Simulation–based investigation of transport policies - a case study in Gladbeck

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1 Introduction

The city of Gladbeck, part of the Ruhr region in Germany, wants to achieve a CO_2 reduction of 68 % by 2030 in the mobility sector Gertec GmbH Ingenieurgesellschaft (2022). In order to progress discussions on how to achieve this goal, a variety of small living labs will be carried out in the city. These will be evaluated with the help of a traffic model to try to quantify their effect on a lager scale and to identify wich should be introduced on a larger scale and on a permanent basis.

2 Methodology

For the investigation of the different measures the software Multi-Agent Transport Simulation (MATSim) is used Horni et al. (2016). MATSim has already been used to study various kinds of scenarios in a variety of regions Schlenther et al. (2022). It has numerous extensions that can be used, such as an emission analysis Hülsmann et al. (2011) or the possibility to study bicycle traffic Ziemke et al. (2017). The base case scenario is derived from the already existing MATSim metropole-ruhr scenario[1], which is developed in cooperation with the Regionalverband Ruhr. The study area is the city of Gladbeck and its neighboring cities Gelesenkirchen and Recklinghausen. Those are cut out from this already existing model. This reduced Gladbeck scenario, contains all agents that perform an activity in the study area or travel through it. This reduced sample size is calibrated so that the modal split of the residents in Gladbeck is matching the corresponding regio star modal split infas et al. (2019). The measures of investigation are identified by the city of Gladbeck. The first on is to give out free public transport tickets. This is modeled by setting the cost of using public transport to zero. Another one is the introduction of a 30 km/h speed limit in the city of Gladbeck. In the model, the speed of all links within Gladbeck, except for motorways and primary roads, are reduced accordingly. The city also wants to test the effectiveness of temporally closing the streets in front of two specific schools for private motorized transport. Utilizing network change events, the streets around the schools in the model will be closed from 8 a.m. - 5 p.m. Other plans for the future include investigating possible improvements to the city's cycling infrastructure. To explore such possible improvements, the following measures are examined in the model: First, increasing the speed of cyclist to 25 km/h. Setting the surface to asphalt and the smoothness to excellent, for every link in Gladbeck. The implementation of bicycle streets in Gladeck, so all non major links are closed for the transport mode car. For this to work, the MultimodalLinkChooser is modified. Agents can use the mode car but have to do an access or egress walk to the nearest link, where the mode car is still allowed. Lastly, introducing cycle paths everywhere, meaning every link in Gladbeck gets a parallel link, dedicated to cyclists.

3 Results

For all the policy cases the analysis here is limited to the effects on mode-share and the overall reduction of air pollution metrics. Table 1 shows the change of the modal split share, for each

[1] https://github.com/matsim-scenarios/matsim-metropole-ruhr

of the polices in comparison to the base case. Since bicycle streets are closed for the mode car,

policy	bike	car	pt	walk
free public transport	-4,8	-1,6	9,1	-2,6
closed school streets	0,5	-1,6	0,6	0,5
cycling streets	1,8	-4,8	1,0	2,1
cycle paths	0,7	-0,6	0,0	-0,1
faster cyclist	11,0	-3,6	-1,7	-5,7
speed limit	0,7	-1,7	0,5	0,6
smooth surface	0,2	-0,6	0,2	0,2

Table 1: Modal Shift all figures in [%]

policy	CO_2	NO_x	PM
free public transport	-2,5	-2,4	-2,3
closed school streets	-1,7	-1,7	-1,6
cycling streets	-12,5	-13,1	-12,9
cycle paths	-0,2	-0,4	-0,3
faster cyclist	-4,8	-4,8	-4,6
speed limit	3,5	1,6	2,4
smooth surface	-0,7	-1,0	-1,0

Table 2: Changes in air pollution all figures in [%]

this leads to the highest decrease in the modal split share for the transport mode car. The motorized interactions are not enabled Ziemke et al. (2018), so bike lanes do not have as much of an effect as might expected. Increasing the speed of cyclists shows, that it moves closer to the mode car in its characteristics as it is faster, making it more attractive as a result. From all the measures that affect cycling, the change of surfaces and smoothness, has the smallest effect on the modal split in the simulation. Introducing the speed limit or offering free public transportation have a similar effect on the mode share of the transport mode car. Free public transportation draws agents away from riding bicycles or walking. The introduction of a reduced speed limit makes alternative means of transport more attractive, thus a small increase of the alternative modes can be observed. However, focusing only on reducing car traffic falls short if the goal is to reduce air pollutants. Table 2 shows the changes in air pollution metrics for the different polices, compared to the base case, only if all links within Gladbeck are analyzed. The greatest reduction (e.g. -12,5 %) in CO_2 emissions can be achieved by introducing bicycle streets. Although the introduction of the reduced speed limit leads to a reduction in motorized traffic, air pollution actually increases overall.

4 Discussion

New data sources have become available, necessitating a re-calibration of the model. Gladbeck is a smaller city and the Ruhr region is very interconnected. Thus, especially the infrastructure measures should be introduced on a larger scale, as agents perform a lot of activities outside of the study area. As indicated earlier, modeling of the change in bicycle infrastructure can still be improved. Additionally other fleet compositions for the transport mode car should be used to calculate emissions. It ought to be examined how the individual measures and, if necessary, further measures can be combined to a strategy with which the goals set by Gladbeck can be achieved. Not all measures taken by the city are fully simulated yet. Gladbeck recently introduced an app called Klimataler. It allows people to earn virtual coins by reducing their CO_2 emissions. To estimate the effect of the app, different monetary values are tested out, which the agents receive according to their behavior.

5 Conclusions

The small results in the reduction of CO_2 emission show, how difficult it is to reach the goals Gladbeck has set itself. Still, there seems to be a harsh political debate about these less effective measures. This puts into questions whether the political implementation of more ambitious measures can realistically be expected. Models can help to clarify which of the measures are worthwhile. The agent based approach allows for a more detailed analysis of each individual policy.

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