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Reluctant acceptance: Exploring implementation and contextual factors influencing the acceptability of a newly implemented low emission zone in a UK urban setting

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ABSTRACT

Low emission zones (LEZ), known as Clean Air Zones (CAZ) in England, aim to improve air quality by restricting the movement of the most polluting vehicles in urban areas. Despite their increasing deployment across European cities, they remain a contentious policy amongst populations, with suggestions that they have adverse impacts, such as an inequitable impact on different communities. Few studies have explored how communities and businesses are impacted by the introduction of a CAZ. The current study explored adaptations made and attitudes towards the Bradford CAZ in the first year of implementation. Semi-structured interviews were conducted with 20 workers in professions which had the potential to be directly affected by the CAZ (e.g. bus and taxi firms, local tradespeople), and eight diverse focus groups held with 51 residents, between March - August 2023. Thematic analysis identified key themes inductively. Overall, respondents suggested that the CAZ worked as intended, encouraging businesses to upgrade vehicles. Mitigations such as exemptions and grants were used, but were not felt to be enough to support smaller businesses. The majority of participants supported the CAZ, but there were strong negative attitudes including dissatisfaction with how the intervention worked, feelings of unfairness, lack of trust in those implementing the intervention and issues with the communication of the policy. Policies such as CAZ operate within a complex system and it is important to systematically capture wider impacts, both positive and negative. Ultimately, these factors impact on political popularity, which will in turn influence the likely continued implementation of such policies at scale.

Introduction

Outdoor air pollution is a major environmental health risk, associated with 4.2 million premature deaths annually worldwide [1]. Road traffic emissions are a key source of air pollution, causing 64 % of the exceedances in air quality standards in Europe [2] and the main source of Nitrogen Dioxide (NO₂). Transport is also a major contributor to global warming, in the UK alone representing 26 % of overall carbon emissions in 2021 [3]. Transport demand management (TDM) policies are being encouraged and implemented worldwide to deal with congestion and emissions in the attempt to reach net zero and improve health, exemplified in the World Health Organisation's Health,

Environment and Climate Change Road Map [4], The New EU Urban Mobility Framework [5], United Nations Economic Commission for Europe's Pan-European Master Plan on Walking [6]. Within the UK, transport and health policy aims to realise a reduction in transport emissions through low-carbon vehicles and the promotion of alternative modes of travel, seen in the Zero Emissions Vehicle Mandate [7], and the NICE guidelines on outdoor air pollution [8]. While the UK is no longer subject to EU new regulations it has currently retained the EU air quality standards that existed at the time of exit from the EU [9].

Low emission zones (LEZ), interchangeably called clean air zones (CAZ) in the UK, are increasingly being implemented in European cities; in 2022 there were over 320 zones, with expectations that this number

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will steadily rise over coming years [10]. LEZ aim to discourage the use of more polluting vehicles by restricting access or changing entry to a predefined geographical area for non-compliant vehicles, and encourage drivers to switch to clean energy vehicles, active travel, or public transport.

Despite emerging evidence that LEZ have a positive impact on population health and pollution [11,12], they remain divisive. Infrastructure has been the target of vandalism and protest [13]. Vocal political and public opposition can damage the confidence of those tasked with implementing these policies [14], and there are numerous examples across the UK and Europe where planned LEZ have been opposed, or cancelled [15,16]. Opposition is for a variety of reasons: the potential efficacy of the policy; impact on personal freedom; equitability and fairness; that addressing air pollution is not a priority; people's differing values; and a lack of public trust with policies referred to as 'money making scheme[s]' ([13–17]). Despite these differing opinions, most studies which have sought to quantitatively measure support for LEZ find that there is majority support amongst the populations recruited [18,19].

Few studies have explored how the acceptability of LEZ changes after implementation. Oltra et al [20] and Mebrahtu et al [21] found a high level of support for LEZ from population based surveys which were conducted 3–12 months after a LEZ had been implemented. In a qualitative study, Alliott et al [22] examined the impact of the London ultra low emission zone (ULEZ), (whilst acknowledging that their findings may be context specific). They found that families perceived air to be cleaner and that the ULEZ encouraged a modal shift to active travel. However, a small number of qualitative studies have identified perceived unintended consequences. These include fear of social isolation from a perception that family and friends are no longer able to visit [22,23], and that restrictions disproportionately disadvantage lower socio-economic groups [22] who may be reliant on private transport but less able to afford upgrading vehicles. Using data from a longitudinal panel study, Sarmiento et al. concluded that implementation of a LEZ temporarily decreased life satisfaction, which they suggest is a result of restricting mobility of communities [24].

Understanding the acceptability of LEZ schemes, their influence on the wider transportation system, and potential unintended consequences, is important for understanding the longer-term feasibility and sustainability of these initiatives. LEZ, which are usually implemented as part of wider city or region plans to reduce pollution, are complex interventions and are similarly implemented within 'complex systems' [25]. Contextual influences (for example, socio-economic, legal and political landscapes) along with the settings in which policies are implemented interact, influence and modify implementation processes to determine whether policies are successful or if there are unintended consequences [26].

Bradford, a large Northern city in the UK, implemented a LEZ, (from now referred to as CAZ due to UK terminology) to reduce illegal levels of pollution in September 2022. We aimed to explore how implementation of a CAZ in this city affected resident's and worker's travel behaviours and attitudes towards the CAZ up to 10 months after it had been implemented. Our research questions were:

1. What adaptations did businesses and the public make to the CAZ?
2. What attitudes did businesses and the public have to the CAZ post-implementation?
3. What factors have played a part in influencing the attitudes towards and the acceptance of the CAZ?

Methods

Design

Utilising a constructivist, inductive approach, we conducted a qualitative study including focus groups with residents (living within

and outside the CAZ boundaries) or people who worked in Bradford District, and interviews with key 'workers' (defined as someone whose work or livelihood has the potential to be directly affected by the CAZ). We conducted 8 in-person resident focus groups and 20 face-to-face or online worker interviews [27]. This sample intended to gather perceptions from a diverse range of communities stakeholders to collect data exploring experiences of people living and working within and outside the zone, those with limited income to adapt, those with greater financial means to adapt, lone traders and multinational companies and different business sectors [28]. Data collection was carried out between March to August 2023, 6–10 months after the CAZ launch in Bradford. Ethical approval for the study was obtained from Leeds Bradford NHS Local Research Ethics committee (ref: 20/YH/0158).

Setting and background

Bradford District is the fifth largest local authority in England, UK with a population of over 560,200 [29]. Over a third of the population is under 20 years old, 56.7 % of the population identify as White, 32.1 % identify as Asian/British Asian, 2.7 % as Mixed ethnicity and 2 % as Black/Black British/Caribbean/African [30]. A third of households live in the most deprived decile of neighbourhoods according to UK averages [31]. It has high levels of ill-health, and spatial inequality, with the most deprived populations living in the most polluted areas [32]. The Bradford CAZ was designed to encompass the most polluted areas of the city. The populations living within the CAZ have the most to gain health-wise from improved air quality, but may also be the populations most financially impacted by changes brought about through implementation, as non-compliant vehicles entering this area will have to be adapted or charges paid [33].

Bradford Metropolitan District Council, (commonly called 'the Council'), implemented a CAZ on the 26th September 2022 charging non-compliant (pre Euro 6 diesel and pre Euro 5 petrol) buses, coaches, lorries, vans (including camper vans), and taxis a daily charge to enter the zone. (See Fig. 1 for locations of Bradford and the CAZ). There is an additional requirement for all registered private hire vehicles to be a minimum petrol hybrid standard. Private cars or motorcycles are not charged. In advance of the launch, a package of grants and limited exemptions were open to small and medium enterprises (SMEs) and taxi drivers who lived within Bradford District to support upgrading vehicles. Grants for retrofitting buses and coaches were available for companies who frequently enter the Bradford CAZ. A pre-launch information campaign targeted businesses first, and households later, within the Bradford District. Road signs were erected to alert drivers to the upcoming launch of the zone. At present, fixed road signs indicate the zone boundaries and provide messaging regarding how to pay online.

At the time of data collection CAZ was a new concept in the UK. Only 5 CAZ (including London) were live (See Table 1). Within 30 miles of Bradford, one neighbouring city (Leeds) had been declared to no longer need a CAZ and another, Manchester, had paused their CAZ implementation plans [34,35]. There was much on-going media attention relating to CAZs.

Recruitment and procedure

The sampling strategy for interviews and focus groups was developed through two workshops, one with members of the Bradford Council CAZ development team and another with members of a longstanding community steering group established by the research team in 2019 (see Supplementary Material A). We aimed to recruit a diverse sample 'sufficiently large and varied to elucidate the aims of the study' [40] of exploring the impact of the CAZ.

For focus groups, the aim was to recruit a diverse sample of residents: a) to reflect community demographics, b) living within the CAZ boundary, c) living outside the boundary, d) who may face inequalities in impact of a charging intervention. Desired characteristics included

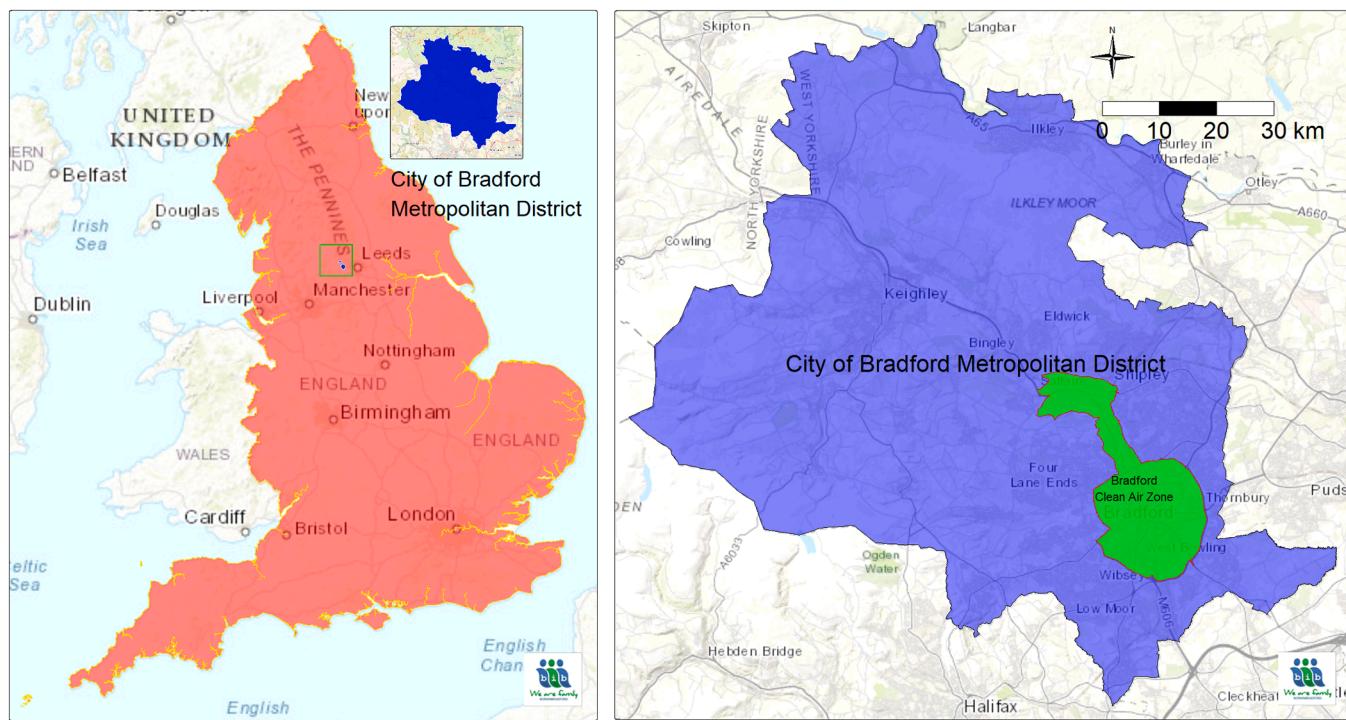


Fig. 1. Location of Bradford Metropolitan District Council in the UK and the location of the Bradford CAZ

Copyright data: Base map from Esri, HERE, Garmin, FAO, NOAA, USGS, OpenStreetMap contributors, and the GIS User Community; boundary data from the Office for National Statistics (Open Government Licence v3.0); Clean Air Zone boundary from the City of Bradford Metropolitan District Council, Contains public sector information licensed under the Open Government Licence v3.0.

Table 1
CAZs in the UK, their launch date and vehicle compliance [36–39].

Local Authority	Date of implementation	Type of zone	Vehicle types	Area size (square miles)
London Ultra Low Emission zone	First implemented 2019 Expanded summer 2023	Ultra Low Emission Zone	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses, cars, motorcycles	Covering Greater London area, square mileage not specified in government source
Bath	March 2021	C	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses	1.2
Birmingham	June 2021	D	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses, cars, the local authority has the option to include motorcycles	2.96
Portsmouth	November 2021	B	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles	1.16
Bradford	September 2022	C	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses	9.35
Bristol	November 2022	D	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses, cars, the local authority has the option to include motorcycles	1.18
Tyneside (Newcastle and Gateshead)	January 2023	C	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses	0.94
Sheffield	February 2023	C	Buses, coaches, taxis, private hire vehicles, heavy goods vehicles, vans, minibuses	0.9
Glasgow LEZ	June 2023	LEZ	All vehicles (exemptions for blue badge/disability card holders) below Euro 4 petrol and Euro 6 diesel	Approx 1
Dundee LEZ	May 2024	LEZ	All vehicles (exemptions for blue badge/disability card holders) below Euro 4 petrol and Euro 6 diesel	Approx 1
Aberdeen	June 2024	LEZ	All vehicles (exemptions for blue badge/disability card holders) below Euro 4 petrol and Euro 6 diesel	Approx 1
Edinburgh	June 2024	LEZ	All vehicles (exemptions for blue badge/disability card holders) below Euro 4 petrol and Euro 6 diesel	Approx 1

(NB: England and Scotland have different transport laws leading to a different approach in the rules governing LEZs/CAZs).

groups that reflected Bradford's predominant ethnicities, sexes, those of working age and retired, commuters, parents and non-parents, school staff, vehicle owners, non-car owners, and those with mobility issues (see Table 2). It was important to get a range of characteristics to explore a variety of experiences, and to see if any particular sectors of the

population seemed to be unequally impacted.

Through the aforementioned workshops, 'community connectors' (CC) were identified to match the characteristics that met the above requirements. The CCs were people working in voluntary and community sector organisations (VCS) or schools who had trusted, established

relationships with residents. The majority of the CCs were found through pre-existing relationships with VCS and schools. The CCs then recruited participants through word of mouth with their existing groups. Where CCs were not identified, the researcher contacted existing establishments and VCSs that worked with a desired characteristic, to ask if they would be willing to host a focus group. The researcher then attended the centre to do face-to-face recruitment. Focus groups were held in 8 locations across the city. As all but one of the recruitments took place via community connectors refusals or lack of interest were not recorded. Residents received a written information sheet beforehand and, at the session this was read aloud (accounting for differences in literacy). Residents provided signed consent. Each session was conducted in a community setting and in English, with a bi-lingual researcher available if translation was needed. Discussions lasted for one hour and residents received £20 voucher in compensation for their time. Discussion topics centred on perspectives on air pollution, understandings of CAZ, personal impacts of CAZ and Council communications. Focus groups were conducted by CK and RH.

Participants for the interviews were also identified using the aforementioned workshops. The professionals, termed 'workers' here, were thought to be directly impacted by the CAZ as their jobs involved vehicles in some capacity, or may be affected by changes in vehicle costings (e.g. tradesperson, waste disposal service, business receiving deliveries) (see Table 2). Workers were approached through email by a member of the research team and provided with an information sheet. 46 workers were contacted and 20 agreed to participate. Informed written consent was obtained prior to the one hour interviews. Workers were offered a £20 voucher for participation if self-employed or participating out of their working hours. Most interviews were conducted face-to-face with a small number conducted online according to interviewee preference. Interviews were conducted by CK and RH.

Semi-structured interview guides were devised to lead discussions and were piloted with two local businesses known to the team. The worker interviews explored pre-launch communications on CAZ, process of workplace adaptations and access to grants, and the efficacy of

the CAZ framework.

Analysis

Focus groups and interviews were audio recorded and later transcribed verbatim. Themes were constructed using an inductive approach and a coding framework was developed and continually updated during the process [41]. Initial coding was carried out independently by CK and RH, using QSR Nvivo 14 software, and a final coding framework was jointly developed. In addition, an overall summary of the interviews and each focus group were written. These were sense checked by JR through reading transcriptions and summaries of 50 % of the focus groups and interviews. (For further information on reflexivity see Supplementary Material B). Once coding was completed, findings were applied to the Context and Implementation of Complex Interventions (CICI) Framework [26] to help organise themes identified in the data. Where quotes are presented to illustrate themes, these are attributed to a focus group number (e.g. FG01) or worker ID (e.g. W05).

Results

Participants with a range of representative demographics and backgrounds took part in 8 focus groups and 20 interviews (see Table 2).

Adaptations: how have businesses and residents adapted to the CAZ?

Three main adaptations to the CAZ were identified: 1) changes in non-compliant business vehicles; 2) use of exemptions; 3) avoidance of the zone. Reports of non-adaptation came from residents with personal cars and organisations with very specialist vehicles.

Changes in non-compliant business vehicles

All organisations we spoke to who had a 'fleet' of vehicles used for business operations (like deliveries, service provision or patient transportation) changed vehicles to become compliant. Larger companies

Table 2
Characteristics of participants.

Characteristic	Worker Interviews (n = 20)		Focus groups (n = 51)		
	Count	% Group Participants	Count	% Group Participants	Both Groups Overall %
White British	10	50.0 %	24	47.1 %	47.9 %
South Asian	8	40.0 %	13	25.5 %	29.6 %
Other	2	10.0 %	14	27.5 %	22.5 %
Gender					
Male	12	60.0 %	20	39.2 %	45.1 %
Female	8	40.0 %	31	60.8 %	54.9 %
Age					
19-64	19	95.0 %	36	70.6 %	77.5 %
65+	1	5.0 %	13	25.5 %	19.7 %
Own a car					
Yes	19	95.0 %	32	62.7 %	71.8 %
Mode of travel to work					
Drive van/car	14	70.0 %	*	*	*
Walk	3	15.0 %	*	*	*
Train	1	5.0 %	*	*	*
Cycle	2	10.0 %	*	*	*
N/A	1	5.0 %	*	*	*
Other characteristics					
Identify as having a disability	*	*	8	15.7 %	*
A parent	*	*	31	60.8 %	*
School staff member	*	*	6	11.8 %	*
Occupations	Plumber, deliveries, small business, bus services, taxi driver, care management, disability representative, retail representative, small independent retail, charity manager, GP, university staff, small independent café, community centre manager, sports club chair, hospital representative, construction industry, waste services	*	*	*	*

* not collected.

were able to interchange vehicles in their large fleets, moving non-compliant vehicles out of Bradford District and compliant vehicles in.

"So we cascade new vehicles in and cascade older vehicles out so that they would meet the emissions," (W03).

Bus companies retrofitted buses to make them compliant, and reported changing their policies to avoid purchasing diesel vehicles in the future.

Many Bradford-based SMEs, including lone traders, took up grants from the local government to buy compliant vehicles. Medium businesses that took up grants to purchase new vehicles were generally pleased with the outcome, as were bus companies. However, smaller businesses were seen to have less financial capacity for change, and therefore were thought to be impacted harder as the grant did not cover the full cost of a new vehicle.

"We're quite fortunate in what we could afford it, but if you can't afford it your £4000 doesn't go a great deal towards, you know, a £30,000, £35,000 vehicle," (W04).

"I've personally had to go along and borrow money to actually swap my van around, even though there was a grant available, and even to get the grant I had to jump through so many hoops," (W07).

Some workers described changing their vehicles unwillingly, and, in the case of taxi drivers, there was perceived to be no choice; upgrade or stop working.

"It was like a gun held to your head, otherwise if you didn't comply you couldn't be a taxi driver anyway," (W11).

Exemptions

Small business owners, lone traders and campervan owners registered or living in Bradford District were able to apply for exemptions from CAZ charges to their vehicles. Most interviewed lone traders opted for exemptions, due to costs of buying a new vehicle. Exemptions were welcomed, but there was significant concern that the exemption criteria would change in the future. This prompted negativity and uncertainty regarding the CAZ, with one person saying he felt pushed into getting a grant, and a loan for a new vehicle, as he did not know what the future would hold.

Avoidance of the zone

Some residents and businesses reported changes in normal practices to avoid a charge. One construction company said they now speak to contractors on the phone rather than the contractor physically visiting in their non-compliant vehicle. A resident with a friend from outside the zone reported traveling together to avoid a charge.

"We go to the allotment. If we go in his car he would be charged so, but it's not a car, it's sort of a van type thing and it's probably old, so he parks at my house and then we go in my car," (FG03).

Many reported non-compliant business vehicles and non-exempt camper vans avoiding the zone, driving around it, or no longer coming into it.

"I don't know that many people with vans but I know two if not three of them, they drive different routes now in order not to get charged," (FG03).

Several participants felt that people living in other areas of England were avoiding Bradford for fear of being charged. A sports club hosting a national event found that people from other regions were reluctant to come, as they were afraid that their vehicles would be charged, despite reassurances from the organisers that private cars were compliant.

There were also reports of certain independent trades people no longer coming into the zone, as they did not want to pay the charge.

"I've had conversations with other people saying they can't get tradesmen ... to come in anymore because they're being charged," (W01).

A school-based focus group reported a company due to install new playground equipment pulled out as it had become economically unviable.

No adaptions were made

Within all the large organisations that had made adaptions, there were one or two non-compliant vehicles that the organisations decided to keep and accepted receiving a charge. Certain specialist vehicles could not be made compliant, such as vehicles used for towing.

"Unfortunately, there are two that we still have that do incur a CAZ charge, but we can't really swap them out, they are estates, Land Rover Defenders, and they are used to tow certain equipment," (W19).

As private vehicles were not charged within the CAZ, residents did not change their vehicles.

"I know it doesn't apply to me, so when it doesn't apply to me I kind of just don't think about it too much," (FG07).

A retail manager felt there had been little change in behaviour for residents with private cars, as there was no need to change because, *"there isn't really an effect as far as customers coming... that is, just car journeys is what the customers are doing," (SH05).*

What are businesses and residents' attitudes to the CAZ?

We identified five key themes related to acceptability of the CAZ: 1) acceptance; 2) perception that the CAZ was not a priority issue, 3) the CAZ as an ineffective intervention, 4) fairness and 5) fear about the future.

Acceptance of the CAZ

Overall, there was a general acceptance of the CAZ, albeit often a reluctant one. When asked why there was a CAZ, almost all participants said it was to reduce pollution and improve health and the environment. A small number did not know what it was and some felt it was there to 'make money' for the Council. Nearly all participants, from both focus groups and the interviews, wanted the CAZ to continue, as they could not see how pollution could be reduced without such an incentive:

"I think it's something that needs to be just like the congestion zone in London, that's never been abolished or been reduced or removed, it's there for a purpose," (W18).

When discussing potential gains, health benefits were frequently mentioned.

"Its ideals and everything is very positive. It's health, like they say health is wealth so yeah, the aims are admirable. I've got young kids, I want clean air as well," (W11).

Some remarked that the CAZ highlighted that clean air is a serious problem, and helping people start making changes to the way they travel.

"It gives us information that we didn't have before, and at least there's a boundary there to say, you know, making us think about how we use the car in this area," (FG07).

A handful of participants mentioned environmental benefits and the climate emergency.

"The pollution is incredible for, not just for us, but for wildlife, foliage and stuff like that and just, it's pretty obscene, really," (W01).

A CAZ is not a high priority

Several participants felt that air pollution was not the most important issue facing people, and therefore a CAZ was not a priority in terms of interventions the city needed. The frequently mentioned issues impacting their daily lives were financial difficulties and littering/fly-

tipping.

"So many people in Bradford, for them, their focus is around basically how to survive, how to get by and how to make ends meet. So Clean Air Zone is not a priority to them," (W17).

For some participants, this meant they felt a charging CAZ was not needed, that it was the wrong policy to be implementing and that money should be spent tackling the other issues.

The CAZ is an ineffective instrument

Several participants commented on a perceived lack of effectiveness of the policy. There was concern that by not including private vehicles, having exemptions, and having no mechanism to reduce vehicle numbers, there would be little change in air pollution levels.

"The other normal cars we are driving we are still driving, so we are still driving so we are still creating the pollution," (FG02).

Additionally, participants felt that other policy measures were not taking place which would reduce pollution: the public transport service was viewed as expensive and unreliable; there was little in the way of infrastructural provision for bicycles; and high levels of deprivation meant that residents had little disposable income to buy newer vehicles.

Furthermore, there was concern that air pollution would be blown into the zone from other areas of Bradford, making it ineffectual.

"You get a wind coming that way to blow it across, so how can they say that the air's going to be clean and it's not, and it's no fault of ours who live in that area, you know what I mean?" (FG01).

Moreover, pollution could just be displaced elsewhere by vehicles avoiding the zone or being relocated to places without CAZ.

"If all the zone is achieving is to reroute traffic, I don't see how that is actually helping the bigger picture, it will help in certain areas, but all we're doing is exporting our pollution if we're not careful," (W02).

Fairness

Corporate responsibility. All the large companies/organisations spoke of their social responsibility to protect the environment and the public, and therefore that supporting the CAZ was an obligation.

"I think we've got a responsibility to as, you know, as a key institution within the city centre to play our part with this," (W12).

Offering grants for updating vehicles was positively received as essential support for those affected.

"The Clean Air Zone is a good thing and the best part of it to me is the fact that the government are supporting people to upgrade their vehicle to it, which makes it at least easier for them," (FG04).

Relief that private cars are not charged. Although a handful of participants wished that private cars were included to further improve air quality, there was, generally, a sense of relief that private cars were not charged to enter the CAZ both from individuals:

"I think [private cars being compliant] it's a good thing compared to London where they are being, because any time, especially this time because of the cost of living crisis and everything I think people can't afford it," (W11).

and from retail businesses:

"I think if cars were included you are basically saying to businesses, 'shut your door, lock the door and go home,' because there's no customers," (W05).

Perception of penalisation. Some participants felt that the CAZ was penalising communities in a variety of ways, and specifically penalising socio-economically deprived areas, and Bradford as a region.

"Why don't they hit the rest of the Bradford, they've gone inner city, the poorest areas are hit, and it's like well we don't live there so it doesn't matter," (FG01).

"Why not Leeds, Leeds is busier than Bradford, Leeds haven't done a Clean Air Zone," (W19).

Many shared concerns about additional costs incurred by businesses being passed on to local residents. Several participants had seen CAZ charges added to their bills, for example, during building work or trades visits. Many felt taxi fares had increased, but could not say if it was directly attributed to the clean air zone.

"He paying the council, the council get his money. He charging me, he getting his money. What about me? I am losing here. As a consumer like we are losing. Business gaining, council gaining, what about me?" (W16).

Furthermore, the onus was on the driver to check if they would need to pay, with fines being issued immediately if charges were not paid, rather than a warning being given.

"People coming from out of town to work in Bradford, the first time they've been hit, they've been hit with £120 fine," (W08).

There were some cases of participants paying charges when they did not need to (e.g. they were in a private car), or when they could have got an exemption but had not been aware of the system.

Worries about the future

There was a lot of fear that, in the future, private cars would be included in the CAZ policy, or that the exemptions would cease. As a result, all drivers would be impacted financially, either to upgrade or to pay charges, with some worried they would no longer be able to afford a car. This was a particular worry for those who were reliant on their cars due to personal mobility issues and those who were not satisfied with current public transport options.

"Is the government or local Council gonna move the goalposts and say "actually your car needs to be new standard now we've found out, so we're gonna extend it?" (W11).

What factors have played a part in influencing the attitudes towards and the acceptance of the Bradford CAZ?

Using the CICI framework [26], we identified a range of implementation and contextual factors that impacted on attitudes towards the CAZ.

Implementation factors

Whilst the majority of participants agreed something needed to be done to reduce air pollution, there was some criticism of the CAZ, the form it took and the way it had been implemented.

"I think it's a great idea that has been poorly sold," (W02).

There was much criticism of communications from the Council, and of the intricacies of the way the intervention itself was devised at government level.

Communications on the practicalities of CAZ. Overall, many participants felt communications on matters such as the adaptations required from companies and the public had not been sufficient. When discussing information provided pre-launch, several people spoke of a lack of general information. The majority of residents knew the CAZ existed, but not all; of these, most did not own a vehicle. Many had found out about the CAZ through the road signs indicating the zone boundary. This, however, did

not necessarily mean they understood what a CAZ was: “*I didn’t relate it to cars at all. I heard clean air zone and I thought okay that means that this area needs to be cleaned like you know, dogs poo on our streets,*” (FG02).

Certain sectors found they were targeted with information, such as taxis, bus companies and medium businesses.

“There was plenty of information and if you was in the trade of taxi it was unavoidable, it was the hot topic,” (W11).

Others felt there was not enough information, or had difficulty accessing it. Organisations/ Companies attributed this to not having a single contact responsible for vehicles; a lack of co-ordinated national information about CAZ locations; and lack of publicity, leading to finding out about the CAZ via word of mouth.

In both interviews and focus groups there was a persistent thread of confusion over several aspects of the zone: which cities have CAZs; why Bradford had been targeted when other cities were not implementing zones; why different cities had different criteria for vehicle compliancy; the (incorrect) assumption that all cities would have the same charges as London.

“It’s different in Bradford than it is in Birmingham or to Sheffield, or even in London there’s different charges, so yeah, it can be quite confusing if you didn’t know and didn’t understand, you know, how the charging worked,” (W12).

Furthermore, there were a lot of questions over the effectiveness of Bradford’s CAZ policy, with a general lack of understanding of how such a policy could work. Potential flaws cited included: the lack of charging private cars, the exemptions, the replacement rather than reduction of vehicles, secondary air pollution and pollution from other sources.

Lack of communications on benefits of CAZ. At the time of data collection, there was much national media reporting about CAZs and the London ULEZ, with a perception that the vast majority was negative, “*it’s all bad publicity that’s had,*” (W02), and concern that this tarnished CAZs in general.

There was a criticism that information on CAZ was overly focused on the financial implications.

One participant felt all signage encouraged this, as “*you know the metric saying, ‘Clean Air Zone in operation, pay online’, how would you interpret that except, I’m going to get charged, you know, so we’re not really selling the sizzle, are we?*” (W02).

Participants did not recall seeing any information that described the potential health benefits of a CAZ, or the positive improvement in air quality. In fact, several participants felt that the CAZ had not improved air quality, or they would have been told so.

“Interviewee: But I haven’t seen any information that’s come from Bradford Council that has shown that this has worked, and that it’s worked because of A, B and C. ...

Interviewer: do you think that the clean air zone is improving air quality and health in Bradford?

Interviewee: Do you know what? I think if I was the council, I’d be letting people know if it is, so I don’t know, is my honest answer to that,” (W05).

None of the participants knew that the revenue from the CAZ was ringfenced to be spent on other interventions to reduce air pollution. Once informed, all were supportive, and many felt that, if this was known, it would improve opinion of the zone.

“Bradford Council need to ... show people why they’re doing this, and where this financial penalty, where that pot of money is being used, and what is it being used for, and I think that they’re failing on that,” (W05).

Contextual factors

Political context and trust

There was a strong element of mistrust towards local and national government which influenced participants attitudes to the CAZ, who perceived a lack of transparency, financial dishonesty, and competence in Bradford Council and other authorities.

“People do not trust authority, especially from non-white backgrounds, because of the fact that they are continuously used, betrayed, and abused in a way [call breaks up] financially, psychologically, whether prejudice, whatever, and some authorities are not trusted,” (W14).

Many participants felt that the CAZ charges and fines were a way for the local government to create revenue, rather than as a means to improve health. They had heard reports of large amounts of money being collected by the local government and were sceptical about its’ use.

“I think that rightly or wrongly the mentality of a lot of people who live in Bradford that this was the Council finding another way of getting money from the residents without actually putting anything back in,” (W19).

Socio-economic context

Many participants felt that 2022 was the wrong time to implement a charging CAZ due to the national socio-economic context, citing financial insecurity, the COVID-19 pandemic, the UK cost-of-living crisis, and Britain’s exit from the European Union. All participants mentioned financial difficulties or referred to others who were experiencing them.

“It’s been a tough, a very tough post corrective Covid, Brexit scenario, linked, overshadowed by a lot of other factors, you well know, you know about cost of living, you know about gas and electric costs, a lot of negativity,” (W18).

Socio-cultural context

Everyone spoke of financial difficulties, or referred to others who were experiencing them. However, a participant who worked for a delivery company suggested that while some people could not pay, many others did not want to pay extra money to improve the environment.

“Everyone, our customers, the consumers, all want sustainability and sustainable solutions, but no-one wants to pay for them, and I think that’s the problem,” (W13).

Participants also described Bradford’s car culture, suggesting that residents value and feel an affinity to driving.

“I think people in Bradford without stereotyping they do like their cars, their flash cars. You compare it to other cities people in Bradford do like their cars,” (W11).

One participant, a health professional, suggested that the association between health and air pollution may not be well understood by the public at large: “*...patients particularly with us have not always made the link between pollution and the impact on their health... if I’d said ‘what’re your triggers?’ they’d have said all the other things but they wouldn’t have said air pollution,*” (W10).

Table 3 summarises the key findings and the factors which influenced attitudes to the CAZ when considered alongside the CICI framework.

Discussion

We aimed to explore the impact of a CAZ on residents and workers in the first year after implementation. We found that the CAZ encouraged local and national businesses and organisation to upgrade their vehicles, in line with other research on the impact of environmental regulation [42]. The mitigations that were put in place to assist smaller business

Table 3

Summary of key findings.

What impact did the CAZ have?
<ul style="list-style-type: none"> Businesses upgraded non-compliant vehicles Exemptions used by small traders Some avoided the zone by re-routing/phone calls/vehicle sharing Limited impact on general public as private cars were not charged.
What were businesses and resident attitudes to the CAZ?
<ul style="list-style-type: none"> Majority were reluctantly supportive of an intervention to improve air quality. Pleased private vehicles were not charged. Small/medium businesses appreciated grants to enable vehicles upgrades. Larger businesses expressed their corporate responsibilities to upgrade fleets. Some felt that air quality was not a priority issue for communities. Some felt CAZ would have limited impact as a 'stand-alone' policy in the absence of other supportive infrastructure, e.g. public transport, affordability of cleaner vehicles Many felt that CAZ unfairly penalised Bradford as a city, and poorer communities, with people of low income 'bearing the brunt'. Several feared private vehicles would be charged in the future.
What factors influenced these attitudes?
<p>Implementation factors</p> <ul style="list-style-type: none"> Perceived lack of communication from the council about CAZ pre- & post-launch, leaving people confused. Perceived lack of communication on benefits of CAZ to counteract negative media stories No knowledge of impacts 6 months on. <p>Trust</p> <ul style="list-style-type: none"> Participants expressed lack of trust in authorities implementing CAZ and a belief that it was purely revenue creating. <p>Socio-economic context</p> <ul style="list-style-type: none"> The cost of living crisis meant that many felt it was not the right time to introduce the CAZ Due to high deprivation levels, many felt people would struggle to pay extra costs or make adaptations if needed. <p>Socio-cultural context</p> <ul style="list-style-type: none"> Participants spoke of an established 'car culture' in Bradford. Policies which threaten this would not be acceptable. Lack of understanding of link between pollution and health, or are not concerned about personal pollution contributions, so aren't willing to be financially penalised.

and low-income families, including grants and exemptions seemed well-used. For the majority, we found that the CAZ was accepted amongst residents and workers, at the same time as being disliked. A small number of participants felt a CAZ should not have been implemented. Key factors which influenced these views included trust in authority, financial costs, fairness and socio-cultural factors.

Our findings suggest that the CAZ operated broadly as expected, encouraging businesses to upgrade vehicles; this is reflected in analysis of the first years impacts on levels of NO₂ in the city, which improved, perhaps as a result of the CAZ. However, there were some examples of less desired consequences reported, for example, passing on increased costs to consumers, and possible displacement of pollution at national scale, as vehicle leasing companies and national businesses relocate vehicles to areas without restrictions, (possibly resulting in unreported economic impacts to some businesses). (Further research is being conducted to analyse the economic impact of the CAZ and should be completed in 2026 [27]).

Understanding the potential adverse or unanticipated impacts of implementing a CAZ is vital to enable mitigations. The Bradford CAZ was informed by research with seldom heard communities [33] which highlighted early concerns for low-income communities, and also the many other competing priorities that communities face in their daily lives. The research was used by civil servants developing the plan to include mitigations, for example, not charging private vehicles and exemptions for Bradford residents, and enabled the Local Authority to draw down the maximum possible funding to be given in grants to support businesses to upgrade vehicles [14]. However, despite these efforts, some of our participants still felt that smaller businesses did not find these mitigations to be adequate. This highlights the importance of continued dialogue with workers from before policies are developed to after an intervention has been implemented to ensure it is working as intended, with flexibility in policies to accommodate further adaptions if needed.

In line with recent survey findings [21], we found that there was overall support from those interviewed about the need for the CAZ. The clearest perceived benefit of the CAZ was having cleaner air, with subsequent hopes for improved health. A handful of participants also referred to a reduction in emissions that contribute to climate change.

Larger business spoke of a corporate responsibility to tackle pollution and implemented significant changes, including changing a bus company procurement policy. This suggests corporate social responsibility could provide some leverage for encouraging change in business settings. However, despite overall support, negative aspects of the zone dominated discussion in interviews and focus groups.

A majority of participants expressed a lack of trust of the local authority implementing the zone. This manifested in beliefs that a) the CAZ was not being implemented to improve air quality, but instead to gain revenue, and b) that it was not implemented well, nor in the best interests of Bradford citizens. Much of these negative attitudes played out in social media and there was a lot of negative media press at the time. Recent research has highlighted the deep mistrust of politicians [17,43] and the potency of online (mis)information in relation to transport policies in the UK, with dominant themes including alternative facts, suggesting that these schemes increase pollution, 'rip off' tax-payers and includes worrying content, such as encouragement of violence and portrayal of an 'evil' state organising these changes [43]. It is possible that if implementers made more use of alternate information sources, (e.g. research institutes, health organisations and citizens associations) they may be preferable to relying on those from local authorities or Government [44].

As previously found [21,33] cost was a key concern amongst communities and local businesses (the cost of replacing vehicles, fines, increases in bills) and was compared with essential costs, such as buying food. Additionally, there was a lack of understanding about why the zone was needed. CAZs were a new policy in the UK and few were implemented in England, leading to feelings of penalisation. Key to the perpetuation of negative attitudes was a perceived lack of communication about the beneficial impacts of the zone. Knowledge about the benefits is difficult for people to observe as air pollution is mostly invisible, health and environmental gains are longitudinal, and the CAZ did not perceptibly (and did not) decrease the quantity of vehicles on roads. This intangible knowledge is in direct contrast to monetary costs, which are immediate and understood. (Post data collection, it was found that air quality had improved and visits to health services for respiratory and cardio-vascular conditions had declined [45]. It is not known how widely known these findings are).

Effective public communication about the benefits of CAZ will be vital for ongoing acceptability. Riley et al [44] recommend using targeted and localised information, positive framing of messages, and engendering a sense of collective responsibility. If awareness and understanding of the intervention and the reasons for it can be increased, combined with methods to make it fairer, and for it to be delivered by more trusted organisations, attitudes towards these types of interventions may improve. Storytelling, providing short case studies on individuals, rather than the provision of statistics, has also been evidenced to have a strong appeal [44]. If information on the health benefits is not available in the short term, other stories may help, such as the number of taxis that have changed to hybrid or electric, or the number of new compliant lorries.

Based on our learning we have identified a number of recommendations for communication, (see Table 4).

Strengths and limitations of the research

Our study has several strengths. To our knowledge it is one of a small number of studies to explore the experiences and attitudes towards a CAZ post implementation. The qualitative nature of the study provides rich insights from a broad range of workers and residents, helping to identify critical problems, and recommendations, that could help future cities developing CAZ. Given the increasing number of cities tasked with implementing CAZ both in the UK and Europe, our findings are relevant to other areas. We gathered information from 71 individuals with a great diversity of backgrounds, including residents, businesses and institutions and voluntary sector and statutory organisations. Our research followed best practice in conducting and reporting research [46].

There were some limitations. Our focus groups and interviews required individuals to agree to participate; thus, there could be self-selection bias with a vested interest to complain or approve. We tried to remove this bias by offering payment for participation as an encouragement, as well as recruiting through face-to-face contact at some centres where we had previously not engaged. Participants were assured anonymity in an attempt to enable them to feel they could speak freely, although this does not counter for social pressure to conform to norms within a group setting. A wide variety of views were heard, suggesting a level of comfort in the giving of opinions. We focussed on attitudes within one city, whereas different attitudes and reasons for these could be found in other areas. We sought to counter this by applying the findings to the CiCi Framework to help identify factors which could exist in other areas. This was a qualitative study reporting perceptions and beliefs about the impacts of the CAZ. It will be important to track the observed impacts of CAZ on pollution, attitudes and health using quantitative methods to gain a greater understanding of the value of these policies.

Table 4
Recommendations for improving attitudes towards CAZ.

1. Sell the sizzle - promote the good stuff
As a resident said, we are not selling the sizzle. Emphasis should be placed on communicating the planned benefits of CAZ: for example, an improvement in air quality, and subsequently, health; reduction in noise pollution (also harmful to health) achieved through increases in electric vehicles; reduction in the harmful greenhouse gases fuelling climate change; improvements in bio-diversity due to air quality improvements and noise reductions.
2. Regular communications – is it working?
Information on the positive gains from the intervention after it has been implemented should be made public as soon as possible. Data on air pollution may not be available for a relatively long period, of at least a year. Developing other means to communicate the gains is necessary. Infographics showing the increase in hybrid or electric vehicles, or the amount in money of the grants given out could all be widely used. A spectrum of mediums should be used for this to ensure the broadest engagement possible, including traditional methods such as billboards, and publicity stands at significant public events, as well as social media platforms.
3. National communication
A reduction in accidental fines (from non-compliant vehicles that visit from outside of the area) could be achieved through a national communication campaign that addresses why CAZs exist, where they are located and information that charges are variable.

Conclusion

This paper sought to explore the adaptations and attitudes of Bradford residents and businesses to the introduction of a CAZ. We found that larger businesses had the capacity to adapt fairly easily, whereas small traders struggled. While people felt that a CAZ was needed, predominantly from a health perspective, they also had many complaints. Negative attitudes could be attributed to a lack of understanding of the way the intervention worked, feelings of unfairness, lack of trust in those implementing the intervention and communication issues. Ways to improve attitude towards CAZs include changes in communication, and coproduction of the intervention at various stages of its implementation. Policies such as CAZ operate within a complex system and it is important to systematically capture wider impacts, both positive and negative to get an understanding of the overall success of the policy. This paper contributes to the growing literature on attitudes towards CAZs and other TDMs in an attempt to address growing health and climate needs both in Europe and across the world, as increasing attempts to improve lives and reach net zero are initiated.

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CRediT authorship contribution statement

Cathy Knamiller: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Rumana Hossain:** Writing – review & editing, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Josh Robinson:** Writing – review & editing, Formal analysis. **Maria Bryant:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Rosemary RC McEachan:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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