‘No-one visits me anymore’ : Low Emission Zones and social exclusion via sustainable transport policy

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Eva De Vrij and Thomas Vanoutrive
Research Group for Urban Development & Urban Studies Institute, University of Antwerp, Antwerp, Belgium

abstract

For many years, the literature has pointed to the difficulties with the development of transport policy measures which meet both social and environmental policy objectives. Low Emission Zones (LEZ) offer an interesting example of measures that aim to decrease traffic-related air pollution, but which might have significant social effects by reducing the mobility of vulnerable, car-dependent groups. The Antwerp LEZ (Belgium) is used as a case. The assumptions and views in policy documents were compared with the experiences of some affected persons. The research challenges the assumption that only households with a non-compliant vehicle living in the LEZ are impacted by the measure since the LEZ may have a social impact well beyond the delimited zone. Some people with their residence in the LEZ expressed the feeling that they put a burden on friends and relatives from outside the zone who want to visit them. Furthermore, the LEZ affects low-income car owners with an older, damage-prone vehicle that is allowed to enter the zone, by making replacement vehicles less affordable. In general, the case reveals how the views and experiences of those most likely affected by the policy measure are not fully taken into account.

Keywords: Low Emission Zone; social exclusion and transport; Antwerp; accessibility poverty

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Introduction

Since urban areas are concentrations of both traffic and population, many cities aim to decrease traffic-related air pollution (Lenschow et al., 2017). One strategy involves the delimitation of zones where polluting vehicles are banned, also known as Low Emission Zones (LEZ). These include Diesel bans, permit-based schemes and zones accessible for certain categories of polluting vehicles after paying a fee (Cesaroni et al., 2012; Obrecht et al., 2017). Examples are found in Sweden, Germany, Italy, Spain, Belgium and the Netherlands (for an overview see Amundsen & Sundvor, 2018; Holman et al., 2015).

A recurrent question is whether LEZs are effective, which usually means that reductions in Particulate Matter (PM), NO_2 and Black Carbon levels can be observed (Holman et al., 2015). Positive effects were reported in Rome and Amsterdam (Cesaroni et al., 2012; Panteliadis et al., 2014), while small reductions in NO_x in London were comparable to reductions outside the LEZ, although differences were observed for PM (Ellison et al., 2013). Defining the conditions for effective LEZs is challenging given the diversity in geographical scope, stringency and vehicle composition, mobility's dynamic nature, interacting variables, and methodological variety (Holman et al., 2015; Qadir et al., 2013). However, this paper neither focuses on emission levels nor on health outcomes, but on social exclusion-related concerns in policymaking.

Both the health impacts of traffic as well as counteracting measures have generated debate (Charleux, 2014; La Branche & Charles, 2012; Van Brussel & Huyse, 2019). Critiques of LEZs stress the uncertainty about the effects on air quality and the social impact, and sometimes frame it as a disproportionate restriction of driving (Nieuwsblad, 2020; VAB, 2020). The LEZ Madrid Central was framed as a measure of a progressive mayor, which his conservative, car-oriented successor tried to turn back (BBC, 2019). Rotterdam's 'environmental zone' was introduced in 2016 and abolished in 2020, except for trucks, and the communication emphasised that the 'natural' trend towards cleaner vehicles reduced its necessity (Gemeente Rotterdam, 2020; Stichting Rotterdamse Klassiekers, 2019), although one academic called the decision a 'criminal act', given its negative health effects (Vanheusden, 2019). In Ghent, Belgium, plans to increase the LEZ area became a major point of contention. The Green party emphasised that vulnerable groups might particularly benefit, while the social democrats feared the negative effects on the accessibility for low-income groups (Andries, 2020).

These debates indicate that LEZs are illustrative of the tension between the social and environmental dimensions of sustainability (Boussauw & Vanoutrive, 2017; Campbell, 1996; Feitelson, 2002; Martens, 2006; Paulsson, 2018). Interestingly, two social justice-related arguments are placed opposite each other: environmental justice and social exclusion (Lucas, 2004). The environmental justice argument highlights that vulnerable groups are concentrated in areas with higher levels of air pollution (Mitchell & Dorling, 2003; Schweitzer & Valenzuela, 2004), but show lower levels of car ownership, hence the introduction of a LEZ is a progressive measure. Regarding social exclusion, lower-incomes tend to drive cheaper, older vehicles (Departement Omgeving & VMM, 2020), and consequently, LEZs can restrict their travel

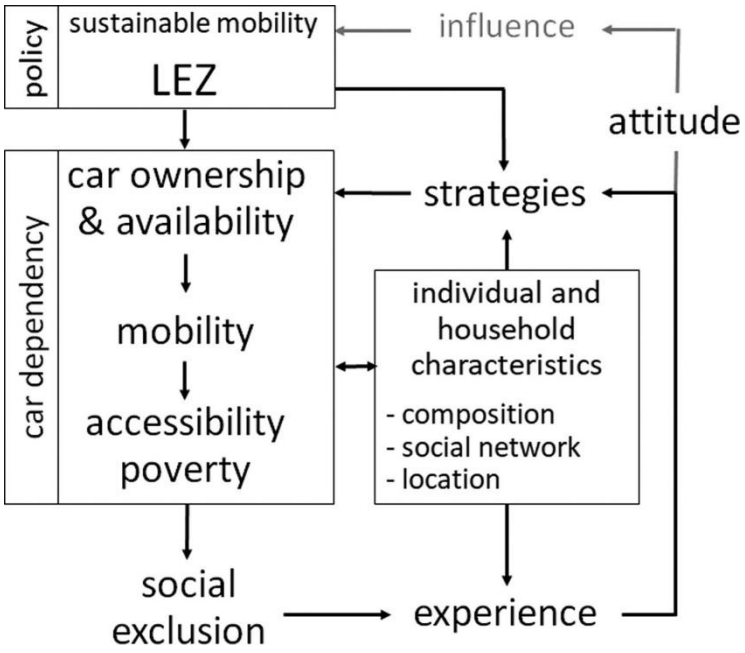
opportunities. However, regarding the 'Assessment of LEZ impacts', there is 'a dearth of research on individuals' mobility behavior' (Charleux, 2014, p. 199).

We aim to contribute to research on the tension between social and environmental sustainability objectives. Environmentally motivated restrictions on car ownership and use are interesting since the car has obtained a central position in the daily life of many people, including members of vulnerable groups. Notwithstanding positive health and environmental effects, increasing barriers to car availability might contribute to accessibility poverty, which is the 'difficulty of reaching certain key activities –such as employment, education, healthcare services, shops and so on– at reasonable time, ease and cost' (Lucas et al., 2016, p. 355). The remainder of the paper is structured around a conceptual framework showing the relationship between LEZs and exclusion, and which is introduced in the next section.

Theoretical background

The conceptual framework (Figure 1) starts with 'policy'. LEZs fall under the sustainable mobility policy paradigm which is omnipresent in academic and transport policy discourse since the 1990s (Baeten, 2000; Boussauw & Vanoutrive, 2017). Sustainable mobility policies typically invest in public transport and bicycle infrastructure, and promote a modal shift away from the car (Hickman et al., 2013; Paulsson, 2018). Mobility-as-a-Service (MaaS), as well as smart and shared mobility have joined sustainability as popular concepts, and typical measures include bike-sharing systems, integrated ticketing and ridesharing applications (Docherty et al., 2018; Sparrow & Howard, 2020). As an environmental policy instrument, LEZs are examples of direct 'command and control' regulation, more specifically spatial controls (Taylor et al., 2012). Auxiliary regulations include economic instruments like entrance fees, and information and communication. The essential feature of LEZs is that vehicle characteristics determine which cars are allowed to enter a particular area.

Figure 1. Conceptual framework.



Next in Figure 1 is car dependency. Car ownership is positively associated with income, and given the high levels of car dependency in Western countries, those with limited financial means either have to spend a substantial part of their income on a car (forced car ownership) or might experience significant mobility constraints (Delbosc & Currie, 2011; Jeekel, 2014, 2019; Lucas, 2012). Research also points to the 'ephemeral' nature of car ownership, particularly among families in poverty, who might alternate periods of car ownership and carlessness (Klein & Smart, 2017). In general, more recent, cleaner, and on average more expensive, vehicles are allowed to enter a LEZ (VAB, 2019), which increases the cost of the cheapest category of vehicles, and may thus impact car ownership among disadvantaged groups. Relatedly, persons with special vehicle preferences might be affected, notably users of old-timer vehicles.

Figure 1 also shows the interaction between car dependency and individual and household characteristics. Besides income, differences in car ownership and use as well as travel possibilities are affected by family composition, life stage, attitudes, physical condition, job status, skills, ethnicity, family responsibilities and gender (Chatman & Klein, 2013; Etezady et al., 2021; Oakil et al., 2016). The set of travel alternatives is further determined by residential location, the place where services and activities are located, and, especially for public transport, timing (Allen & Farber, 2020; Næss, 2005). The need to carry children and luggage may exclude the use of a standard bike (Heinen et al., 2010; Schwanen, 2007). These are only some examples of how being carless may affect one's mobility and accessibility (Lagrell et al., 2018). This brings us to the reason why car ownership and mobility matter to people.

As the literature acknowledges, the social role of mobility is accessibility, i.e. the possibility to reach a variety of activities (Farrington, 2007; Martens, 2012; Preston & Rajé, 2007), covering both actual and potential travel (Kaufmann et al., 2004; Sager, 2006). With high levels of mobility being the norm, restricting car use might imply reduced levels of participation in 'normal' social activities ('social exclusion via transport' Jeekel, 2019), causing accessibility poverty (Martens & Bastiaanssen, 2019), poverty of access (Farrington & Farrington, 2005), or transport poverty (Allen & Farber, 2019; Lucas et al., 2018).

Since individuals are not passive, atomistic actors undergoing exclusion, Figure 1 foregrounds their strategies. Relying on the social network for a ride is one strategy to cope with mobility restrictions. Several studies emphasise the importance of social networks and social capital for travelling (Goodman et al., 2014; Lovejoy & Handy, 2011), in particular for disadvantaged groups and the elderly, but simultaneously recognise the reluctance to ask others to drive them around (Burkhardt, 1999; Schwanen et al., 2015; ten Holder, 2010). Another strategy, in line with the LEZ concept, is purchasing a cleaner vehicle. People can also switch to other modes to reach the same or alternative destinations, which depends on the possibilities provided by transport policy. A strategy which might involve a radical shift in mobility behaviour is residential relocation (Clifton, 2004; Jiron & Carrasco, 2019). However, sustainable mobility measures like LEZs focus on city centres. Resulting increases in liveability may drive up property prices, and amplify residential displacement of low-income households, who then move to car-oriented suburbs, which is known as 'green gentrification' (Blok, 2020; Goossens et al., 2020).

Influencing policy is a last strategy. Triggered by their experiences and the resulting attitudes, people can organise a lobby to abolish a LEZ or demand social corrections. However, being socially excluded often implies being excluded from political participation, and accessibility poverty might decrease access to political activities (Hodgson & Turner, 2003; Kenyon et al., 2002). Furthermore, how and by whom sustainable and smart mobility policies are developed may increase the gap between policy measures and certain population groups. It has been indicated that 'how professionals understand sustainable mobility is closely interlinked with their own mobility practices' (Henriksson, 2019, p. 179), that the 'user identities' they construct 'will include some citizens' experiences of mobility while excluding others.' (p. 180), and that particularly 'middle-class ideals are influencing their understandings of sustainable mobility' (p. 190). Hence, the dominant policy discourse might exclude the experiences and mobility challenges typical for disadvantaged groups. This comes on top of the generally limited efforts made to include these groups in participatory events in transport policy (Elvy, 2014), and the moralising tone of privileged experts is reported as an additional obstacle (Cupples & Ridley, 2008; Green et al., 2012).

The case: Antwerp's LEZ

For years, Antwerp (Flanders, Belgium) and the wider region have struggled to meet European ambient air quality standards, in particular for PM_{10} and NO_2. Air quality is negatively affected by high background concentrations, a dense road network including a ring road close to the city, and the petrochemical cluster in the port (more information on the area is provided as supplementary material online). Recently, the debate on air quality in the study region gained a renewed momentum with the help of citizen science projects in which citizen collect air quality samples (Meysman & de Craemer, 2018; Van Brussel & Huyse, 2019). However, the main motivation to develop the LEZ policy seems to be the infringement procedure which the European Commission initiated in 2009 as a consequence of the failure to meet PM standards.

A Decree that allows municipalities in Flanders to introduce a LEZ came in 2015, and the first went into force on 1 February 2017 in Antwerp. Petrol cars as well as CNG (Compressed Natural Gas) and LPG (Liquified Petroleum Gas) cars meeting at least the Euro 1 standard were allowed to enter the LEZ, as were Euro 3 Diesel cars with a soot filter and Euro 4 Diesel cars (or higher). After a payment, Euro 3 Diesel cars without a filter were allowed to drive in the LEZ, and for other vehicles a Day Pass could be bought (maximum 8/year). There were discounts and exceptions for certain categories of lower-income and disabled groups (Flemish Government, n.d.; Stad Antwerpen, n.d.). In 2020, regulations have become more stringent (at least Euro 2 for petrol cars, and Euro 5 for Diesel cars, while Euro 4 Diesels are allowed to enter the LEZ after paying a fee). Of all registered cars in the region of Flanders, 179,493 (approximately 5%) were not allowed to enter the Antwerp LEZ prior to the 2020 changes, and 619,362 (approximately 17%) afterwards (VAB, 2019). For the city of Antwerp, numbers were estimated at 15,137 (2017) and 28,000 (2020; 56% of Diesel cars and 8% of petrol cars), although it was argued that in 2017 soot filters could make some 6,000 cars LEZ-compliant (HLN, 2015).

In line with the MaaS concept, Antwerp's mobility policy is integrated in the 'smart to Antwerp' initiative which aims to create a marketplace for mobility solutions from which consumers can flexibly choose. A smart combination of transport modes and options (i.e. intermodal or mixed mode transport) is presented as main solution. The communication of the city (stad Antwerpen, n.d.) refers to the 'smart to Antwerp' website (SnA, n.d.) which gives information on the LEZ regulations, exceptions, and provides a tool to check whether a vehicle can enter the LEZ. Subsequently, the site lists following options under the heading 'Which alternatives do you have?': car-sharing, buying another car, Park and Ride, public transport, bike and moped, and taxi.

When the LEZ was introduced in Antwerp, some newspapers staged affected individuals and entrepreneurs who could no longer enter the LEZ: 'By paying 350 euro, you're allowed to pollute the city. That is profiteering.' (Poppelmonde, 2017, p. 13), or 'Who will pay for my new car.' (HLN, 2017). Regarding organised political action, automobile associations and old-timer clubs were the main voices that expressed their concerns (Smets, 2017; Van Wynsberghe, 2016). Some advisory councils mentioned social exclusion, but this was not a major issue during the preparation of the LEZ Decree (Vlaams Parlement, 2015). The website of Flanders' environmental

department provides a response to the question whether LEZs are asocial: 'No, on the contrary. Socially weaker persons generally live in the most polluted locations, while they do not always have a car' (Departement Omgeving, n.d., all quotes translated by the authors). This environmental justice-based statement is followed by the argument that petrol cars are cheaper than Diesel cars, and by a reference to the potential of car-sharing, and the lower fees for certain categories.

In November 2020, the Environmental Department of the Flemish government published a report on the impact of LEZs on vehicle fleet, air quality and socially vulnerable groups (Departement Omgeving & VMM, 2020). In the time path of the Flemish government – with tightening standards in 2020, 2025, 2027 and 2028 – the early phases focus on black carbon (BC), and gradually (with decreasing BC levels) the emphasis shifts towards NOx. Given the focus on these pollutants, the LEZ regulations are stricter for Diesel than for petrol vehicles, whose share increased faster in Antwerp than elsewhere in Flanders. The report repeatedly emphasises that it is difficult to attribute causal effects on air quality measurements to the LEZ given the limited number of measurement locations, and major road works in Antwerp. The conclusion is that the LEZ caused a decrease in BC, but that the effect on NOx is less clear, and health effects are assumed but not quantified given the uncertainties.

The chapter on socially vulnerable groups shows that at the neighbourhood level, there is a significant correlation between air pollution and SES indicators such as the share of tenants, people with a non-European background, and jobseekers (positive), and median income and the number of cars per household (negative). The report stresses that 'a large share of socially vulnerable households which have their residence in the low emission zone does not have a car. Hence, they do not experience a negative impact of the introduction of the low emission zone, and profit the most of the health benefits.' (Departement Omgeving & VMM, 2020, p. 82). Subsequently, the report discusses how socially vulnerable households with a car are hit hardest by the LEZ. Due to a lack of data, the regional household travel survey (version 5.1–5.4, 2015–2018) was used to obtain a subsample of households with their residence in a city with a LEZ (Antwerp and Ghent). Of the 118 households with a car in the lowest income quartile, 39 had a non-LEZ-compliant car (using vehicle age as proxy), which was the only car available for 34 of these households. Using these limited data, the report recognises the potential impact on socially vulnerable groups, though without providing absolute numbers. The report ends with 'measures to soften the social impact' (p. 86). The fact that most petrol cars are LEZ-compliant is seen as having the largest positive effect on inclusion, together with the possibility to postpone the purchase of a replacement vehicle by buying a LEZ permit (€180/year). In contrast to the communication by the city, the document ignores other options like choosing alternative travel modes. Also noteworthy is that the discussion of the impact on the fleet repeatedly mentions that purchasing behaviour outside the LEZ is affected, while the part on vulnerable groups does not mention the impact outside the LEZ.

Method

The aim of this study is to explore how a LEZ can contribute to transport-related social exclusion, and how policy assumptions correspond to experiences of vulnerable groups. The previous section discussed policy documents, reports, and newspaper articles. To better understand the experiences and interactions between factors, semi-structured interviews were carried out (in 2018) after the introduction of the Antwerp LEZ and before more stringent standards went into force, enabling respondents to reflect on both a measure in place (2017), and tighter, future standards (2020). The focus was on members of vulnerable groups who had a vehicle that was no longer allowed to enter the LEZ, either in 2017, either in the future (2020).

The added value of a qualitative approach (Maxwell, 2013) to better grasp the impact of sustainable mobility measures on the daily life of citizens was already highlighted by Raje (2004). She stressed the relevance of input from local voices when developing measures like road pricing and workplace parking levies. Their experiences help to detect the possible effects on social exclusion and to understand the often informal travel arrangements and strategies of at risk groups. For this paper, six interviews with persons living inside or just outside the LEZ are used to include the voice of some members of affected groups. We did not aim to include all possible experiences of exclusion but to illustrate the main mechanisms using a rather homogenous sample of parents, who have particular challenges according to the literature. Furthermore, all respondents had a migration background. Interviewees were recruited via organisations which focus on people in poverty, organise language courses for migrants, or make use of 'social employment' programmes. In this exploratory analysis, we did not include the elderly, who experience specific accessibility challenges (Burkhardt, 1999; Ryan & Wretstrand, 2019), nor people with disabilities for which specific measures are in place. Table 1 provides some characteristics of the interviewees.

Table 1. Overview of the interviewees.

ID	Gender	Age	Children	Education	Job	Residence	Workplace	Physical health	Car	Migration	Interview word count
A	M	50–59	5	Lower sec.	Full time	inside LEZ	outside	0	y	1st generation non-EU	1762
B	M	30–39	3	Lower sec.	Full time	inside LEZ	outside	+	n	1st generation non-EU	2713
C	F	30–39	4	Higher sec.	Full time	outside LEZ	inside	0	y	1st generation non-EU	5877
D	F	40–49	3	Univ. college	Home-maker	outside LEZ	–	−	n	2nd generation non-EU	8293
E	F	50–59	2	Higher sec.	Unem-ployed	outside LEZ	–	−	n	1st generation EU	6137
F	F	30–39	2	Lower sec.	Part-time	outside LEZ	inside	0	n	2nd generation non-EU	5451

After filling out the informed consent form and a short introduction of the research, some introductory questions were asked about the respondents' mobility behaviour, and their familiarity with the LEZ regulations. This was followed by questions about the impact of the LEZ on their daily routines, their experiences and coping strategies. Subsequently, alternative travel options were discussed, and interviewees were asked to give their opinion. Respondents could also add additional remarks. The interviews were transcribed verbatim and coded using NVIVO 12. Most elements fell in the categories of travel behaviour, transport modes, and LEZ (knowledge, impact, opinion, strategies). The other categories were daily routines, residential location, workplace, family, health/stress, shared mobility, virtual mobility, and a miscellaneous 'other' category.

Results

LEZ impact

The presentation of the results follows the conceptual framework (Figure 1). The main causal force of the social impact of a LEZ is car dependency, which implies that the availability of a vehicle has a major effect on the mobility and accessibility of car-dependent households. Interestingly, some respondents had an older LEZ-compliant car, but which broke down after the LEZ was introduced, and they were not able to immediately find an affordable second-hand

replacement vehicle. This resulted in a situation of reduced mobility for several weeks, months, and for one respondent even a year (ephemeral car ownership).

Households may end up in a vicious circle of buying a second-hand car which is allowed to enter the LEZ until standards are tightened, having difficulties selling their old car for a reasonable price, and having limited means to buy a new car. Furthermore, those who switched to the bicycle or public transport as main alternative considered this as an effect with far-reaching implications on their mobility. Most respondents indicated that the temporary or permanent situation of being without a car generated difficulties. For example, the second-hand car of a young family with two children broke down, and one parent describes how they found a solution and how they perceive car dependency:

> Yes, it broke down and then we have for a while … we bought my father's car. That car was declared total loss, but he could fix it, and he said 'you can have it'. […] Because financially, it was a bit difficult for us to immediately buy a good car. […] Saving well, [laughter] to buy a good car. Well, a good one, in the first place a car with the right standards. Have to, if you have children and you want to travel and so. That's necessary. Without car is harder. [respondent F]

Someone who uses a second-hand car to bring her three children to school and to other activities expresses her connection to the vehicle:

> I find it really weird. I have to change again within two years … uh. I find really beautiful my car and then now I have to sell that beautiful car. Crazy. [respondent D]

Most interviewees mentioned that grocery shopping has become more challenging than before. One interviewee with walking difficulties puts it as follows:

> Yes, but to do grocery shopping by public transport. I did it, I've done it. Really, that's suffering. For a family, well I mean lugging with bags, boxes. The bus that doesn't stop in time. Yes, heavy stuff, milk and the like. Well, I mean, try to do it by public transport, yes. Practical and, you can say, I do it in small parts, getting a little every week, but that isn't always so convenient. [respondent E]

A father of three young children recognised the difficulties, but offered a nuanced view:

> For me is also difficult, last week my car was broken. I was two days without car. And I don't feel well, for example the first day was a bit difficult. I had to do grocery shopping and to walk there. But after that I thought, okay five years ago, I was also without car. And I was always … I've become lazy. I have to be strong. [respondent B]

In general, scheduling is more difficult without a car. People feel dependent on public transport, which is considered a more time-consuming transport mode. Respondent C simply stated that 'when you have to rely on public transport you need always one hour extra, in case of', and

another interviewee discussed how she tried to combine the care for three children with commuting by public transport and described this commute as follows:

> public transport is very cumbersome. […] That's all time lost. Time lost. Since I say, that needs to go more efficiently by now? It's 2018, almost 2019, and you think it isn't still what it should be. But really two hours on the way, well two hours and if I missed the bus, a bit longer, to go to work. That's not feasible. You can't keep doing that. [respondent D]

The presence of, in particular multiple and young, children has a major impact. Respondent A stated somewhat bitterly, 'if you are alone, my car is not necessary. Problem is my children. That's the severe problem'. Another father, with one child in nursery and two in kindergarten, compared both facilities:

> Just, due to lack of time I have to go to work, well if I walk or so. The kindergarten, half past eight that has to go to kindergarten. Nursery is easier, you can also go earlier. [respondent B]

The interviews highlighted the impact of the LEZ on the social life of the respondents. One respondent was very active as a volunteer until her car was no longer allowed to enter the LEZ and commented:

> I always went to them. And it are also people who are ill, who have disability to go outside. But if I haven't my little car, then I can't get there. [respondent E]

Also, other interviewees mentioned how difficult it had become to visit friends and family. The impact of the LEZ extends well beyond the zone itself. For example, a large part of the family of one respondent lives in Brussels (50kms south from Antwerp), and he stated:

> family came every week Saturday, Sunday. They live in Brussels. But not since that [LEZ] has started. Seriously, no-one visits me anymore. [respondent A]

An illustrative example considers the organisation of a wedding party:

> My sister she wanted to marry here, but then we had to think about all these people that came from the Netherlands, to visit. Well yes, other people. And then she didn't organise her wedding here although she liked the room and that because, actually, because people would had to park their car far away and walk. Or someone had to pick them up. So, it is, we didn't thought at it in the beginning, but afterwards we had to cancel it because it is really annoying, because you invite people. [respondent F]

Strategies

A main LEZ-related strategy is to purchase a LEZ-compliant car, and several interviewees stated that they were willing to pay the fee to enter the LEZ. Local public transport (bus and tram) is another option, albeit not preferred by most respondents. The problem is not that public transport in Antwerp is of bad quality, but that it is more time-consuming and less flexible. Cycling is common in Antwerp, but was not popular among the respondents, except as a leisure activity. Regarding functional trips, stress was a recurrent theme, especially for cycling with children.

> then I'm completely overstressed when I arrive at school, like finally … I've arrived safely with the children at school […] Yes, if you have the [major road], where you have the [tramway] tracks, the motorway entries. You just have to cross that to, actually, and after that you have all bicycle lanes. But that is a stressful part, since you have an entry there, an exit there. [respondent D]

Another issue with bicycles is theft. One mother stated:

> my oldest son. He comes always home by bike. So he locked with two keys, it's a new bike. He is for a quarter of an hour upstairs, to eat. Fast downstairs. When he is downstairs those two bikes gone. It's just one month or two months ago we bought those two bikes, more than a thousand euros for two bikes with a discount. [respondent C]

Like many other cities, Antwerp promotes shared mobility (SnA, n.d.). Several interviewees referred positively to the bike-sharing system with fixed stations, but only two made use of it. Another speaks enthusiastically about bike-sharing since her husband uses it which enables her to chauffeur the children:

> he's really grateful that it exists, it's actually also by chance that he came to known from a friend of his. He said 'but why don't you use the city bikes?' [respondent D]

Besides the association of cycling with stress, non-users indicated that the standardised bikes do not allow to carry children or large shopping bags and that a credit card is required for subscription. One respondent made use of car-sharing to occasionally drive into the city and acknowledged that it is less flexible, and thus less suitable for last-minute decisions. He mentioned the case of his father-in-law who was fallen and to whom he was not able to travel quickly. Car-sharing was perceived as expensive by one individual, and after giving examples of car-sharing providers another interviewee perceived it (correctly) as short-term car rental. In general, respondents prefer to rely on their social network to get rides instead of formal car-sharing provided by private companies.

Attitudes and opinions

The LEZ produced mixed feelings. Most respondents are aware of the bad air quality, but the social consequences are a concern. One interviewee summarised the effects in following way: 'My property and freedom are taken away. And time.' [respondent F]. Another stated:

> I find difficult. Because many people have bought such cars, not everyone has money to buy new car hu. OK, I have permanent position now and can buy on credit. Usually people cannot buy. [respondent C]

Several people were suspicious of the true aims of the LEZ, and suspected the city of searching for money, to 'please the rich', or to control people. One interviewee formulated her suspicion as follows:

> I don't know, it is, there are regulations invented all the time just to keep it running financially, to the benefit of the richer then. [respondent F]

In particular, the exclusion of the ring road and the option to pay an entrance fee were used to argue that the environment was not the only concern, or not even the real motivation to introduce the LEZ. This was accompanied by references to the disproportionate impact on 'common people' or 'the poor'. This illustrates the possible link between lived experience, attitudes, and opinions. Finally, no interviewees had developed initiatives to influence policy.

Discussion and conclusion

The interviews confirm the literature (Jeekel, 2014; Lucas, 2012; Mattioli, 2014) showing how restrictions on car use might lead to social exclusion via transport. Without a car, particularly the presence of children has a profound impact since scheduling becomes challenging (Bernardo et al., 2015). Furthermore, respondents indicated that shopping requires a car. The effects reach well beyond the LEZ borders. Residents who no longer have a car indicate difficulties to visit others, and several respondents indicated that they could no longer expect that friends and relatives from outside the LEZ visited them. It is as if by living in a LEZ, someone puts a burden on potential visitors.

Despite the urban character of Antwerp, the level of car dependency remains high. In general, many households will do everything within their powers to have a car at their disposal (Mattioli, 2014). A typical short-term strategy is to buy a second-hand car that is allowed to enter the LEZ until the regulations are tightened, which reduces the resale value and thus the financial means to purchase a cleaner, more expensive vehicle. Some interviewees with a LEZ-compliant vehicle also fell the impact since their older vehicles are more likely to break down. When this happens, they experienced more difficulties to find an appropriate replacement vehicle.

This suggests that social impact studies should not only focus on households with a non-authorised car living inside the LEZ (Charleux, 2014), but also on those with limited means to purchase a replacement vehicle, on those visiting carless families and households with an authorised car, and on those living outside the zone. In itself, banning the most polluting vehicles is not the problem -this may particularly benefit the urban poor- but car dependency. This brings us to the role of alternative travel modes.

In theory, trips by car can be substituted using other transport modes. Respondents were generally familiar with the local public transport system, but the offer is less flexible and more time-consuming. Cycling was often associated with stress, in particular by parents accompanying children. Like many other cities, Antwerp promotes shared mobility and Mobility-as-a-Service (MaaS). As reported elsewhere, these models mainly take into account the demands and skills of middle class and younger groups (Durand et al., 2018). The exclusion of children and the credit card requirement were mentioned as barriers to bike-sharing. Car-sharing was not perceived as a viable option by most interviewees. The umbrella organisation Carshare Belgium is aware of the financial, cognitive, legal, psychological and geographical barriers, and aims to make car-sharing more inclusive (autodelen.net, 2019). It is yet to be seen whether this will make car-sharing popular among vulnerable groups.

The analysis indicates that the LEZ policy shows limited sensitivity to the experiences and views of vulnerable groups. The social impact was hardly discussed in the period when the LEZ was introduced, and the official communication stresses the benefits for the urban poor. Later, a report stated that socially vulnerable groups without a car 'only experience benefits from the low emission zone' (p.8, 14, 88; 90 Departement Omgeving & VMM, 2020), which contradicts the experienced impact on social contacts discussed above. Interviewees are aware of the negative effects of air pollution but are also confronted with the top-down implementation of a measure which severely impacts their mobility. Even when we leave the question aside why certain groups have become 'vulnerable', it is remarkable why so little attention is paid to the needs, experiences, and opinions of those affected most. Hence, a democratic deficit may lie behind the tension between the social and environmental dimensions of sustainability (Pickering et al., 2020).

This study presents a conceptual framework to analyse the potential effects of sustainable mobility policies on social exclusion and illustrated this with the experiences of a small sample. Future research could start with interviewing a more diverse sample of potentially affected persons to inventory the variety of effects and interactions. Subsequently, this can be used to organise a large-scale survey to measure the extent of the detected problems. Furthermore, more attention can be paid to positive health effects, in particular for vulnerable groups, as well as to the impacts on mobility patterns of the Covid-19 pandemic. Finally, the policy process can be studied in more detail to reveal how social exclusion and the voices of disadvantaged and affected groups were taken into account, and to investigate how participation can be strengthened.

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