MANCHESTER 1824
The University of Manchester

Manchester Urban Institute

Governing Urban Transformation

Analysing the 'Low Emission Zone' tool for the Manchester City Council.

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1. Executive Summary

Manchester's air quality has come under close scrutiny with it being viewed as having some of the worst levels in the UK. Research has been conducted that shows that current levels of air pollution are having significant impacts on public health. Furthermore, the European Union (EU) have passed legislation, which all member states must adhere to that includes air quality. Manchester City Council (MCC) has taken the issue very seriously and in partnership with the Greater Manchester Central Authority (GMCA) has developed a number of policy documents advising on a number of approaches to improving air quality. Within these documents MCC have highlighted that the potential implementation of a Low Emission Zone (LEZ) could offer the improvements to air quality the region requires.

Therefore this report has been developed to firstly analyse the scale of the air quality problem in Manchester and then to analyse how the implementation of the LEZ tool in London and Lisbon, with a view to using this data to further inform MCC on how an LEZ can be implemented in practive. At the end of the report a number of suggestions have been included aimed at aiding MCC's research into LEZ's and also advising on their strengths and weaknesses.

1. Introduction

In 2008 the EU developed the 'Air Quality Directive' which set air quality targets for certain gases, which each member state must adhere to under EU law (EU, 2008). The most harmful of these gases to human health which this report will be focussing on are Particulate Matter (PM10) and Nitrogen Dioxide (NO2) which the EU targets can be viewed in Table 1.

Pollutant	Obligation	Time period	Compliance deadline	Permitted annual exceedences
Nitrogen dioxide (NO_2)	Hourly limit value of 200 µg/m³	1 hour	01/01/2010 (possible extension to latest 1/1/2015)	No more than 18
	Annual mean limit value of 40 µg/m³	Calendar year	01/01/2010 (possible extension to latest 1/1/2015)	n/a
Coarse particulate matter (PM_{10})	Daily limit value of 50 µg/m³	24 hours	01/01/2005 (possible extension to 11/6/2011)	No more than 35
	Annual mean limit value of 40 µg/m³	Calendar year	01/01/2005 (possible extension to 11/6/2011)	n/a

Table 1. EU directive air quality targets for NO2 and PM10 (Climate Earth, 2014).

The reason why PM10 and NO2 has received so much attention is that has been increasing evidence that these gases are extremely harmful to public health, especially the young and the elderly, and have also been linked to causing premature death (WHO, 2005; Wilkelstein et al, 1982; WHO, 2013).

In a report developed by Public Health England into mortality rates caused by air pollution Manchester was highlighted as a hotspot for poor air quality (PHE, 2014). Figure 1 has been adapted from the reports data and shows Manchester had the second highest emissions of PM2.5 (a smaller reading of PM10) in the country outside of London and also the second highest percentage of deaths caused by PM2.5 outside of London in the year 2010.

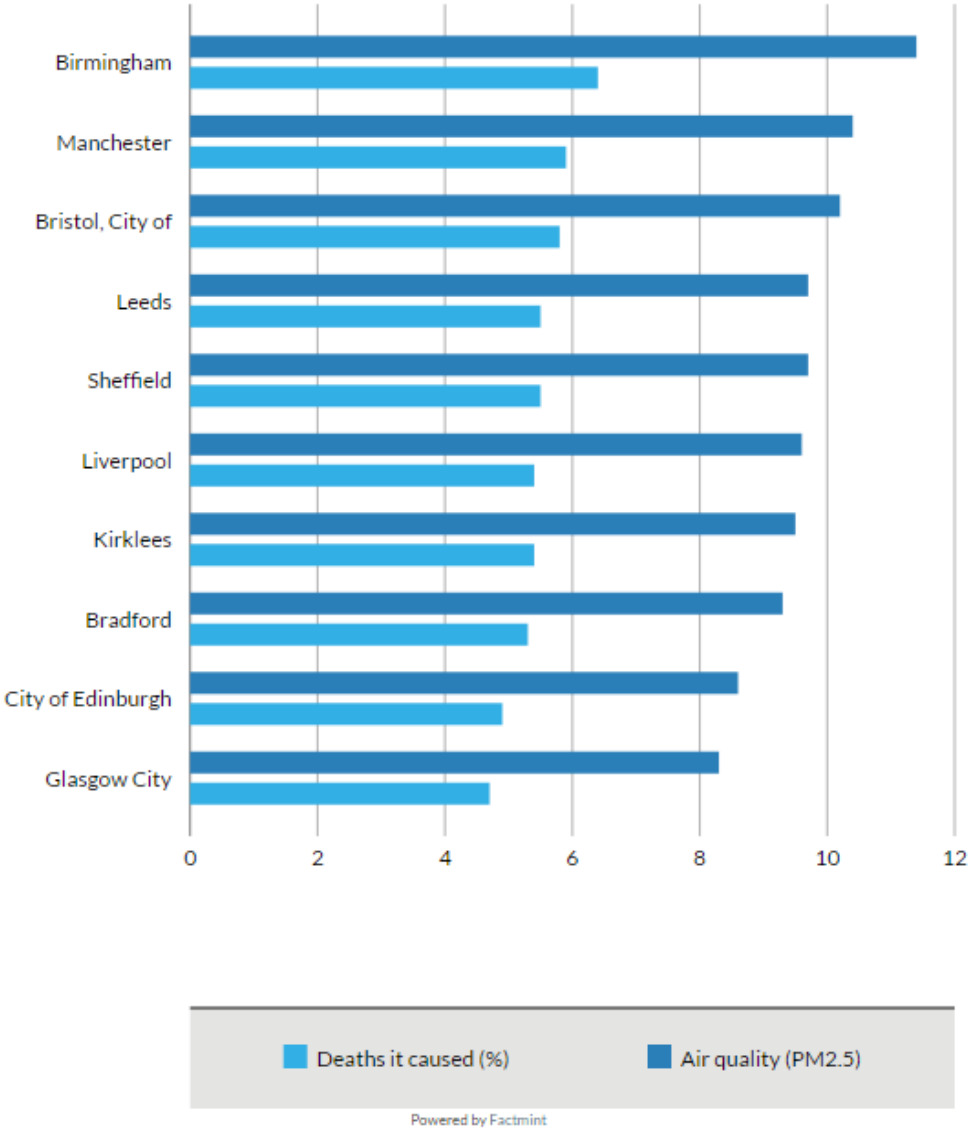

Figure 1. Data showing the highest levels of particulate matter outside of London and also the % deaths caused by it (Jawad and Kirk, 2015).

Furthermore, data collected from the Air Quality England website, shows that over the last year Oxford Road, one of the busiest roads in central Manchester has breached EU directive targets on numerous occasions. Figure 2 represent the NO2 levels and Figure 3 represent the PM10 levels recorded between July 2016 and April 2017. Figure 2 has been amended to include lines to roughly represent the EU directives targets.

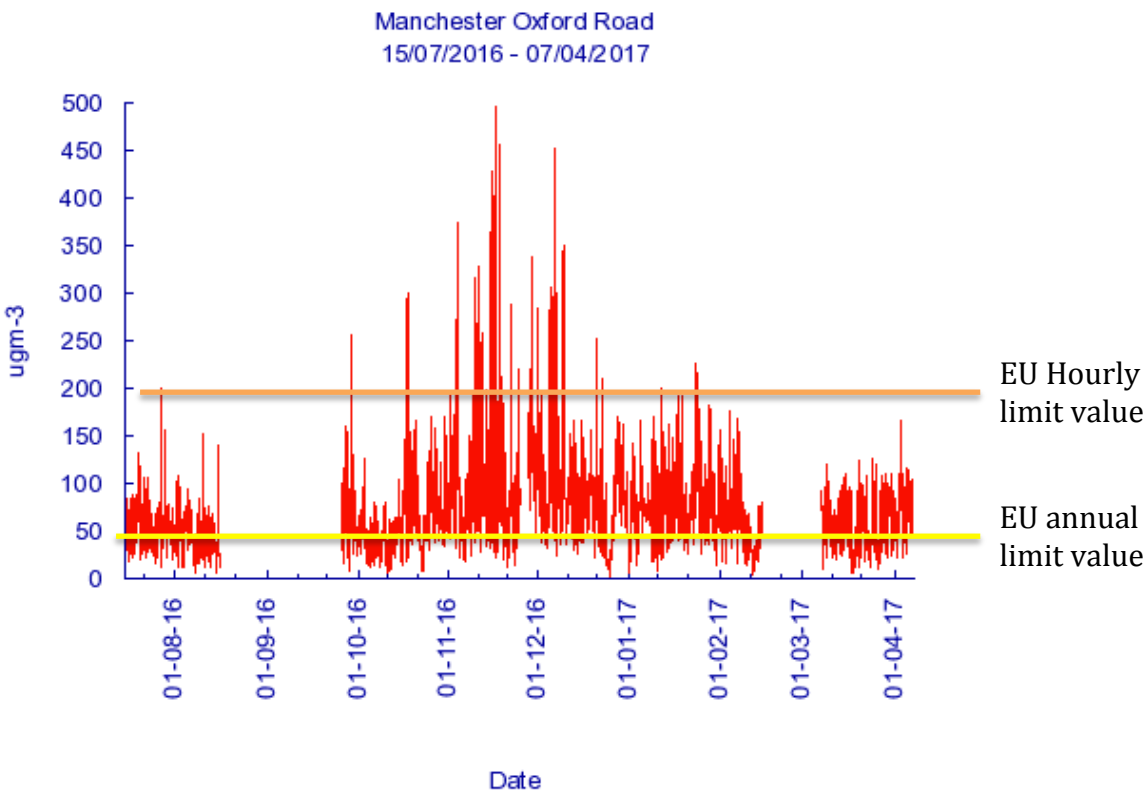

Figure 2. NO2 levels on Oxford Road from 15.07.2016 to 07.04.2017 (AQE, 2017).

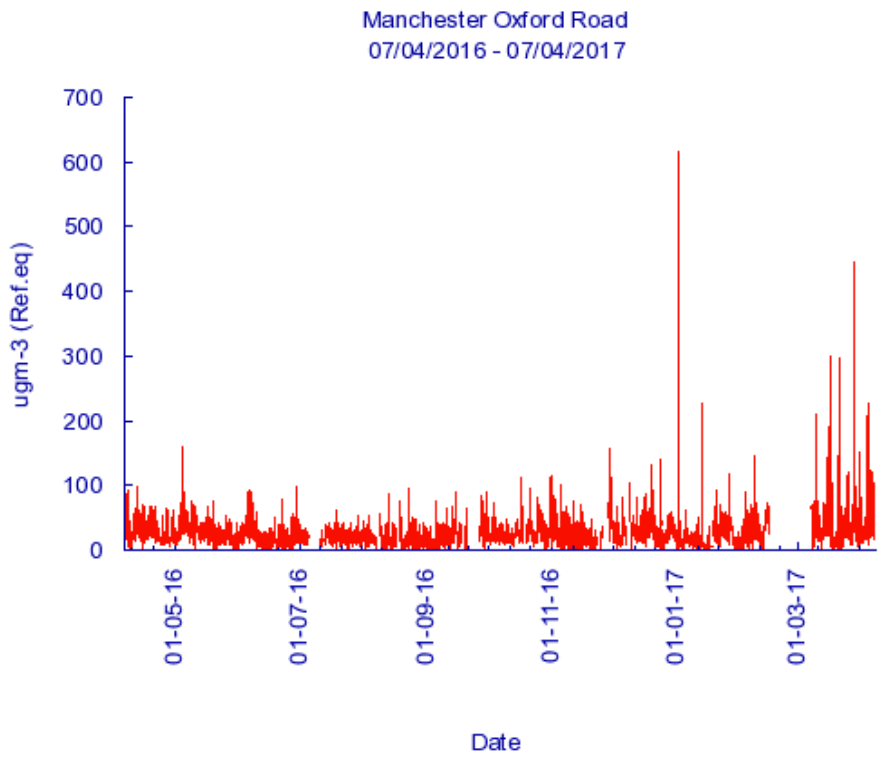

Figure 3. PM10 levels on Oxford Road from 15.07.2016 to 07.04.2017 (AQE, 2017).

Road traffic has been found to be the most dominant cause of PM10 and NO2 emissions (Xia et al., 2015: Zhang and Batterman 2013). Therefore, In response to the issue MCC and the wider Greater Manchester Central Authority (GMCA) have suggested that the implementation of a low emission zone (LEZ) which is a traffic control related policy could potentially improve air quality in the region (GMCA, 2016; Cox: 2017). An LEZ is a specific zone that restricts access for some vehicles depending on the vehicles emissions standards. In Europe the adoption of LEZ's has been widely accepted as the most important measure a city can take to improve air quality (Holman et al., 2015).

Therefore this report has been assembled to review the LEZ tool for to aid MCC's research into the tool by analysing two case studies of its implementation and resulting effects, these are in London, UK and Lisbon, Portugal. By analysing a number of factors this report will consider how effective both these LEZ's have been in improving air quality and ultimately

reaching the EU directive targets in these cities. The paper will then use the information collected from this analysis to make suggestions for how the MCC could potentially implement an LEZ and what potential problems its implementation could face

3. Context

One of the main reasons why air quality has become such a prominent issue for the EU and the UK is that exposure to PM10 and NO2 can have detrimental effects to human health. It is estimated that the current levels of PM10 in the EU cause around 348,000 premature deaths a year (Wolff, 2013) and in 2013, NO2 emissions caused almost 70,000 alone (Crisp and Matthews, 2017). Focussing on Manchester it has been reported that 458 people die a year prematurely from the effects of air pollution, which is more than obesity (Cox, 2016). These health problems also have a considerable impact on the economy, reportedly medical care for air pollution related illnesses amount to around £16 billion per year in the UK (DEFRA, 2013). Furthermore, it has been highlighted that air pollution is causing significant negative effects to the environment as well, as it disrupts a number of natural ecosystems across the country (DEFRA, 2007: Cox et al., 2016).

Although there is mounting evidence that poor air quality is causing a number of social, economic and environmental problems across the UK, the government has so far failed ‘to grasp the serious impacts of poor air quality on British people’ (Smith, 2016), with their most recent policy proposal to tackle air pollution being rejected and labelled by London Mayor, Sadiq Kahn as ‘woefully inadequate’ (Carrington, 2017). In contrast the MCC have taken a number of steps to improve air quality in the local region and have recently developed a document in partnership with Transport for Greater Manchester suggesting that the implementation of an LEZ could improve air quality in the region (Cox, 2017).

The way LEZs work is by restricting certain vehicles that do not meet predetermined emissions standards within a defined geographical area, and they are enforced by either charging or banning the restricted vehicles (Malina

and Scheffler, 2015). Historically the first LEZ's were introduced to Europe in 1996 in Sweden, who imposed them in three major cities with their purpose being to ban older Heavy Duty Vehicles (HDVs) from particular areas of the cities to potentially improve air quality. There are now currently over 200 in Europe and they are considered to be one of the best approaches to improve air quality in urban areas (Holman et al., 2015).

The GMCA which the MCC are part of released the 'Greater Manchester Air Quality Action Plan' in 2016 which proposed various approaches to improving the regions air quality, which as Figure 4 represents, rates the LEZ as the second best approach to potentially improve air quality and also reduce carbon to help tackle climate change (GMCA, 2016).

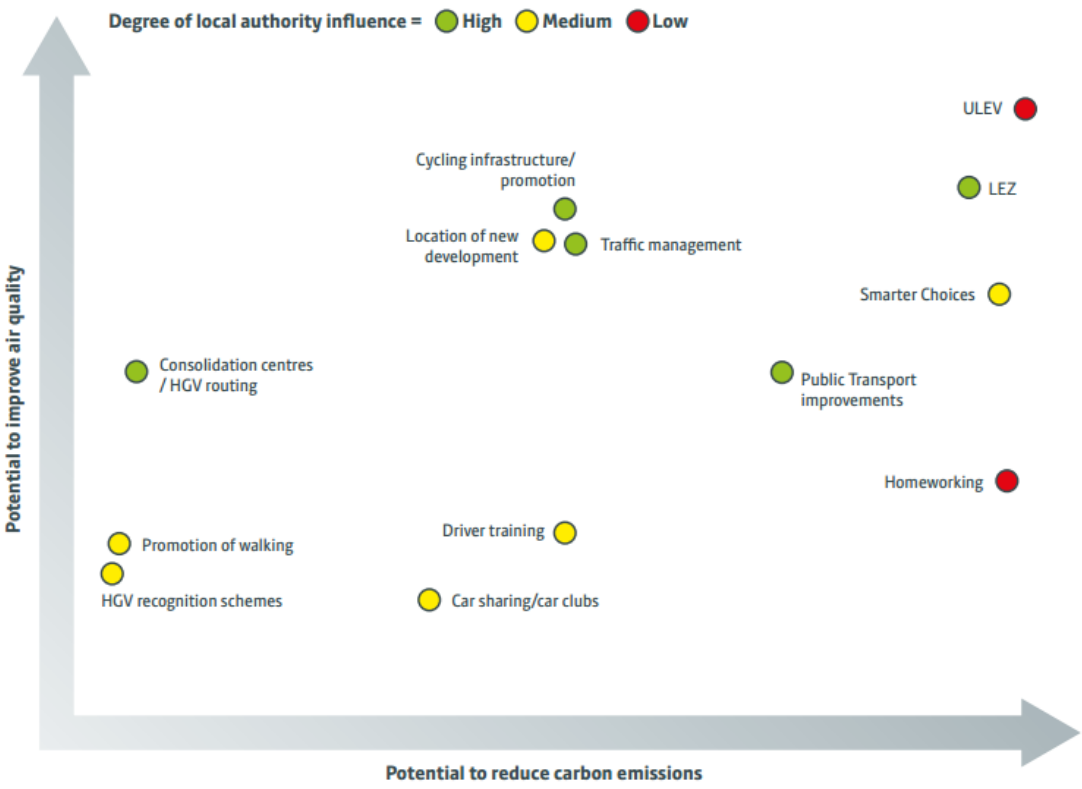

Figure 4. GMCA comparison of potentially improvements to air quality and reductions to carbon emissions different approaches could have (GMCA, 2016).

Therefore a review of the tool is required to inform the MCC and the wider GMCA if the tool has the potential they consider it may have to improve the regions air quality. There is evidence to suggest that the implementation of an LEZ offers considerable advantages in regards to tackling the air quality issue (Clear Air, n.d). Furthermore, research completed into the effectiveness of alternative traffic control methods to the LEZ suggests that they had 'no effect' in improving air quality in those regions **(**Wolff, 2013). Although, in a substantial study conducted by Holman et al. (2015) which considered the implementation and effectiveness of a number of LEZs across Europe it was concluded that LEZ's had done little if anything to the reduce NO2 and PM10 emissions in a majority of the studied areas. Wolff (2013) therefore advises that due to the uncertainty over the effectiveness of LEZ's it makes it difficult to produce 'informative…policy options and to gain public support' (Pg. 482) for this approach.

Given that the MCC lost a referendum on the implementation of a congestion charge in the region by a landside in 2008 (BBC, 2008) It is evident that drivers would be weary of any changes to traffic management policy in the region, especially if it involved them being charged. Furthermore, MCC would want to avoid a negative public reaction to any imposed scheme, therefore this reports review of the LEZ's implementation and effectiveness is essential to ensure the MCC can make as informed decision as possible on the issue.

4. Methodology

The research for this paper has been designed with an academic approach that has utilised secondary data including scientific reports and policy documents related to air quality, furthermore it will also include information from media outlets, including online and newspaper articles.

4.1 Case Study Selection

There are various types of LEZ's that operate across Europe, therefore it was decided for this paper that a more concise review of two different LEZ's would be more beneficial to the MCC than a wide review. Hence, this report will

focus on two European LEZ's in operation; these are London, UK and Lisbon, Portugal.

The reason why these LEZ's were chosen was for four main reasons. (1) Both cities have implemented the LEZ as a measure to achieve the EU directive targets for air quality, which MCC are trying to achieve as well, (2) the LEZ's are implemented in different ways, (3) both cities can relate to Manchester, London because it is in the same country therefore will have similar breakdown of vehicles, Lisbon because the area the LEZ has been implemented in is roughly the same size as Manchester, (4) both LEZ's have been in operation long enough to have had reports written about their effectiveness, therefore there is a literature to present an analysis from.

4. 2 Key Performance Indicators

To review the effectiveness of the LEZ's in the chosen case study areas this report will use a set of Key Performance Indicators (KPI's), which have been set out in the 2016 GMCA 'air quality action plan' by which they believe achieving these will improve air quality in the GMCA region. These are, (1) Reduce Traffic, (2) Increase Efficiency, which will be referred to in this report as lower emissions and, (3) Improve Fleet, which means to promote the swapping of older vehicles to less polluting newer vehicles. The reason why these have been chosen is because the MCC was complicit in the production of these KPI's, and also it gives an understandable structure to the report and what it is analysing.

Furthermore the analysis will also consider the effectiveness of the LEZ's in regards to the health, economic and governance impacts where information is available, and also ultimately if the LEZ's have helped the cities achieve the EU directive target.

5. Case study analysis

The analysis of each LEZ has been split into two separate sections; the first gives a brief explanation of the implementation of the LEZ, which will give some context to the results and also further inform the MCC. Second, the results of how effective these LEZ's have been in achieving the set out KPI's will be reviewed under there own subheadings, there will also be a fourth heading which will given an overall review of the findings and how they relate to key issues surrounding air quality and most importantly if it has helped that region hit the EU directive targets.

The report will allude to Euro standards for vehicle emissions during the analysis; these are explained in Table 2.

Emissions standard	Applied to new passenger car approvals from	Applied to all new registrations from
Euro 1	1 July 1992	31 December 1992
Euro 2	1 January 1996	1 January 1997
Euro 3	1 January 2000	1 January 2001
Euro 4	1 January 2005	1 January 2006
Euro 5	1 September 2009	1 January 2011
Euro 6	1 September 2014	1 September 2015

Table 2. EU vehicle emissions standards (RAC, 2017)

5.1 London

5.1.1 Implementation

Before the LEZ was implemented a number of reports were commissioned by the government to consider the business and economic impact (SDG, 2006), health (AEA, 2006) and feasibility (MCA, 2009) of an LEZ. The findings of these reports concluded overall that the implementation of an LEZ would be beneficial for the city (Ellison, et al. 2013). The LEZ was implemented in early 2008 becoming the worlds largest, and covered the area shown in Figure 5.

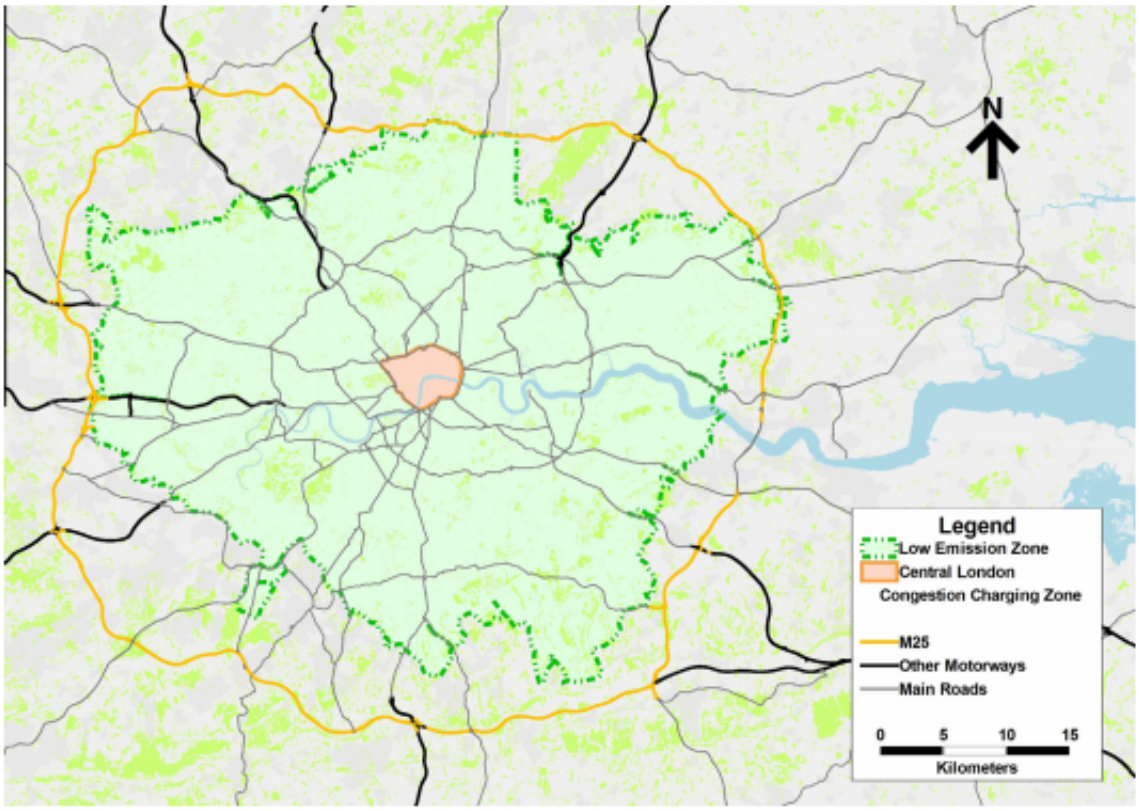

Figure 5. Map showing the size of the implemented London LEZ (Ellison et al, 2015)**.**

Initially in the first stage of implementation in early 2008 heavy goods vehicles (HGVs) that weighted more than 12 tonnes were restricted, this was then expanded in July 2008 to include other goods vehicles, buses and coaches that weight more than 3.5 tonnes. These restrictions only applied to these

vehicles if they were using diesel and biodiesel fuels, and also that they complied with the Euro III emissions standards (Jones et al., 2012). Owners of vehicles not compliant with the minimum standards who nonetheless choose to enter the LEZ were required to pay a charge for each day they travelled in the zone. Currently the charge is £100 for large vans or £200 for heavy vehicles. If these charges were not paid that day the driver could receive an increased fine of £500 for smaller and £1000 for large vehicles (Ellison et al., 2013). The LEZ is operational 24 hours a day and is enforced using camera technology.

5.1.2 Results

5.1.2 (i) Reduction in Traffic

There is very little data available relating the implementation of the LEZ to a reduction in traffic within the zone. Although one report does mention that within the first two year of the LEZ's implementation there were no signs of traffic reduction within the zone (Jones et al., 2012).

5.1.2 (ii) Lower Emissions

There has been a marginal improvement in London's air quality with data showing reductions in concentrations of PM10 and NO2. As shown in Figure 6 (next page) which represents PM10 and Figure 7 which represents NO2 data from before the LEZ implementation in 2008 to after in 2011.

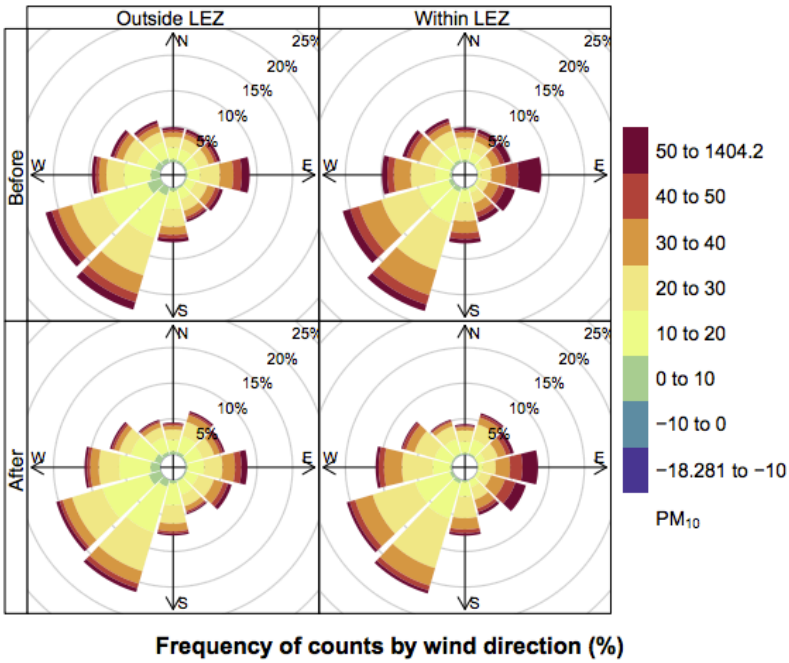

Figure 6. PM10 levels inside and outside the London LEZ pre 2008 and after 2011 (Ellison et al., 2013)

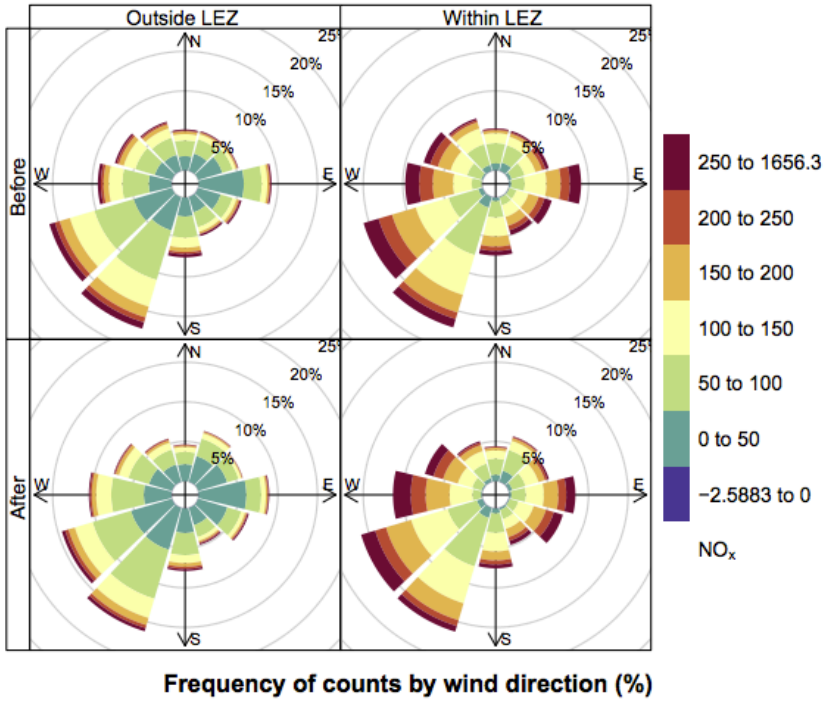

Figure 7. NO2 levels inside and outside the London LEZ pre 2008 and after 2011 (Ellison et al., 2013)

From this information it is evident that a reduction of PM10 is more within the LEZ than outside, suggesting that the LEZ's implementation caused this decrease, but there is only a very small decrease of NO2 levels observed inside the LEZ to outside (Ellison et al., 2013).

5.1.2 (iii) Improve Fleet

It has been reported that there has was a noticeable improvement in vehicle users upgrading from older to newer vehicles after the implementation of the LEZ (Ellison et al., 2013). It was also reported upon the introduction of the LEZ around 1% of the entire effected vehicle fleet was upgraded between 2007 to 2009 (Jones et al., 2012). The LEZ has also reportedly lead to a noticeable switch from larger vehicles to smaller vehicles, which has also led to the increase of the number of vehicles above the Euro III standard being used (Ellison, et al., 2013).

5.1.2 (iv) Overall Effects

Although, there are signs from this analysis that the LEZ had improved PM10 and NO2 emissions the LEZ ultimately failed to have a significant impact in helping London achieve the EU directive targets (Holman et al., 2015). Furthermore, a study into the effect the LEZ had on improving health of children in highly polluted areas of the city concluded the LEZ had had no effect on improving their health (Wood et al, 2015). This is further backed up by a recent report, which found that hundreds of nursery's and schools within the capital are still subjected to very dangerous levels of air pollution (Laville et al., 2017).

In regards to improving fleet the LEZ was created as an additional incentive for organisations to replace their existing vehicles with newer and less polluting ones. But it has been argued that the LEZ is causing economic damages to smaller businesses as they struggle to improve their fleet with no financial aid from the government (Nakamura and Hayashi, 2013).

It comes as no surprise that the local government in London have now promoted an Ultra Lower Emission Zone (ULEZ) which would restrictions on other polluting vehicles, this has been announced to launch in 2020 (BBC, 2017). Although, the ULEZ has been met with some resistance, as it is believed on its own it will not achieve the EU directive targets (Hill, 2014). One reason for this is due to the fact London taxi's are made exempt from the restrictions, which as some of the cities highest emitting vehicles has made some people very angry (Lydall, 2017).

5.2 Lisbon, Portugal

5.2.1 Implementation

The Lisbon LEZ was implemented in areas where the highest levels of PM10 and NO2 were found. Therefore before its implementation the local council carried out a number of traffic studies across the city to help characterize the volumes and origins of air pollution (Nunes Da Silva, 2014). This led to an agreement that the first phase of the Lisbon LEZ should be implemented, which took place in 2011, where pre-Euro 1 also referred to as Euro 0 emitting vehicles were banned from entering the area defined as 'LEZ zone 1' in figure 8. This was then followed in early 2012 by the development of a second much larger zone, which required vehicles to be at least Euro 1, to enter LEZ zone 2 and to be at least Euro 2 to enter LEZ zone 1 (Ferreira et al., 2012).

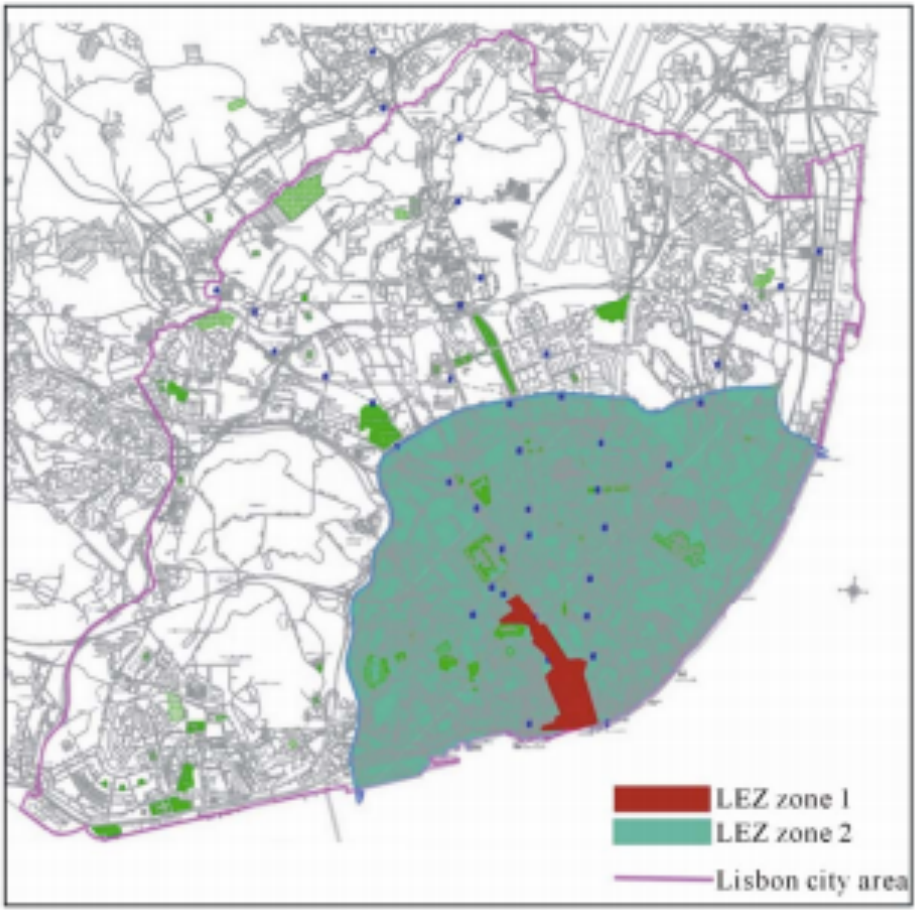

Figure 8. Map of Lisbon LEZ in relation to the size of Lisbon (Feirreira et al., 2012)

The ban meant that all vehicles were affected by the legislation, regardless of fuel type. Also the LEZ operated between 07:00 to 21:00 and only on weekdays (Monday – Friday). It was enforced manually by the Lisbon Police Department (Ferreira et al., 2012). With fines for non-compliance ranging from 25 euros to 125 euros (Goncalves, 2014).

5.2.2 Results

5.2.2 (i) Traffic Reduction

As figure 9 Shows from a study completed by the Universidade Nova de Lisboa (UNL) (The New University of Lisbon) after 'LEZ zone 2' was implemented in 2012 there was a significant dip in traffic numbers, but the following years it began to rise again, with it rising above pre-LEZ levels in 2015.

Figure 9. Traffic data showing the average number of vehicles inside the Lisbon LEZ zone per day (FCT, 2016).

5.2.2 (ii) Emissions Reduction

Using further information from the UNL study Figure 10 Shows that there were recorded reductions in both PM10 and NO2 levels in 2012 a year after the LEZ was implemented.

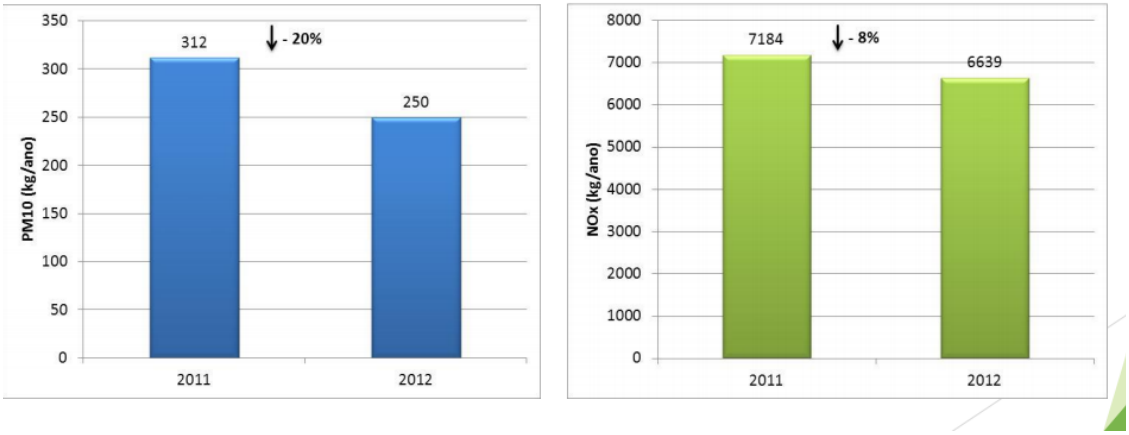

Figure 10. Graphs showing the reduction in PM10 and NO2 in Lisbon before and after the LEZ's implementation (FCT, 2016).

Furthermore the PM10 reductions within the LEZ between January 2011 and December 2013 were more significant, although this was not the same for NO2 which can be seen in Figure 11. (Feirreira et al., 2015).

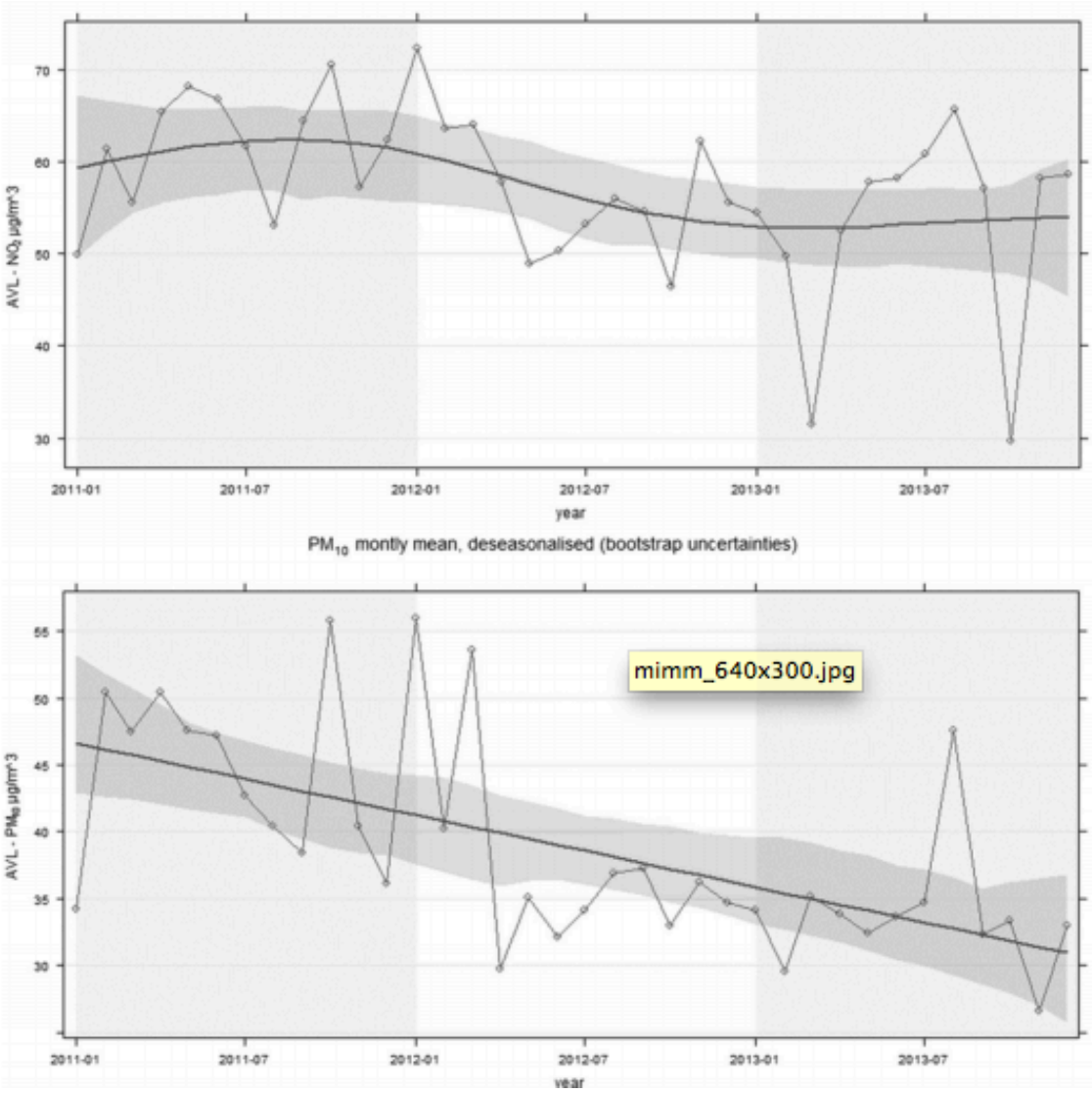

Figure 11. PM10 (bottom graph) and NO2 (top graph) readings from inside the LEZ from January 2011 to July 2013 (Feirreira et al, 2015).

5.2.2 (iii) Improve Fleet

The results from Feirreira's et al (2015) report from that from road traffic characterization indicate that there was a change in the make up of the traffic within the LEZ with a noticeable drop in the number of HDV's shown in figure 12.

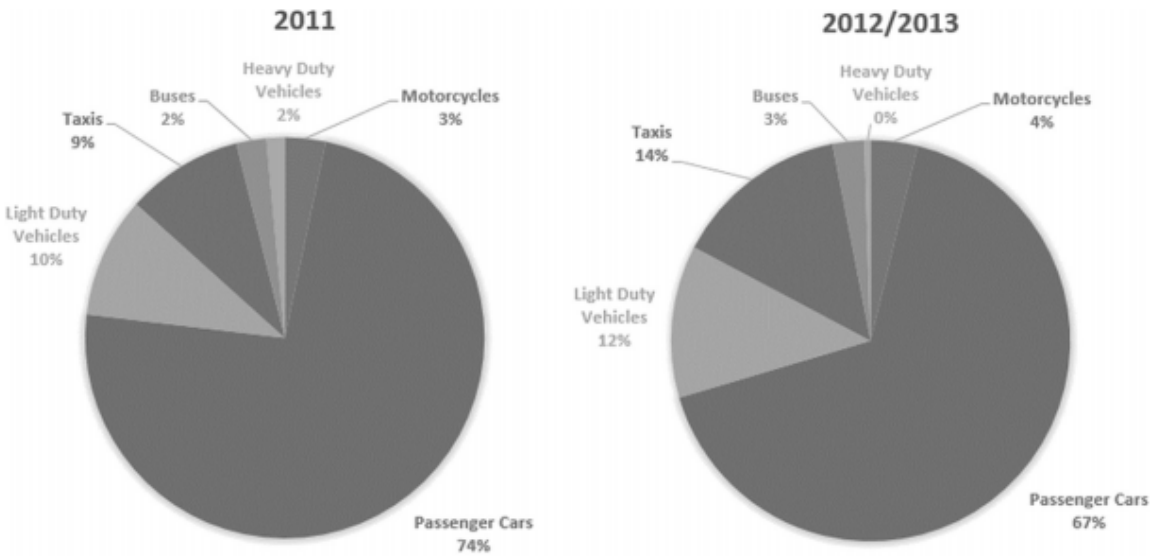

Figure 12. Pie charts representing the breakdown of vehiceles used within the Lisbon LEZ in 2011 and then in 2013 (Ferreira et al., 2015).

Furthermore, reports found that there was an increase in the use of EURO 4 and EURO 5 vehicles within the LEZ between 2011 and 2013. (Feirreira et al 2015)

5.2.2 (iv) Overall effects

The analysis finds that against the KPI's set out in the methodology of this report the Lisbon LEZ has had an impact in achieving lowering emissions and improving fleet, but not on traffic reduction, which has gone up since. Also like London although Lisbon's air quality is improving it is nowhere near enough to hit the EU directive targets.

This is due to a number of reasons, firstly it is argued that the first zone implementation was not fit for purpose, but as Nunes da Silva (2014) advises that the main goal of the first phase of implementation was to have a 'break of the inertia in this subject' (Pg.138) instead of leading to sizeable emissions reductions, therefore implying the LEZ is a much longer term project and is still only in its infancy. Another reason why the emissions reductions and fleet improvement has not been as dramatic as might have been is expected is that due to the exemptions drawn up in the policy residents who live within the

LEZ do not need to upgrade their vehicle therefore there is an unknown number of Euro II or below emitting vehicles in use that are unaffected by the policy (Feirreira et al., 2015). Furthermore, Lisbon taxi's account for a third of total emissions of all cars within the LEZ, yet they are exempt from restrictions (Nunes da Silva, 2014), clearly there is a powerful vested interest from the taxi firms to stop the taxi's being effected by the LEZ, which is not helping the reduction of emissions (Goncalves, 2014).

There are also enforcement issues, as It is argued that the reason why the LEZ has not had the effect the local government is due to poor enforcement as the resources of the Lisbon police department are stretched therefore keeping up the LEZ rules is very low on their priorities (FCT, 2016)

Due to enforcement issues and also general failure of the current LEZ to achieve the EU directive targets there is an argument that the 3rd phase of the Lisbon LEZ needs to be implemented. This phase will not change the rules to the current implementation but it will add automatic enforcement, using number plate recognition (Goncalves 2014; Nunes da Silva, 2014).

6. Conclusions and Suggestions

This study can conclude that both the LEZ's in review have had some success in achieving the KPI's that were set out in the methodology of this report. Although, none of the improvements attributed to the implementation of the LEZ are significant enough to have hit the EU directive air quality targets or led to any proof that an LEZ can improve public health. Furthermore, it is evident from the research that both municipalities are eager to implement the next phase of air quality actions whether it be a ULEZ in London's case or a 3rd phase in the case of Lisbon.

Therefore given this information this paper can offer some final suggestions to MCC to consider when going forward with the potential implementation of an LEZ:

- The MCC implementation process must start with a thorough review of pollution levels across the city and also reports into potential economic, environmental and health benefits an LEZ could bring.

- There must be a focus on strong governance, both Lisbon and London's LEZ's failed to achieve the targets they set due to too many exemptions. For example, the taxi fleets in both cities were some of the highest emitters yet remained exempt. Evidently for an LEZ to work the highest emitters must be restricted of offered a financial incentive to upgrade.

- Given that both London and Lisbon are pushing to implement improvements to their current LEZ's, this report suggests that MCC follow these developments before starting to implement their own as evident the LEZ does not offer the solution to air quality that the MCC currently desire.

- It is hard to measure effectiveness of the LEZ in relation to other campaigns that could be helping to improve air quality. For example in Manchester the introduction of the cycle lanes could be having an effect. Therefore research needs to be done into how to differentiate the measurements from one air quality tool to another.

- To avoid public resistance, this reports suggests following Lisbon's approach by starting with a small LEZ, to introduce the concept to the public and also experiment with how it could work and then build on this research to develop a larger LEZ.

- The MCC should review other tools to improve air quality, with a view to potentially including the LEZ within a much wider implementation programme including a number of other approaches.

- To avoid the problems of enforcement that Lisbon faced, the LEZ would need to be enforced with a cameras system so it could be as effective as possible.

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