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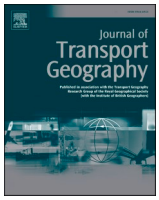

How experiments with superblocks in Vienna shape climate and health outcomes and interact with the urban planning regime

Anna-Katharina Brenner [a,d,*], Willi Haas [a], Christian Rudloff [b], Florian Lorenz [c], Georg Wieser [c], Helmut Haberl [a], Dominik Wiedenhofer [a], Melanie Pichler [a]

[a] Institute of Social Ecology, University of Natural Resources and Life Sciences, Vienna, Austria
[b] Austrian Institute of Technology GmbH, Vienna, Austria
[c] LAUT - Landscape Architecture and Urban Transformation, Thurngasse 10/5, 1090, Vienna, Austria
[d] Leibniz Institute of Ecological Urban and Regional Development, Dresden, Germany

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ABSTRACT

Superblocks are traffic-calmed neighborhoods that contribute to climate change mitigation and improve living and health conditions of inhabitants without requiring extensive reconstructions. This article investigates experiments with superblocks in Vienna (Austria) from initial discussion to the first experimental implementation. We use an integrated mixed-method approach: First, we examined potential climate and health benefits of three hypothetical superblock sites through transport modeling. We then conducted stakeholder interviews at two points of time to investigate the perceived acceptance of superblocks and to examine how superblock experiments align with the conventional planning regime, thereby focusing on actor's composition, dominant discourses, and mode of governance. The modeling results suggest that reductions in greenhouse gas emissions and public health benefits are 2–3 times higher when superblocks are implemented in more deprived compared to more affluent urban areas. In the course of implementing the first superblock experiment in Vienna, the discursive reframing of superblocks as a redistributive intervention, which we could trace through the interviews, resulted in implementing the pilot project in a district with the most beneficial sustainability outcomes.

1. Introduction

Car-bound mobility is one of the main drivers of greenhouse gas emissions in cities (European Court of Auditors, 2020) and has detrimental effects on public health through air pollution exposure and lack of physical exercise (Wolkinger et al., 2018). These effects are not equally distributed among urban populations, with low-income and minority communities bearing a greater burden than their more affluent counterparts (European Environment Agency, 2018). Despite the presence of well-established public transport systems, many cities struggle to reduce car use (European Court of Auditors, 2020). Current institutional structures tend to support car-bound mobility in cities (Marsden and Groer, 2016), with conventional urban planning regimes (Healey, 2007, 2018) favoring the provision and maintenance of streets and parking spaces. Deeply rooted beliefs that streets are exclusively intended to be used by cars, as well as the absence of more comprehensive approaches to transform car-bound mobility infrastructure, hinder low-emission alternatives such as walking and cycling, as well as the use of urban space for leisure activities (Brovarone et al., 2023). To effectively reduce greenhouse gas emissions and improve public health, a transformation of car-bound mobility infrastructure is necessary (Creutzig et al., 2016a, 2016b; Wiedenhofer et al., 2018), requiring changes within the urban planning regime.

In both research and practice, experiments have gained considerable momentum as an option for reducing energy use and emissions (Castán Broto and Bulkeley, 2013; Karvonen, 2018), among others due to their potential to help transforming urban planning regimes (Sharp and Raven, 2021). Of these experiments, superblocks have emerged as a potentially interesting response for overcoming persistent car-bound mobility in cities (Rueda, 2019). The urban planning intervention integrates several housing blocks into a single superblock, transforming the area into a compact and connected neighborhood (Mueller et al., 2020). To achieve this, the interior roads in this area are pacified by closing off street junctions and implementing a one-way system. This strategy effectively curbs through traffic while still allowing access for motorized deliveries and pickups. The superblock is bordered by the

* Corresponding author.
E-mail address: a.brenner@ioer.de (A.-K. Brenner).

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basic road network, and public transport stops are within walking distance, ensuring connectivity with other urban areas. Moreover, surface parking within the superblock can be reduced, thus providing an opportunity to reclaim space from car-use. This repurposed space can then be dedicated to pedestrian walkways, cycling paths, leisure areas as well as green spaces and recreational facilities, fostering new opportunities for community interaction and engagement (Rueda, 2019). Design measures may initially involve temporary interventions, such as the use of trees in movable tubs, street furniture, and painted road markings. These can serve as experimental elements to test and explore different uses of the street space before implementing more permanent alterations (Amati et al., 2023). Experiments with superblocks have gained prominence in cities all over Europe, in particular in the Spanish city of Barcelona (Barcelona City Council, 2014; Frey et al., 2020; Joensuu et al., 2019; Lluis and Graziano, 2021; López et al., 2020; Zografos et al., 2020).

Recent studies have modeled the potential shift from car-bound towards active forms of mobility, along with the possible reduction in greenhouse gas emissions and the potential improvements in public health. These studies suggest a positive influence on climate and health outcomes through the implementation of a city-wide superblock strategy (Mueller et al., 2020; Benavides et al., 2022). However, these modeling exercises lack spatially resolved details regarding the expected climate and health benefits of individual superblock implementations. This is a challenge because the implementation of superblocks is a contentious issue (Zografos et al., 2020) and the process of bringing the modeled climate and health benefits into practice progresses at a very slow pace (Benavides et al., 2022). Insights on spatially specific benefits may affect decision-making processes, particularly when it comes to the distributional effects on different social groups.

Whether experiments with superblocks can realize potential climate and health benefits, however, depends on decisions and changes in the urban planning regime (Sharp and Raven, 2021). To reduce greenhouse gas emissions and improve public health, the selection of superblock projects, thus, needs to rest upon detailed assessments of potential changes in mode choice behavior under consideration of local socio-spatial characteristics and perceived acceptance of superblock implementation. This requires to analyze actors, coalitions, discourses, and institutional processes that support or hinder the implementation of superblocks. Progress in understanding the effectiveness of superblocks to help improving livelihoods and health, and to reduce traffic-related greenhouse gas emissions, hinges upon understanding both, the potential effects of superblocks on mode choice and the transport system and their potential role in cities' urban planning regimes. This calls for an interdisciplinary analysis of both the expected sustainability outcomes in different local contexts as well as the interaction with the urban planning regime, that is, the governance processes that drive these decisions.

In this article, we analyze superblock experiments in Vienna (Austria) from initial discussions starting in 2019 to the first experimental implementation via a pilot project in 2022, which was still ongoing at the time of submission of this article. We model potential sustainability outcomes (i.e., climate and health benefits)[1] in three districts and carve out the perceptions of key actors at the time the intervention started to gain prominence in the city. After the decision to implement the first superblock pilot project in one of these districts, we further examined how this implementation critically interacts with the conventional urban planning regime. More specifically, we address the following research questions:

- What are the expected sustainability outcomes of superblocks in different parts of Vienna?
- How do different actors perceive a possible introduction of superblocks in different districts in Vienna?
- What drives the implementation of a first superblock pilot-project in Vienna?

Rooted in neoinstitutional planning theory, we argue that experiments interact with the long-established planning objectives and routinized actions of the urban planning regime, which critically shape the implementation of the experiment.

2. An analytical perspective on the interaction of sustainability outcomes and the urban planning regime

Mobility infrastructures play a crucial role in achieving sustainability outcomes, including climate and health benefits. Studies on transportation have demonstrated that interventions in street space, such as limiting on-street parking, are among the most effective ways for reducing car-bound mobility in cities (Christiansen et al., 2017). Additionally, relocating essential services (e.g., grocery stores, public and educational facilities) and workspaces closer to residential buildings can decrease travel distance (Delso et al., 2018). A reduction of car-bound mobility and travel distances can lead to a decrease in energy use and greenhouse gas emissions, thus, providing essential climate benefits. Moreover, an increase in walking and cycling can provide physical exercise for urban populations that often lacks daily exercise (Wolkinger et al., 2018), contributing to health benefits.

Our analytical lens is informed by social ecology, a research field concerned with the reduction of societies' impacts on the environment while promoting well-being for all (Haberl et al., 2016). Socioecological research has recently begun to focus on the role of material stocks in driving excessive resource use (Haberl et al., 2017). Long-lasting physical structures such as mobility infrastructures as well as buildings and other durable goods are prominent examples for these material stocks. Material stocks drive resource use patterns (e.g., streets and parking spaces induce emissions from car-use, urban sprawl induces emissions from commuting) and therefore play a crucial role in shaping sustainability outcomes. As such, this perspective also prompts us to analyze the formation of mobility infrastructures and how to reshape them to achieve intended sustainability outcomes.

We argue that the urban planning regime is decisive for understanding the evolution as well as potential changes in mobility infrastructures. The literature indicates that changes in the material infrastructure can evolve via new modes of governance (e.g., experiments) (Bulkeley, 2019; Karvonen, 2018). Research has shown that experiments often take place at the fringes of the conventional urban planning regime (Karvonen et al., 2014). Based on neoinstitutional planning theory, particularly on sociological institutionalism (Giddens, 1984; Healey, 2007, 2018), we define the urban planning regime as the formal and informal rules and routinized actions that provide the context in which experiments are taking place. Expected sustainability outcomes and perceived acceptance can affect the governance processes, including identifying who benefits the most from potential improvements and where decision-makers can expect the least resistance. Thus, the urban planning regime can either constrain or enable ways of acting, including modes of governance, that critically shape the implementation of experiments. The urban planning regime comprises a range of actors like urban governments, planners/administration, representatives of business and labor interests, local associations, civil society initiatives as well as residents who influence and are themselves influenced by the regime. In this regard, governance comprises the mechanisms (e.g., arenas for interaction, interactive practices, and governance modes) required for shaping collective actions in the urban planning regime.

For a systematic analysis of the interaction between the superblock experiment and the urban planning regime, we develop the following

[1] We are aware that superblocks might also stimulate other sustainability outcomes like increases in urban green space, which are beyond the scope of this article.

dimensions (see Table 1): *Key actors*, their positions and interests as well as *networks and coalitions* influence who gets involved in the experiment in the first place. The *dominant discourses* shape what project ideas come forward and how they are framed. *Stakeholder selection processes* define who else is included in the experiment next to the key players. *Arenas for interaction* and *interactive routines* shape how the interaction between key actors and stakeholders is organized. And finally, the (dominant) *mode (s) of governance* shape how experiments are enacted (e.g., top-down, bottom-up) (see also Healey, 2007).

3. Methods

To model the potential climate and health benefits of superblocks in Vienna and to grasp the interactions of the experiment with the urban planning regime, we apply an integrated mixed-method approach (Schoonenboom and Johnson, 2017). We combine (1) quantitative transport modeling and health assessments to identify potential sustainability outcomes with (2) qualitative stakeholder interviews at two points in time: during initial discussions and during the preparation of the first superblock pilot project implementation. We started with the quantitative modeling of climate and health benefits and integrated the results into the interview guidelines to get a better understanding of the influence of expected sustainability outcomes for the implementation of the superblock experiment.

3.1. Transport modeling and potential climate outcomes

The goal of the transport modeling was to estimate how superblocks could affect mobility behavior and travel distances of the inhabitants in three districts in Vienna. We used the three hypothetical superblock study sites located in the 7th, 10th, and 17th districts that had been identified in the scoping project SUPERBE (Frey et al., 2020).

As no direct observational data is available, we used data from the representative large-scale Austrian mobility survey "Österreich Unterwegs" (OEU) (Tomschy et al., 2016). We adopted a Latent Class Model (LCM) (see Greene and Hensher, 2003 for a detailed review of LCM) that was estimated based on data collected in a Mobility-Activity-Expenditure Diary described in Hössinger et al. (2020) to predict the mode choice behavior of people traveling in and out of the potential superblock study sites.

The Latent Class model has two parts providing the foundation of the analysis described in detail in the supplementary material (SI). The logit models for the class membership uses utilities based on the binary socio-demographic variables sex z_{sex}, age below 35 z_{u35}, age above 55 z_{o55}, income higher than median z_{ih}, education high-school or above z_{eh}, living in urban area z_{urb}, kids living in the household z_{kids}, single household $z_{single}$and full time work with at least 38 h a week z_{ft}.

The utility for class membership of class 1 is fixed at 1 to make the model identifiable. The utility for user I to belong to class 2 is given as:

$$U_{i2} = \theta_2 + \sum_{v \in V} \theta_v z_v$$

where θ_v are the parameters belonging to the variables described above.

The second part of the latent class model are the class specific mode choice models. The corresponding utilities are given as.

$$U^q_{foot} = \beta^q_{tt_{foot}} tt_{foot},$$

$$U^q_{bike} = asc^q_{bike} + \beta^q_{tt_{bike}} tt_{bike},$$

$$U^q_{car} = asc^q_{car} + \beta^q_{tt_{car}} tt_{car} + \beta^q_{cost} x_{cost_{car}} + \beta^q_{P_{job}} x_{P_{job}} + \beta^q_{tt_{foot}} tt_{acc_{car}},$$

$$U^q_{PT} = asc^q_{PT} + \beta^q_{tt_{car}} tt_{car} + \beta^q_{cost} x_{cost_{pt}} + \beta^q_{transfer} x_{transfer} + \beta^q_{tt_{foot}} tt_{acc_{pt}},$$

where asc_m is the alternative specific constant for mode m, tt_m the travel times for mode m and tt_{acc_m} the walking access times for mode m, $x_{cost_m}$the costs of mode m, $x_{transfer}$ the number of transfers in the pt. journey and $x_{P_{job}}$ the availability of a parking space at work. There are two parameter sets for the two for the classes q = 1, 2. The parameters can be seen in Table 2.

We expect that parking space reduction significantly influences mode choice behavior. Thus, we focused our analysis of modeled sustainability outcomes on the scenario in which surface parking is reduced more drastically within the superblock. To this end, we added a walking stretch of five minutes to each car journey of the OEU data, changing the LCM for car routes. Finally, we used the modeled car km/cap/day to calculate changes in cumulative final energy and CO_{2equ} emissions per year. More information about the interim results and methodology can be found in the supplementary information (SI).

3.2. Potential health outcomes

We estimated how the reduction in car-bound mobility affects public health through its possible effect on increased activity levels. The health assessment focused exclusively on increased physical exercise, as reduced car use in one superblock has only a moderate impact on air pollution, which is also caused by various sources and – with regards to cars – mainly stems from the main traffic routes (Bachler et al., 2016). Thus, we assessed potential changes in mortality due to increased activity levels (Δ min/person/week). The transport modeling provided a

Table 1
Dimensions of the urban planning regime that critically interact with experiments. Own table adopted from Healey (2007).

Dimensions	The urban planning regime interacts with experiments through the following dimensions:	The urban planning regime may be transformed through:
Key Actors	Positions, roles, strategies, interests of key players (Healey, 2007) (e.g., city, district politicians, administration, representatives of civil society)	… the interplay of interactions leading to an agreement to implement an experiment (Bulkeley, 2019).
Networks and Coalitions	Ordinary allies (Healey, 2007) (e.g., party networks, government coalitions, representatives of business/labor interests)	
Dominant Discourses	Framing issues, problems, solutions, interests (e.g., greenhouse gas emissions reduction targets vs. not reducing car-bound mobility to strictly) (Healey, 2007)	
Stakeholder Selection Processes	Collaborations (Healey, 2007) (e.g., established governance elites, civil society initiatives, local renewal office, Agenda 21)	
Arenas for Interaction	The institutional 'sites' (e.g., council meetings) (Healey, 2007)	… new forms of collaboration between local authorities and civil society (Sharp and Raven, 2021).
Interactive Routines	Communicative repertoires (e.g., meetings behind closed doors, structured by agendas defined by the powerful actors) (Healey, 2007)	
Mode(s) of Governance	Planning routines, the repertoire for acting (e.g., top-down/bottom-up) (Healey, 2007)	

Table 2
Parameter values of the Latent Class Model used in the analysis. The values show the parameter values and the t-values in brackets. Bold values are significantly different to 0 at a 10% significance level.

Parameters Mode Choice				Class 1	Class 2	Parameters Class Membership Class 2	Parameter Values
				Parameter Values			
asc^{q}_{bike}	−1.69 (−14.63)		−2,85 (−6,38)	θ_2		1.49 (5.95)	
asc^{q}_{car}	−1.38 (−12.40)		0.03 (0.28)	θ_{sex}		0.65 (2.88)	
asc^{q}_{PT}	−1.11 (−8.44)		−1.28 (−9.73)	θ_{u35}		−0.28 (0.27)	
$\beta^{q}_{tt_{foot}}$	−11.35 (−24.90)		−7,66 (−23.96)	θ_{a55}		0.05 (0.87)	
$\beta^{q}_{tt_{bike}}$	−5.14 (−19,41)		−13.64 (−6.08)	θ_{ih}		0.03 (0.14)	
$\beta^{q}_{tt_{car}}$	−7.04 (−10.04)	−6.21 (−11.17)	θ_{eh}	−0.63 (−3.08)			
$\beta^{q}_{tt_{PT}}$	−2.12 (−5.66)	−4.15 (−10.94)	θ_{kids}	−0.002(−0.009)			
$\beta^{q}_{p_{job}}$	0.31 (3.41)	1.21 (12.43)	θ_{single}	−0.57 (−1.71)			
$\beta^{q}_{transfer}$	−0.50 (−5,08)	0.74 (7.80)	θ_{urb}	−1.18 (−5.43)			
β^{q}_{cost}				−0.64 (−14,62)	−0.59 (−18,12)	θ_{ft}	−0.49 (−2.03)

new modal split that was used to estimate the additional physical activity in minutes compared to the baseline. Thus, additional distances walked or cycled were used to calculate minutes of physical activity over average travel speed. The increased walking time to parking spaces for each car trip was also considered. The total increase in weekly physical exercise per average person was used to calculate a hazard ratio for each scenario and each superblock area based on a time-mortality function derived from a meta-analysis (Arem et al., 2015). This hazard ratio was then applied to the annual mortality of the residents in superblock areas estimated using Vienna's mortality rates (Statistik Austria, 2020). The result is then the change in mortality expressed as a percentage and as reduced mortality per 100.000 inhabitants.

3.3. Stakeholder interviews

We conducted stakeholder interviews at two points in time. First, prior to the implementation of the pilot project (November 2020 to January 2021). At that time, politicians, planners, and civil society increasingly discussed superblocks. In these interviews, we focused on the perceived acceptance of superblocks in the three hypothetical study sites developed by SUPERBE (Frey et al., 2020) for which we had applied the transport model (i.e., in the 7th, 10th, and 17th districts). We presented the potential climate and health benefits to the stakeholders because we wanted to know to what extent these would be considered when deciding where to implement a first superblock pilot project. Second, during the preparation of the first superblock pilot project implementation in the 10th district (January to February 2022), we were interested in how the conventional urban planning regime, that is, the actors' composition, dominant discourses, and routinized modes of governance, shapes the eventual implementation of the superblock experiment. We triangulated the stakeholder interviews with document analysis, mainly analyzing urban planning documents (e.g., urban development plans, city-coalition agreements, statistical yearbook of the city) to contextualize the findings of the interviews.

We conducted 15 interviews with representatives of the city council, the three district councils of the potential superblock study areas, representatives of administration, Vienna's smart city agency, the Chamber of Labor, the Chamber of Commerce, and the civil society initiative Platz für Wien (*Space for Vienna*). For the first phase, we developed a semi-structured interview guideline that addressed questions concerning the perceptions and acceptance of the stakeholders on implementing superblocks in the hypothetical study sites. In the second phase, questions addressed changes and stability of the discourse, key actors, networks, and coalitions that influenced actors' positions and interests, the effectiveness of planning routines as well as the influence of sustainability outcomes on the implementation of the superblock experiment.

After the transcription of the interviews, we conducted a thematic coding analysis using both inductive and deductive coding. We coded for changes and enduement in involved actors' composition, arenas for interactions, coalition building, networking, discourses, modes of governance, and sustainability outcomes. Interview transcription and data coding were supported by MAXQDA. Direct quotations for the article were translated into English because all interviews were conducted in German.

4. Experiments with superblocks in Vienna

In 2018, the research project SUPERBE was initiated, bringing together researchers and practitioners from the Technical University of Vienna, the Austrian Institute of Technology, and independent landscape planners to explore the potential application of superblocks in Austrian cities (Frey et al., 2020). In Vienna, SUPERBE concentrated on the potential application of three superblocks which were selected for their variations in size, green spaces, and centrality within the city. Fig. 1 shows the three superblock study sites in Vienna in more detail. The publication of the SUPERBE project results, coupled with a series of workshops in 2019, propelled the concept of superblocks and their potential application in Vienna to the forefront of discussions among urban politicians, planners, and civil society. Between 2021 and 2022, the government of Vienna decided to implement the first superblock pilot project in the 10th district.

The pilot project involves two phases: the first phase aims to test and explore different uses of the street space through temporary interventions, and the second phase focuses on transforming the tested measures into permanent alterations.

In the following paragraphs, we first delve into the potential climate and health benefits and perceived acceptance associated with superblocks in Vienna, using the three study sites identified in the SUPERBE research project. Understanding these benefits and perceived acceptance is crucial, as it can significantly influence the choice of location for superblock implementation and the primary beneficiaries of these outcomes. Next, we elaborate on Vienna's conventional urban planning regime—the formal and informal rules and routinized actions—that form the context for experiments with superblocks in Vienna. We then expand upon how the superblock experiment, including the distribution of potential benefits among the study sites and perceived acceptance, interacts with the conventional urban planning regime which in turn influences the selection process for the first superblock pilot project in Vienna.

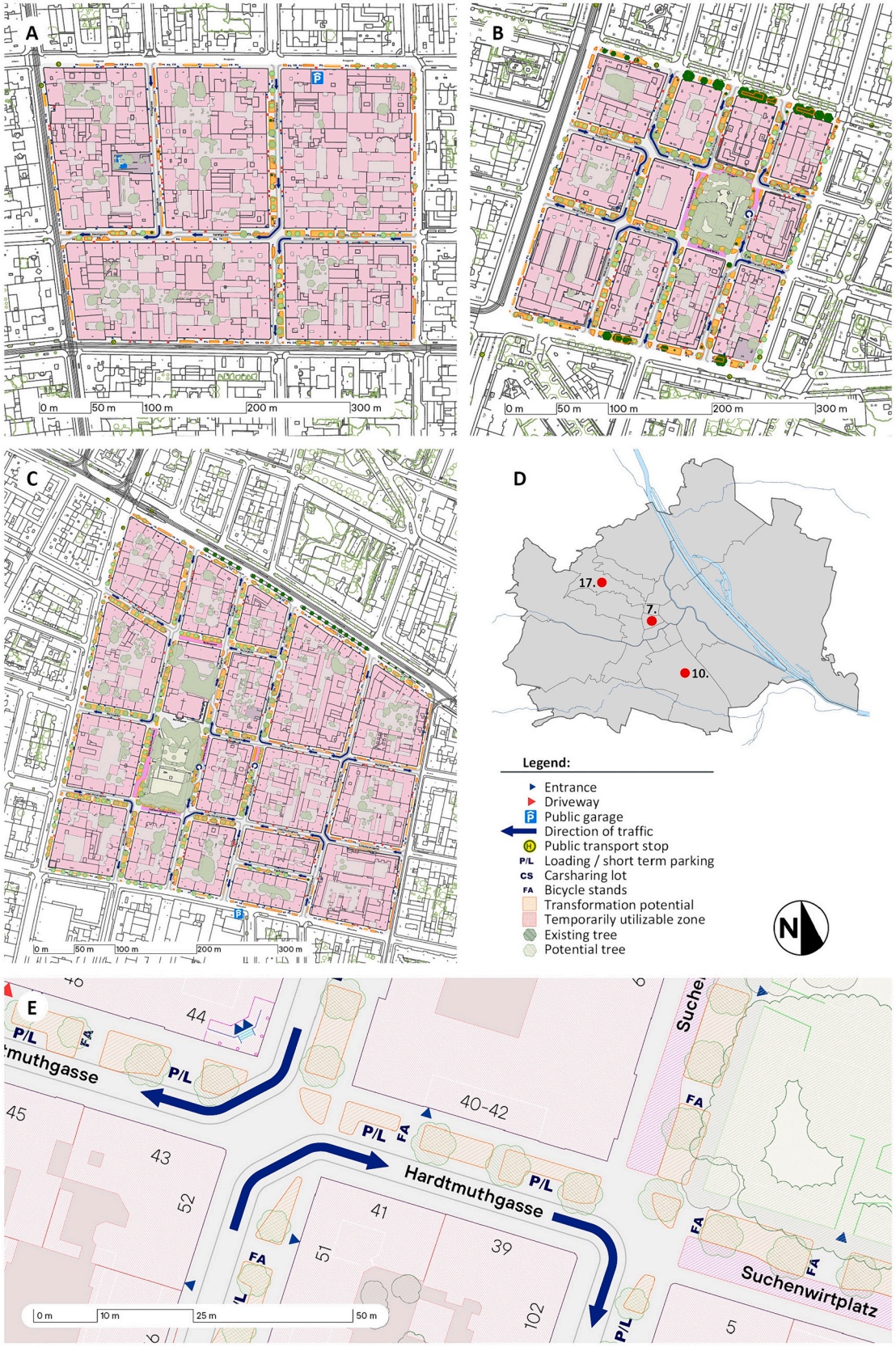

Fig. 1. Three potential superblock study sites in Vienna in A) the 7th district B) the 10th district and C) the 17th district. D) shows the city of Vienna and locations of potential superblocks. E) zooms into one of the superblocks, illustrating potential changes to traffic organization, allocation of street spaces, and potential tree sites (results by SUPERBE).

5. Potential climate and health benefits and perceived acceptance in three hypothetical superblock study sites

In this section, we introduce the potential climate and health benefits associated with superblocks as well as the perceived acceptance of the urban planning intervention in Vienna. These factors can play a significant role in determining the choice of locations for superblock implementation and identifying the primary beneficiaries of the outcomes.

Results from transport modeling show that expected changes in mobility patterns differ due to varying modal split baselines in the three superblock study areas. These differences reflect energy consumption, emissions, and health impacts. Fig. 2 shows the modal split (in % of traveled kilometers) for each scenario and potential superblock study site in the different districts. In all three locations, public transport holds a large share in total traveled kilometers even under baseline conditions. This is particularly pronounced in the 7th district, with 90% of all kilometers traveled by public transport. The dominance of public transport, among other things, is attributed to the compact urban form and the central location (District representatives, December 2020, January 2021). Comparing the modal split baselines shows that in the 17th district, the highest share of kilometers is traveled by car (44%), closely followed by the 10th (41%). The 7th district shows only very low shares of car use (4%). Table 2 gives an overview of socio-spatial characteristics for each district and the expected sustainability outcomes for each superblock study site.

5.1. Potential benefits and acceptance in the 7th district

The first hypothetical superblock study area is located in the 7th district (Neubau) (Fig. 1c). The district is near Vienna's center, densely built and populated, relatively small (161 ha), and has few green spaces. It accommodates a relatively small number of people, of which 64% are born in a foreign country, 18% of them in non-EU countries.

Given average incomes there, Vienna's 7th district appears as an (upper-)middle-class area where residents are perceived to be more urban. Residents own fewer cars than in other districts and are more likely to use active forms of mobility (see Fig. 2). For some time now, the district has increased efforts in limiting on-street parking to redistribute space to walking and cycling as well as places to linger (7th district representative, December 2020). Indeed, district politicians and residents are perceived to be open and engaged in implementing experimental urban planning interventions in response to the climate crisis (District representative from another district, December 2021, Smart City representative, December 2020).

Looking at the expected climate and health benefits, our model results shows that there is an energy and greenhouse gas emissions reduction potential of 50%. This results from reducing per capita kilometers traveled by car from 4% to 2% of all traveled kilometers and corresponds to an annual energy saving of −101 MJ/cap/year. It reduces transport-related CO_{2equ} emissions from 17 to 8 kg/cap/year, which are both very low values compared to the Vienna average of 1800 kg/cap/year, due to the already small share of car-based mobility in the baseline. Mortality is reduced to under 1% which corresponds to reduced mortality due to increased activity levels by 7 per 100,000 people.

5.2. Potential benefits and acceptance in the 10th district

The second hypothetical superblock is located in Vienna's 10th district (Favoriten) (Fig. 1d). It is an outlying district with the highest share of residents (207,193 residents) in Vienna and a relatively vast area of 3180 ha. It can be characterized as a working-class neighborhood, where residents have a low average income by district standards and are more likely to work in precarious jobs. 57% of the residents are born in foreign countries, of which 30% are born in non-EU countries (see Table 1). The car ownership rate is only slightly higher than in the 7th district and lower than Vienna's average, nevertheless, the 10th district has a car-dependent reputation (District representatives, January 2021, January 2021, Representative of Vienna's Chamber of Labor or, December 2020) which is also reflected in the transport modeling outcomes (see Fig. 2).

The interviews show that the implementation of local interventions to enhance the public area and limit car-occupied space has slowly entered the district's agenda (District representative, January 2021, Smart city representative 2020). Even though superblocks were viewed with great interest, at the beginning of 2021, its implementation in the 10th district, however, was perceived as unrealistic (District representative, January 2021). The public acceptance of realizing such an intervention was perceived to be divided between those welcoming and also demanding greener living environments and those who vigorously reject any restrictions in their car mobility (District representative, January 2021).

Results of the transport model show that superblocks are expected to

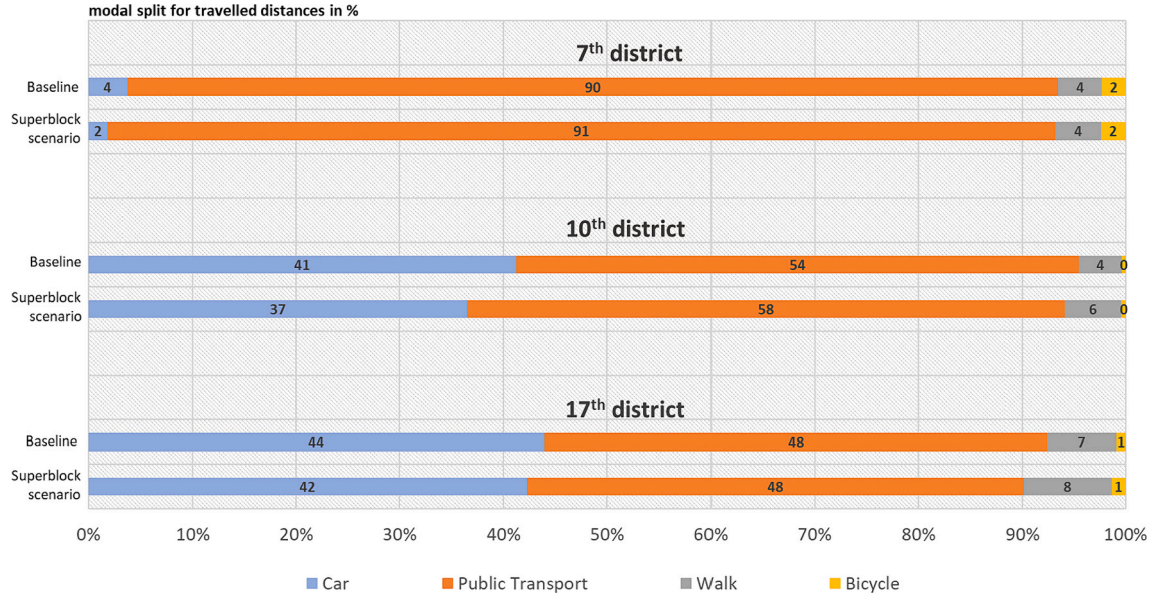

Fig. 2. Potential changes in mode choice behavior: Graph of baseline compared to superblock scenario for three districts in Vienna (in % of traveled kilometers).

decrease traveled car kilometers by about 5% points. This corresponds to an energy-saving of −286 MJ/cap/year, and a reduction of transport-related CO_{2equ} emissions from 179 to 159 kg/cap/year. The calculations of the health assessment show that the shift from car use to more active modes of mobility in the 10th district can reduce the number of premature deaths by 24 per year per 100,000 inhabitants. This indicates that expected sustainability outcomes are higher in the 10th district than in the 7th district resulting from higher shares of car use in the baseline.

5.3. Potential benefits and acceptance in the 17th district

The third superblock study site is located in the 17th district (Hernals) (Fig. 1e). The former industrial area lost most of its working-class characteristics and is today a middle-class residential district. The district spans 1135 ha and accommodates 57,027 people, of which 61% had been born in a foreign country (24% of them in a non-EU country). The district has a high share of urban green space. Compared to the other districts, the car ownership rate is the highest (see Table 1) and high shares of traveled kilometers are covered by cars (see Fig. 2).

The interviews show that maintaining unrestricted car use has quite a high priority on the political agenda (District representatives, December 2020). Simultaneously, greening measures and the enhancement of publicly accessible spaces gained prominence among both politicians and residents. The acceptance of parking space reduction in this regard is, however, perceived to be mixed, high among some groups, low among others (District representatives, December 2020). Moreover, some interviewees argued that the proposed changes to traffic organization, allocation of street spaces, and potential morphological changes in the 17th district superblock application area (see Fig. 1e) would be too vast and, therefore unfeasible (District representatives, December 2020).

The results of the transport modeling show that the sustainability outcomes are least pronounced in the 17th district. The superblock scenario potentially reduces car-bound mobility by about −2% points which correspond to an energy-saving of 53 MJ/cap/year and a CO_{2equ} emission saving in kg of 3% per cap. However, the health assessment outcomes show that the shift from car use to more active modes of mobility in the 17th district can reduce the highest shares of premature deaths (25 premature deaths per 100,000 annually).

6. The conventional urban planning regime in Vienna

In this section we introduce Vienna's conventional urban planning regime along the dimensions identified in Table 1. We focus on the key actors and coalitions, dominant discourses, and governance modes as well as dominant arenas for interaction and interactive practices and how this has shaped experiments targeting the reduction of car-bound mobility so far.

6.1. Involved actors' composition

Vienna is characterized by a high state-led planning capacity (Kazepov and Verwiebe, 2021). The Social Democrats have effectively maintained political control in Vienna for more than 100 years (except during the Nazi regime) with a focus on redistributive policies, especially with social housing and the public provision of key basic services (Kazepov and Verwiebe, 2021). With regard to transport politics, the interest to develop and maintain the spatially dense, high-frequency public transport network is of utmost importance (Smart city representative, November 2020, District representative, January 2021, former Social Democratic city council representative January 2021). Indeed, high shares of everyday mobility are already covered by public transport (City of Vienna, 2021). Over time, the actor's composition in the urban planning regime diversified mainly through the rise of smaller parties. Raising public awareness about environmental issues and the climate crisis gradually increased voters' support for the Green Party (especially since 2015) which has been a coalition partner in the city government between 2010 and 2020. During this time, the Greens provided the vice-mayor and the city councilor in charge of urban mobility. Next to the expansion and promotion of public transport, the Greens vigorously pushed for vast improvements in cycling infrastructure, car-free zones, shared streets, on-street parking management, and an opposition to the construction of new urban highways (Buehler et al., 2016). At the same time, the Austrian right-wing Freedom Party (FPÖ) gained considerable electoral support in the municipal elections in 2015. The party has a tradition of vigorously promoting car-bound policies and infrastructures in the city.

Table 3
Socio-spatial characteristics and potential sustainability outcomes for hypothetical superblocks in three districts of Vienna. Source: Municipal Department of Economic Affairs, Labor, and Statistics (2019) and own calculations, see SI for more information.

	7th district	10th district	17th district
Socio-spatial Characteristics			
Urban milieu	(upper)-creative middle class	Working-class district	Middle-class residential area
population	31.961	207.193	57.027
Average annual gross income	37,403€	27,246€	32,378€
Share of residents that are born in a foreign country	Total: 64%,N on-EU: 18%	Total:57%,N on-EU: 30%	Total: 61%N on-EU: 24%
Urban fabric	Centrally, densely built, and populated, small (161 ha), a small share of green space	Outlying, heterogenic, with densely built and populated areas, large (3.180 ha), a high share of green space	Outlying, heterogenic with densely built and populated areas, large (1.135 ha), a high share of green space
Car ownership rate	312 cars/ 1.000 pers.	335 cars/ 1.000 pers.	439 cars/ 1.000 pers.
Expected sustainability outcomes			
Potential energy consumption savings	101 MJ/cap/yr.	286 MJ/cap/yr.	53 MJ/cap/yr.
Potential CO_{2equ} savings	8 kg/cap/yr.	25 kg/cap/yr.	5 kg/cap/yr.
Reduced mortality per 100,000 persons	7	24	25

6.2. Dominant discourses

The city government has set ambitious targets for reducing local per capita greenhouse gas emissions in the transport sector by 50% by 2030 and by 100% by 2050 (City of Vienna, 2019). The dominant discourse to accomplish these targets is centered especially around a sufficient provision of public transport (Smart city representative, November 2020, District representative, January 2021, former Social Democratic city council representative January 2021). The reduction of car-bound mobility is not equally established in the discourse. Indeed, high shares of public space remain occupied by cars, which require substantial energy and material resources for vehicles and infrastructures and lead to high greenhouse gas emissions (Virág et al., 2021). However, the city government struggles with the transformation of the urban design, not internalizing this potential for sustainable mobility (Smart city representative, November 2020, Civil society initiative representative, January 2021, former Social Democratic city council representative, January 2021). Interviewees mentioned that some politicians either cannot imagine how urban life could look without the dominance of cars, or fear losing voters to the right-wing party when reducing car use too strictly (Civil society initiative representative, January 2021, former Social Democratic city council representative, January 2021).

6.3. Modes of governance

The interviewed stakeholders describe the dominant mode of governance as top-down and redistributive. The city provides basic services like waste and water management, public transport, or housing that are, in turn, largely accepted, appreciated, and also demanded by the population (former Green Party city council representative, January 2022, former Social Democratic city council representative, January 2021). When it comes to the reduction of car-bound mobility, the Social Democrats pursue a 'politics of small steps' mode of governance (Smart city representative, November 2020, District representative, January 2021), which is described in the literature as a long-term, multi-staged process, requiring compromise and political deals (Buehler et al., 2016). Interviewees and the literature refer to these arenas as politics behind 'closed doors', as political negotiations are rarely open to other actors before an internal consensus is reached (Buehler et al., 2016; former Social Democratic city council representative, January 2021, former Green Party city council representative, January 2022). Seeking internal consensus is generally accompanied by private consultations of all key stakeholders including, for example, representatives of commerce and labor interests, local groups, and representatives of the administration (Buehler et al., 2016). Thereby, the decentralized distribution of competencies and implementation budgets implies that the interaction between the districts and the city-level politicians is particularly important (for example Representative of Vienna's Chamber of Labor, December 2020; Vienna's Chamber of Commerce, December 2020, district representatives, December 2020, January 2021, January 2021).

With regard to the stakeholder selection process, the urban planning regime occasionally opens up to civil society and residents, often in a council meeting style, to discuss how many parking spaces can (or cannot) be converted to other uses (Civil society initiative representative, January 2021; Administrative representative, February 2022). This is a contested and highly emotional topic and triggers high-volume criticism by car lobbyists while other groups often remain silent (Civil Society initiative representatives January 2021, Green Party district representative, December 2020, Social Democratic district representative, December 2020, Administrative representative, December 2020). These experiences, have, however, strengthened the assumption that the public does not accept interventions to reduce car use (Representative of the Social Democrats, December 2020, January 2021; January 2021).

More recently, individual district representatives started to implement temporal interventions like pop-up bicycle lanes or a pop-up swimming pool at a highly frequented traffic juncture. These incentives, however, have been met with reservation by politicians and residents, fueled by negative articles in the tabloid media (Social Democratic and Green Party district representatives, December 2020, January 2021, January 2021).

Overall, the conventional urban planning regime does not offer ideal conditions for superblock experiments. Nevertheless, the redistributive mode of governance has shaped the implementation of the superblock experiment in a way that we further elaborate in the next section.

7. Interaction between Vienna's first superblock experiment and the urban planning regime

In this section, we explore the factors driving the implementation of Vienna's first superblock project by examining how the superblock experiment, including the distribution of potential benefits among the study sites and perceived acceptance, interacts with the conventional urban planning regime. We introduce our findings along the dimensions identified in Table 1, including shifts in the involved actors' composition and a reframing of the dominant superblock discourse towards a redistributive intervention.

7.1. Shifts in the involved actors' composition

The 2020 city elections caused changes in the composition of actors, including networks and coalitions shaping the interaction between superblock experiments and the urban planning regime (see Table 3). During the election campaign, pent-up frustration between the former coalition partners (Social Democrats & Green Party 2010–2020) broke out. With regard to the superblocks, the Green-led district Leopoldstadt (which was out of scope of our modeling efforts) pushed ahead and commissioned a first preparatory superblock study at the responsible municipal department in early 2020. The superblocks became a Green Party-framed intervention and influenced the political conflict between the Social Democrats and the Green Party (Administrative representative, December 2020). On the one hand, green Party members were increasingly frustrated about their lack of agency in relation to the perceived Social Democratic power apparatus (former Green Party city council representative, January 2022). For some members of the Social Democrats, on the other hand, the Greens and their struggle for agency became "unbearable" (former Social Democratic city council representative, January 2021). After the elections, the Social Democrats formed a coalition with the Liberals although the Green Party achieved its best-ever election result at the city level. In the district in which the first preparatory superblock study was commissioned, the Green Party lost its majority and, thus, access to the institutional sites to follow up on the implementation of the superblock. Indeed, there was no real interest of the new Social Democratic district representative to pursue a Green Party-framed project (former Green Party city council representative, February 2022). (See Table 4.)

At the municipal level, driven by the rise of the Fridays for Future movement and a public that was increasingly exerting pressure to react to the climate crisis, it became even more clear that "things in the city had to change" (Representative of the Social Democrats, February 2022). Furthermore, due to a range of scandals at the national level, the right-wing Party's influence in urban politics decreased due to dwindling electoral support. This opened a window of opportunity to implement bolder experiments to reduce car use (former Representative of the Social Democrats, January 2021), but with a Social Democratic 'handwriting'. At the end of 2020, the new coalition thus agreed to implement so-called 'Supergrätzl' (*Grätzl* is the colloquial Viennese term for neighborhood) in the vicinity of educational facilities throughout the city.

Drawing on the Social Democratic party network, negotiations about who would be willing to implement the first Supergrätzl pilot project started. In the past, the right-wing party had achieved particularly high electoral results in some of the high population districts. In response, a

Table 4
The conventional urban planning regime, its interaction with the superblock experiment, and changes that might become transformative in the future. Own table adopted from Healey (2007).

	Conventional urban planning regime	The urban planning regime interacts with experiment through the following dimensions:	The urban planning regime may be transformed through:
Key Actors	• Green Party challenge their coalition partner (the Social Democrats) with novel interventions for reducing car-bound mobility in the city	• New major (2018) who promotes the implementation of urban planning projects, especially in the outlying districts • Social Democrats regain control of traffic politics after Green Party is excluded from city government (2020)	… an agreement to implement a first superblock experiment in the 10th district
Networks and Coalition	• City coalition between Social Democrats and Green Party (2010−2020) • Right wing party gains strength in the city election (2015), particular in outlying districts	• Social Democrats form a new city coalition with the Liberals • New focus of city government to support outlying district representatives	
Dominant Discourses	• Ambitious greenhouse gas emissions emission reduction targets • Develop and maintain public transport	• The city government reframes superblocks as redistributive intervention that aligns to a ´politic of small steps´	… superblocks becoming part of the urban discourse
Stakeholder Selection Process	• Private consultation of key stakeholders	• Private and public consultation of key stakeholders	
Arenas for Interaction	• Exchange with civil society via council style meetings		… street lab as exchange platform between urban authorities and civil society
Interactive Routines	• Decisions are made ´behind closed door´	• Decisions about superblock site, traffic relocation and parking space reduction are made ´behind closed door´	
Mode(s) of Governance	• Top-down and redistributive concerning basic services • Politics of small steps • Reluctant to experiment in the mobility sector	• Approaching traffic rerouting and removing parking spaces via a top-down governance approach	… approaching civil society involvement via an experimental governance approach ("agile mode of governance")

new Social Democratic mayor was elected in 2018 because he put emphasis on local redistribution and promised to promote future urban planning projects, especially in these districts (former Representative of the Social Democrats, January 2021). Accordingly, respective city government representatives selected only well-known and trusted district representatives as well as administrative subject experts to discuss the first *Supergrätzl* site selection "behind closed doors" (Social Democratic Representatives, January 2021, February 2022). The Social Democrats have thus strived to regain control over traffic politics after the Green Party was excluded from city government. By the turn of the year 2022, the government of Vienna agreed to implement the first *Supergrätzl* pilot project in the 10th district.

7.2. Reframing the dominant superblock discourse

By the end of 2020 and the beginning of 2021, the interviewed district representatives, administrative representatives, and representatives of civil society valued superblocks positively. Superblocks interlink with already pursued greenhouse gas emissions reduction strategies like a 'city of short distance' and with public transport as the preferred mode of mobility covering trips throughout the city (political representatives, administrative representatives, and civil society representatives from November 2020 to January 2021, January–February 2022). Business representatives, commonly known for being critical of reducing car mobility in the city, highlighted the benefits of increasing customer fluctuation and stimulating local business (Representative of Vienna's Chamber of Commerce, December 2020). Furthermore, superblocks were seen to contribute to the extension of consumption-free public spaces, thus distributing access to public space more fairly in the city (Representative of Vienna's Chamber of Labor, December 2020).

After the election and subsequent changes in actor composition, however, the government authorities shifted the discourse on superblocks to align more strongly with the conventional urban planning regime. The Social Democrats re-framed superblocks as a redistributive planning intervention benefiting more deprived areas, which is well aligned with the long-established planning routine of not changing things too rapidly (District representatives January 2021; January 2021). Planning representatives highlighted, superblocks add to the existing street organization into minor and main roads, the latter often frequented by public transport (Administrative representative, December 2020). Thus, changes to the city's overall structure are not too severe, adding to the conventional policy discourse of a 'politics of small steps' (Representative of the Social Democrats, Feburary 2022). Furthermore, the possibility for cars to enter the block for deliveries and pick-ups (i.e., granting mobility for the elderly, craftsmen, and suppliers) became central in the discourse about superblocks (Representative of the Social Democrats, December 2020, January 2021; January 2021; Representative of Vienna's Chamber of Labor, December 2020). Simultaneously, Social Democratic government representatives reframed superblocks as providing substantial benefits for socially disadvantaged people, corresponding to the redistributive mode of governance. It became central to the debate that if something in the city had to change, it should at least benefit the socially disadvantaged areas, such as the 10th district, but preferably in areas where urban renewal schemes are already on their way (Representative of Vienna's Chamber of Labor, December 2020, December 2020, former Social Democratic city council representative, January 2021, outlying district representative, February 2022). The perspective to improve the district's reputation via an internationally recognized experiment further motivated the decision for implementing the first superblock pilot project (Outlying district representative, February 2022): *"And then the decision came down to the 10th district. The head of the district wanted it, it is an area with a very high proportion of migrants, and a lot of people are on the streets because it is not so easy with housing. Yes, several criteria have spoken for it"* (*Administrative representative, February 2022).*

7.3. Modes of governance in the superblock experiment

At the time of preparing Vienna's first superblock pilot project implementation (beginning of 2022), involved stakeholders state that the coincidence of key actors with little experience in governing experiments directly reducing car-bound mobility and their expressed intention to try something new might open a window of opportunity for a shift in governance (Administrative representatives, February 2022,

2022). This includes the organization of the superblock experiment in two project phases (one to try out and experiment and a second in which the tested temporal material structures and designs are transformed into lasting ones). Further, there is the intention to implement the experimentation phase in the summer of 2022 via a combination of conventional top-down planning with more "agile modes of governance" (Administrative representatives, February 2022, 2022).

In summer 2022, the test phase is put into practice. In the first step, traffic rerouting and removing parking spaces in the conventional top-down mode of governance is approached. In close exchange with district representatives, urban planners decide on traffic matters and parking spaces (Outlying district representative, February 2022). Local residents are not included in the decision-making process but are informed via a council meeting style exchange and an urban street lab event. In a next step, planners and district politicians build on existing cooperation with schools, local area renewal offices, and local educational associations (i.e., Wiener Kinderfreunde), so-called multipliers to design the public space available due to reduced car use (Outlying district representative, February 2022, Administrative representative, February 2022). This process thus replaces the conventional arena for interaction with civil society in a council meeting style by the installation of a street lab. Further, the urban street lab is not only used to inform the locals but also for consultation. This promotes low-threshold interaction in which planners, local area renewal office and local agenda 21 representatives, civil society, and district politicians exchange ideas, fears and needs. The broader inclusion of civil society in form of co-designing and co-decision making are, however, not part of the experimentation phase. Comparing the conventional mode of governance with the new one in the Supergrätzl governance an interviewee states as follows: *"A classical participation project was always on Thursday evening, participants sitting and arguing for two hours about parking spaces. This annoyed everyone, really everyone. In the end, something came out, but it was not a joyful process. And now it is like this, okay, we do not discuss the cars anymore, they are already gone. Now it is a matter of joyfully doing something, playful, haptically, simply letting the people try it out. And what works we will keep and when it does not work, we will not do it again."* (Administrative representative, February 2022).

8. Discussion and conclusion

We performed research to evaluate the potential of superblocks to transform long-standing car-bound mobility infrastructure towards sustainability. Our study assesses potential climate and health benefits, perceived acceptance, and the factors driving the implementation of Vienna's first pilot project. We combined quantitative transport modeling and climate and health assessments with qualitative stakeholder interviews during the pre-phase and early implementation of Vienna's superblock pilot project from the end of 2019 to the beginning of 2022.

Our transport modeling exercise indicates that the introduction of a superblock in the 10th district, where Vienna's first superblock pilot project is implemented, has the highest potential to reduce greenhouse gas emissions by −25 kg per capita per year. This potential climate benefit is more than twice as high in absolute terms compared to the 7th district and four times higher than the greenhouse gas emissions reduction potential in the 17th district. The potential health benefits in the 10th and 17th districts are relatively similar, with the potential to reduce premature deaths by 24–25 per 100,000 people annually due to increased activity levels. Comparing health outcomes between the 10th district and the more affluent 7th district, we find that health benefits are three times higher in the lower-income area. While the hypothetical superblock study area we evaluated may not be identical to Vienna's first superblock pilot project site, both areas share similarities in terms of low-income levels, a high proportion of non-EU citizens, size, material structure, and access to public transportation. As a result, we suggest that the potential climate and health outcomes of Vienna's first pilot project are likely to be similar to our estimates for the 10th district study site.

The 10th district is characterized as a working-class area with a comparatively low average income, a significant proportion of residents in precarious employment, and a higher share of non-EU-born residents compared to other Vienna districts. The district is notably dependent on cars, making the potential implementation of a superblock a somewhat surprising choice for Vienna's first pilot project. While our research did not directly influence this decision, it did show that this district had the most beneficial sustainability outcomes. Additionally, our findings reveal that the city government's reframing of the superblock experiment as a redistributive intervention played a pivotal role in selecting the 10th district. This differs significantly from the superblock sites selection process in Barcelona, where redistribution concerns did not play a prominent role (Anguelovski et al., 2023). Instead, Barcelona's superblocks were selected with the intention of having marketable flagship programs that were perceived as likely to succeed (Zografos et al., 2020). This selection criterion raises concerns about amplifying existing inequalities in the city (Anguelovski et al., 2023) and the risk of gentrification (López et al., 2020).

Compared to previous studies focusing on potential climate and health outcomes based on urban-scale macroscopic approaches, we adopted a more localized approach that simulates potential mode choice behavior (Mueller et al., 2020; Rodriguez-Rey et al., 2022). The positive effects on climate and health benefits resulting from superblocks are inherently localized, tied to practical implementation. Applying a different approach to investigate environmental and health benefits before and after the implementation of superblocks in three distinct areas in Barcelona, the local agency of public health reported that localized benefits are expressed in qualitative terms rather than quantitative terms (Agència de Salut Pública de Barcelona, 2021). These include an increase in overall well-being, improvements in mental health, reduced stress, noise reduction, and enhanced social interaction. Thus, it is likely that localized benefits in Vienna's pilot project become particularly evident in terms of improving livelihoods. Our applied modeling approach proves to be valuable for examining potential sustainability outcomes under various mode choice scenarios. However, it also comes with certain limitations. Firstly, it relies on an existing Latent Class Model developed for general mode choice behavior, rather than specifically tailored for superblock-related inquiries. While mode choice models are generally robust, it is essential to acknowledge these limitations when interpreting the transport modeling results. Secondly, the mobility behavior data utilized, sourced from the representative large-scale Austrian mobility survey "Österreich Unterwegs" (OEU), offers only relatively coarse geographical resolution. Due to privacy considerations, data is only available at the district level, assuming uniform behavior within each district, which might not fully account for even more localized variations in mode choice behavior.

To fully unleash the potential of reducing car-bound mobility in the city and delivering climate and health benefits on a larger scale, the establishment of more superblocks in Vienna is a viable intervention. Several other districts in Vienna have also allocated funding for superblock experiments. However, the outcome and progression of these future experiments remain uncertain. Given the sluggish pace of implementation processes, there is an argument for supplementing the superblock intervention with other measures to accomplish intended sustainability outcomes (Benavides et al., 2022). In a recent systematic review of interventions aimed at reducing car-bound mobility in cities, Kuss and Nicholas (2022) advocate for implementing a multiple intervention approach, with congestion charging identified as one of the most effective interventions for achieving a substantial reduction in overall car-bound mobility. This approach can readily align with a more extensive superblock implementation strategy (Benavides et al., 2022). However, such interventions require a reconfiguration of Vienna's urban planning regime, shifting the focus away from promoting car-bound mobility and towards creating traffic-calmed neighborhoods.

The embeddedness of redistribution principles within Vienna's urban planning regime may help uphold principles of distributional justice in the process.

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CRediT authorship contribution statement

Anna-Katharina Brenner: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Willi Haas:** Conceptualization, Investigation, Methodology, Supervision. **Christian Rudloff:** Data curation, Formal analysis, Investigation, Methodology. **Florian Lorenz:** Conceptualization, Visualization, Writing – review & editing. **Georg Wieser:** Conceptualization, Visualization. **Helmut Haberl:** Conceptualization, Funding acquisition, Project administration, Supervision. **Dominik Wiedenhofer:** Conceptualization, Project administration, Supervision. **Melanie Pichler:** Conceptualization, Methodology, Supervision.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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