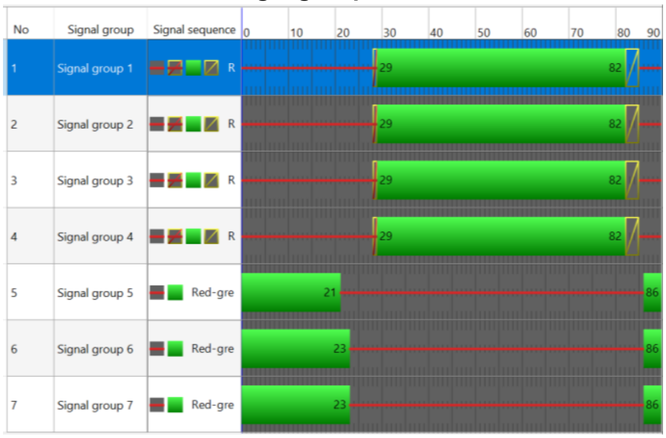


Figure 26. Pedestrian Crossing signal plan

- Teollisuuskatu/Kustaankatu-Päijänteentie (330)

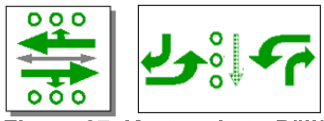


Figure 27. Kustaankatu-Päijänteentie signal phases

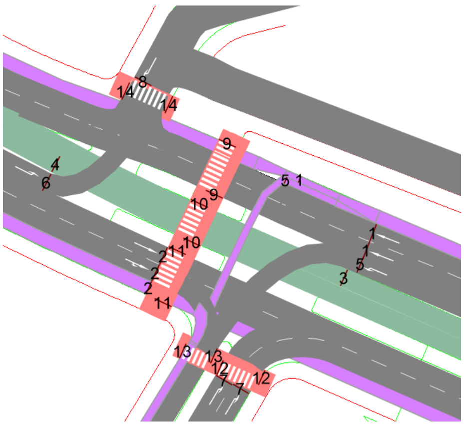


Figure 28. Kustaankatu-Päijänteentie vissim model

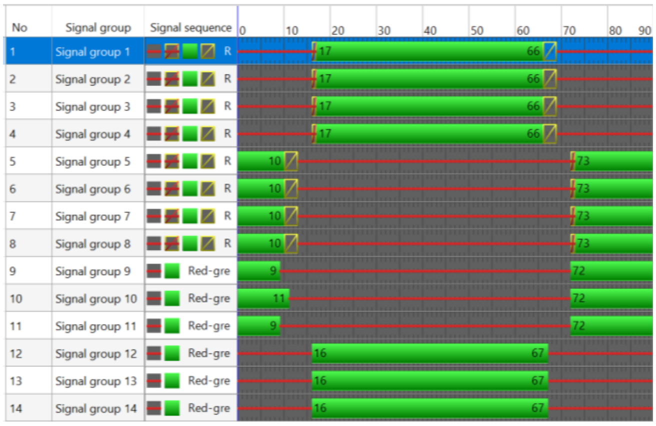


Figure 29. Kustaankatu-Päijänteentie signal plan

Volumes

1.1. Source of the traffic input:

In **Scenario A** (2030), the assigned forecasted traffic volumes for the morning rush hour were based on WSP's traffic microscopic model of Junatie. Those volumes, when compared with the values of Ramboll's mesosimulation model, are around 10 percent lower (for car traffic going from Kalasatama to Pasila) and 25% higher for car traffic going from Pasila to Kalastama. Such volumes are seen more realistic when compared with the capacity of the road and the traffic count of 2018/2019.

In **Scenario C** (2030), the used traffic forecast volumes were based on Ramboll's (mesosimulation) model. Those volumes are around 0 – 30% lower than the ones in Scenario A, in some cases similar to the volumes used in Scenario A, as shown in Figure 31.

1.1. VISSIM traffic input:

Based on the traffic forecast input, the figures below compares the traffic demand in Teollisuuskatu, at both morning and evening rush hours. On average, for westbound traffic, traffic demand between Vääksyntie and Telekatu is higher in the morning than in the evening, and vice versa for traffic demand between Telekatu and Jämsänkatu. On the other hand, for eastbound traffic, evening rush hour traffic demand is always higher than morning rush hour, of around (15 - 35%). Figure 30, Figure 31, Figure 32, Figure 33 compare the traffic demand between intersections for westbound and eastbound traffic, in morning and evening rush hours, of scenarios A & C. Figure 34 and Figure 36 show the overall traffic demand of all scenarios in morning and evening rush hours.

Figure 30. Car traffic volumes at morning rush hour westbound

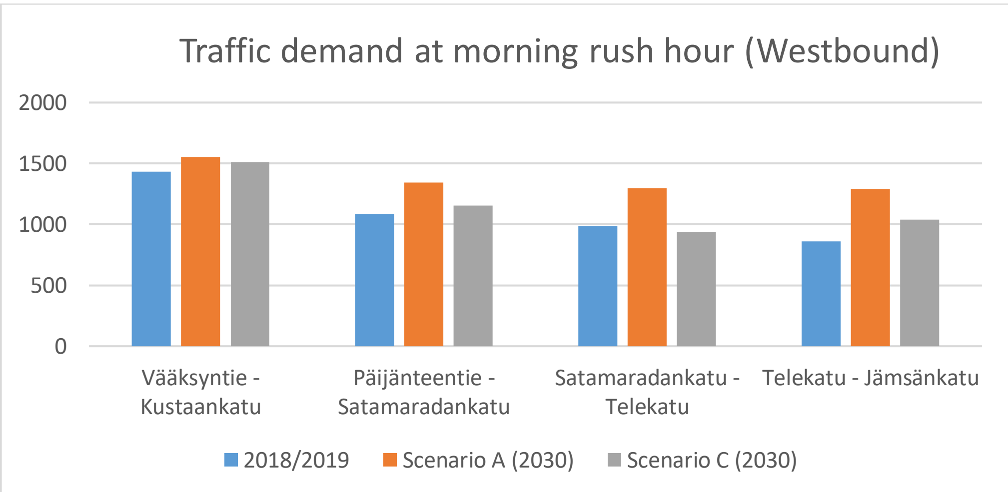


Figure 31. Car traffic volumes at morning rush hour eastbound

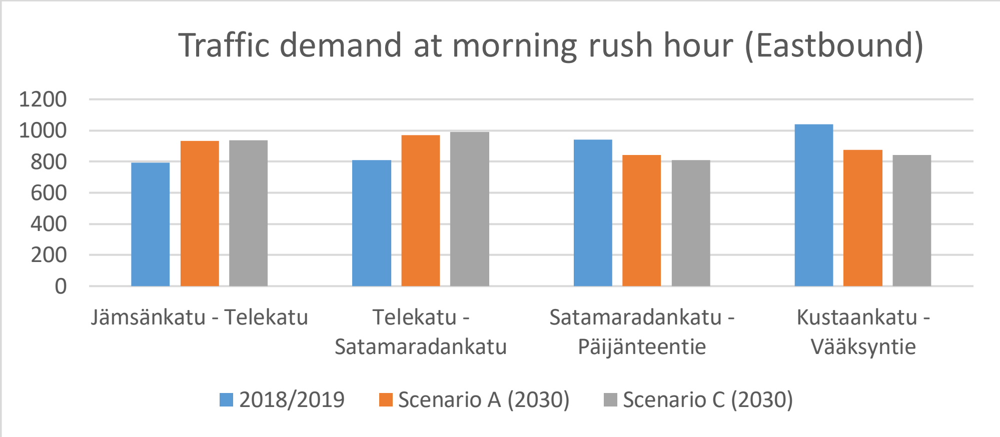


Figure 32. Car traffic volumes at evening rush hour westbound

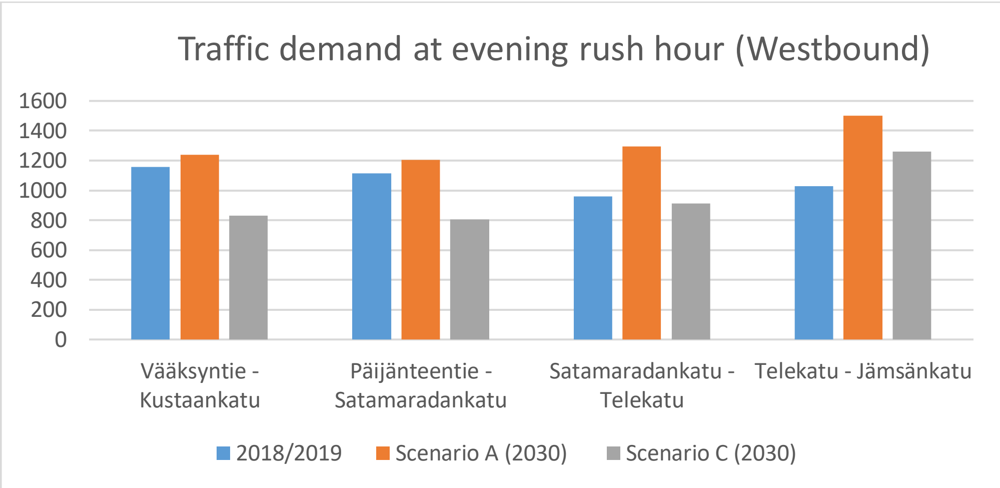


Figure 33. Car traffic volumes at evening rush hour eastbound

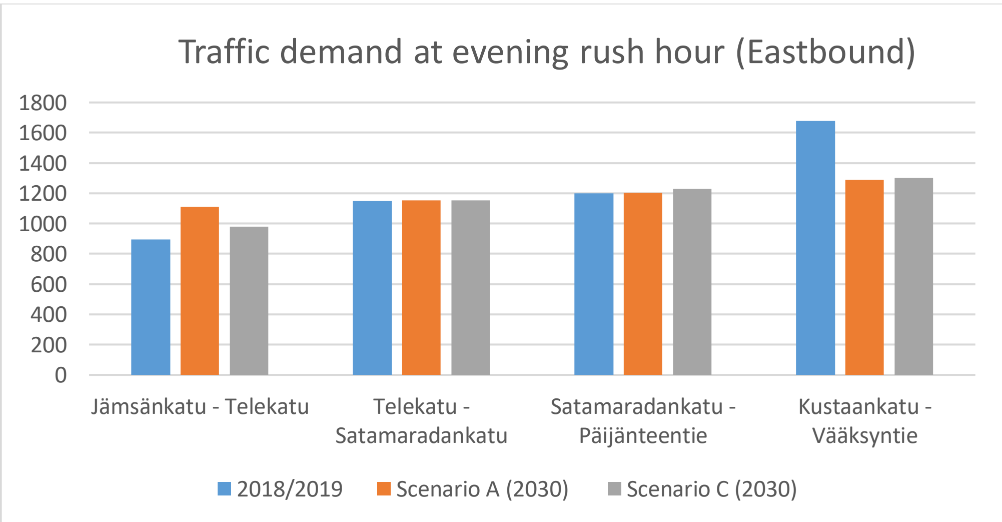


Figure 34. Scenario A - morning rush hour traffic volumes

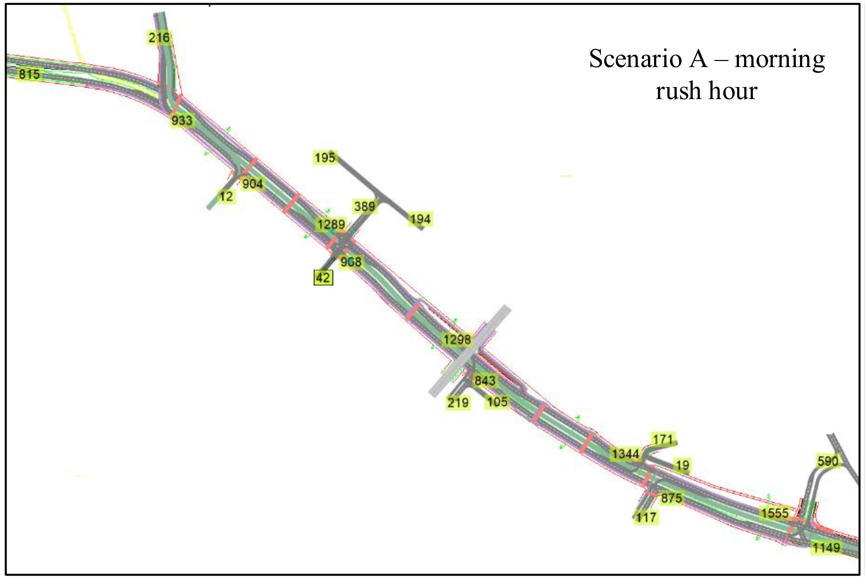


Figure 35. Scenario A - evening rush hour traffic volumes

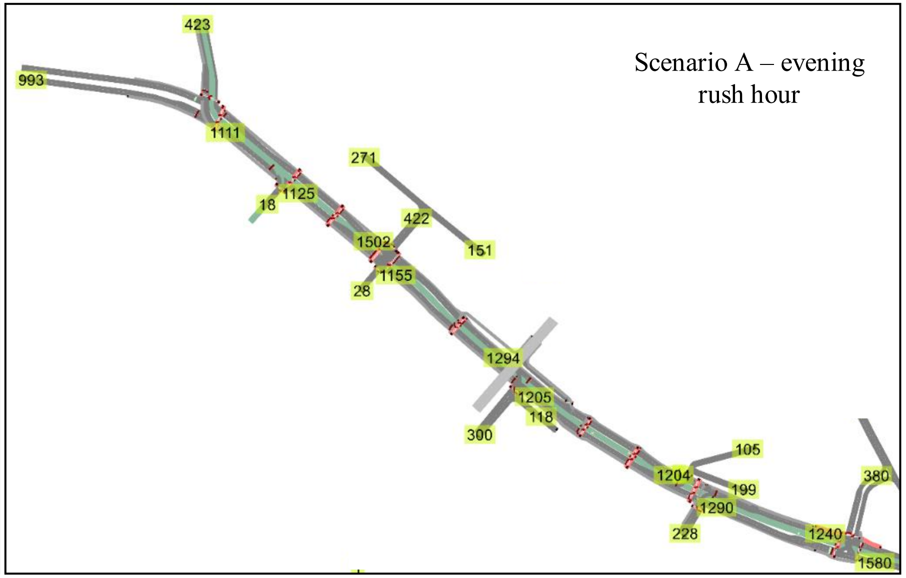


Figure 36. Scenario C - morning rush hour traffic volumes

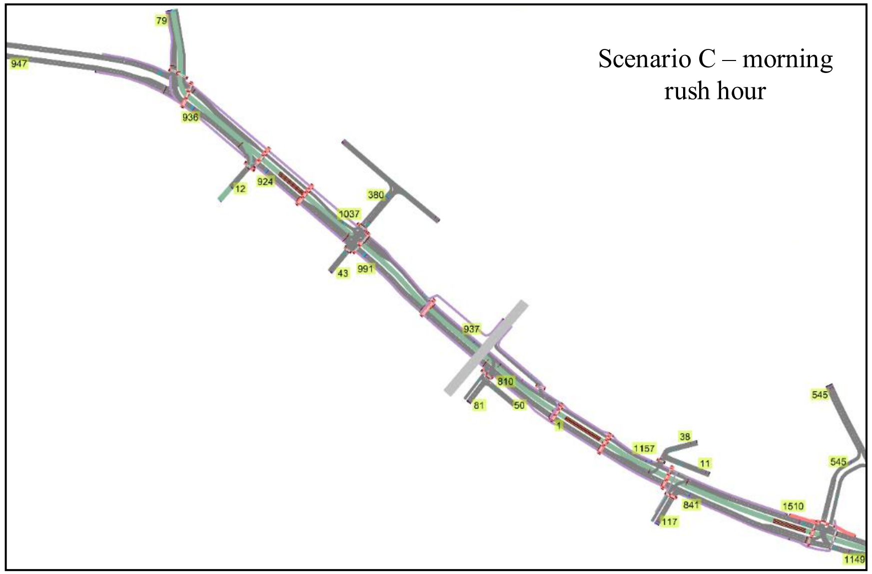
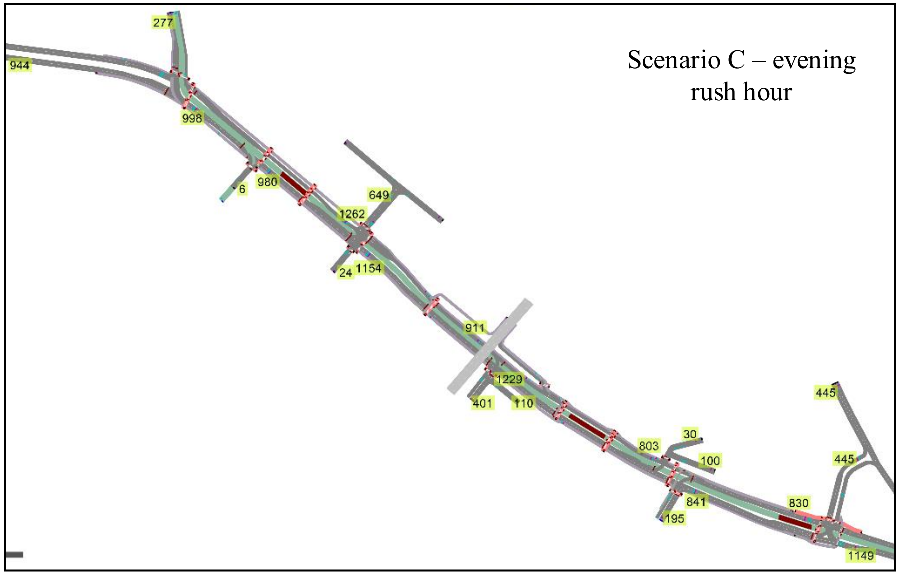


Figure 37. Scenario C - evening rush hour traffic volumes



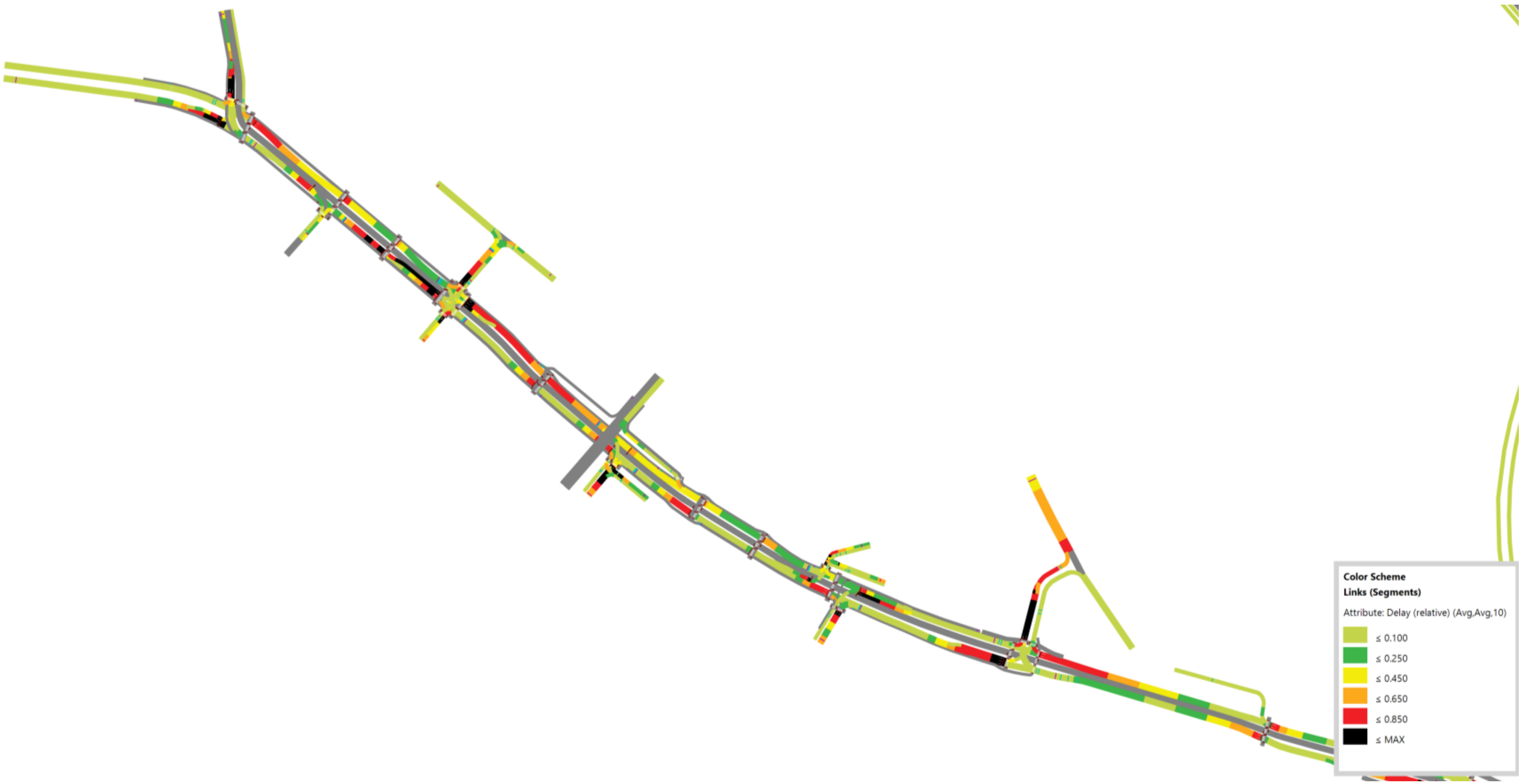
Results and discussion

In this chapter, we will present and compare the output results of Teollisuuskatu's VISSIM simulations. In the discussion, we will analyze and compare the average delay of vehicles, at morning and evening rush hours. The point of this comparison is to highlight the main issues/congestion points in the network.

1.1. Delay (relative) – Scenario A

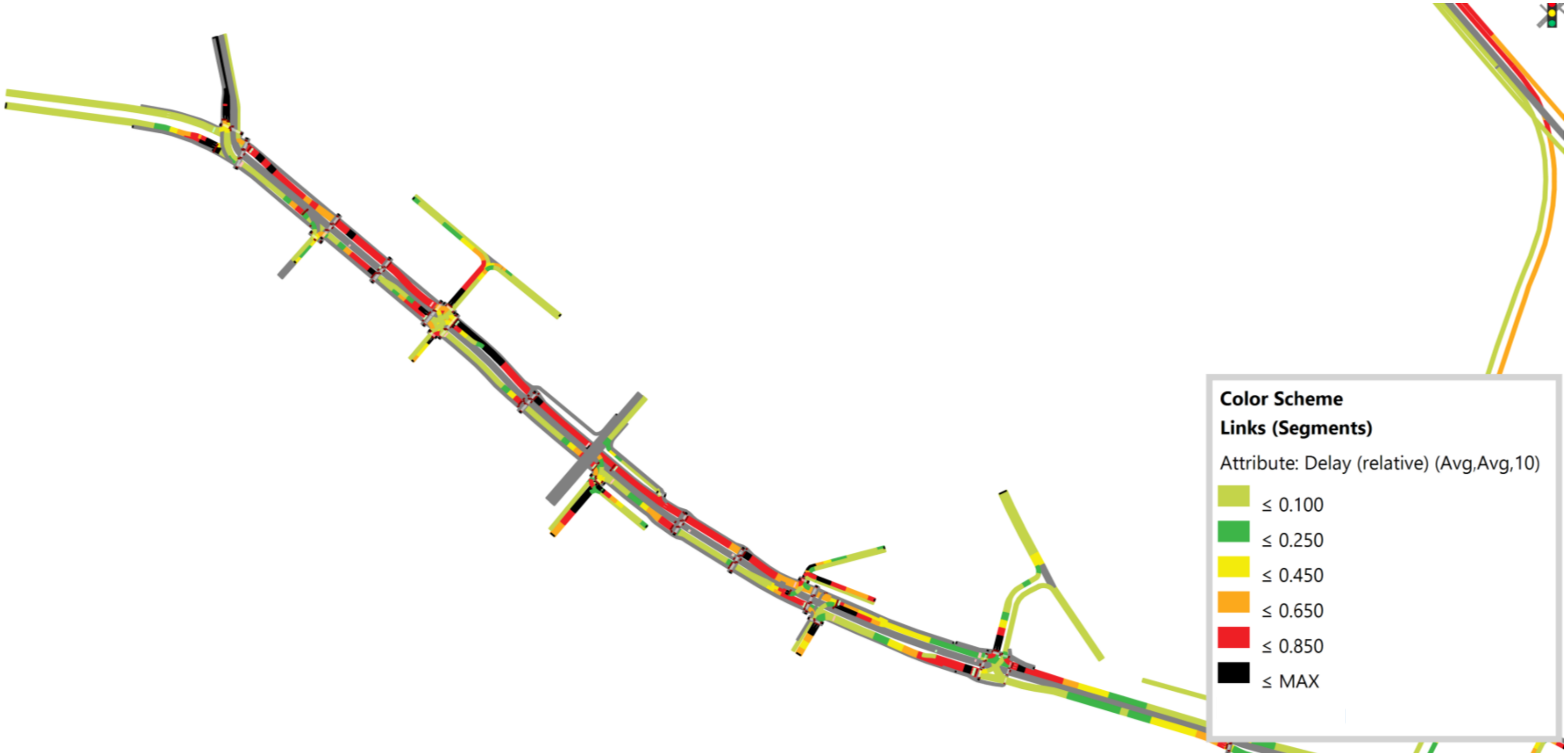
Relative delay is the total delay divided by the total travel time of all vehicles in the link segment during the time interval. VISSIM calculates delay by subtracting the actual travel time from the theoretical (ideal) travel time. In the figures below, the higher the value the more delay there is in the segment. VISSIM calculates relative delay of vehicles traveling within every 100 m road section.

Figure 38. (Relative delay) at morning rush hour



Based on the relative delay graph of the morning rush hour traffic Figure 38, it seems that the delay time is mostly under 45% of the total travel time (sections colored with green and yellow). However, at some intersections, highest of them is Telekatu experience most delay (between 65 - 85% of the travel time) at sections colored with red and black. For left/right movement traffic, it is clear that Telekatu eastbound (left turn) traffic demonstrates a high delay time. This is due to the high volume 166 vehs/hr, which is three times higher than the morning traffic, along the low green time for left turn movement traffic of (5 seconds). Since this turn is important for vehicles arriving to their work in the morning, it is important to consider extending the green time in that direction. However, since through traffic already experience some significant delay at Telekatu, it restricts the possibility to extend the left green phase.

Figure 39. (Relative delay) at evening rush hour



For evening rush hour traffic, Figure 39 shows a significant delay throughout most of the western direction corridor, most significantly between Jämsänkatu and Telekatu. Due to the bottlenecks happening in the western corridor, only 76% of the total westbound traffic volume were able to arrive and pass through the whole network, while 86% made it through the network at morning rush hour. On the other hand, 92% of the eastbound traffic made it to the end of the network in the morning rush hour, while 84% did on the evening rush hour. On average, the total travel time for vehicles traveling westbound starting at Vääksyntie and ending at Jämsänkatu is around 6.5 minutes in the evening rush hour, double the time of those traveling in the same direction in morning rush hour. On the other hand, around 3.3 minutes the average vehicle spends to pass the network from west to east, in both morning and evening rush hours.

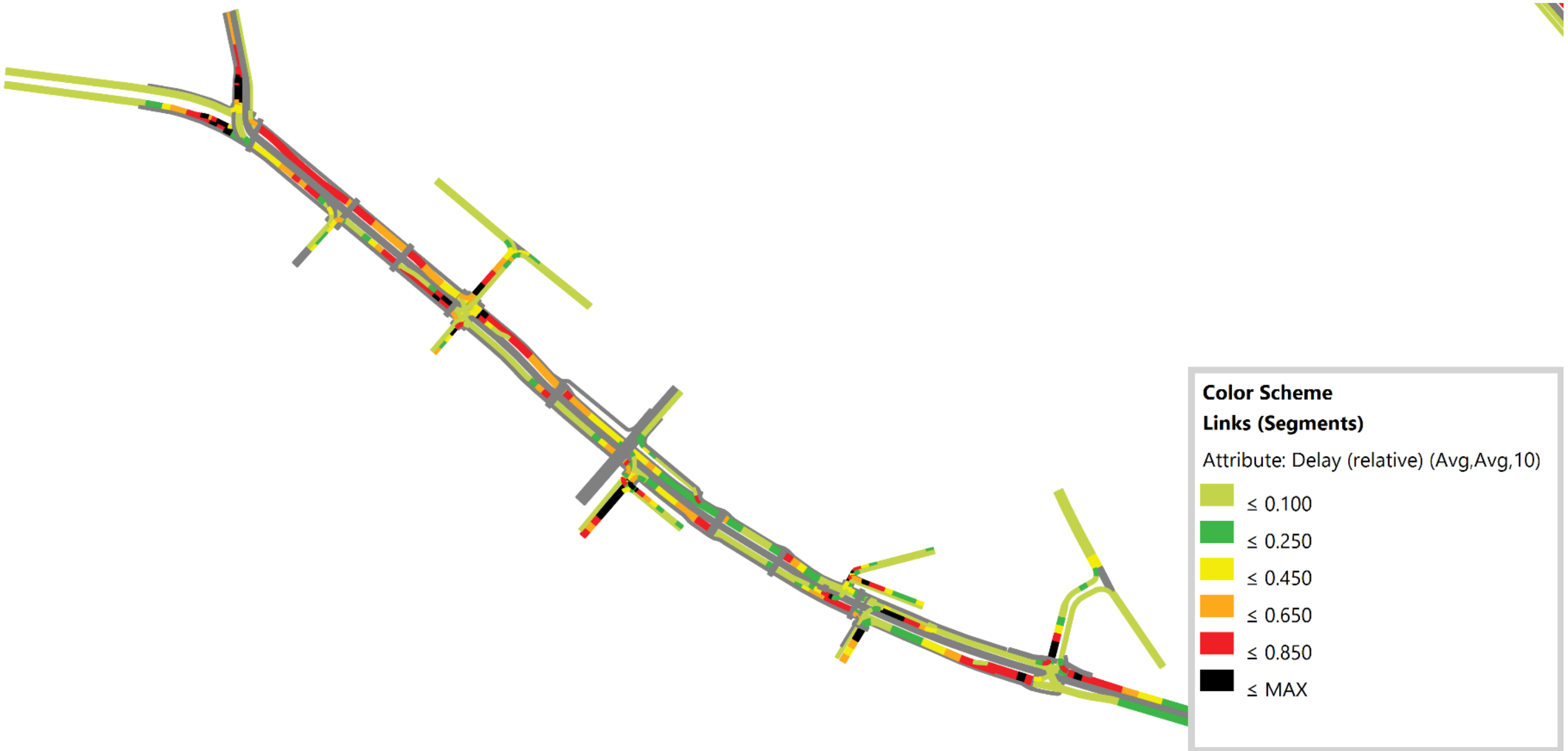
In the evening rush hour, one significant intersection approach that is experiencing very significant delay is traffic arriving from Jämsänkatu to Teollisuuskatu as shown in black in Figure 39. In this Jämsänkatu approach, more than 85% of the travel time is delayed time. Figure 52 show that the number of vehicles arriving at this approach is double the number of vehicles arriving at the morning rush hour, hence the significant delay. There are two recommendations that may be able to solve this issue here:

1. More green time given for this phase. Shown in Figure 4, the total green time given for this signal group in the original model is only 7 seconds, and therefore the demand is at least two times higher than the capacity. However, with 90 seconds total cycle time, this may be restricted with the pedestrian crossing minimum green time. Therefore, using longer cycle time may help solve this issue.

   After experimenting with longer cycle time for Jämsänkatu in the evening rush hour traffic, it seems that traffic overall became smoother, most importantly for westbound traffic as shown in Figure 40. As the capacity for Jämsänkatu increased with longer green time duration, the northern approach had the most significant reduction in delay compared to the original model Figure 39. In addition, the westbound traffic traveling through Telekatu and by Sturenkatu had a dramatic reduction of their average vehicle's delay time. The average travel time through the whole network from Väksynkatu to Jämsänkatu decreased by around 40 percent, from 6.5 minutes to 4 minutes.

   Overall, for through traffic in both directions, the most vehicle delays are experienced at Jämsänkatu intersection, eastern approach. Although there seems to be heavy delays for left and right turn traffic at intersections Jämsänkatu, Vääksyntie and Kuustaankatu, the average queue lengths do not pass the length of the turning lanes. On the other hand, the average queue length at Telekatu is longer than the left turning lane, which is also the case for the morning rush hour traffic.

Figure 40. (Relative delay) at evening rush hour with 120 seconds cycle at Jämsänkatu



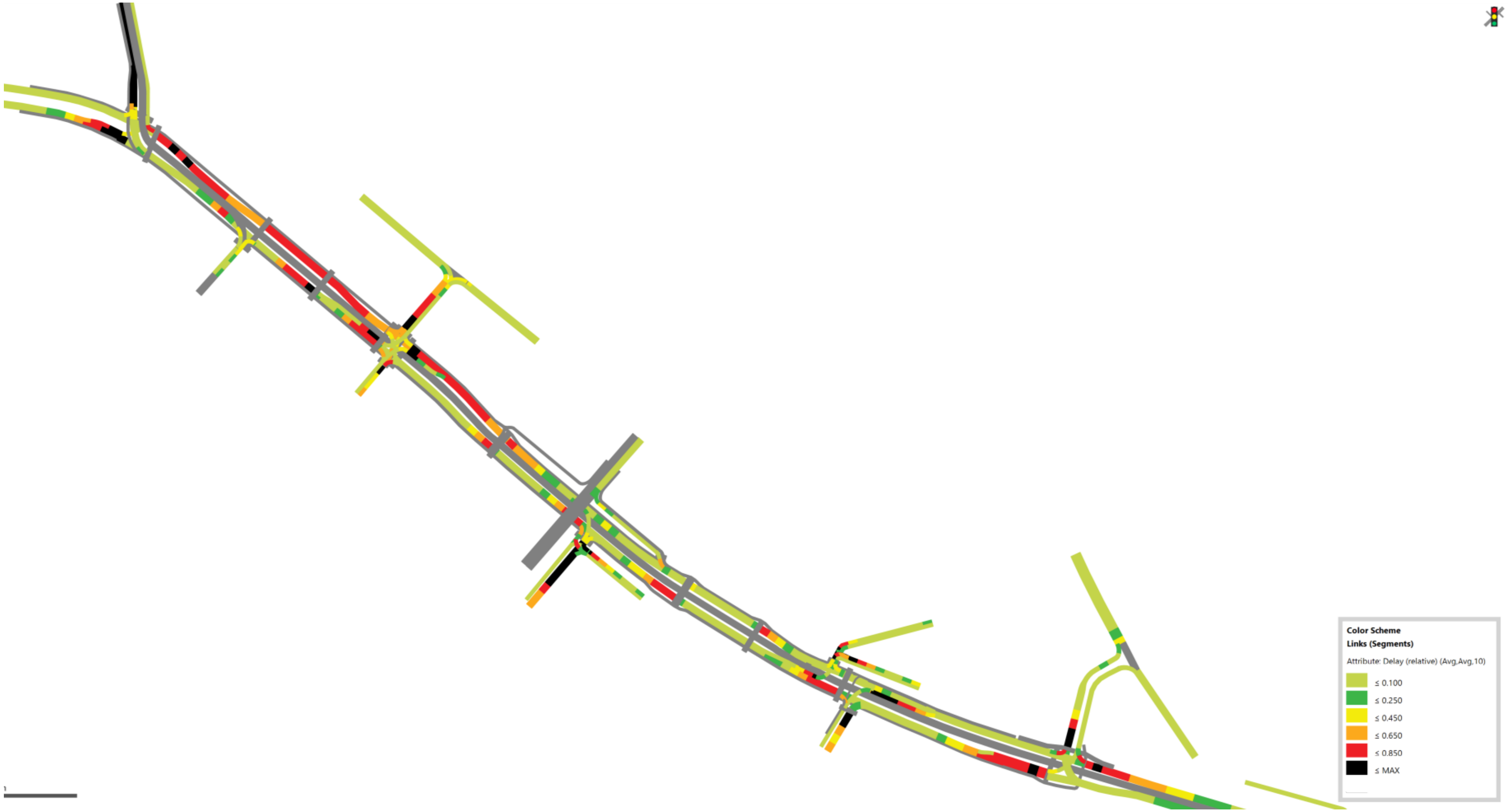
2. By moving the south/north pedestrian crossing from the eastern side of Jämsänkatu's intersection to the western side. Trams, bikes and cars traveling east of Teollisuuskatu from Jämsänkatu, depicted in signal groups 6, 4, 7, 8 and 9, as shown in Figure 5, will be able to share the longer phase duration that is restricted by the minimum pedestrian crossing time, instead of sharing it with signal group 5 (as in the current situation). Hence, the higher demand (almost double) of signal group 6 (left turn from Jämsänkatu) than signal group 5 (left turn from Teollisuuskatu) as shown in Figure 46 and Figure 52.

   After experimenting this case for the evening rush hour traffic, it appeared that although things got better for traffic coming from Jämsänkatu, vehicles arriving from Pasila and turning to Jämsänkatu were heavily congested. This is due to the low green time (8 seconds) and high traffic volume (288 vehs/hr), making demand much higher than capacity. Attempts in increasing the green time worsened the situation for Teollisuuskatu's through traffic in both directions.

In the evening rush hour of the original model, the traffic volume heading from Telekatu towards Teollisuuskatu (west) is double that of the morning rush hour traffic, which therefore causes significant increase in traffic and delay on the western side of the network towards Jämsänkatu. Based on the simulation results, it seems that for westbound evening rush hour traffic, demand is higher than the capacity of the network causing heavy congestion and delay in the network. Since it is clear now that 90 seconds cycle time is insufficient for the traffic demand, causing demand to be higher than capacity. Instead of increasing the cycle time from 90 seconds to 120, we will test the same model by simulating 10% lower traffic volumes across the whole network and analyzing its effect on traffic flow and delay in the evening rush hour.

After experimenting 10% lower traffic demand as shown in Figure 41, it is clear that the traffic flow became significantly better. However, some intersections including Jämsänkatu, Töysänkatu and Telekatu, still experience significant delay on westbound traffic. In addition, Jämsänkatu still experience heavy congestion due to the low green duration.

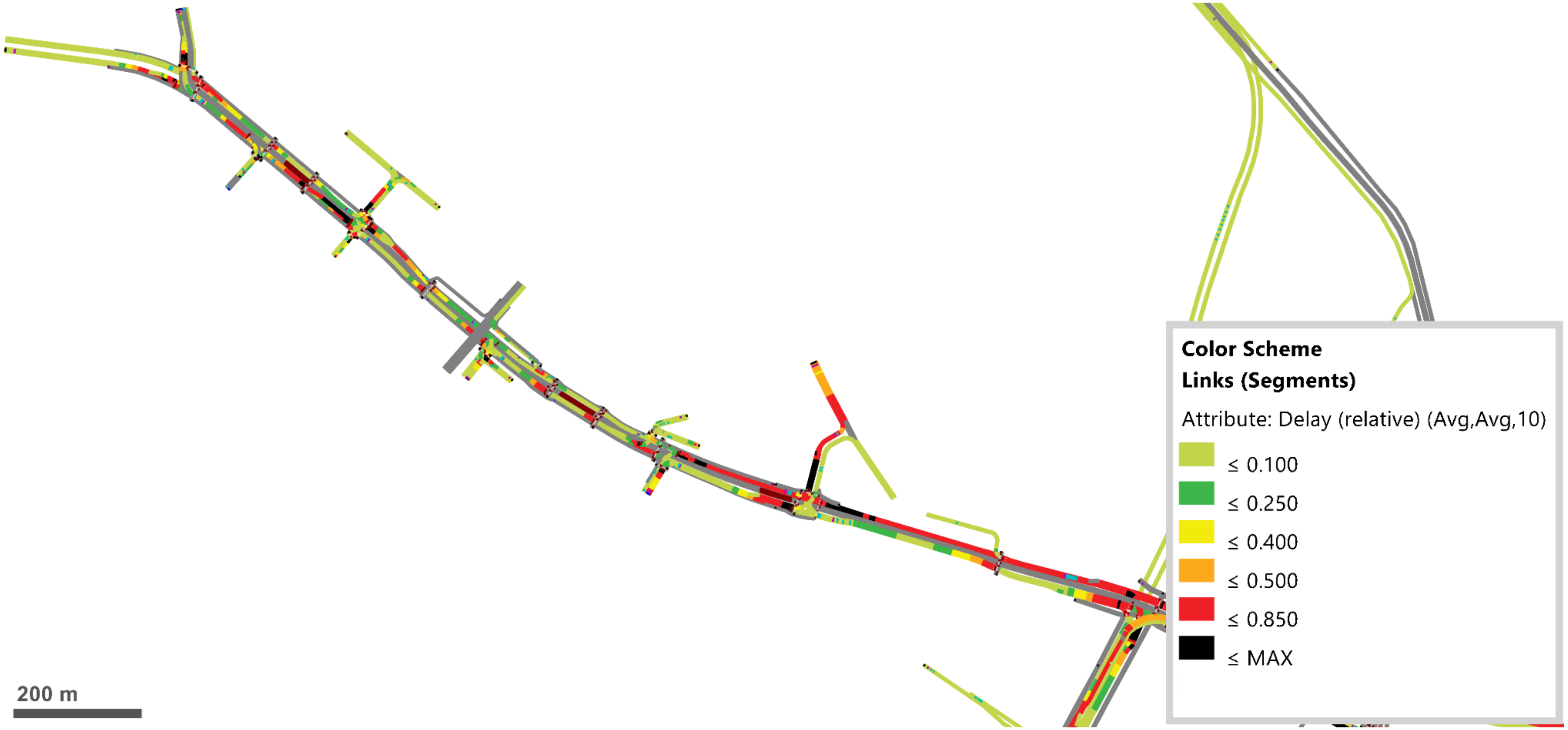
Figure 41. (Relative delay) at evening rush hour with 10% lower traffic



1.2. Delay (relative) – Scenario C

Using the traffic volumes and the street design of scenario C, explained in chapters Content and scope of the work and Volumes. By simulating the model on VISSIM, Figure 42 shows the average delay for morning rush hour traffic.

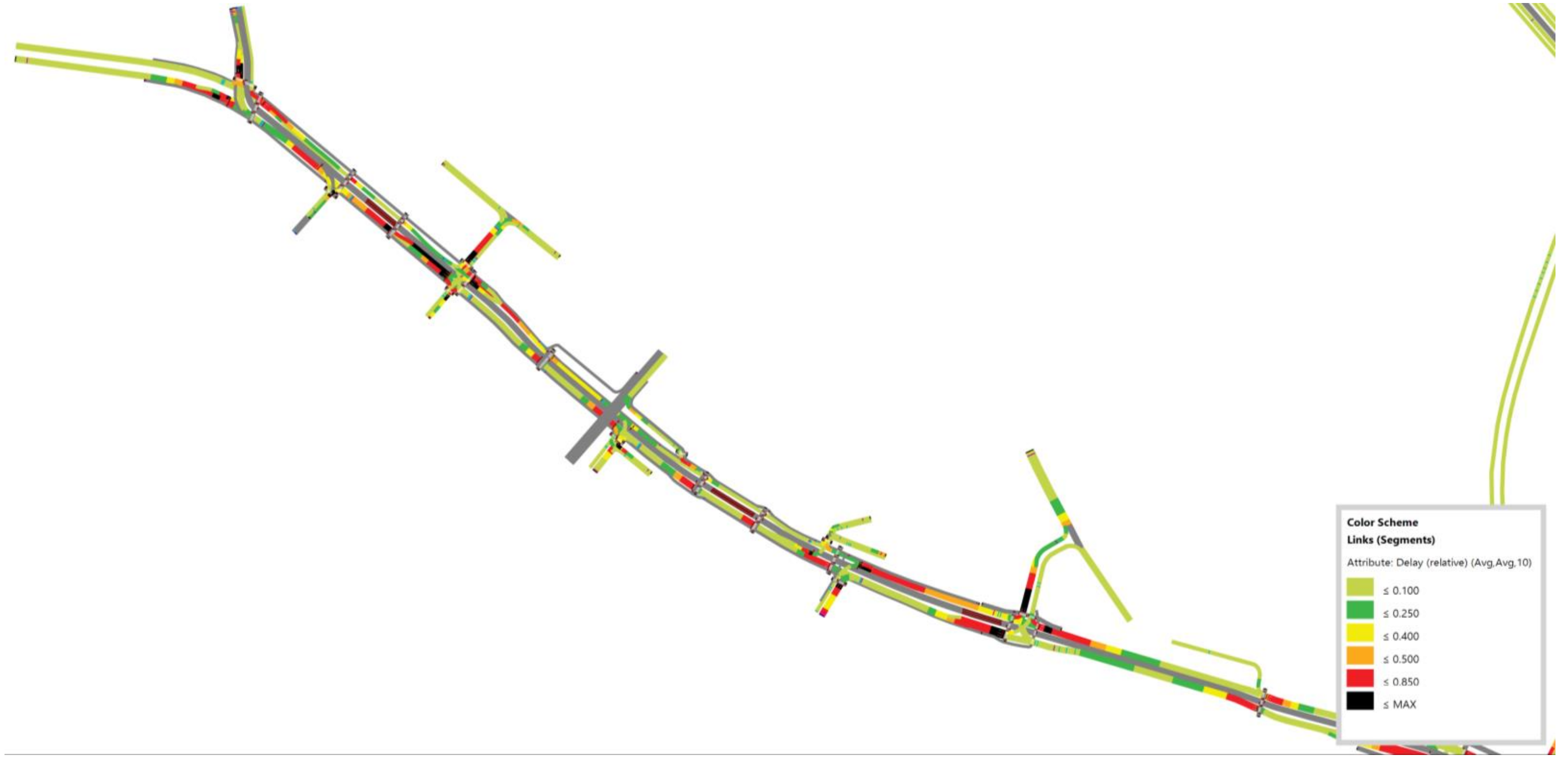
Figure 42. (Relative delay) at morning rush hour traffic



In this scenario and as explained earlier, the number of lanes going west has been reduced to only one-lane causing reduction in capacity. Based on the used traffic volumes shown in Figure 36, it is quite clear that the traffic demand is much higher than the capacity of the road especially for westbound traffic sections, starting at Junatie, colored with red and black in Figure 42. (Relative delay) at morning rush hour traffic. As the westbound traffic of Teollisuuskatu face the most delay due to the reduction in capacity, it is causing significant delay rise in roads approaching Vääksyntie from Kalasatama, in contrast to scenario A, Figure 38. This is due to the high arriving traffic demand at Kuustaankatu (1510 vehs/hr), which is higher than the capacity of a single lane road. The bottleneck in this scenario starts at Vääksyntie. So what happens if we try to reduce the traffic by 10%?

By reducing the through traffic demand arriving from Vääksyntie by 10%, we can notice from Figure 43 that the overall traffic delay decreased significantly, specifically at Vääksyntie and Kustaankatu. This is intuitive as the highest traffic demand is in this section, however traffic demand falls dramatically after Päijänteentie.

Figure 43. (Relative delay) at evening rush hour traffic with 10% lower westbound traffic



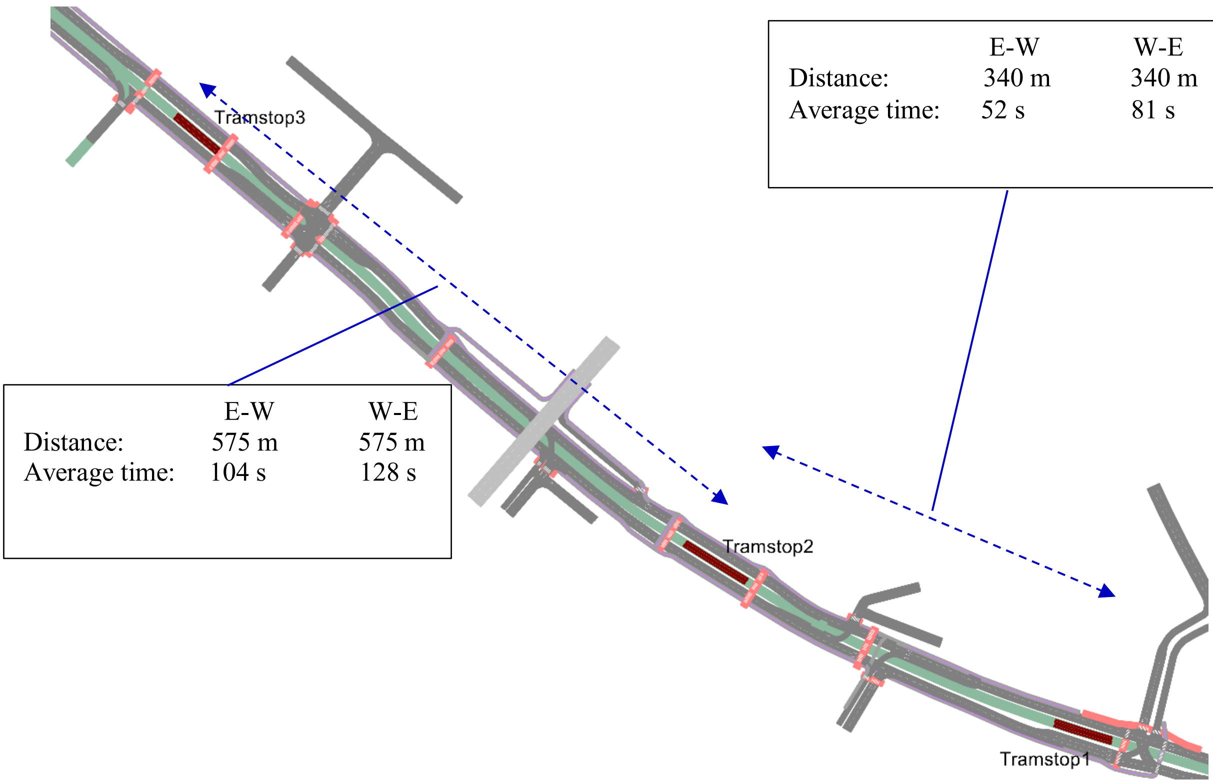
Public transport

This will show a brief result for the performance of public transit in Teollisuuskatu, based on the average travel time between stops.

Assumptions:

- Tram/trunk buses dwelling times for all (three) tram/trunk bus stops along the network were assumed to have an average dwelling time of 20 seconds.
- The used signal controllers in this simulation is not yet developed to give transit priority. This should be developed in the future for further transit system assessment of the model.

Figure 44. Tram/Trunk bus travel times between stops



Conclusion

Overall, it seems that on average there is more delay for vehicles traveling westbound than eastbound, in both morning and evening rush hours. The highest intersection delay for westbound traffic happens at Telekatu and Jämsänkatu in Scenario A. The high traffic demand between Telekatu and Jämsänkatu in the evening rush hour is causing significant delay and heavy congestion. However, traffic becomes smoother when the cycle time is increased to 120 seconds. The high traffic demand arriving at Teollisuuskatu from Junatie is already causing a bottleneck at Vääksyntie in Scenario C. However, things get better when westbound through traffic is reduced by 10%.

It is important to note that the used traffic forecasts of 2030 in this VISSIM model are based on WSP’s Junatie microsimulation and Ramboll's Teollisuuskatu dynameq mesosimulation. Moreover, some of the used traffic demand volumes, specifically in areas with most congestion in this model are 25% higher than 2018/2019’s counts as shown in Figure 30 & Figure 32. Which in some cases mean about 2.5% annual increase in traffic demand.

Here is a highlight of the heaviest congested points in the model, in different scenarios and rush hours:

For scenario A - morning rush hour.

- The highest through traffic delay is experienced at Telekatu’s east approach as shown in Figure 38.
- The highest turning lane traffic delay is experienced at Telekatu’s west approach.
- The average total queue lengths however do not extend between intersections. Other than Telekatu, the traffic demand does not seem to be much higher than the capacity of the road.

For scenario A - evening rush hour.

- High traffic delay and bottlenecks are experienced westbound all the way between Päijänteentie and Jämsänkatu as shown in Figure 39. Overall, the traffic demand from Vääksyntie arriving to Teollisuuskatu is higher than its capacity.
- The highest turning lane traffic delay is experienced at Jämsänkatu’s north approach.
- By testing longer signal time duration (120 seconds) instead of (90 seconds) at Jämsänkatu, there has been a dramatic change in the overall performance across the whole network. Around 40% lower travel time for westbound traffic and overall reduction in delay have been experienced as shown in Figure 40.
- By testing the original model with 10% less traffic demand, the overall travel time and delay have been reduced and the overall performance enhanced. However, Jämsänkatu and Telekatu still faced a relatively high delay time as shown in Figure 41.

For scenario C - morning rush hour.

- The reduction in road capacity specifically between Vääksyntie and Kustaankatu caused significant delay rise in lanes approaching Vääksyntie from Kalasatama in contrast to scenario A. The bottleneck in this scenario starts at Vääksyntie and the beginning of Teollisuuskatu starting at Kustaankatu.

- By testing the original model with 10% less traffic demand, the overall travel time and delay have been reduced and the overall performance enhanced. While Jämsänkatu and Telekatu experience lower delay in Scenario A than in Scenario C, Kustaankatu suffer more delay in Scenario C than in Scenario A.

Appendix

1.1. Scenario A - Turning volumes during morning peak hour

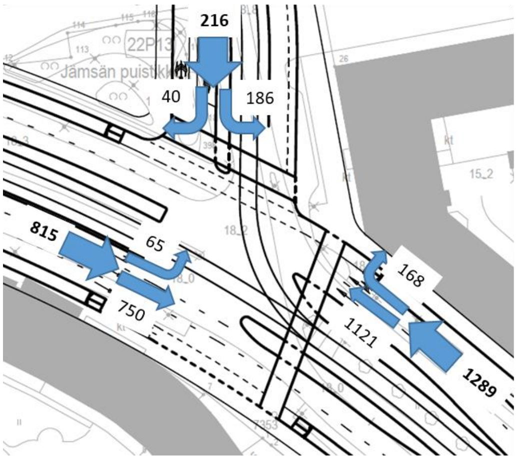


Figure 46. Teollisuuskatu/Jämsänkatu

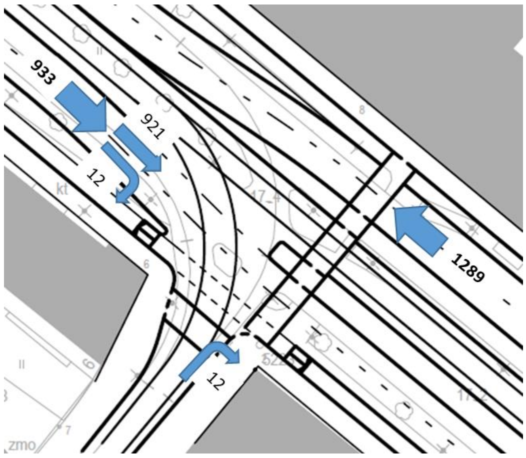


Figure 45. Teollisuuskatu/Traverssikuja

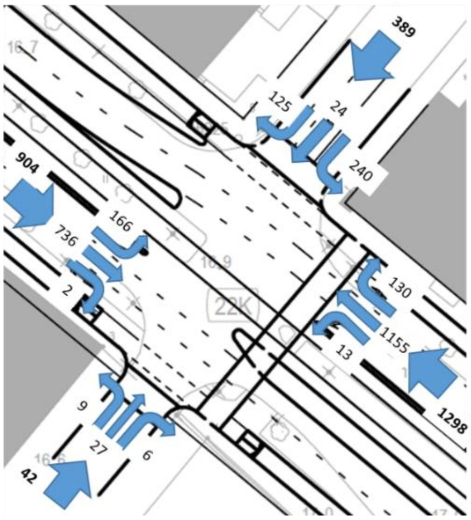


Figure 47. Teollisuuskatu/Telekatu

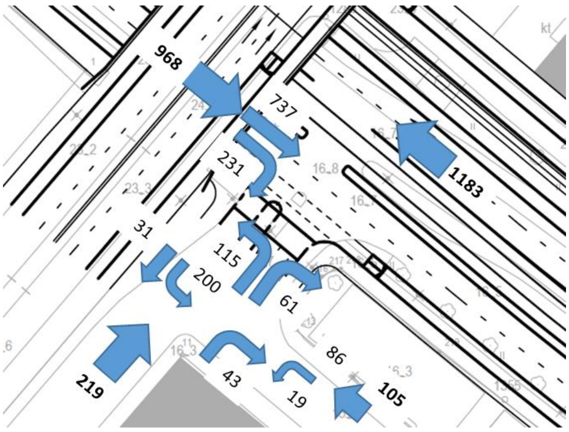


Figure 49. Teollisuuskatu/Satamaradankatu

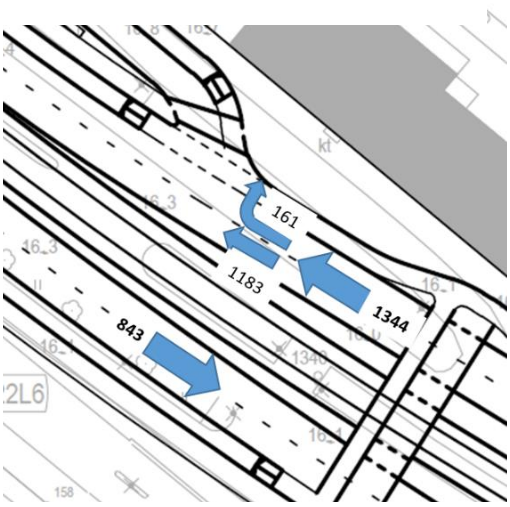


Figure 50. Teollisuuskatu/Sturenkatu ramp

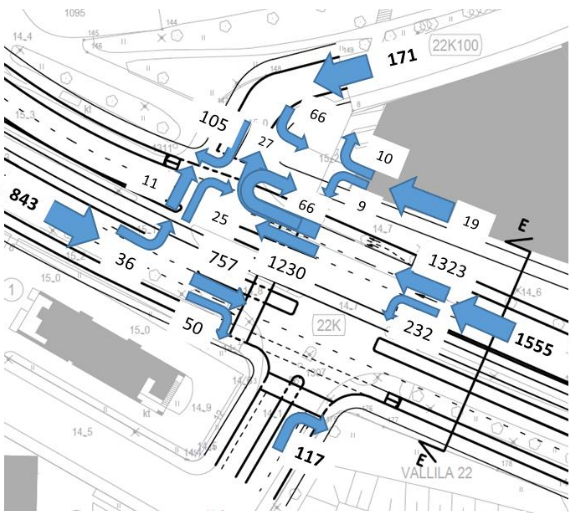


Figure 48. Teollisuuskatu/Kustaankatu & Päijänteentie

1.2. Scenario A - Turning volumes during evening peak hour

Figure 52. Teollisuuskatu/Jämsänkatu

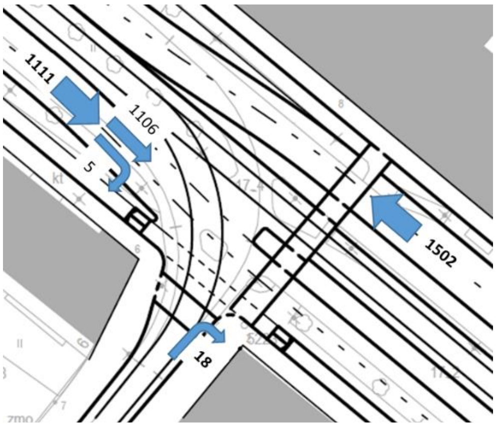


Figure 51. Teollisuuskatu/Traverssi-kuja

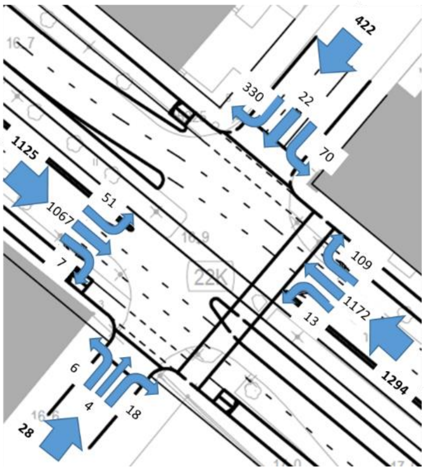


Figure 54. Teollisuuskatu/Tele-katu

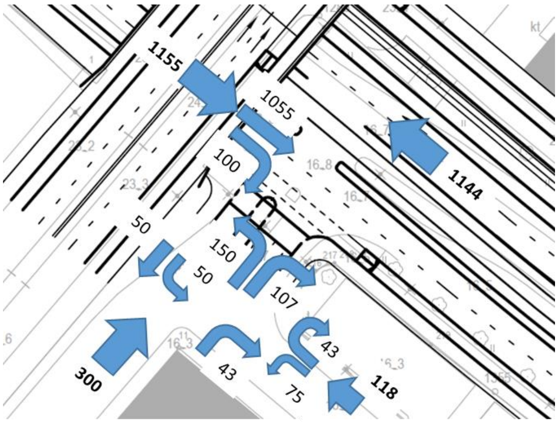


Figure 53. Teollisuuskatu/Satamaradankatu

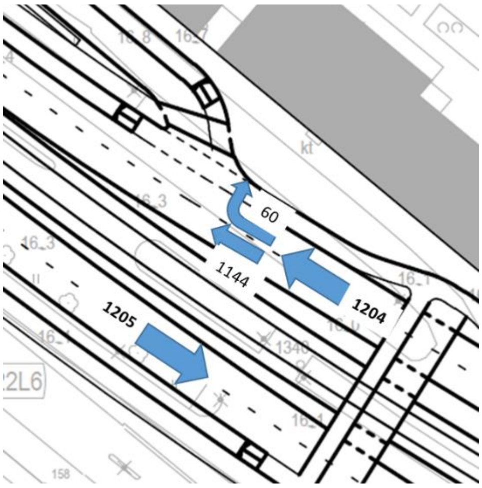


Figure 55. Teollisuuskatu/Sturenkatu ramp

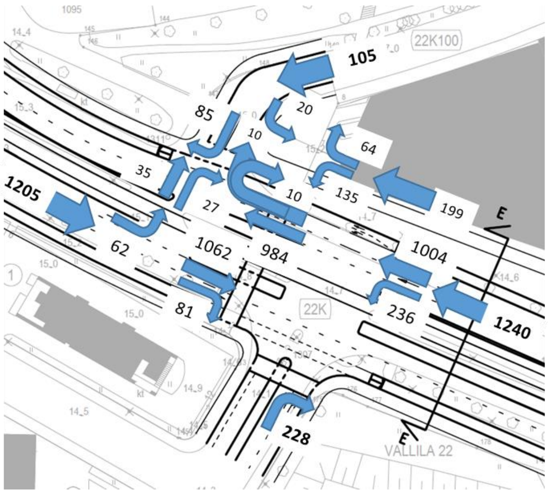


Figure 56. Teollisuuskatu/Kustaankatu & Päijänteentie

1.3. Scenario C - Turning volumes during morning peak hour

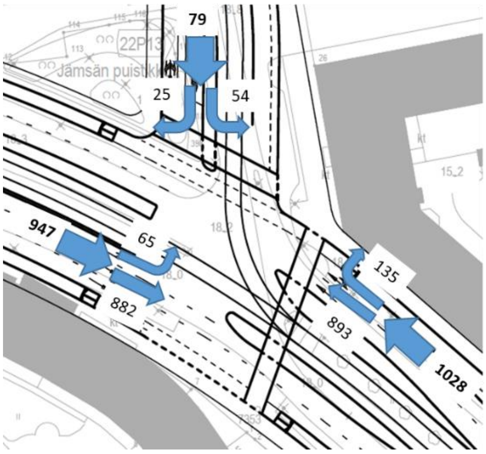


Figure 58. Teollisuuskatu/Jämsänkatu

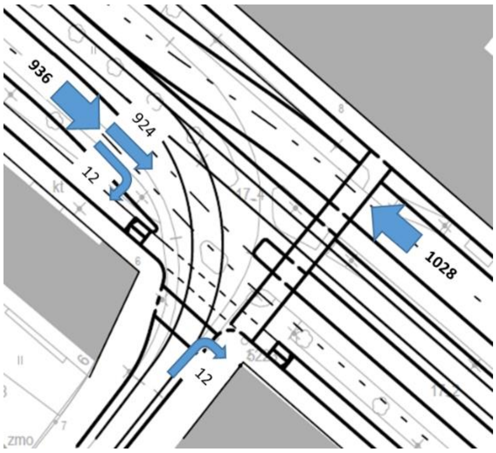


Figure 57. Teollisuuskatu/Traverssi-kuja

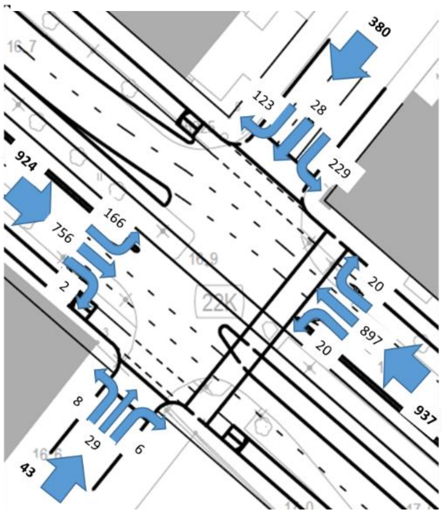


Figure 59. Teollisuuskatu/Telekatu

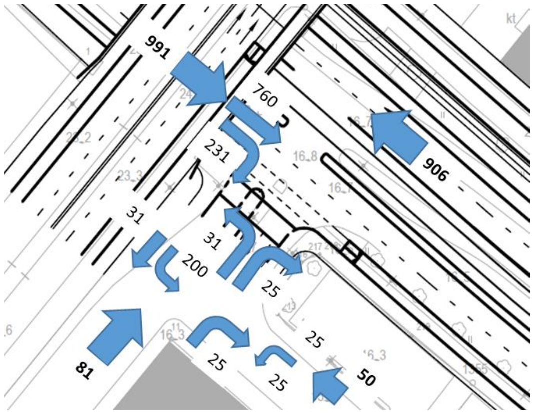


Figure 60. Teolleosuuskatu/Sataramadankatu

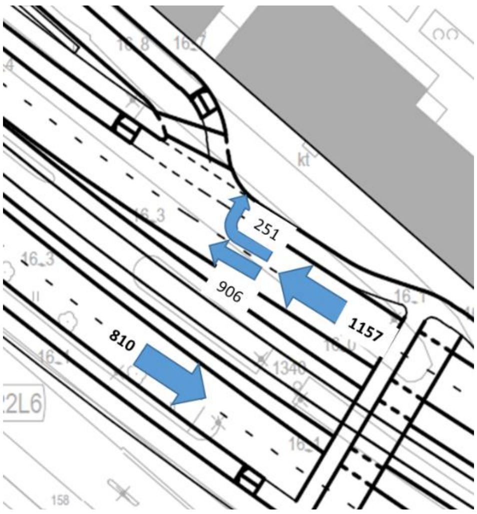


Figure 62. Teollisuuskatu/Sturenkatu ramp

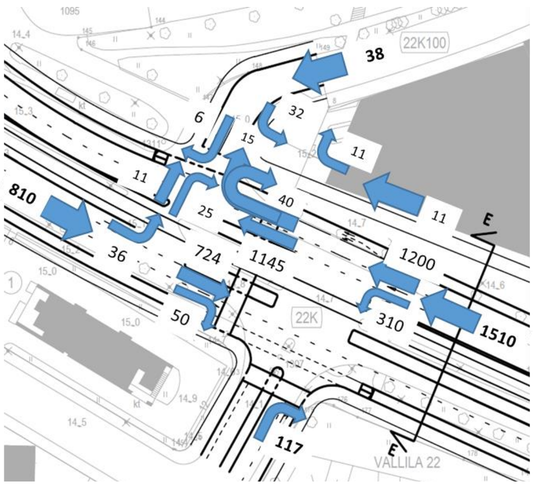


Figure 61. Teollisuuskatu/Kustaankatu & Päijänteentie

Future steps

On Public Transit:

All signal controllers used in this simulation model are fixed-time. This means that there is no logic yet that allow transit signal priority. At an early planning stage, such preliminary analysis could give a good evaluation basis of the functionality of the network, in terms of traffic demand and capacity. This could be further developed for future analysis, including the assessment of the transit system. Such modifications could allow analysis for example of the travel time, average speed and delay of public transit traffic including trams and buses. In addition, it may also be specifically useful for traffic management to analyse the effect of tram green wave on other traffic modes. However, this may require more detailed data input for example tram entry time distribution and dwelling times.

On Active Transport Modes:

Future analysis regarding the geometrical safety of traffic conflict between cyclists and vehicles could be further investigated in traffic management. In cases including Jämsänkatu, where there is a big number of cyclists and right turn cars sharing the same green phase. This, however could be more investigated in the street design phase, and later simulated and tested for efficiency along with the traffic signal plans.

On Car Traffic:

With the opening of the new tunnels in Pasila, there may have been changes to the amount of traffic counts going through Teollisuuskatu, east and west bound. The effect of the tunnel on the traffic demand could be later investigated and modified for Teollisuuskatu's simulations.

Helsinki

Kaupunkiympäristön toimiala huolehtii Helsingin kaupunkiympäristön suunnittelusta, rakentamisesta ja ylläpidosta, rakennusvalvonnasta sekä ympäristöön liittyvistä palveluista.