15th ITS European Congress, Lisbon, Portugal, 22-24 May 2023

Paper ID #402

Simulation of a full-scale implementation of Superblocks in Vienna

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Abstract
Superblocks have been introduced in the city of Barcelona as a traffic management and urban planning concept to enhance public health and reduce traffic in dense urban neighborhoods. The general idea of prioritizing active mobility modes and diminishing motorists and parking space has meanwhile been adopted by many other cities to various city grid structures. The impact on mode choice behavior and traffic volumes has been difficult to measure as the pilot projects are rather small interventions and before-after-analyses were rarely conducted. In this article, we therefore use an agent-based mesososcopic traffic simulation (MATSim) to model different configurations and numbers of Superblocks. In the case study for the city of Vienna 61 scenarios with up to 46 Superblocks are simulated. The results show that the number of car trips in the affected Superblocks decrease linearly by around 100 car trips per day and Superblock.

Keywords: Superblock, mode choice behavior, modal split, agent-based modeling, MATSim

Introduction

The Superblock concept (*superilles*) was originally presented in Rueda (*1*) and is based on the first experiences with test areas such as the Poblenou Superblock. Its main objective is to reorganize the distribution of public space to give priority to pedestrians and cyclists, thus improving environmental conditions and people's quality of life (*2*). The theoretical model envisions a Superblock as an association of nine street blocks with an edge length of approximately 400 x 400 meters. It is enclosed by basic streets, often arterial roads, where through and connecting traffic circulates at a maximum speed of 50 km/h. On the inner roads, motorized traffic is limited with a speed limit of 10 or 20 km/h. This not only restricts the flow of traffic, but also breaks the mono-functionality of the street and parking area, and allows a diverse use of public space. The traffic flow is organized in a way that a Superblock cannot be passed through by motorized individual traffic (*1*). Assuming that the average speed of a car in cities is about 20 km/h, it takes the same amount of time to cross a Superblock as it does to drive around it. The introduction of several Superblocks in Barcelona would reduce the total length of thoroughfares by 61 % and open up the possibility of redesigning 45 % of all streets. In the current masterplan for Barcelona, the Superblock concept is upscaled in the number and dimension of the proposed intervention. A total of 503 Superblocks are planned, with entire streets also to be transformed into green corridors. This transfers the principle of the Superblock to another planning scale and creates a network of Superblocks.
The concept of superblocks is fairly new and there are no before/after studies that measure the exact impact of Superblocks on traffic. The concept itself has recently become quite popular in other cities as a potential planning concept (e.g. Berlin, Basel, Vienna). Vienna is one of the cities where the concept has also been prototyped and implemented in a test phase (*3*), and further expansion of the concept to other parts of the city is being discussed. The question is whether the Superblock concept has the potential to reduce the

share of car traffic in the modal split of the city so that climate targets can be met. To find answers to this question, the agent-based mesoscopic traffic model of Vienna (*4*) is used to model and simulate the impacts of Superblocks.

The paper starts with a review on traffic effects of Superblocks and similar traffic interventions. It discusses the different methods used to define Superblocks, as well as their implementation in the MATSim traffic simulation. This is followed by a presentation of the results of the evaluation of the modal splits in the different simulation scenarios and a subsequent discussion, as well as the limitations of the study.

Literature review

In the literature review, we first deal with approaches to transfer the Superblock concept to other cities. The second part summarizes traffic impacts of Superblocks and other traffic calming measures based on observation and models. This will help identifying the current research gaps and related the results of our study to existing findings.

The original Superblock concept was developed for the Eixample district of Barcelona, which is characterized by a grid structure atypical of European cities. There has been only a few research on how to transfer the Superblock definition to general city grid structures. The most recent approach is based on sole geographic analysis of the street network by Eggimann (*5*). The author calculates the potential for Superblocks in twelve different cities by analyzing the street network and other urban indicators (*6*) such as population density and building coverage. Streets which are excluded as potential Superblock streets are those which are categorized as primary, secondary or trunk streets. Also streets on which trolleybus and tram routes are located are excluded. For the selection of Superblocks in our study, we integrate some further variables such as access to public transit (PT) as described in the method section.

Another highly relevant topic in research about Superblocks is the impact of the intervention. The change of mobility behavior and other traffic and environmental impacts is needed to prove the usefulness of the concept and to adjust measures if necessary. Since some effects like car ownership are long-term impacts, they cannot yet be observed for the Superblock concept since it has only been implemented for a few years. Therefore, we also take similar traffic calming measures into account where there has been more research done already.

The traffic concept that comes closest to the *Superblock* is the *circulation plan*. The concept was originally developed for the city of Groningen (*7*) and gained popularity when being taken up by the city of Ghent which implemented it in 2012 as response to the rising amount of car traffic in the inner city (*8*). To take the transit traffic out of the city center, the city prohibited access to the center and additionally assigned six larger sectors around this area. Traffic from one sector to another via the sectoral roads was also prohibited by changing the traffic directions of the roads which causes car drivers to always use the ring road around the six sector if they want to go from one sector to another one. Cycling was not affected by these regulations.

A less strict approach on a smaller scale than a Superblock is the concept of *low-traffic neighborhoods*. Several measures such as one-way streets, prioritizing cycling, walking and public transit, and reducing public parking space can be part of the concept.

Mini Hollands are an approach applied in the residential neighborhoods of the Greater London area. Their principles are based on the *Woonerfs* in the Netherlands. Road traffic regulations in many countries often allow for similar traffic management forms, commonly known as *living streets*. All these traffic calming measures aim to reduce car traffic speed and thus make road space safer. By removing parking lots, road space is repurposed for other functions such as greenery or street furniture. This approach is also known as *open street* if it is a temporal implementation.

In regards of impacts of these traffic calming measures, mostly emissions, traffic indicators (e.g., vehicle miles travelled (vmt), modal split, travel time), and car ownership rates have been analyzed. Rojas-Rueda et al. (*9*) simulated a shift of transport modes for Barcelona in different scenarios. In scenarios with 40 %

mode shift to bicycles or bicycles and public transport, they revealed a reduction of 203,251 t CO2/year. Holman et al. (*10*) reviewed low emission zones in Germany and conclude that they may have reduced PM10 and NO2 concentrations by a few percent. In other places, there was no clear effects on PM10 and NO2 levels observed. Ku et al. (*11*) similarly evaluated low emission neighborhoods in Europe (Milan, London, Paris (no data), Rome) and observed a reduction of NOx in all cities of about 13-18 %, a reduction of CO2 in all cities about 15-35 %, and a reduction in traffic in all cities of 20-35 %.

According to Goodman et al. (*12*), the Mini Hollands decreased the car ownership by 6 % after two years (2 % decrease in areas with no intervention), and effects became stronger if the intervention was established for a longer duration (at least 1 year). Nieuwenhuijsen and Khreis (*13*) analyzed temporal interventions and found that car free Sundays can reduce NOX levels by up to 40 %. Even one-time events like the Tour de France start in Leeds reduced NO2 by 20 %. However, temporal measures unsurprisingly had never permanent impacts. Masiol et al. (*14*) come in their study to a slightly different conclusion. They examined 13 years of air pollution data in the city of Mestre in the Po Valley and tried to assess the effect of motorized traffic free Sundays. There was no statistically significant impact of traffic free Sundays on air quality but the weather was more important instead. They observed that the traffic often diverted to the suburbs of the city on car-free Sundays. Sleiman (*15*) evaluates the impact of the impacts of the downtown "Georges Pompidou" riverbank closure in Paris in 2016. The authors analyzed that the probability of congestion on ring road lanes with the same flow direction as the riverbank increased by 15 %. A 10 km trip took in average 2 min longer whereas it was 6 min longer for directly affected car drivers. Only a small fraction changed to public transit.

The most relevant literature in regards of Superblocks and impacts on traffic is summarized in Table 1. Mueller et al. (*16*) measured modal shifts modal shifts before and after the implementation of Superblocks and revealed a reduction of the car modal split by 5 % (-20 % of car traffic), and an increase in bicycle trips by 2 % and walking trips by 3 %. Another very important reference is the assessment of the circulation plan in Ghent (*17*). They observed an increase in the mean bicycles volumes by 46 % and 55 % in the morning and evening rush hour (p.30), higher usage of park & ride (p.33), and a reduction of motorized individual transport by 20 % inside the circuit road and by 12 % outside in the morning and by 20 % (inside) and by 19 % (outside) in the evening. However, the closure of thoroughfares caused additional traffic on the circuit road. About +9 % to +18 % more traffic volumes are observed in the morning and evening rush hour, clock and anti-clockwise (p.128-p.129) after the Circulation Plan was implemented.

The reduction of parking space has a significant impact on the mobility behavior. Christiansen et al. (*18*) conclude that limited access to parking is the single most effective way of reducing car use on work trips. The authors found out that the likelihood of driving decreases with increasing distance to the parking place. This observation has also been made by Knoflacher (*19*). In a further study, Christiansen et al. (*20*) specified they previous study results. Their findings reveal that access to private or reserved parking triples the likelihood of car ownership. There are significant differences in the number of trips by foot (more), car (less) and public transport (more) if parking lot is more than 50 m away from home. Longer distances between home and home parking location reduce the car's modal share significantly.

The review reveals that the reduction of car modal split can be quite large (up to 20 % forecasted for Barcelona, 20 % measured in Ghent). But the studies do not show a coherent picture. In particular, Rodriguez-Rey et al. (*23*) find that superblocks alone (without additionally implementing low emission zones) will not achieve the necessary reduction of car traffic and emissions. The approach with macroscopic traffic simulation they applied will be enhanced in our study by applying an agent-based modelling approach which simulates traffic on the large scale on a rather detailed level. Another purpose of this paper is to find an answer to the question of how modal split changes when the Superblock concept is introduced iteratively. In the Barcelona (*16*) and Ghent (*17*) studies, only fully implemented measures are considered. The results are important for communication with citizens and political stakeholders because the desired effect for reducing car traffic may only appear when further Superblocks are implemented.

Table 1 Overview of literature on Superblocks and other traffic calming concepts.

Concept	Reference	Description	Impact on mode shifts/VMT/private car ownership/other traffic impacts
Superblock	(*21*)	Describing plans for the Barcelona Superblock concept	+67.2 % pedestrian space (when fully implemented: +270 %: 230ha $\rightarrow$ 852 ha), 70 % of car space will be freed up, 61 % of through-fares banned for cars
	(*16*)	Quantitative health impact assessment (HIA) study for Barcelona following the comparative risk assessment methodology. Physical activity derived from Barcelona Health Survey 2016/17.	-5 % car (around 20 % of current modal split), +2 % PT, +3 % walk
	(*22*)	Simulation for optimal number of entry points for a Superblock in China.	3 % mode shift from car to PT in the scenario with an optimal number and positioning of entry points
	(*23*)	Macroscopic traffic simulation for Barcelona: low emissions zones, tactical urban planning, superblocks	Traffic flow reduction inside affected areas: -21,000 vehicles/day (-24%), increase in adjacent streets: +6,000 vehicles/day (+30%) in Tarragona, +5,500 vehicles/day (+125%) in Viladomat in the scenario with tactical urban planning and Superblocks
Circulation Plan	(*8*)	Simulation for traveling salesperson problem in Ghent with and without Circulation Plan	Average increase in delivery tour duration by 126 %, tour distance increase by 20 %
	(*17*)	Analysis of the traffic in Gent before and after Circulation Plan – Report Part II includes some adaptions in the traffic guidance	Increase in mean bicycle volumes by 46 % and 55 % in the morning and evening rush hour, higher usage of P+R, MIT reduction by 20 % (inside), 12 % (outside) in the morning and -20 % (inside) -19 % (outside) in the evening. Additional traffic on the circuit: +9-18 % in the morning and evening rush hour, clock and anti-clockwise.
Reduced parking spaces	(*18*)		Limited access to parking is the single most effective way of reducing car use on work trips; likelihood of driving decreases with increasing distance to the parking place
	(*20*)	Norwegian national transport survey 2013, in-depth parking survey with 2000 urban dwellers	Longer distances between home and home parking location reduce the car's modal share significantly. People are on average willing to accept 155m between home and home parking (sd = 167 m). Access to private or reserved parking triples the likelihood of car ownership.
	(*19*)		Transport planning that provides parking spaces for car owners at their homes, workplaces, shopping centers and recreational places has supported increased private car use.

The aspect of access to the parked car is important for the choice of the car as a means of transport. This is therefore also taken into account in our modeling approach.

Methods

In this section, we describe the definition of Superblock areas for our case study in Vienna, and subsequently explain the implementation of the restriction for cars in the agent-based simulation framework. Finally, we describe the scenarios simulated.

Selection of Superblock candidates

For the definition of Superblock we take the OpenStreetMap (OSM) data as a basis. Instead of taking the road network and distinguish between the hierarchy of street levels (e.g., primary, secondary, tertiary), the network of aboveground PT lines is considered as the base layer. The polygons defined by the edges of the PT lines are basis for the selection of Superblocks for which the following criteria need to be valid:

- There needs to be a *good access to public transit*. People are more willing to change to public transit if the nearest stop is close to their home. A location was considered as well accessible by public transit if the beeline distance to the nearest PT stop is less than 250 m. A Superblock is defined as well accessible by public transit if the well accessible area covered more than 90 %.
- There need to be a high demand for pedestrian areas in the neighborhoods. An indicator about the need to pedestrianize a neighborhood is the *space that is dedicated to cars* and to pedestrians. Based on the OSM data, areas for roads and parking on the one side, and pedestrians and bicycles on the other side are estimated. If the space for cars is larger than the space for pedestrians, the polygon is labeled as an area with a high need for a better pedestrianization.
- There need to be a *high population density*. Based on addresses of residents, the population density can be estimated for each polygon. Since the demand for Superblocks is higher in denser areas, the minimum population density required is set to $25,000$ people/sqkm or 250 people/ha.
- The areas should not be too small. Superblock candidates should not deviate too much from the original Superblock area of around 400×400 m. Therefore, the minimum area was set to $100,000$ sqm which corresponds to 0.1 sqkm or 10 ha.

The above mentioned four criteria result in 46 Superblock candidates which are shown in Fig. 1.

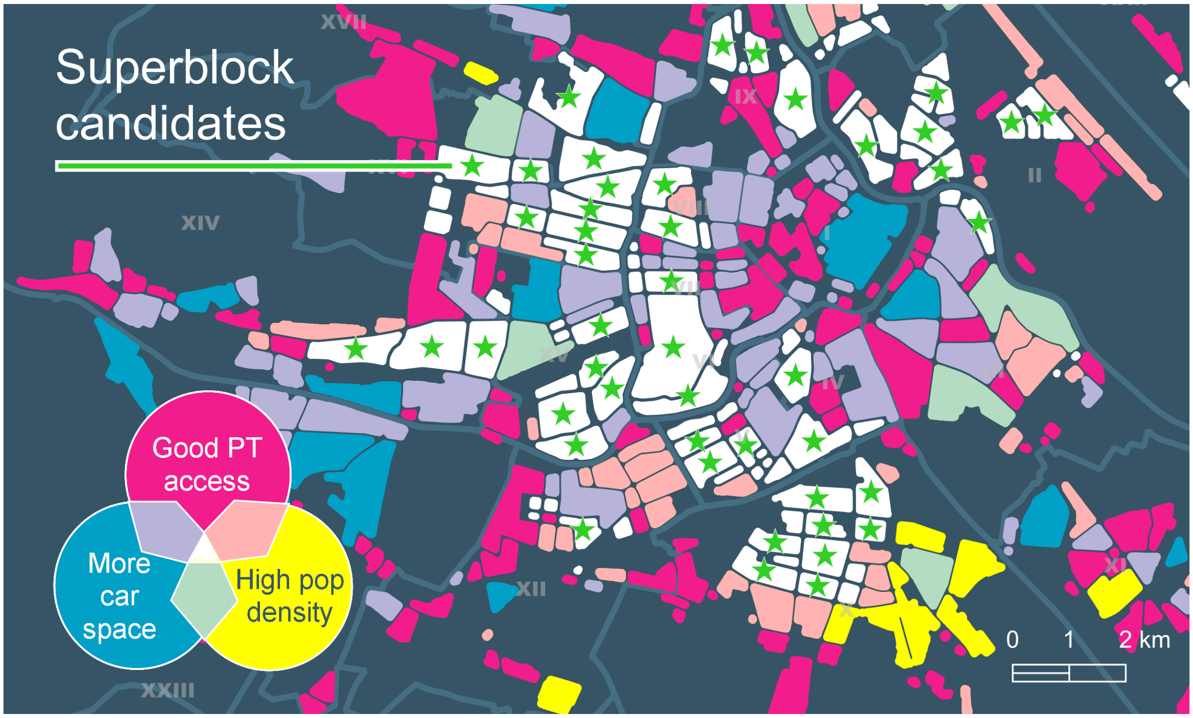
Implementation into MATSim

For simulating the effect of Superblocks we consider the MATSim model for Vienna as a case study. MATSim (*24*) is a mesoscopic agent-based simulation framework in which agents perform given activities over a day and choose the optimal transport mode for the trips from one activity to the next over several iterations. The road network is always allowed for cars in the baseline model.

Implementing Superblocks in a simulation requires consideration of exactly how the concept is intended to be implemented. As mentioned in the literature review, while there is a basic concept of a Superblock, the measures to mitigate automobile traffic tend to occur in stages. A Superblock can also be implemented in different ways. For example, a city may already be content with organizing the directions of traffic on streets so that it is no longer possible to drive through the entire block. Another form of implementation would be the designation of a living street that formally does not allow the street to be used as a thoroughfare. Again, another option is to reduce the maximum speed on the inner roads. Reducing the number of public parking spaces can also be part of the implementation of a Superblock, as the example in Vienna (Supergrätzl Favoriten (*3*)) shows. This can culminate in a completely reorganized parking management, allowing parking only on the outer edges of the Superblock (e.g. in parking garages) and completely prohibiting car driving within the block.

For the implementation in the traffic simulation it is important to consider that the measures represent adequate restrictions on the mesoscopic scale on the one hand and the measures can be transferred to arbitrary

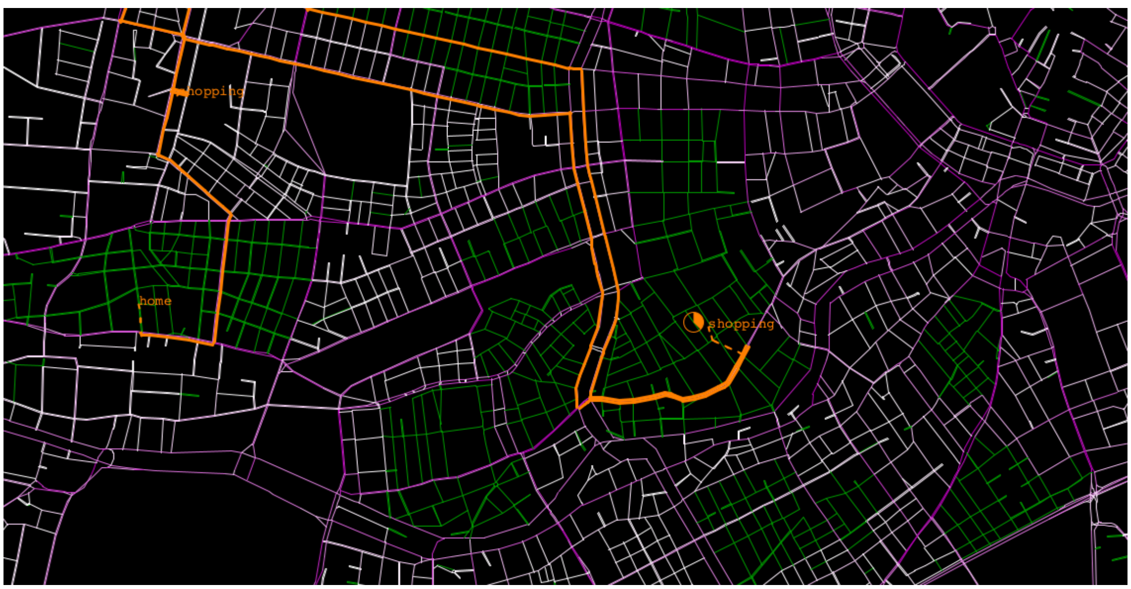
Figure 1 Map of Superblock candidates in Vienna. Green stars mark Superblocks that fulfill all criteria and are selected for the further analysis.



Superblocks.
Automated determination of driving directions is not feasible, which makes this first very soft Superblock measure not suitable for implementation in the simulation. Organizing the streets of a Superblock as *living streets* - which would legally make driving through illegal - is also not implementable, as the router in the simulation is not aware of this street type and would therefore continue to route vehicles through the block. Conceivable solutions are therefore the limitation of the maximum speed limit and the entire closure of roads to motor traffic. The reduction of the maximum speed would have to be significant to make corresponding effects visible. Currently, roads in residential areas are mostly limited to 30 km/h ($\approx$ 20 mi/h). A reduction to 10 km/h or 5 km/h would result in some increase in travel time. However, it still does not ensure that through traffic would be banned from the Superblock, as even a reduced speed may have a time advantage over detours on outside streets. While the increased travel time would be reflected in the more negative trip scoring, the router would still be able to suggest the route through a Superblock to agents, since the maximum speed is not taken into account when searching for routes.
Hence, the most suitable implementation of a Superblock is to remove the links from the network that lie within a Superblock. Fig. 2 shows an example of how this implementation looks like. The link of the road network associated with each facility is resolved for the facilities located in the Superblock and only the coordinates of the facility are considered instead. In a simulation with Superblocks, the roads within the Superblock are cut out of the original network. Each facility in the Superblock is assigned a new link in the new network. This is the geographically closest link by beeline distance and is located on the surrounding streets of the Superblock. The distance that an agent still has to travel on foot between link and facility is considered in the scoring for the trip. This type of implementation reliably prevents through traffic in a Superblock, and the gains in travel time due to possible Superblock implementation measures as mentioned above are adequately reflected in the simulation. It thus also takes into account the extended access routes

to the vehicle parking area intended in a planning implementation of Superblocks which was found to be decisive for the mode choice in the literature.
Pedestrians, bicyclists, and public transit are not affected by the street network constraints. The benefits of a more pedestrian-friendly environment in the Superblock seem obvious, as they are associated with lower disutility for active modes. However, there is a study (*25*) on physical activity in Superblocks in Barcelona that even shows lower total activity time after one year of implementation of the measures. Therefore, we argue that it is justified to keep the benefit functions for pedestrians, bicyclists and public transport as in the baseline scenario.
Each scenario is run for 100 iterations and represents a full day. The model of the city of Vienna is a 12.5 % population which needs to be considered when interpreting the simulated absolute values which are presented in this article.

Figure 2 Example of an agent doing activities within a Superblock and using the orange routes on the network. As Superblocks (indicated as green streets) are banned for cars, the agent has to walk the last part of the trip (dashed red line



Scenario configuration and evaluation
To analyze the impact of different Superblocks and increasing number of Superblocks, scenarios with different configuration of Superblock implementations are implemented in the simulation. The baseline scenario contains no Superblocks and serves as a reference scenario, while the maximum scenario contains all 46 Superblocks. The scenarios consist of Superblock configurations with 1, 5, 10, 20, 30, or 40 Superblocks. For each number of Superblocks, ten different Superblock configurations are randomly created, so that a total of 61 Superblock simulation scenarios are simulated.
In the scenarios, the number of Superblocks and the change of modal splits is analyzed by evaluating the mean and standard deviation for all ten configurations. The data is used to fit curves for each mode. Polynomials up to the fourth degree are examined and compared. To estimate the parameters of the polynomials, we use the python library `scipy.optimize.curve_fit` (version 1.9.0). The optimization method for the parameters is based on the Levenberg-Marquardt algorithm and is described in Newville et al. (*26*).

Table 2 Mean and standard deviation of mode shifts [trips/day] averaged over all ten Superblock configurations for different number of Superblocks. The absolute numbers represented non-scaled simulated numbers and have to be multiplied by a factor of 8 (simulated population: 12.5%) to obtain the actual absolute numbers.

#Superblocks	walk		bike		car		PT	
	mean	std	mean	std	mean	std	mean	std
1	7.5	10.9874	-1.9	10.9489	-6.1	11.5513	0.5	19.1616
5	17.2	20.7675	4.0	8.1513	-48.0	18.8149	26.8	25.7932
10	62.4	30.071	-11.2	31.5024	-136.9	56.7694	85.7	40.2576
20	78.9	57.4832	9.2	39.4315	-198.4	88.7508	110.3	70.1206
30	155.6	54.5409	11.7	42.4684	-380.9	94.639	213.6	101.1777
40	220.4	67.9349	13.7	41.7374	-531.9	103.7438	297.8	119.2018
46	318.0	NaN	28.0	NaN	-616.0	NaN	270.0	NaN

Results

At the beginning, we focus on the modal split, which includes only trips that start or end within the affected Superblocks. Figure 3 (above) shows the four mode changes considered with respect to the baseline scenario. The corresponding lines combine the mean values of absolute mode changes for different numbers of Superblocks. The exact numbers are given in table 2.

All evaluations have been done for longest distance mode and main mode. While the longest distance mode classifies a trip by the mode of the leg with the longest distance, the main mode categorizes hierarchically the transport modes PT, car, bike and walk (*27*). The main mode is determined by the mode of the leg with the highest hierarchy. The results show that there are no significant differences between longest distance mode and main mode in the tables and figures which is why the presentation limits to the results for the main mode.

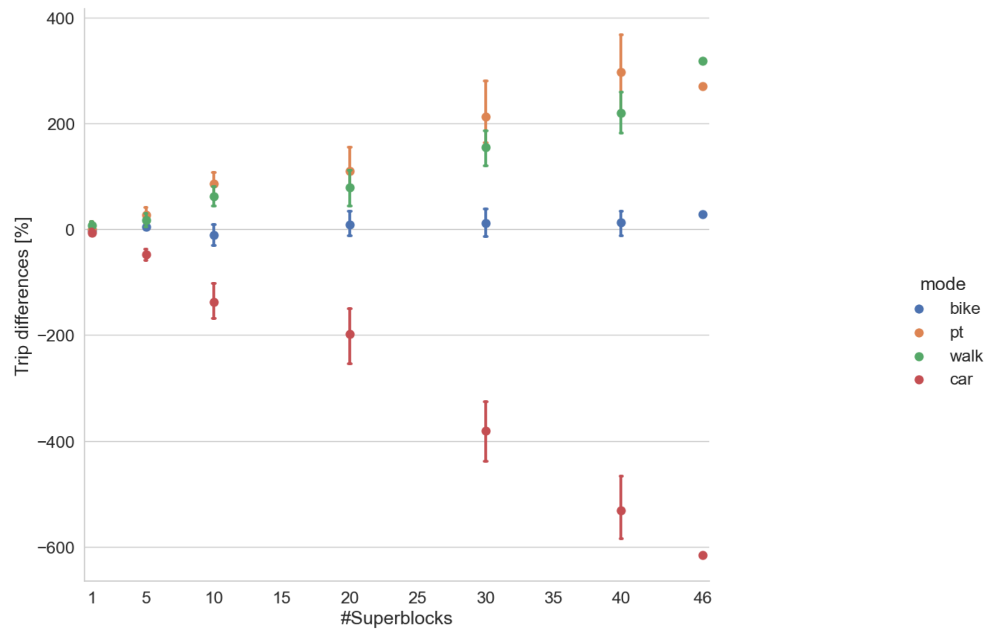
In Figure 3(above), it is clearly visible that as the number of Superblocks increases, the number of car trips decreases, while walking and public transit trips increase. PT and walk substitute the majority of trips by car, while trips by bicycle increase only very slightly. In scenarios with five or fewer Superblocks, the proportion of change is very small, while for ten or more Superblocks, a linear to exponential trend in the decrease in auto trips is apparent. In particular, with more than 20 Superblocks, the proportion of car trips decreases more rapidly.

A very clear variation in the effects is evident in scenarios with only one Superblock. As can be seen from Table 2, in these scenarios the standard error is very significantly above the mean values. For the bike mode, the standard error is much higher than the mean in all scenarios, suggesting that the effects on the mode are very site-specific, and thus difficult to generalize. One reason is assumed to be the generally very low share of bicycle share in the modal split (currently 7 % in Vienna). For car trips, however, the standard deviation of the values is relatively low. This is an indicator that the decrease of car trips is more certain and independent of the area in which the Superblocks are established.

In Fig. 3 (below), the changes in trips relative to the total number of trips to and from the affected Superblocks are shown. As they increase with the number of Superblocks, the trend of decreases in car trips and increases in walking and public transit trips remains relatively stable. However, the decrease in car trips shows a slightly negative trend, indicating that the decrease in car trips is not only correlated with the number of trips, but also increases with a growing number of Superblocks.

Analysis of modal split changes is also performed by considering them in relation to all trips in the simulation area. The impact of Superblocks obviously becomes more marginal, but the typical pattern remains. Only walking is similarly indifferent to the baseline when considering all trips in the simulation area. Public transit increases by up to 0.2 % (about 1500 trips/day), while automobile trips are reduced by

Figure 3 Changes in the modal split of the affected Superblock areas in absolute numbers [trips/day] (above) and relative to the total number of trips per day (below). Considered are all trips with origin or destination in the affected Superblocks. The absolute numbers represented non-scaled simulated numbers and have to be multiplied by a factor of 8 (simulated population: 12.5%) to obtain the actual absolute numbers.



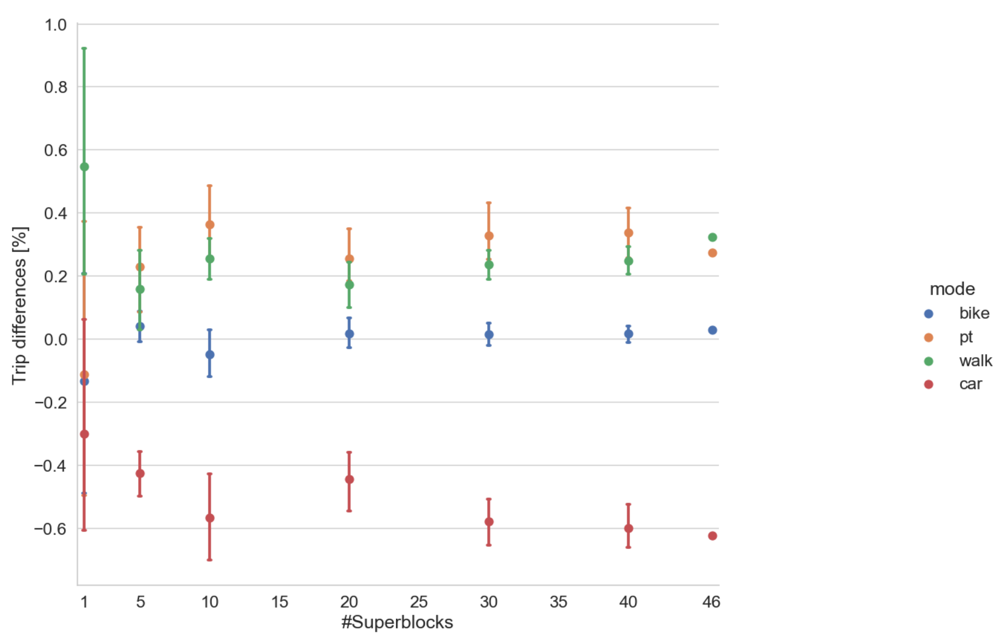


Table 3 Curve fitting results for a linear polynomial $a \cdot x + b$ for each mode.

mode	a	b	R^2
walk	5.5495	-6.5536	0.7513
bike	0.4908	-4.2591	0.0482
car	-13.3024	17.6134	0.8734
PT	7.2621	-6.8007	0.6803

that amount. Since the results are similar to those presented and differ only in the amount of trips affected, we continue our analysis with the data set containing only trips to and from the affected Superblocks.
In a second step, the results are used to estimate curves as a function of the number of Superblocks to describe how they depend on it. The modal splits of the 61 simulated scenarios serves as the input, while the target variable is the absolute difference in the number of trips compared to the baseline scenario. The curves are estimated separately for each mode by using the Levenberg-Marquardt algorithm in `scipy.optimize`. The results show that a linear function is sufficient to describe the relation between number of superblocks and changes in modal split. Therefore, only these results are shown in Table 3. The curve fitting and the corresponding parameters also allow a quantitative interpretation of the simulation results. With some caution, we can claim that the implementation of a Superblock in the real world will generate around 45 walk trips and 60 PT trips according to our model. The values result from the extrapolation factor 8 (since only a 12.5 % population is simulated) and the linear factors a from Table 3. In addition, it can be assumed with a greater certainty that the construction of one Superblock results in 100 fewer car trips to and from the Superblock.

Discussion

The decrease in car traffic seems to be quite low with about 0.6 % compared to the examples simulated and measured in Barcelona (-5 % change in modal split, relatively: -19.2 %) and Ghent (up to -20 % cars within a block), respectively. However, it must be taken into account that the result for Barcelona refers to an implementation of all possible Superblocks ($n = 503$) and no traffic modeling was done (*16*). The study using a macroscopic traffic model (*23*) showed significant reduction in NOx only when introducing further measures such as low emission zones and a reduced car demand. The numbers from Ghent (*17*) refer to traffic volumes and not modal split. A major reason for the differences between our results and the Ghent circulation plan is probably the size of the zones, which are much larger with an edge length of about 1 km than our simulated Superblocks with an edge length of around 200 to 700 m. Thus, the walking distances from the edge to a point inside the Superblock are quite short, and the small surplus of walking distance motivates quite few motorists to change.
Another limitation of our approach is the routing in the simulation. The routing framework used (*28*) prefers to route on primary and secondary roads if possible and can only insufficiently represent the phenomenon of shortcuts through residential areas that can be observed in everyday life. Thus, the effect of stopping the passage through Superblocks is not sufficiently evident in the scenarios.
Another point of discussion is the selection of the Superblocks. The selection of potential candidates has taken into account the extent to which a Superblock makes sense to be realized in practice. However, selection criteria such as high population density and good accessibility to public transit are probably responsible for the fact that the Superblocks are only simulated in areas where there is a high affinity to alternatives to the car anyway. As a result, it is likely that the desired transfer effects away from the car are quite small. Future implementations of Superblocks should therefore focus on representing the entire potential of Superblock by also integrating those candidates in peripheral urban areas with a high proportion of car drivers.
The analysis of the scenarios can also be extended to the analysis of the road network. Here, it is particu-

larly important to look at the changed traffic volumes on the links adjacent to the Superblock. In discussions with the public, the additional car traffic load is often used as a counter-argument to Superblocks, with the reasoning that traffic is only shifted, but not avoided. An analysis of this effect can shed light on this point. In addition, increase in travel times and traffic volume changes on the entire network of primary roads and secondary roads should be evaluated to identify possible backlogs.

Conclusion

In this paper, we discuss the effects on modal splits when upscaling the Superblock concept. For a case study in Vienna, Superblocks are implemented in an agent-based traffic simulation by cutting off the network for cars in the affected areas while allowing other modes to continue to pass through. The proposed Superblock candidates are based on the blocks formed by the above-ground public transport lines. A total of 61 scenarios simulate various Superblock configurations and the number of Superblocks. The differences in trips of each mode compared to the baseline scenario are evaluated and a curve fitting is performed.

The results show a linear trend between the number of simulated Superblocks and mode shifts for car, walking, and public transit, while bicycle trips cannot be estimated sufficiently well due to the high standard deviation in the modal splits. Car trips decrease by about 100 trips per Superblock when trips that begin and end in the Superblocks are considered. They are largely substituted by walking and public transit trips.

Further research is needed to evaluate traffic volumes on arterial streets around the Superblocks and potential backlogs caused by restricting car traffic in the Superblocks. It is also of interest to see how Superblocks in peripheral areas of the city affect the modal split.

Acknowledgements

We acknowledge the work of our partners in the TuneOurBlock project, whose literature review and definition of the Superblock concept are a basis for the content of this article. We also acknowledge financial support for this article from FFG (Austrian Research Promotion Agency) that funded our work as part of the JPI ERANET ENUAC project *TuneOurBlock*, project no 884273.

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