JOAQUIN - JOINT AIR QUALITY INITIATIVE

Work Package 2 - Action 6

The implementation and evaluation of health-relevant air policy measures in North-western Europe

FINAL REPORT

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Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

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This report was drafted as a part of the Joaquin-project. This is an INTERREG IVB NWE project aiming to improve air quality in the Northwest European region.

Joaquin (Joint Air Quality Initiative) focusses on the air quality in Northwest Europe, the associated health effects an possibilities for improvement. The project comprises the measurement of some parameters showing a stronger correlation with health effects (ultrafine particles, particulate matter composition (metals, soot …) than the currently measured PM_{10} and $PM_{2,5}$ parameters.
The project will also evaluate measures currently available to policy makers. Certain measures will even be piloted in the participating cities. These findings will be presented to stakeholders and policy makers, whilst providing them with a tool to start working on these measures (decision supporting tool).
Finally, this project will also spread information on these novel parameters and air quality in general to both experts and the general public, that will enable them to better assess the air quality in their own region.

Duration: 01/05/2010-30/11/2015

Partners:

- Belgium (4): Vlaamse Milieumaatschappij (VMM), Intergewestelijke Cel voor het Leefmilieu (IRCEL-CELINE), Vlaams Agentschap Zorg & Gezondheid (VAZG), Stad Antwerpen
- France (2): École des Ingénieurs de la Ville de Paris (EIVP), Atmo Nord Pas de Calais
- The Netherlands(4): GGD Amsterdam, Provincie Noord-Holland, Rijksinstituut voor Volksgezondheid en Milieu (RIVM), Enery research Centre of the Netherlands (ECN)
- United Kingdom (6): University of Brighton, University of Leicester, Leicester City Council, London airTEXT, Greater London Authority (GLA), Transport for London (TfL)

More information on the project can be found on www.joaquin.eu.

This report was mainly written and compiled by Jill Guijt as part of an internship under supervision of Marieke Dijkema at GGD Amsterdam. The internship was part of the Master Programme 'Toxicology and Environmental Health' at the Institute for Risk Assessment Science at University of Utrecht.

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Abstract

The cooperation project Joint Air Quality Initiative (JOAQUIN) between different countries in North-western Europe (NWE) has started in 2011 to support health-oriented air quality policies in NWE. This part of the JOAQUIN project has the aim to pilot the implementation and evaluate air quality measures of five hotspot areas in NWE. Air quality measures in Antwerp, London, Leicester, Amsterdam and the Province of Noord-Holland were evaluated, focusing on air quality improvement and the implementation process. Each measure was summarized based upon existing documents and interviews with local civil servants and/or JOAQUIN-partners involved. All information regarding the implementation process was analyzed using a structured SWOT (strengths, weaknesses, opportunities and threats) protocol. The air quality effectiveness was evaluated using a range of different methods (e.g. monitoring in Amsterdam, dispersion modeling in Antwerp and a qualitative approach in Noord-Holland). Three health-oriented air quality measures have been implemented and evaluated, two have been prepared, decided upon and will be implemented soon. The low emission zone in Amsterdam has resulted in a decrease of 5% in NO_2-concentrations at roadsides, while in Antwerp an improvement of 9% for NO_2 is expected from model studies on the proposed low emission zone. Nevertheless, due to elections and change in the political orientation of the administration, implementation has been postponed until 2016. Other pilots include zere-emission busses in Noord-Holland, traffic light sequencing in Leicester and raising awareness by volunteers in London. Experiences from these pilots are translated into recommendations for successful future implementation of health-relevant air quality policies in NWE and abroad.

1. Introduction

Air quality is affecting environmental health as is known for centuries (Kampa and Castanas, 2007). In early years of civilization, people already had to deal with air pollution (Mosley, 2014): Indoor cooking and heating with open fires caused poor indoor air quality, which could result in negative health effects for, especially, sensitive people (Mosley, 2014). From the early 20th century onwards, measures against air pollution were taken (Public Health Act, 1926**).** Although these measures were hardly reducing air pollution, the issue of air pollution was established as being influential on public health. Worldwide attention for air pollution rose after the incident in Meuse Valley in Belgium in December of 1930 in which stagnant weather conditions for several days prevented the local and industry-generated pollutions from dispersing from the area (Nemery *et al.,* 2001). As a consequence, more than 60 people died prematurely in these days (Nemery *et al.,* 2001). In December 1952, a similar situation occurred in London due to coal smoke, which could not be dispersed because of similar weather conditions and lead to 4000 premature deaths (Logan, 1952). The London and Meuse Valley incidents resulted in stricter air quality policies in the second part of the 20th century. Legislation eliminated most of the air pollution of 1952 (Guerreiro *et al.,* 2014).

Despite the successful legislation for several decades, air pollution has re-emerged as a major environmental health issue (Brunekreef & Holgate, 2002), mainly due to the increase of transport (Colvile *et al.,* 2000). Several associations have been found between traffic-related air pollutants and adverse health effects. Traffic-related air pollutants such as nitrogen oxide (NO_x) and nitrogen dioxide (NO_2), sulphur dioxide (SO_2), black carbon and particulate matter (PM) are associated with preterm birth and low birth weight (Wilhelm *et al.,* 2011), respiratory disease, cardiovascular disease and premature mortality (Su *et al.,* 2015; Beelen *et al., 2008*).

Concentrations of traffic-related air pollutants are highest near roads and at ground level, the area were people are walking, cycling and commuting. Within 300 meters from a major road and 500 meters from a highway, concentrations of traffic-related air pollutants are elevated (Su *et al.,* 2015). In European cities there is even a higher potential of exposure to traffic-related air pollutants then in American cities (Muller, 2004), because cities in Europe are developed around narrow pedestrian-centred places that were established before the major use of vehicles, which results in a high risk of exposure to traffic-related air pollutants.

Europe has legislation on air pollution, setting daily and annual mean concentration limits for several air pollutants to reduce exposure (Varvastian, 2015). In current legislation, each member state is obliged to meet these air quality standards before the date the limit value formally enters into force (Air Quality Standards, 2015). However, these limits are exceeded for years in many countries of the European Union (EU) (Guerreiro *et al.,* 2014). Where limits are evaluated an air quality plan or program has to be developed to ensure that new limits will be met. Reducing traffic-related air pollution in our mobile society is difficult and needs coordinated and supported policies (Brauer *et al.,* 2013). Cooperation between different countries, cities and areas in Europe is needed to make a difference. There are many different types of measures that can be implemented to reduce exposure to traffic-related air pollutions. Measures that tackle the source of traffic-related air pollution (e.g. introducing cleaner vehicles or stimulating renewal of polluting vehicle fleet), the system (e.g. introducing speed limits or improve traffic flow) or raise awareness.

In 2011 a cooperation project, called JOAQUIN (Joint Air Quality Initiative, www.joaquin.eu), between different countries in North-western Europe (NWE) has started. The aim of this project is to support health-oriented air quality policies in NWE. The JOAQUIN project consists of three work-packages; I: capacity building, II: measures and III: dissemination & communication. In work-package I: capacity building, the project gathers data about health-relevant air pollutants from current local or regional situations, to improve knowledge for future protection of human health and to support future sustainable developments. Work-package II: measures aims to explore, implement and evaluate different measures to decrease public exposure to air pollution. The third work-package; dissemination & communication, aims to promote health-orientated air quality policies by building public and political support.

As part of work-package II: measures, local authorities and cities are assisted and supported during the practical implementation of health-oriented air quality measures and action plans. Five of the hotspot areas in NWE participated in this part of the project: Antwerp, London, Leicester, Amsterdam and the Province of Noord-Holland. In this report the implementation processes of five piloted air quality measures taken in these areas are evaluated, and air quality effects as published separately (Yperman *et al.,* 2012; Drummond & Kirk, 2013; Programma van Eisen – openbaar vervoer concessie Haarlem/IJmond; Sustrans I, 2014; www.milieuzones.nl) are summarized. Based on both evaluations, this report results in recommendations for successful future implementation of health-relevant air quality policies in NWE and abroad.

2. Method

The JOAQUIN project aims to support health-oriented air quality policies in Europe. The project achieves this by providing information for best-practice measures that can be taken to improve air quality in local and/or regional situations. To evaluate the process of introducing air quality measures in different situations and to provide recommendations for future implementation of similar measures, the process behind the implementation, including the successes and failures, are described. For every pilot documents about the effectiveness of the measure were, when available, collected. Of these documents a summary of the measure that is or will be implemented is made in the same style of the Decision Support Tool (output of WP2A5). In this Decision Support Tool style the measure is described, effects and co-benefits of the measure, together with a description of the contents and a process description of the implementation of the measure.

2.1 Interview

A process description is usually not included in reports about measures. But in order to learn more about the process behind the implementation and the successes and failures during the process, the people involved with the actual implementation process of the measures were interviewed. Semi- structured interviews were held live, via Skype or by telephone for the duration of one hour and recorded. Interviews were based upon a loose structure consisting of open-ended questions (Britten, 1995). Questions asked were about the content of the action plan or implemented measure, achievements of this measure, the expected effect, earlier performances of this type of measure and specific questions about the process description. The process description questions were based upon documentation about the measure or action plan. Other questions were about the strengths and weaknesses of the process. The interview ended with the question whether they have any recommendations for future implementation of similar measures. The recorded interviews were worked out on paper and used for the analysis. In Appendix IA-E interview questions of the different pilots can be found.

2.2 SWOT-analysis

To analyse the information gathered by the interviews, a Strength-Weaknesses-Opportunities-Threats (SWOT) analysis tool was used. A SWOT-analysis is a tool that can be used to identify the strengths and weaknesses of an organisation, or in this case an action plan or a measure (Fig. 1) (Coman & Ronen, 2009). The results can provide recommendations for future implementation of similar measures. The SWOT analysis showed strengths and weaknesses from within, which were directly or indirectly influential for the process.. One of the strengths for example, is the vast experience with the type of measure and knowledge on the subject which helps to achieve the objective. A weakness on the other hand which could be a risk for a successful implementation could be when there is a lack of information or knowledge or when there are insufficient resources.Opportunities and threats are of external origin. An opportunity could be when a connection is made with a similar project and data can be linked. A threat could be caused by political interference or insufficient financial support; both harmful for achieving the objective. The analysis of these four categories resulted in useful and S.M.A.R.T (Specific-Measurable-Agreed upon-Realistic-Time-based) recommendations (Haughey, 2014).

Figure 1. SWOT-analysis tool
(http://cdn.projectsmart.co.uk/pdf/smart-goals.pdf)

2.3 Feedback

Feedback moments were scheduled with interviewees to create a critical and substantiated analysis of the process and the SWOT-analysis. Several weeks after the interview a feedback moment was scheduled with the participants. This feedback moment was to evaluate the SWOT-analysis and to complete missing aspects in the process description and in the SWOT-analysis. In this way the SWOT-analysis is critically substantiated and the recommendations are useful for future implementations. Another feedback moment was scheduled after two to three weeks when the first feedback round was processed.

2.4 Literature comparison

In the discussion section an interpretation for all pilots together has been made. The five measures of this project were divided into three different measure categories: source, system and awareness measures. These three categories are evaluated with help of the SWOT-analysis tool. The measures that have been taken in the pilots have been compared with examples from literature and evaluated. From this analysis recommendations can be extracted for future implementation of such policies or measures.

3. Updated local policies

Apart from the five health-relevant policy measures that have been, or will be implemented the JOAQUIN project offered participating cities the possibility to assist in updating current air quality policies. Four countries have participated in this part of the project and delivered updated air quality action plans. These action plans contain several smaller actions in specific cities or areas within the country to improve the air quality and meet European limits for air pollutants. Some local action plans are updates from previous years and contain also evaluation of former measures that were taken. About 10 action plans were updated due to the JOAQUIN project.
Hereafter you fill find short summaries about these action plans and the links to the documents on the internet.

3.1 The Netherlands

The Netherlands provided three updated air quality action plans. One air quality action plan is of Diemen council in which a former action plan is evaluated and new actions are described (http://www.diemen.nl/uploads/tx_ncgovris/incoming/Actieplan_luchtkwaliteit_2013-2016_ontwerp_d_d__24-09-13.pdf). Actions in this action plan are: lobbying for maximum speed limits on the highway near Diemen, advising companies about air quality and raising awareness among the general public about air quality issues.
The other two documents that Amsterdam delivered were; a Sustainability Agenda of 2014 (http://www.amsterdam.nl/gemeente/volg-beleid/duurzaam-amsterdam/agenda-duurzaamheid/) and a document about Clean Air for Amsterdam (www.amsterdam.nl/publish/pages/366744/schone_lucht_versie_5.pdf). The first document contains measures to become a sustainable city in the future. To become a sustainable city they have set up four transition routes: sustainable energy, clean air, circular economy and a climate resistant city. For each of these transition routes the city has set up some measures and ideas to reach this goal. The second document Clean Air for Amsterdam is about several measures that can be taken that are cost-effective and give a maximum effect in the improvement of air quality. Examples of measures that can be taken are: providing grants for electric vehicles, changing the public transport fleet and installing low emission zones were vehicles can only enter the city with Euro IV engine maximum.

3.2 Belgium

Belgium provided two updated action plans and one evaluation of an air quality action plan. The first action plan was an air quality action plan of Flanders from 2012 (http://www.lne.be/themas/luchtverontreiniging/bijlage1-luchtkwaliteitsplan-v5.pdf). In this air quality action plan the current policies for air quality are described, which will not meet the limits set by the European Union for air pollutants. The main focus of these measures lies with traffic emissions, directed towards tackling traffic related air pollutants.
The second air quality action plan was a local action plan of the city of Gent (https://stad.gent/over-gent-en-het-stadsbestuur/stadsbestuur/wat-doet-het-bestuur/uitvoering-van-het-beleid/natuur-milieu/luchtkwaliteitsplan). Gent wants to make a complementary policy for the improvement of their air quality by making optimal use of all possible measures. The local air quality action plan of 2010-2015 contains of 50 actions that can be taken, mainly measures and actions relating to the traffic in Gent. These traffic related actions contain: traffic flow regulation, broadening of the car free zone in the inner city and introducing cleaner busses and cars. Next to these actions the city of Gent wants to raise awareness among local residents.
The third delivered action plan was an evaluation of the Air Quality plan of Flanders (http://www.lne.be/themas/luchtverontreiniging/nieuwactieplanantwerpen-2014-2018-

goedgekeurd.pdf). In 2013 the Flemish government made an evaluation about the reduction conditions of NO_2. In 2012 the NO_2 emissions were reduced with 30% relative to 2000. This was mainly due to the reduction of emissions of old vehicles. Together, European policies and the air quality action plans have lead to emission reductions in several sectors. Until 2016 the Flemish government will evaluate the progress of their air quality action plans twice a year.

3.3 United Kingdom

Another three updated air quality action plans were provided by the United Kingdom. Islington delivered their updated Air Quality Strategy for 2014-2017 (www.islington.gov.uk/airqualitystrategy). The aims of this air quality strategy are: reducing the impact of poor air quality on the health of people, meeting the limits that are set by the European Union, encourage and implement cost-effective measures to reduce emissions, raising public awareness and encourage good practice of businesses and people in the borough.
The second action plan that was delivered from the United Kingdom came from Brighton and Hove. They delivered an Air quality action plan (http://www.brighton-hove.gov.uk/content/environment/air-quality-and-pollution/air-quality-management-city) with a majority of measures related to road traffic including road constructions; infrastructural changes and to advise people in how to travel best reducing air pollution.
The last document from the United Kingdom was provided by the London borough of Croydon. An air quality action plan for the period 2012-2017 (http://lovecleanair.org/wp-content/uploads/2014/03/AQAP-2012-2017_FINAL.pdf). This air quality action plan tackles emission from road traffic, industry and homes. Next to this there are measures to keep the community informed about air quality. There are 10 measures to improve air quality in this action plan: low emission strategies, reducing pollution from idling vehicles, air quality and freight, cleaner air for schools, non-road transport emissions, airTEXT, encouraging smarter travel behaviour and improving the public transport road network in London. Currently the air quality of Croydon meets all but one existing statutory objective, namely NO_2. With the help of these 10 measures the borough Croydon wants to improve their total air quality and not only NO_2 concentrations.

3.4 France

France updated their air quality action plan in 2013: Plan de Protection de l'Atmosphere poure l'Ile-de-France (http://www.driee.ile-de-france.developpement-durable.gouv.fr/IMG/pdf/Plan_de_Protection_de_l_Atmosphere_revise_pour_l_Ile-de-France_cle7fe9b8.pdf). This updated air quality action plan is the result of evaluating former policies to improve their air quality. This action plan contains policy measures and stimulating actions with the goal to improve all sources of air pollutants in France. Examples of measures in this action plan are campaigns to raise local awareness about the local air quality problems and traffic related measures.

4. Implementation of a LEZ in the City of Antwerp

Measure

Implementation of a low emission zone in the City center of Antwerp.

Description

A Low emission zone (LEZ) is an area where only vehicles are allowed to enter the zone with an emission class below a certain limit. When a restricted vehicle does enter this LEZ, a fine can be given. The inner city of Antwerp will implement a LEZ for all vehicle types in late 2016. Enforcement of the LEZ will occur through an Automatic Number Plate Recognition (ANPR)-camera system.

Effect

The expected air quality effects of the implementation of a low emission zone will be a reduction of vehicle emissions. In 2020 the emission of elemental carbon is expected to be reduced with 69%, for PM10 and PM2.5 41% and for NO_2 a reduction of 12%. This shows in an improvement of the air quality of the inner city of Antwerp.

Suggested reading

Yperman, I., Vanhove, F., Delhaye, E., Scheltjens, T., Hens, D., Voogt, M., den Boeft, K. (2012). Haalbaarheidsstudie voor de invoering en beheer van lage emissiezone(s) in de stad Antwerpen. http://ecohuis.antwerpen.be/Ecohuis/Ecohuis-Hoofdnavigatie/Milieuplannen/Lage-emissiezone/LEZ-Haalbaarheidsstudie.html
The feasibility study for a LEZ in the city of Antwerp. All options that are calculated and evaluated can be found in this document (document is written in Flemish).

Lutz, M. (2009). The low emission zone in Berlin – Results of a first impact assessment. http://www.stadtentwicklung.berlin.de/umwelt/luftqualitaet/de/luftreinhalteplan/download/paper_lez_berlin_en.pdf
Article about the LEZ in Berlin and the expected effects of the LEZ on air quality.

Ellison, R.B., Greaves, S.P., Hensher, D.A. (2013). Five years of London's low emission zone: Effect on vehicle fleet composition and air quality. *Transportation Research Part D23: 25-33*
Article about the impact of LEZ on air quality and the vehicle fleet composition after five years in London. A decrease of 2.5% of particulate matter in the LEZ has been seen, but no decrease in NO_x concentrations.

Malina, C. & Scheffler, F. (2015). The impact of Low Emission Zones on particulate matter concentration and public health. *Transportation Research part A 77: 372-385.*
Article about the impact of the LEZs in 25 cities in Germany on human health. Stringent entering conditions have an even greater impact on public health.

4.1. Measure

The city of Antwerp wants to introduce a Low Emission Zone (LEZ) in the city centre. This zone will cover the whole area from the Scheldekaaien to the Singel on the right bank and the residential area on the left bank (Fig. 2) and will have restricted access for specific types of emission class vehicles only. The LEZ will be implemented to improve the air quality and increase the liveability of the city. There are many types of measures possible to improve the air quality, but a LEZ will be most effective.

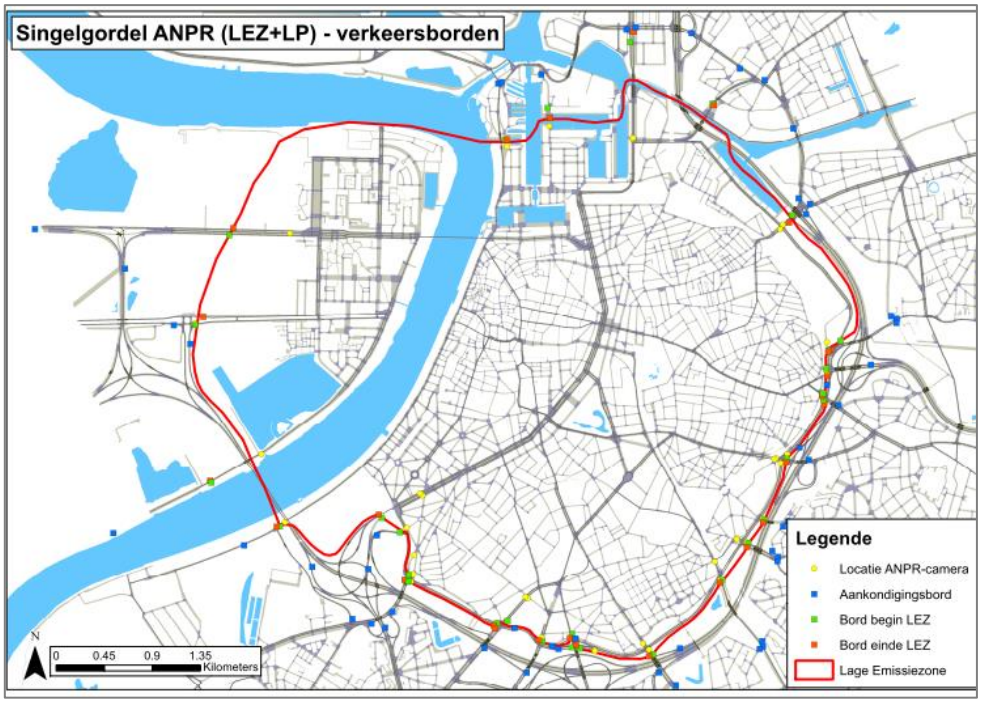

Figure 2. The area of the Low Emission Zone in Antwerp (red line); places of entering signs (green dots); announcement signs (blue dots); ANPR-camera system (yellow dots).

Vehicles which meet the environmental conditions (based on the emission of pollutants) are free to enter the LEZ. Other vehicles which do not meet the requirements, may obtain an exemption for a certain period of time or are refused access to the zone.

There is restricted access for vehicle categories M,N and T in the LEZ: i.e. passenger transport (private cars, buses) and freight transport (delivery vans and heavy duty vehicles) and agricultural vehicles. The LEZ does not apply to motorbikes and scooters.

Enforcement of the LEZ rules will be done with an Automatic Number Plate Recognition (ANPR)-camera system; cameras will be installed at the portals of the LEZ (see figure 1). Nearing the city centre the LEZ will be announced giving drivers of polluting vehicles the possibility to take an alternative route. At each portal traffic signs will indicate the entrance of the LEZ.
In time the admission conditions for the LEZ will gradually become more stringent. An overview of the emission class vehicles which may enter the LEZ in the different periods can be found in table 1.
Four newly installed permanent air quality monitoring stations will deliver measurements of air pollutants in- and outside of the LEZ. This way the stations will show the immediate and long term effects of the LEZ measure.

Table 1. Minimum emission classes that can enter the LEZ in different time periods

2016-2019	Diesel	Euro 3 with particulate filter
	Benzine	Euro 1
2020-2024	Diesel	Euro 5
	Benzine	Euro 2
2025 – 20..	Diesel	Euro 6
	Benzine	Euro 3

4.1.1 Examples

In Europe a common policy to reduce vehicle emissions to improve air quality is the introduction of a LEZ (Malina & Scheffler, 2015). The LEZ in Antwerp is the first in Belgium, but not the first LEZ that will be implemented in Europe. In many other cities in Europe there are already LEZ. However, each LEZ in the EU has its own rules about the types of vehicles that are restricted from entering the area and each LEZ has its own enforcement system for offenders of the measure. An overview of all LEZ in the EU can be found at this website: www.urbanaccessregulations.eu. A few examples of LEZ in other cities in the EU are given below.

London

In the United Kingdom a LEZ (Fig. 3) was implemented in phases in London in February 2008. Vehicles with a weight of more than 12000 kilos operating in the LEZ were required to meet a minimum of the Euro III standard (Ellison *et al.*, 2013). In July of 2008 the second phase was implemented, vehicles of more than 3500 kilos as well as busses and coaches had to meet those requirements. In 2012 the minimum standard was increased to Euro IV for heavy vehicles, busses and coaches and a minimum standard of Euro 3 for light vehicles (Ellison *et al.*, 2013). From 2015 the requirements are increased to Euro VI and hybrid busses (www.urbanaccessregulations.eu/london). Enforcement occurs by a fixed and mobile camera system that scans the vehicles number plate when it drives into the LEZ. Vehicles not compliant to the minimum standards that do enter the LEZ can pay a charge for each day they are in the LEZ.

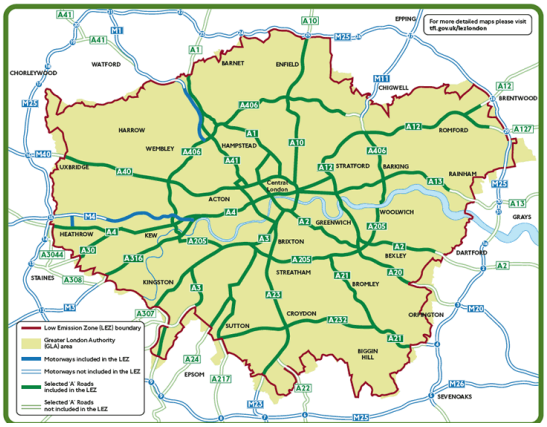

Figure 3. Area of the LEZ of London, United Kingdom
(Source: www.urbanaccessregulations.eu)

http://urbanaccessregulations.eu/countries-mainmenu-147/united-kingdom-mainmenu-205/london

Berlin

In the main capital of Germany, Berlin, a LEZ is implemented since the first of January of 2008 (Fig. 3). The LEZ is implemented in two stages, stage 1 from 2008 and stage 2 from 2010. In stage 1; vehicles needed at least emission class Euro 2 or Euro 1 with a particle filter for diesel-vehicles and Euro 1 for petrol vehicles to access parts of the LEZ. In stage 2 restrictions were tightened and only diesel-vehicles with Euro 4 and petrol with Euro 1 class can access the LEZ. Registration of vehicles is organised with stickers on windshields. Enforcement of this measure happens manually by the police and a windshield sticker is obligatory. When there is no sticker on the windscreen the vehicle is considered illegal in the zone. The penalty for driving or parking in the LEZ without a valid sticker is €80 (http://urbanaccessregulations.eu/countries-mainmenu-147/germany-mainmenu-61/berlin). Results in 2009, one year after the implementation, show a decrease of NO_x of 12% and a faster renewal of the vehicle fleet due to stage 1 of the LEZ (Lutz, 2009).

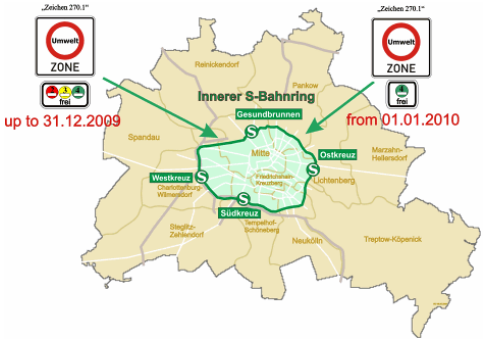

Figure 4. Area of the LEZ of Berlin, Germany
(Source: www.urbanacessregulations.eu)

Aalborg

Since the 1st of February 2009 the city of Aalborg in Denmark has a LEZ. The vehicles prohibited to enter this LEZ are all diesel-powered vehicles above 3500 kilos. All vehicles need to have a LEZ windshield sticker when they want to enter the LEZ. Foreign vehicles are also required to fit a windshield sticker. From July 1st 2010 vehicles must be at least Euro 4 or fitted with a certified particle filter to enter the LEZ in the city of Aalborg. Enforcement of the measure is done manually by routine road checks of the police.
http://urbanaccessregulations.eu/countries-mainmenu-147/denmark-mainmenu-221/aalborg

4.1.2 Co-benefits

Implementation of a LEZ in the inner city of Antwerp will not only have an effect on the local air quality, but will also stimulate faster renewal of the current vehicle fleet. Due to implementation of the LEZ in Antwerp, companies and residents are looking for new vehicles that can enter the LEZ for a longer period. This will result in a vehicle fleet with 'cleaner' emissions than before. Without the implementation of the LEZ polluting vehicles would be driving longer in the inner city of Antwerp, polluting the air were many people reside during daily activities.
Another co-benefit of the implementation of the LEZ is that visitors of the city of Antwerp will rather choose for a Park & Ride outside the city than risking a fine by entering the city. This may lead to fewer cars in the LEZ. Due to this possibility there needs to be sufficient Park & Ride places around the inner city of Antwerp. Bus services to and from these Park & Ride areas are also necessary to give a fast connection to the city centre.

4.2 Description

4.2.1 Process description

Onset of the process

At European conferences the city of Antwerp frequently discussed the practice of low emission zones. As member of Eurocities, the European organisation of metropolitan cities, the representatives of the city of Antwerp participated in working groups on Air Quality and Mobility were they met colleagues of Stockholm and London, who already had a LEZ in their city. Due to these contacts the possibility of a LEZ came to Antwerp's attention.

Furthermore, Antwerp is an air quality hotspot area. As a result of regular exceedances of the air quality limit values in Antwerp the EU Commission has charged Belgium for failing to meet the standards on particle emissions put forward in the air quality Directive and opened an infringement procedure before the European Court of Justice. Because of this indictment Antwerp now has to prove to the Commission that adequate actions will suffice to improve the urban air quality according to the EU standards.

In order to take the right and most effective measures the city of Antwerp commissioned the Flemish research facility VITO (Flemish Institution for Technological Research) to study the current situation and to give advice about the impact of these measures. About 100 proposed measures divided into three groups were studied. The first contained small scale measures (e.g. optimal tire pressure), the second focused on the implementation of a LEZ in the inner city of Antwerp and the third set of measures comprised the establishment of a congestion charging zone. The last one is a comprehensive measure to charge vehicles for their contribution to the air pollution before entering the inner city, a measure which has been successfully applied in London, Stockholm and Milano.

All measures applied together would result in a dramatic reduction of the air pollution in the Antwerp and put it on the map as one of the cleanest metropolitan cities of Europe. However, taking in to action all measures needs to be acceptable and affordable for government and citizens alike. This proved not be be the case. The measure with the largest impact on air quality was the implementation of a LEZ, which resulted in an elaborate feasibility study about the LEZ in Antwerp.

Management of the process

The implementation of the low emission zone in Antwerp is managed by the municipality of Antwerp. Because Antwerp is the first city in Belgium that will implement a LEZ, the municipality has to initiate and follow up all the new procedures on different government levels in Belgium. It has to acquaint the federal and the Flemish governments with all the juridical, communicational and infrastructural capacity that is needed to introduce the LEZ in their city.

Formatted documents

Implementation of a LEZ includes much research and many documents that need to be formatted before the actual implementation can start. In advance of the implementation a feasibility study has been drawn up. This feasibility study gives insight in the effects of different options in the organisation of a LEZ. Several calculations have been made to investigate the most beneficiary effects of different measures that can be taken in a LEZ. It took less than one year to conclude the preliminary report. The whole feasibility study (in Dutch) can be found by clicking this link:
http://ecohuis.antwerpen.be/Ecohuis/Ecohuis-Hoofdnavigatie/Milieuplannen/Lage-emissiezone/LEZ-Haalbaarheidsstudie.html

Before the LEZ can be implemented, a new Flemish decree had to be introduced. The decree contents the manner of implementation of the LEZ, which cars can enter the zone and the enforcement of the measure. The city of Antwerp can slightly deviate from this decree with conditions for exemption. Table 1 above gives an overview of the vehicles that can enter the LEZ of Antwerp over time.

Resources and activities

Being the pioneering city in Belgium the examples used to develop and introduce the LEZ were sought elsewhere in Europe. The main examples for the LEZ of Antwerp were German cities and London. From

the concept of "green zones" with limited accessibility, as it exists in Berlin and many other German cities Antwerp took the idea of an emission zone that is applied to all vehicles. In Germany there is an uniform anti-air pollution law, which requires all vehicles to drive with a special environmental sticker on their windshield to finally enter the city's "green zones". Depending on the emission key number, which can be found in the vehicle registration papers, a red, yellow or green sticker can be obtained (Fig. 4). These different stickers will give entrance to different areas of the LEZ. A LEZ road sign with a specific colour sign below, shows which vehicles are allowed to enter that part of the LEZ. There are no exceptions for vehicles which want to enter the LEZ without an environmental sticker. Entering a LEZ without a sticker will be fined (www.german-way.com).

Figure 5. The different environmental stickers that can be received for vehicles, and the road sign at the beginning of a LEZ. No sticker means worst pollutant class, Euro 1 or older diesel vehicles; red sticker is a pollutant class 2, Euro 2 diesel cars; yellow sticker is a pollutant class 3, Euro 3 diesel vehicles; green sticker is a pollutant class 3, Euro 4 for diesel vehicles and Euro 1 and better for petrol vehicles (picture: http://www.umwelt-plakette24.de/; sticker information: http://www.urbanaccessregulations.eu/de-foreign-table).

For enforcement of the LEZ, Antwerp looked at the system that is used in London. London uses an ANPR-camera system. These cameras automatically read vehicle number plates to interrogate vehicle databases and monitor and control the passage of polluting vehicles through the LEZ (Griffiths, 2013). At federal level a new road sign had to be developed, a sign that would be clear for all road users that they are entering or leaving a LEZ. The road sign that has been developed for the LEZ of Antwerp can be seen in figure 6.These two new signs are registered in the Highway Code by a royal decree (Bellemans, 2014).

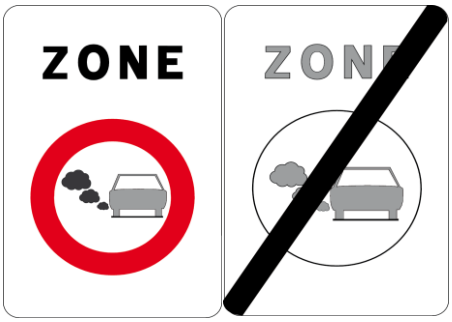

Figure 6. Road signs of the LEZ of Antwerp: left start of the LEZ; right end of the LEZ

Due to influence of the JOAQUIN project four permanent air quality stations will be built in Antwerp. These stations will provide continuous measurements about air quality in the urban environment. These monitoring stations will be installed in Antwerp by the end of 2015. The intention is that these stations are operational before the LEZ will be introduced. In this way the improvement of air quality can be registered.

Another activity that currently is taking place is the development of an entry system at the website A-city of the city of Antwerp (www.a-stad.be). An entry system that provides residents and visitors information whether they can enter the LEZ with their vehicle, or not. With this system the city of Antwerp wants to give people easy and fast information about entering the LEZ and applications for exemptions.

Connections with other projects

As there are no examples of LEZs in Belgium there is no legal framework to start from. The city of Antwerp gained knowledge for the implementation of their own LEZ from several other European cities with a LEZ, especially from Germany and United Kingdom (London). In Europe there are several different types of LEZ, from which Antwerp learned a lot about possible measures and how to enforce the rules..

As a member of the European organisation EuroCities, Antwerp worked in projects with the theme of air quality and mobility. Due to participation with this project Antwerp was already familiar with possibilities of measures, which can improve air quality. Euro Cities brought them in contact with people of the cities Stockholm and London, where they have already a LEZ for many years.

Inspiration was found in the LEZ of London and Berlin; an ambitious LEZ affecting almost all types of motorised vehicles to be screened for entering the LEZ, is planned. From different EU-countries and metropolitan cities Antwerp could learn how these LEZ are working in reality and what their impact is on air quality.

4.2.2 Interview

Background information about the implementation process of the LEZ of Antwerp was provided by three participating members of the city of Antwerp: Filip Lenders, project manager of the LEZ Antwerp; Jan Bel, involved in the feasibility study of the LEZ and project leader air quality for the municipality; and Christina Ceulemans, involved in the organisation and follow up of the LEZ. The interviews took place on May 19th 2015. The interview questions can be found in appendix IA.

4.3 SWOT-analysis

To gain insight in the strengths, weaknesses, opportunities and threats of the implementation process of the LEZ in Antwerp a SWOT-analysis has been done. An overview of the results can be found in table 2.

4.3.1 Strengths

Before the actual implementation process of the LEZ started, Antwerp already investigated the possibilities and expected effects of a LEZ. In this feasibility study Antwerp calculated the effects and costs of different types of measures in the LEZ. From this feasibility study the city learned what the best options were in their situation. The study provided the city of Antwerp with the results of informed and substantiated choices which have been made elsewhere. The feasibility study laid the foundation and gave motivation to proceed with the implementation of an ambitious LEZ. The feasibility study helped the city to make a strong case about its initial cause and to integrate a stricter regulation for the future from the start.

Despite the fact that Antwerp is the first city in Belgium that will introduce a LEZ, there have been several differently conceptualised zones implemented in Europe in the course of the last 10 years. There are already many cities in European member-states with a LEZ, varying in access conditions (emission standards), applied control systems, allowed exceptions and exemptions and enforcement regulations. For Antwerp all these LEZs were examples against which pros and cons regarding admission conditions and enforcement policy had to be weighed. From these examples and from the feasibility study the city of Antwerp has chosen the type of LEZ that applies to almost all vehicles (with 4 wheels) and uses an ANPR-camera system for control and enforcement.

The strength of this process is that it can use the experiences in similar projects. As regular participant in Eurocities meetings, Antwerp was already familiar with different policy strategies to tackle air quality problems in metropolitan cities. Via other members of the Eurocities environment forum Antwerp heard

about the effectiveness of existing LEZs. Due to these contacts and the lessons learned in other cities Antwerp decided to implement its own LEZ with a particular focus on transparency, and automated registration and enforcement..

4.3.2 Weaknesses

Weakness of this implementation process was not meeting the implementation deadline. The actual implementation date of the LEZ in Antwerp was set on January the 1st 2016. However, there will be no implementation of a LEZ in January 2016. Due to several delays in the process there is no exact implementation date yet. Probably the LEZ will be implemented in the fall of 2016; however, this is not certain. This delay may result in a retrospective fine of the EU for not meeting their implementation date of their action plan.
Another weakness is the dependence of legislation by other parties and/or in other fields. Since the law on Low Emission Zones is not finished and fully clear yet, the city of Antwerp experiences difficulties in preparation of circumstantial facilities. Among such facilities are issues regarding enforcement technology, but also topics such as communication strategy. Also, legislation on fields quite far from traffic appeared to be of importance. During the implementation process the city of Antwerp found out that they had to involve the privacy commission. Due to the enforcement system with ANPR-camera's, a new system has to be developed to connect the vehicle license plates to the owner and the emission type of the vehicle.
In Belgium license plates are personal and contain personal information. The city of Antwerp had to take this into account when they decided to use the ANPR-camera system. To have access to necessary information for the enforcement system, rules have to be made and approved of by the privacy commission. When the privacy commission disapproves of the enforcement system, which is currently placed on all entrances of the LEZ, this enforcement system may not be used. If this is the case, the city has to implement another enforcement system, which might cause another delay of the actual implementation date.

4.3.3 Opportunities

For the implementation of the LEZ, Antwerp used many opportunities and some given opportunities were not used. The participation in the Euro Cities organisation and visits to conferences brought the city of Antwerp in contact with other countries with a LEZ. Antwerp made good use of these connections. They learned several possibilities for improvement of air quality and gained insight in other cities' LEZs. This has resulted in the actual idea of implementing the LEZ in Antwerp. Without these connections it might have taken a while before Antwerp actually started with implementing a LEZ. In the port area of Antwerp there might be an LEZ implemented too. When this is the case, the LEZ will be extensively broadened. This will result in the largest LEZ in the EU.
Another great opportunity for the LEZ was participating with the JOAQUIN project. This project gave funding and support for the implementation process. Furthermore, due to the JOAQUIN project 4 permanent air quality-monitoring stations were funded and are currently placed to measure the air pollutants in the LEZ. Without this project the city might not have built four permanent measuring stations.
An untouched opportunity of the city of Antwerp may be the opportunity to make a national law of the access conditions of a LEZ, instead of a Flemish decree only. The country is divided into three states with their own governmental system and a federal government. For this implementation process the federal government only had to agree upon the LEZ road sign. The decree gives meaning to the LEZ road sign, which vehicles may enter and enforcement of the decree. As a pioneer in Belgium, Antwerp could have brought the LEZ to a national level. A federal law about the rules for a LEZ, in such a way that in whole Belgium the same rules apply for a LEZ. Now, it is possible that, for example, Brussels introduces a LEZ with other access restrictions than those that are used in the LEZ of Antwerp. This may result in confusion of visitors of the different cities in Belgium with a LEZ in the future. The reason that Antwerp did not use this opportunity is because of communities' own authority. Communities can decide upon their own completion of a decree. Antwerp did make a fundamental start for a national law about LEZ.

However, due to their pioneers work the city is happy with the implementation process they are now working on. A national law for LEZ has to be introduced by the regional government.

4.3.4 Threats

There are also some threats for the successful implementation of a LEZ in Antwerp. The decree still has to be approved of by the government. Without approval of the decree the city of Antwerp does not know when the LEZ can be implemented. Due to this, Antwerp cannot go further with planning its campaign to raise awareness about the upcoming LEZ and its access conditions. Antwerp wants to start a communication campaign about the LEZ at least a year ahead of introduction of the LEZ. In this campaign they will provide residents, visitors and foreign visitors information about the access conditions of the LEZ. Because communication is an important factor for a successful introduction of the LEZ in late 2016, they want to start with this campaign in October of 2015.
Currently there is also another threat for the implementation process. The media is publishing all kinds of articles about the LEZ and the city of Antwerp cannot reply to these articles. This is mainly due to the fact that the decree is still not approved of. The city cannot give more information about the LEZ, because it is still not certain when the LEZ will be introduced and what will be approved of. At the moment this leads to false communication and might cause false acquisitions about the LEZ, which can lead to revolt of the local community to the implementation of the LEZ.
Another possible threat or even an opportunity are the scheduled major road works in Antwerp, starting in 2016. For 8-10 years these major works will take place. The bus station will be improved and some tramlines will be moved. These works will have a major impact on mobility in the city. Some major passageways in the city will be closed and traffic needs to take another route. This may lead to congested areas of vehicles, which might be able to undo the expected air quality results of the implemented LEZ. Furthermore, due to the road works more work traffic vehicles, which might even be more polluting than normal vehicles, are entering the zone daily for 8-10 years. On the other hand, it could also result in even less vehicles in the inner city. National and international campaigns are raising awareness about these major road works and advice visitors to avoid entering the city due to major delays. When this campaign works, many visitors of the city of Antwerp will take alternative ways to visite the city.

Table 2. Summarizing overview of the SWOT-analysis on the implementation process for a Low Emission Zone in Antwerp. All items are explained in the text above

Strengths	**Weaknesses**
• Feasibility study • Examples from other EU cities with LEZ • Connections with projects with similar projects • A lot of communication about the topic • LEZ applies to all entering vehicles	• No introduction of LEZ in January 2016 • Legislation on other topics (such as privacy) • Low Emission Zone legislation (by other government) not being implemented yet
Opportunities	**Threats**
• Involvement of JOAQUIN • Participation in Euro Cities project • Meetings with other countries with LEZ measures • LEZ in the harbours of Antwerp • Nationalizing the access conditions of a LEZ • Major construction works in the centre of Antwerp	• Implementation of the LEZ decree will not be on time • Decree acceptation • Media attention • Major construction works in centre of Antwerp

4.4 Recommendations

Antwerp is the first city in Belgium that will introduce a LEZ. However, this is not the first LEZ that will be implemented in Europe or the last to be introduced. Because associations have been found between traffic-related air pollutants and several health effects (Su *et al.,* 2015), implementation of a LEZ will have a great influence on air quality in densely populated areas. To provide future implementations of LEZs an easy implementation process, recommendations from this LEZ implementation can be taken into account.
The SWOT-analysis of the LEZ implementation process gave insight in the strengths and weaknesses of the process behind the implementation. This analysis showed that a thorough investigation of all possible measures in a LEZ gives a good support of the implementation process. At least one year before the onset of the implementation process such a feasibility study should be done. Due to a feasibility study the implementation process will be better substantiated before the actual implementation starts. Furthermore, involvement in projects with a similar topic can give insight in possibilities to introduce air quality improvement measures and to investigate the results in reality. A large network of people in the same subject field can give new ideas and support.
For a successful and smooth implementation process all possible involved parties should be questioned about their ideas for the implementation. This should be done at the beginning of the implementation process. In this way all wishes are known from the beginning and could be taken into account.
A difficulty is to comply all legislation, since LEZ legislation is often composed as part of the implementation process but by other governments. The LEZ legislation and enforcement are furthermore related to other legislations, such as privacy legislation, which introduces unexpected hurdles on the road to implementation. Close cooperation between implementing and legislating authorities in the preparation process is therefore recommended.
The city of Antwerp also gave some recommendations for future implementations of LEZs in Belgium or other countries in Europe. One of these recommendations was that an implementation process for a LEZ should directly start with multidisciplinary work. Because there are so many aspects that are involved in the implementation process all participating parties should be involved from the beginning. Another recommendation of the city of Antwerp was that a well substantiated, and at least one year before the actual start of the LEZ, communication campaign should be done. In such a communication campaign residents of the LEZ will be provided with all the information about the conditions of the LEZ. Besides the recommendation for multidisciplinary work and communication campaigns, a recommendation was that an implementation of a LEZ should have accompanying measures. These accompanying measures should make it more attractive for all concerned persons or companies. Accompanying measures can be small-scale measures like benefits for companies with vehicles who want to improve their fleet or a subsidizing system for purchasing a vehicle with an emission class that may enter the LEZ.

Recommendations for future implementations of LEZ:

- Start a year ahead with a feasibility study of the measure
- Start from the beginning with multidisciplinary work
- Make use of connections on a similar topic
- Implementation of a LEZ should also have some accompanying measures (e.g. benefits for companies with vehicles, a subsidizing system, shared car possibility)
- A supported communication campaign is needed for an audience sensitive topic, started at least one year before the actual implementation date

5. Implementation and evaluation of a LEZ in the city of Amsterdam

Measure

Implementation and evaluation of a Low Emission Zone in Amsterdam

Description

A Low Emission Zone (LEZ) is implemented in the city of Amsterdam to improve the air quality in the city centre. Borders of the LEZ are set by the river IJ and ring highway A10. Heavy-duty vehicles above 3500 kilo and with Euro 0, 1, 2 and 3 diesel engines are restricted from entering the LEZ. To evaluate the effect of the implemented LEZ on air quality, two monitoring stations within the area have been used.

Effect

Since the implementation of the LEZ in Amsterdam in 2009, traffic-related air pollutants were decreased by 4.9% for NO_2, 5.9% for NO_x, 5.8% for PM10 and 12.9% for elemental carbon.

Suggested reading

Panteliadis, P., Strak, M., Hoek, G., Weijers, E., van der Zee, S., Dijkema, M. (2014). Implementation of a low emission zone and evaluation of effects on air quality by long-term monitoring. *Atmospheric Environment 86: 113-119*
Article about the evaluation of the LEZ of Amsterdam. In this article the measuring methods are described and the results of the implemented LEZ.

Ning, Z., Wubulihairen, M., Yang, F. (2012). PM, NO_x and butane emissions form on-road vehicle fleets in Hong Kong and their implications on emission control policy. *Atmospheric Environment 61: 265-274*
Article about emission profiles and the effect of measure control and policies to reduce traffic-related emissions.

5.1 Measure

A low emission zone (LEZ) has been introduced in 2008 in Amsterdam to reduce traffic-related air pollutants and improve air quality in the city centre. Borders of the LEZ are set by the ring highway A10 and the IJ River (Fig. 7). The LEZ in Amsterdam gives restricted access to heavy-duty vehicles heavier than 3500 kilo. Trucks with Euro 0, 1, 2 or 3 diesel engines are not aloud to enter the LEZ. Passenger cars, exceptional transport (e.g. fire trucks, ambulance) and heavy-duty vehicles with a cleaner engine and vehicles lighter than 3500 kilo can enter the zone.
(http://www.amsterdam.nl/parkeren-verkeer/milieuzone/milieuzone/milieuzone/)

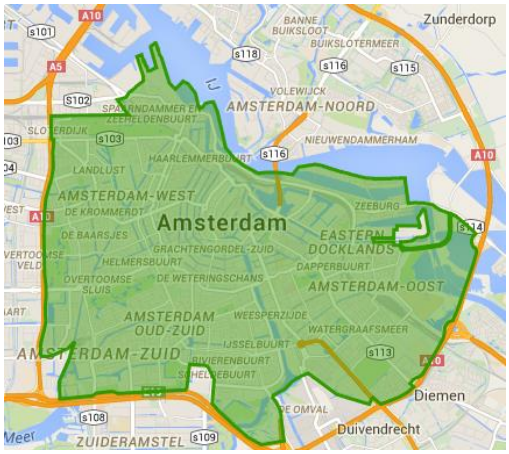

Figure 7. Area of the LEZ of Amsterdam
http://netraam.nl/od/milieuzone.png

Vehicles that do not meet the criteria to enter the LEZ can apply for an exemption of their vehicle. An exemption starts at 00:00 hour and finishes at 06:00 hours the next day. In exceptional cases the municipality of Amsterdam can give an exemption with a maximum of 12 months. This, for example can be issued when a company has ordered a new truck with the requirements of the LEZ and is waiting for the delivery of the truck.
Enforcement of the LEZ is done with an Automatic Number Plate Recognition (ANPR)-camera system provided by the company GATSO. This system scans vehicle license plates and identifies vehicles based on their license plate information. When a truck is not aloud to enter the zone the image of this truck is downloaded and a fine of €230,- is issued to the owner of the truck. Figure 8 shows the ANPR-camera system of the GATSO company at an entry road of the LEZ in Amsterdam. The ANPR-camera system of GATSO was installed without traffic disruption and the system was mounted on existing street furniture (GATSO: Case study – LEZ Amsterdam).

Figure 8. ANPR-camera system in the LEZ of Amsterdam
To investigate the local effect of the implementation of a LEZ, one roadside and one urban background monitoring station located within the LEZ of Amsterdam were chosen (Fig. 9). These two monitoring sites were chosen due to routine measurements of these monitoring sites of PM_{10}, NO_x, NO_2 and soot

concentrations. These two monitoring sites are part of the Amsterdam Air Quality Monitoring Network, which consists of 14 stations were air pollutants are routinely monitored. The roadside monitoring station was located at the Jan van Galenstraat and the background station at the Vondelpark.

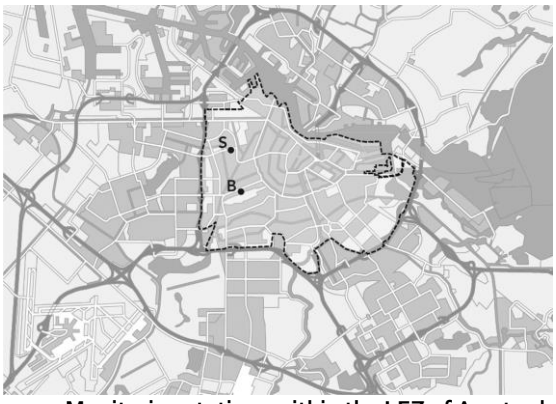

Figure 9. Monitoring stations within the LEZ of Amsterdam.
Roadside monitoring station is indicated with S (Jan van Galenstraat) and background monitoring station indicated with B (Vondelpark)

The air quality was monitored from 2007 until 2010; two years before and two years after the implementation of the LEZ (Panteliadis *et al.*, 2014). Daily mean concentrations of PM10, NO_x, NO_2 and soot were obtained from these monitoring stations.

5.1.1 Examples

There are many LEZs in Europe, each with its own restrictions and enforcement systems. Several LEZ have been evaluated to gain insight in the actual effect of the implemented LEZ. Evaluation of the impact of an implemented LEZ can be done in several ways. Modelling and air quality measurements are used to calculate or evaluate the impact of a LEZ (Ferreira et al., 2012; Jensen et al., 2011). Below two examples of different evaluations of the impact of a LEZ are given.

Copenhagen

Since September 2008 the city of Copenhagen, Denmark, has a LEZ. To enter this LEZ vehicles must be at least Euro 4 or fitted with a particulate filter. Vehicles that are affected are all diesel powered vehicles of more than 3500 kilo. Enforcement of the LEZ occurs manually by inspectors, wardens or police (*www.urbanaccessregulations.eu/copenhagen*). In 2011 Jensen et al. evaluated the impact of the LEZ of Copenhagen by a combination of air quality measurements, dispersion modelling and registration of vehicle number plates. Measurements showed a decrease of particulate matter of 5% after the implementation of a LEZ in Copenhagen (Jensen et al., 2011).

Lisbon

The first LEZ of Portugal was implemented in 2011 in the main capital city Lisbon. This LEZ affects all types of vehicles and enforcement of the LEZ happens manually (*www.urbanaccessregulations.eu/lisbon*). Ferreira *et al.* (2012) evaluated the implementation of the LEZ in Lisbon by modelling the situation of two scenarios. In scenario 1 there is no fleet renewal, but the total amount of cars decreases within the LEZ; in scenario 2 the banned cars are replaced by cars that may enter the zone, but are not the latest model. Modelling of these scenarios's resulted in NO_x emission reductions of 7% in scenario 1 and 1% in scenario 2. For PM_{10} scenario 2 will give a reduction of 25% and scenario 1 a reduction of 34%.

5.1.2 Co-benefits

As a co-benefit from the implementation of the LEZ for heavy-duty vehicles in Amsterdam there is an increased renewal of trucks that frequently deliver in the inner city of Amsterdam. Due to the implementation of the LEZ several vehicles have been renewed to meet the requirements for entering the LEZ and the inner city of Amsterdam. Without the implementation of the LEZ this would be less.

5.2 Description

5.2.1 Process description

Onset of the process

In the Netherlands there are several areas that do not meet the air quality guidelines for NO_2 and particulate matter (PM). To meet the air quality guidelines and to improve air quality, the Netherlands have started a national collaboration project for air quality (Nationaal Samenwerkingsprogramma Luchtkwaliteit, NSL) in the whole country. For smaller regional exceedances a regional collaboration program for air quality (Regionale Samenwerkingsprogramma's Luchtkwaliteit, RSL) has been set up. These two parties have introduced a convenant to stimulate low emission zones for heavy-duty vehicles in several cities in the Netherlands. The city of Amsterdam is also part of this program. There are several streets in Amsterdam that do not meet the air quality standards and the air quality has to be improved in these areas. Because the main source of air pollution in Amsterdam is traffic-related, the most effective measure to improve the air quality is to introduce a low emission zone. This national program was the onset for the LEZ in Amsterdam.
The city of Amsterdam has its own air quality monitoring network (www.luchtmeetnet.nl) and measures air pollutants at several different locations. These measurements are routinely done at a number of street and background stations. This air quality monitoring network gave the opportunity to analyse the effect of the LEZ on PM_{10}, NO_2, NO_x and soot concentrations. Measurements were done two years before and two years after the implementation of the LEZ.

Management of the process

Implementation of the LEZ in Amsterdam for heavy-duty vehicles was managed in the beginning by Herman Algra. He was responsible for introducing the ANPR-camera enforcement system. Amsterdam was the first city that would implement this enforcement system in the Netherlands. Herman Algra was an accurate coordinator and founder of the enforcement system in Amsterdam. Erik Regterschot was already involved with the preparations of the LEZ and tuning of the discussion of the state and community and is now project leader.

Formatted documents

The implementation of the LEZ for heavy-duty vehicles in Amsterdam was part of a national program. Due to this there were already guidelines and rules for the implementation process. In the national convenant and guidelines everything was already recorded. The implementation of the LEZ in Amsterdam could start immediately. The city of Amsterdam was only responsible for the geographical layout of the LEZ and countervailing measures. The city investigated the impact of different geographical layouts of the LEZ.

Resources and activities

The implementation of the LEZ in Amsterdam had many resources. The largest resource was the national program (NSL) that introduced LEZs in different cities in the Netherlands. Due to this program there were already guidelines, or also called the convenant, which contains the rights and obligations for all convenant partners (http://www.milieuzones.nl/sites/default/files/Het%20convenant.pdf). The convenant contains agreements about: description of a low emission zone, which vehicles are affected by the zone, entrance criteria, exemption possibilities and a guidebook for how to introduce a LEZ. http://www.milieuzones.nl/sites/default/files/Draaiboek%20uitvoering%20milieuzone.doc.pdf

The national program to introduce LEZs gave the city of Amsterdam guidance for the implementation process. However, Amsterdam had to correspond with companies and residents about the geographical layout of the LEZ. Requirements for the LEZ were that the area should contain locations with air quality problems and a geographical area that would be clear for residents and visitors. The LEZ can be clearly defined by the ring highway A10 and the IJ river. This area is the most densly populated area of the city and has the most traffic movements. However, for some companies within the zone the implementation of a LEZ would have negative economic effects. These industrial areas are nearbye the ring highway A10 and do not have supply routes through neighborhoods; no people are living in these areas and there are no air quality issues. The LEZ would have adverse effects on those companies. Under the condition of no air quality issues in these industrial areas, the city of Amsterdam has decided to leave these areas that are close to the ring highway A10 out of the LEZ.
Before and after the implementation of the LEZ measurements had to be done. Two years before the actual implementation of the LEZ two monitoring stations within the zone were monitoring air pollutant concentrations of NO_2, NO_x, particulate matter and soot. One station at the Jan van Galenstraat as a roadsite monitoring station and one at the Vondelpark as background station. NO_2 and NO_x were measured each hour. Daily averages were calculated from these hourly measurements. Particulate matter was continuously measured and for soot two types of measurement analysis were done: absorbance and elemental carbon analysis (Panteliadis *et al.*, 2014). Measurements were provided by the Amsterdam Air Quality Monitoring Network (www.luchtmetingen.amsterdam.nl) and were available from January 1st 2007 (two years before implementation) until new years eve 2010 (two years after implementation of the LEZ).

Connections with other projects

The implementation and evaluation of the LEZ in Amsterdam has no special connections with other projects of a similar background. Involvement of the national project (NSL) made all the connections with other communities that were introducing a LEZ in their city. Due to this the city of Amsterdam did already have a large network of other similar projects in the Netherlands.

5.2.2 Interview

Background information about the process behind the implementation and evaluation of the LEZ in Amsterdam is given by Erik Regterschot from the city of Amsterdam. He was involved in the preperations of the LEZ, negotiations and the implementation of the LEZ. The interview took place on June 2nd 2015 and the questions from the interview can be found in appendix IB.

5.3 SWOT-analysis

The implementation and evaluation of the Low Emission Zone for heavy duty vehicles in Amsterdam had its strengths and weaknesses. To gain insight in these strengths and weaknesses a SWOT-analysis was made. A summary of this SWOT-analysis can be found in table 3.

5.3.1 Strengths

The LEZ in Amsterdam was not the first LEZ of its kind. There were already seven other LEZs in the Netherlands before Amsterdam was implemented; Den Bosch, Breda, the Hague, Eindhoven, Rotterdam, Tilburg and Utrecht. Also in other countries in Europe there were already LEZs. For Amsterdam this was a strength because the city did not have to introduce guidelines or legislation for the introduction of a LEZ. The national program that gave guidance to all cities and communities in the Netherlands to implement the LEZ was also a strength for this process. This lead to an easy implementation process in the field of legislation and guidelines.
Another strenght of the LEZ implementation process is the support of companies and others for the enforcement system. When the city had decided upon implementing a LEZ, companies and residents that would be affected by the LEZ were in favour of the ANPR-camera system as enforcement system. In unision the city, companies and others felt that there should be an enforcement system that gives a high compliance of the LEZ and this was found in the ANPR-camera system. The chosen enforcement system was a strength of the implementation process because companies that would suffer of the implementation of the LEZ were also in favour of this enforcement system. All participating parties agreed on this measure.
In some areas of Amsterdam there was support of local residents for the implementation of the LEZ. These residents were aware of the improvements the LEZ would have on the air quality in their neighbourhood. Especially residents near busy industrial areas were many trucks drive. These residents were represented by a residents association. For the implementation of the LEZ this was a strength, because beneficiaries of the LEZ were aware of the effects the LEZ would have on their health. Due to this support, there was more pressure in hotspot regions to implement the LEZ. Without this support, it might have cost more time to come to agreements with industrial companies.
In Amsterdam the air quality is measured routinely by the Amsterdam Air Quality Monitoring Network. This monitoring network gave the opportunity to analyze the effect of the implementation of a LEZ on air quality. Two years before the implementation and two years after implementation of the LEZ measurements of NO_2, NO_x, PM10 and soot were done and resulted in a good insight in the actual effect of the implemented LEZ (Panteliadis et al. 2014). Monitoring the long-term effect of the implemented LEZ is a strength of this pilot, because of this monitoring system the actual effect of implementing a LEZ can be shown.

5.3.2 Weaknesses

Implementation of a LEZ is problematic. Residents and companies will be affected by the implementation of such a measure. The community of Amsterdam resisted to the implementation of a LEZ for all vehicles. For this reason the city first implemented a LEZ for heavy-duty vehicles only.This way, the community could get used to the idea of a LEZ and after a few years the LEZ could be introduced for other vehicles as well. Implementing the LEZ only for heavy duty vehicles can be seen as a weakness of the measure, because the LEZ is only implemented for one type of vehicles. This could result in a lower impact of the measure on air quality. However, heavy-duty vehicles are the major sources of NO_x, particulate matter and soot in urban areas (Ning et al., 2012).
The national program to introduce LEZ in several communities of the Netherlands is partial a weakness for the implementation process of the LEZ in Amsterdam. Amsterdam is a large city and has the capacity to organise many things on its own. However, due to the national involvement the city had to

deal with several delays. These delays were caused by the involvement of smaller local authorities, which resulted in discussions about which types of exemptions and how to negotiate with companies. Had the city of Amsterdam not been dependent on the national program, it could have implemented some measures of the LEZ faster than it did now.
Evaluation of the LEZ had also its weaknesses. To evaluate the effect of the LEZ only two measuring points were chosen. One roadside monitoring station at the Jan van Galenstraat and one urban background monitoring station in Vondelpark. Two measuring points in such a large zone can give the wrong immage of the situation in the whole zone. More than two monitoring sites would have given a more accurate immage of the LEZ effect. However, measuring points that were routinely monitored were chosen for the evaluation. Only these two measure points met the criteria.

5.3.3 Opportunities

The implementation and evaluation of the LEZ in Amsterdam had several opportunities. Due to the national project in the Netherlands, Amsterdam could start right away with the implementation of the LEZ. The city did not have to do any pioneers work and could use documents set up by the national project. This gave the city an easy process at the level of legislation and guidelines for the LEZ.
Implementation of the LEZ had enough financial support. Evaluation of the LEZ used the opportunity of support from the EU Interreg project JOAQUIN. JOAQUIN partially funded the evaluation project of the LEZ and supported the evaluation with guidance when needed. The involvement of JOAQUIN was a good opportunity for the city of Amsterdam to evaluate the actual effect of the LEZ.
The LEZ of Amsterdam has some areas close to borders of the zone were there are exceptions for heavy-duty vehicles. These exceptions for the industry located at the border of the zone might also been seen interpreted as a weakness of the LEZ. However, these areas are no hotspot zones of Amsterdam and entering of trucks of the zone to reach these companies will have no negative impact on the effect of the LEZ. Due to this, the city of Amsterdam has decided to give companies located in the zone but next to the highway an exemption to reach these companies. The trucks will only drive to these companies and will not go further into the city.
As an enforcement system the city of Amsterdam implemented the ANPR-camera system. Amsterdam was the first city which applied the ANPR-camera system as an enforcement system. An untouched opportunity of this ANPR-camera system could have been that this system could also be used for other purposes, like counting the number of vehicles passing. The system could be used for many other goals as well, rather than only registrating the license plates of trucks.

5.3.4 Threats

Implementation of a LEZ in a city has its concequences for residents and companies who have to be in the city. In the case of the LEZ of Amsterdam, mainly companies with trucks are disadvantaged by the implementation of the LEZ. The greatest threat of the LEZ implementation process was the Food Centre in Amsterdam. The Food Centre is located at the Jan van Galenstraat, which is one of the hotspot areas of Amsterdam. The companies of the Food Centre were not in favor of the implementation of a LEZ. To get the Food Centre companies along with the implementation of the LEZ the city have introduced a separate convenant, which is only set up for the companies of the Food Centre. In this convenant there are agreements specific for these companies. A new access road at the north side of the Food Centre will be constructed. In this way, the trucks will not be driving through the hotspot area of the Jan van Galenstraat. If the Food Centre would not have agreed with these terms, then this could be a major threat for a successful implementation of the LEZ in Amsterdam. Other companies within the LEZ could also be a threat for the implementation of the LEZ. There are several companies within the LEZ, which lie close to the highway. All these companies together are large stakeholders in the process. Without collaboration of these companies the LEZ would not be implemented with success.
Another possible threat for a successful evaluation of the LEZ is the operating status of monitoring station. Two measuring stations were selected in the LEZ of Amsterdam to monitor the effect of the

LEZ. One of these monitoring stations served as a background station. It could be a threat for the measurements when these monitoring stations would not be working properly the whole measuring period. This could have lead to insufficient data about the effect of the LEZ. Luckily, the monitoring stations are checked on routinely basis and this was not the case during the monitoring phase.

Table 3. Summarizing overview of the SWOT-analysis on the implementation and evaluation process for a Low Emission Zone in Amsterdam. All items are explained in the text above

Strengths	**Weaknesses**
• Experience on LEZ in the Netherlands • Enforcement with ANPR-camera system • Modelling of the air quality situation • Support of local residents • Monitoring of the air quality effect of the LEZ by measurements	• LEZ only for heavy duty vehicles • Delay due to dealing with other authorities • Day/year exemptions • Only 2 monitoring sites
Opportunities	**Threats**
• Enough financial back-up • JOAQUIN involvement • Exception for industrial areas within the zone • ANPR-camera system can be used for other goals	• Complicated position of Food Centre Amsterdam • Opposing companies • Dependency of limited number of monitoring stations

5.4 Recommendations

Implementation of the LEZ in Amsterdam was not the first LEZ that was implemented in the Netherlands. Due to the national program in several cities in the Netherlands there are LEZ for heavy-duty vehicles implemented. To provide future implementation and evaluations of LEZ an easy start, recommendations from this LEZ can be taken into account.
The SWOT-analysis of the implementation and evaluation of the LEZ gave insight in the strengths and weaknesses of the implementation and evaluation process. This analysis showed that the national program in the Netherlands, to introduce LEZ in several cities, provided an easy start for the implementation process of the LEZ in Amsterdam. However, on the other hand this national program was in some cases a delaying factor. Some aspects of the implementation could better be organized by the city itself. In a national program there should be the possibility to solve city related problems themselves at a local level and not at a national level for all cities or communities together. This would decrease delays of the implementation process for separate cities. Furthermore, consulting with concerned companies has shown to create support for the measure. Without consulting affected companies of the measure there would be no support for the measure that will lead to a healthier environment for all residents and visitors of Amsterdam.
Another recommendation that can be extracted from the SWOT-analysis would be that measuring the long-term effect of the LEZ provides a good insight in the actual improvement of the air quality due to the implemented measure. When measurements of air quality starts at least 2 years before the actual introduction of the measure and 2 years afterwards a realistic representation can be obtained of the situation. Different weather conditions and changes in the daily amount of traffic are then taken into account. Even changes in tightening's of the LEZ rules can be seen in the measurements. This gives a good insight in the actual effect of small measures in the LEZ.

Recommendations the city of Amsterdam gave were more technical recommendations. As an enforcement system of the LEZ the city of Amsterdam uses the ANPR-camera system. This system registrates license plate numbers and connects these images to a database which checks the vehicle whether it is aloud to enter the zone. The city thinks that this system would be more cost-effective if it could be used for other goals as well. In that way, the system would be even more useful than it is now.

Recommendations for future implementations of public tendering are:

- Start at least 3 years before the concession period starts with preparing the Program of Demands and Assessment forms that are needed for the public tender.
- Eight months before tendering the Program of Demands and Assessment Forms are finished to make them public for two months.
- Consult with the local community, public transport companies, department of Traffic & Transport of the community, the Environmental department and the department of Purchases to gain insight in possibilities and wishes.
- It is important to have social and political support for the ambition of sustainable public transport before the tendering starts.
- Use connections of projects with similar contents, these projects can provide knowledge and insight in the possibilities for setting up the Program of Demands.
- Schedule monthly meetings with participating parties to discuss the progress.
- Share all knowledge with all participating parties for an open honest character of the project.

6. The implementation of a traffic lights sequencing system in Leicester city

Measure

Implementation of a traffic lights sequencing system

Description

To improve the flow of the congested Glenhills Way junction in Leicester a new traffic light sequencing system will be implemented. This traffic lights sequencing system will have less and smarter stages, which results in a faster traffic flow.

Effect

The expected air quality effects of the implementation of a traffic lights sequencing system can be seen at the junction of Glenhills Way and Lutterworth Road. Due to a better flow and less congestion of traffic after implementation of the system, the air quality at that area will improve.

Suggested reading

Fisher, S. (2015). The most dangerous roads in Leicester and Leicestershire revealed. *Leicester Mercury January 2nd 2015.*
http://www.leicestermercury.co.uk/dangerous-roads-city-county/story-25797500-detail/story.html
Short article in the Leicester Mercury newspaper about the roads in Leicester and Leicestershire with the most accidents and possible sollutions to reduce the accident rate.

Kim, K.H., Lee, S., Woo, S.H., Bae, G. (2014). NO_x profile around a signalized intersection of busy roadway. *Atmospheric Environment97: 144-154.*
Article about an investigation to understand the effect of traffic control on air pollution. In this article the NO_x pollution profile at a signalized intersection of a busy roadway is investigated.

6.1 Measure

The A426 is the main entrance into Leicester City from Lutterworth and Rugby and has been identified as a congested route. To improve the traffic flow on the A426 Leicester City and Leicestershire County Council applied for the Better Bus Area Fund (BBAF) with the A426 Bus Corridor project. Aim of this project was to reduce journey times and improve bus services. Several infrastructural improvements have been made, especially to improve bus journey times in and out of the city. Infrastructural improvements contained introducing bus lanes and redesigning of street furniture to make right turns easier. In figure 10 an overview of all improvements of the A426 can be found.

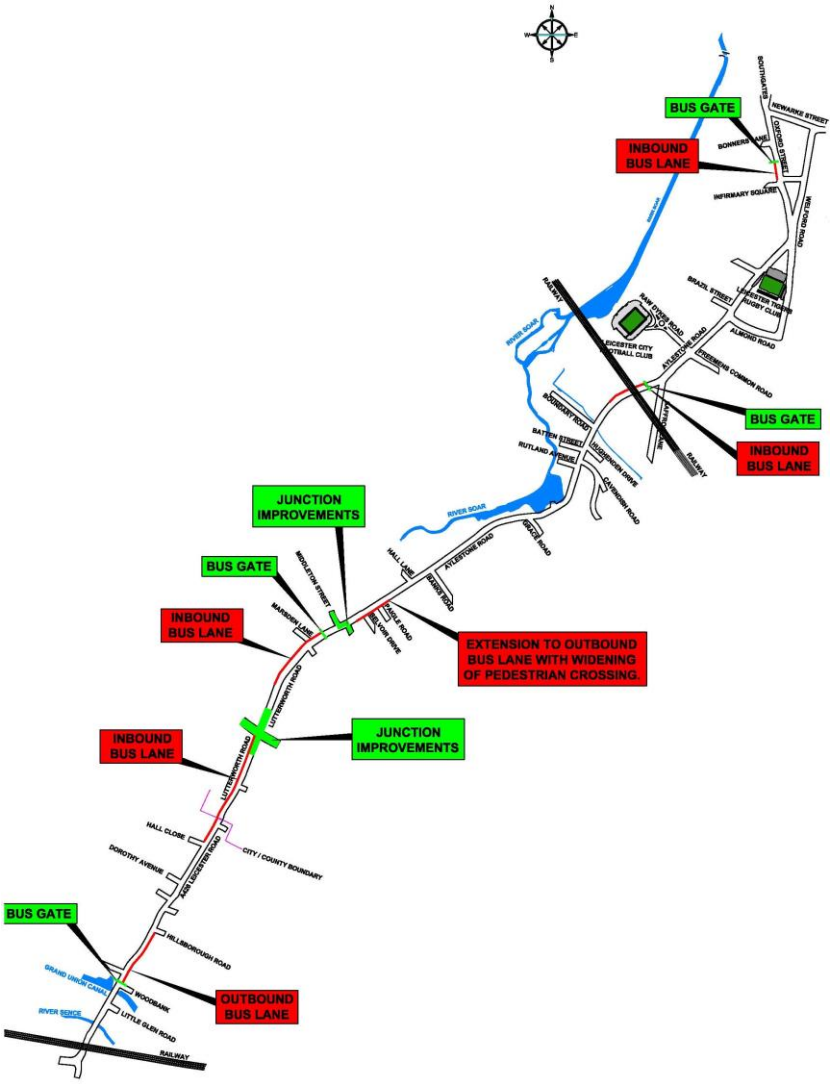

Figure 10. Overview of all improvements at the A426 Bus Corridor Project

Another aim of the Bus Corridor project was to encourage a modal shift to public transport away from personal vehicles to reduce congestion and emissions at the A426. To accomplish this, the project will implement several actions like: smart ticketing, bus stop timetables and personalised travel planning. Other improvements will be made on the existing bus services, making public transport more attractive for public.

One infrastructure improvement will be at the Glenhills Way junction. Glenhills way junction is part of Air Quality Management Area in Leicester. Glenhills Way is one of the hotspots in Leicester and it records highest readings for NO_x and NO_2. At the junction there is a monitoring station (Fig. 11), which measure

the concentrations of NO_x and PM10. To improve the traffic flow at the junction the staging arrangement of the traffic lights sequencing system will be improved.

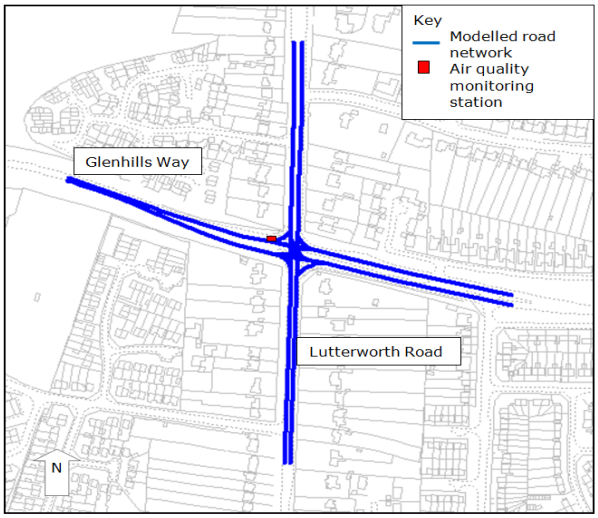

Figure 11. Glenhills Way junction with monitoring station

6.1.1 Examples

Dense urban networks exist in many large towns and cities. A smooth traffic flow at junctions can improve travel time, but also air quality at the junction. A special traffic signalling system, called SCOOT, was designed to control urban dense networks and creates good progression to vehicles through the network. Glenhills Way junction is not the first junction were this traffic lights system has been used. Examples of other junctions are given below.

London

In early 1984 a SCOOT system was implemented in the area of Westminster (*www.scoot-utc.com/london*). In 2009 Transport for London (TfL) has started with increasing the number of traffic signals that use the SCOOT system. So far, the system has reduced delays with 13%. At some locations this is even 20% reduction of delays. Next to implementation of SCOOT for motorised vehicles, there will be a SCOOT version for pedestrians as well. This system will detect large groups of people at the pedestrian crossing and the new traffic signing system will allow them to quickly move through areas of London (*http://www.traffictechnologytoday.com/news.php?NewsID=37610*).

Beijing

In Beijing traffic control was uncoordinated. By implementing a SCOOT traffic lights system, which controlled cycle traffic as well as motor vehicles reduced journey times of bicycles with 7% and 16% for vehicles. This has increased the traffic capability of the road-network.
http://www.scoot-utc.com/Beijing.php?menu=Results

6.1.2 Co-benefits

Besides an improvement of the air quality at the junction there are also some co-benefits of this implemented traffic light system at the Glenhills Way junction. Due to the new system more traffic is now able to cross the junction then before. This results in a larger capacity per day of the junction. Another co-benefit is improvement of the design of the junction. A number of movements were quite difficult for large vehicles, which were striking street furniture with their turns. In the new design there is more room to make right turns, which also resulted in less queuing for these right turns at the Lutterworth road.

6.2 Description

6.2.1. Process description

Onset of the process

Leicester is a city with a busy commercial centre, which can be entered by major roads. Road traffic has grown in recent decades and this has resulted in exceeding of the NO_2 annual mean air quality objective since 2000 (http://laqm.defra.gov.uk/documents/CaseStudy_Leicester.pdf). Leicester has been declared as an Air Quality Management Area (AQMA) since then. To improve the air quality, the government has started a bus corridor project at the A426. This project should improve the bus journey time at congested urban areas and achieve a model shift towards public transport use, free up valuable road space and reduce carbon emissions. Glenhills Way junction is part of the A426 and will be addressed with the bus corridor project. An air quality monitoring station at the Glenhills Way junction measures the NO_x and PM10 concentrations. Modelling indicated that the pollution at the Glenhills Way junction came from traffic. This was also the onset to introduce a smarter traffic light sequencing system.
Glenhills Way was also a dangerous junction due congestion and striking of street furniture by large vehicles at right turns. The former junction layout had several small islands and pedestrians' refuges, which made turning movements for large vehicles difficult. By improving the infrastructure of the A426 and introducing a new traffic light sequencing system the queuing and maintenance of street furniture problems will be solved.

Management of the process

The traffic light sequencing system was part of a larger project, the A426 Bus Corridor Project. Project leader of this project was Lynne Stinson. She is leader on this project to improve the bus journey time and make public transport more attractive. In this project many people were involved, due to the diverse adjustments that were done at the A426.

Formatted documents

The Bus Corridor project addresses several different aspects of the A426, including bus infrastructure improvements of the A426 and traffic flow improvements. Before the implementation could start, designs had to be made to improve bus journey times by addressing identified delays at the A426. These designs contained proposals for bus lanes and junction improvements. Glenhills Way junction was a junction were a new staging scheme had to be developed to improve the traffic flow at that junction. The staging scheme was first developed in a model made with the software package LinSig to find the right combinations of safe stages. After development the model was tested for safety issues in a factory, before it was build in the actual junction.

Resources and activities

The implementation process of the traffic lights sequencing system at the Glenhills Way junction made use of the software package LinSig, which contained information about other traffic lights sequencing systems of several junctions. This software package is produced by the company JCT and is created for designing and as an assessment tool for traffic junctions and road networks (www.jctconsultancy.co.uk). LinSig contains examples, with which the traffic engineers build a new scheme for the Glenhills Way junction. Another resource for the Glenhills Way junction traffic management was other junctions with the special SCOOT (Split Cycle Offset Optimisation Technique) traffic control system. SCOOT is a tool to manage and control traffic signals in urban areas. Due to detectors embedded in the road the system responds automatically to fluctuations in traffic flow (www.scoot-utc.com).
For the Glenhills Way junction the SCOOT tool and LinSig software package were used to improve the flow of the traffic at the junction (Fig. 12). The main job was to get an optimal performance out of the junction in terms of signalling. At traffic junction traffic and pedestrian movements have to be controlled. Only certain traffic lights signalling combinations can run safely together. The Glenhills Way junction was a complicated junction were several accidents have occurred and street furniture was frequently hit by turning of large vehicles.

To improve traffic flow they worked out which conflicting movements could be combined to get the smallest number of stages. A stage is a combination of movements that can run together at the same time; like pedestrians crossing together with specific movements of vehicles, which can safely be combined. Separating traffic movements resulted in increased traffic flow. In the old traffic lights sequencing system vehicles that were turning to the right were opposed and had to move through opposite traffic. On the A426 a lot of traffic wants to make this move, which resulted in blocking all other traffic behind. Separating the right turns resulted in a better flow of this manoeuvre and resolved some accident problems of the junction. After designing the model of the Glenhills Way junction, the model was tested for safety issues in a factory. After which the traffic lights sequencing system was installed by a contractor.

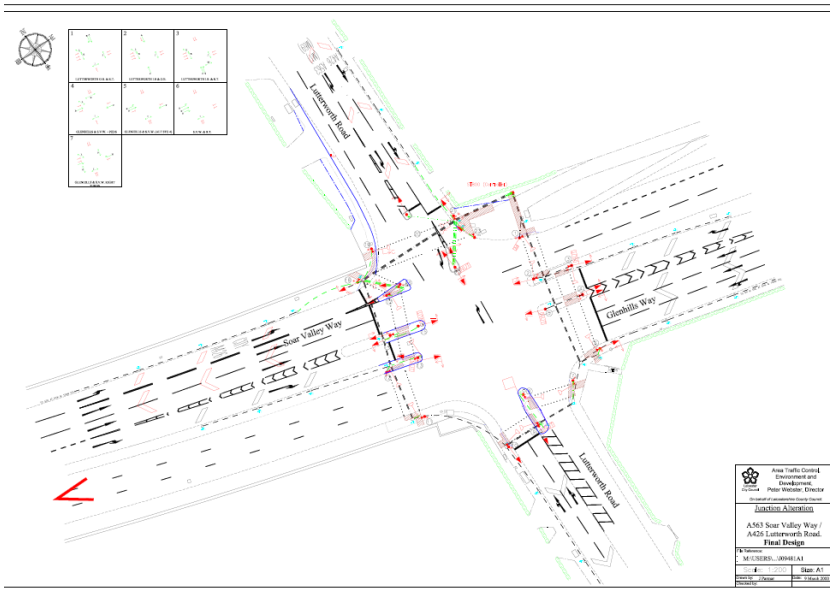

Figure 12. A map of the SCOOT scheme implemented at the Glenhills Way junction

Connections with other projects

The implementation of an improved traffic lights sequencing system at the Glenhills Way junction is part of the A426 Bus Corridor project of Leicester City Council and Leicestershire County Council. The improvements of A426 corridor are part of the Government Better Bus Area Fund, but not linked with any other corridor developments in the city.

6.2.2 Interview

Background information about the implementation of the traffic light sequencing system at the Glenhills Way Junction in Leicester was given by Matthew Mason, a traffic engineer at Leicester City Council. He was involved with developing, modelling and programming of the traffic lights sequencing system. The interview took place on April 14th 2015. Another short interview with Lynn Stinson, the manager of the Bus Corridor project, took place on May 6th 2015. She provided some background information about the whole project and referred to the Bus Corridor website for further information about the project: http://www.leics.gov.uk/a426_bus_corridor_project. The interview questions asked to Matthew Mason can be found in appendix IC.

6.3 SWOT-analysis

To gain insight in the strengths, weaknesses, opportunities and threats of the implementation process of a traffic lights sequencing system, a SWOT-analysis has been done. An overview of the results can be found in table 4.

6.3.1 Strengths

Glenhills Way junction is known as one of the most challenging roads in Leicester and Leicestershire (Fisher, 2015), frequently congested due to the turning traffic. To improve safety and reduce congestion at the junction traffic engineers have reduced the number of stages of the traffic lights sequencing system. A major strength of this process was the reduction in number of stages necessary to run a safe junction with a better traffic flow. In the old system there were 7 stages, now in the new system there are only 5 stages. This has resulted in a better flow of traffic at the Glenhills Way junction, which will lead to less emission of vehicles. Deceleration, idling and accelerations are causing high levels of NO_x concentrations (Kim et al., 2014). Due to the increased traffic flow the deceleration, idling and accelerations of vehicles will be reduced and by that the emissions of NO_x. The new traffic lights sequencing system will improve the air quality of the Glenhills Way junction.
Not only is the traffic flow improved at the Glenhills Way junction, but also the infrastructure at the junction. The former junction contained several small islands and pedestrians' refuges, which made turning movements of large vehicles difficult. The new design has removed these small islands of street furniture and made it easier to make turning movements. This has resulted in less striking of the street furniture and thus less maintenance issues. Together with the improved traffic lights sequencing system this will give a safer and healthier junction.
Strength of the process was modelling the traffic light system before it was actually implemented at the junction. In this way the best options could be weighed and tested before the final model was build. This resulted in only 5 stages in the traffic light system, which will give a better flow of traffic at the junction. After modelling the traffic light system was tested in a factory, which gave insight in operating of the system in a real situation with the safety of the factory. With this testing phase safety issues of the system could be examined before the system was implemented at the real junction. Due to these two steps in the process the new traffic light system was double checked and safe to operate in the real situation.

6.3.2 Weaknesses

The implementation process of the traffic lights sequencing system also had some weaknesses. One of those weaknesses was that the success of the implementation was dependent of the work the contractors, who installed the system delivered. The implementation process encountered some managing problems regarding the contractor. The contractor did not deliver the right equipment to get the junction running at an optimal performance, which is called SCOOT. Due to dependency on the contractor for the installation, junction is running, but it still has not been running at its most optimal performance. However, a traffic response method known as Microprocessor Optimised Vehicle Actuation (MOVA) was commission. This MOVA gives already a good result in managing the site. SCOOT will come online at a later, still unknown, date.
Another weakness or even a downside of this implementation process is the fact that the congestion problem at this junction has been shifted towards next junctions. The new traffic lights sequencing system at the Glenhills Way junction a bigger capacity of the junction was reached. However, this caused problems up- and downstream of the junction. The blockage that is released from the Glenhills Way junction is impacting on surrounding junctions, which are at their full capacity. The implementation of the new system at the Glenhills Way junction caused adjacent junctions to become busier. A weakness of this implementation process and the Bus Corridor project is that they did not foresee this problem and did not introduce the same system at all other junctions of the A426. A holistic approach to the whole area would have achieved significant results in reducing the congestion at the junctions and therefore in the whole area.

6.3.3 Opportunities

The implementation process to improve the Glenhills Way junction had also some opportunities. The A426 Bus Corridor project was one of these opportunities. This project will tackle a major part of the A426 to improve bus journey times and reduce traffic on this road. Glenhills Way junction was part of

this project. Due to the Bus Corridor project the infrastructure of the junction was improved as well as the traffic flow of the junction. However, the A426 Bus Corridor project could be used as an opportunity to improve all traffic light systems at all junctions up- and downstream of Glenhills Way junction. In this way the blockage of the Glenhills Way junction would not be shifted towards other junctions.
Another opportunity for a successful implementation of the new traffic lights sequencing system at the junction was the software package LinSig that was used. This software package contained schemes of other junctions. Although each intersection is different, this program delivered useful information about possibilities to improve the traffic flow of this junction. This resulted in an easy developing process of only 2 weeks for the Glenhills Way junction traffic lights scheme.
The Glenhills Way junction is one of the hot spots of high pollution in Leicester. For over 10 years PM10 and NO_x has been monitored at this junction. Extensive investigations have taken place to identify the pollution sources at this junction. After the investigation it was concluded that due to the junction being located on a slope drivers of vehicles have to use higher revs to go up the junction and thus creating more pollution than at the similar junction located on a flat area. There are no industrial sources of pollution located near or at the junction, so traffic is the only source. This is why improvement of the Glenhills Way traffic lights system was started. The JOAQUIN project was involved from the air quality side of things and provided background information and support for the extensive investigations that have taken place.

6.3.4 Threats

A number of threats were identified, which could prevent a successful implementation of the traffic lights scheme. The first threat was the possibility of failure of the whole new traffic system. Such threat would have caused no improvement of the traffic flow at the junction and the rate of accidents would not have been reduced.
Another threat was the possibility that the contractors would not deliver a high quality end product, which in turn could cause the traffic lights not to work properly causing increased congestion at the junction or even accidents.
A major threat to the Bus Corridor project could have been negative reactions from the residents of the surrounding areas. In such scenario residents could have been against the infrastructure changes and the junction improvements. They could have protests against any changes at all and could have negated the benefits such as improved journey times. Residents could have also been afraid that the trees along the corridor would have been cut and that the road would be too close to their homes. Furthermore, residents could have been afraid that their houses would decrease in value due to the infrastructural changes. The opposition of residents to the project could have caused major delays to the delivery of the project.
The Bus Corridor project avoided any of the above and the trees and the green walkway were preserved. Residents questioned the improvement of journey time for all users of the A426. However, not only the journey time of public busses improved, but also the journey time of other vehicles, due to improvements of traffic flow at junctions.

Table 4. Summarizing overview of the SWOT-analysis on the implementation process for a traffic lights sequencing system in Leicester. All items are explained in the text above

Strengths	**Weaknesses**
• 5 instead of 7 stages • Improved infrastructure of the A426 • Modelling of the new system • Testing of the new system • MOVA has already a great impact on the situation of the junction	• Shifting the problem towards other junctions • Not all performances of the traffic lights system are working yet • Dependent of subcontractors • Not introducing this system at all junctions of the A426

Opportunities	Threats
• Involvement of JOAQUIN • A426 Bus Corridor Project • Software package that was used	• Opposed residents • Failing of the system • Work delivered by the subcontractor

6.4. Recommendations

Traffic signals, which are not optimised, can lead to congestion of traffic at junctions, which in turn can result in an increase of air pollution levels (Kim *et al.*, 2014). Glenhills Way is a busy junction ,located on one of the main radial roads in Leicester, part of the Air Quality Management Area (AQMA) in Leicester. To improve air quality the traffic flow at the Glenhills Way junction a smarter traffic signal system was introduced. Glenhills Way junction is not an isolated example ,where there is a persisten congestion issue. In order to aid future project involving improvements at junctions to reduce congestion the Glenhills Way junction can be used as an example.
SWOT-analysis of the implementation process of the Glenhills Way junction gave insight in the strengths, weaknesses, opportunities and threats of the process behind the implementation. This analysis showed that improvement of a traffic signal system could increase traffic flow at the junction. Due to more combinations of traffic movements there are now less stages in the traffic lights sequencing system. As a result, there is less congestion at the Glenhills Way junction and an improved air quality. This shows that making smarter combinations of traffic movements can result in an improved traffic flow. To reach this result the use of recognised software package and method is necessary. For the Glenhills Way junction the software package that was used provided the necessary background information of other junctions and their traffic signal system improvements. Every junction is different, but examples can provide ideas and options for new junctions. Due to this, making a new model for the Glenhills Way junction went reasonably well. Within two weeks there was a new traffic lights sequencing system with less stages than the former traffic lights system.
Modelling in the software package LinSig and test modelling in a factory provided this process with a double check, whether the new traffic lights sequencing system would improve the traffic flow of the Glenhills Way junction in a safe manner. However, at the real junction the traffic light system is not operating at its optimal performance. The main reason for this is that some of the options of the traffic lights system are not yet operating; the contractor is still working to improve this. This shows that the success of the implementation process depends on the work delivered by subcontractors as well and should be taken into account. The success of an improved traffic flow at a junction lies not only with an improved traffic lights sequencing system. Accompanying measures to improve the infrastructure of the junction will also improve the flow of traffic at a junction. Thereby, using the opportunity to improve traffic flow in different ways will lead to a greater success of the measure.

Recommendations for future implementations of traffic lights sequencing systems:

- Use a recognized method which includes all best practice options as a reference for the new traffic lights sequencing system at the junction
- Make use of accompanying measures to improve traffic flow at the junction
- Take at least 4 weeks time to develop and model the new traffic lights sequencing system
- Test the new system in a testing factory to avoid safety issues at the real junction
- Smarter and less combinations of traffic movements at a junction leads to improved traffic flow

7. A public bus tender for low emission busses in the Province of Noord-Holland

Measure

A clean bus tender: public transport with less emission of NO_x, particulate matter and soot in the region Haarlem-IJmond.

Description

Province of Noord-Holland, responsible for public transport within the area, is required by law to tender for the next concession period. A concession gives a public transport company the exclusive right to provide public transport in a certain area for a certain time. In this concession the province of Noord-Hollands tries to tender for the 'greenest' concession possible.

Effect

Expected air quality effects of this tender are improvements in congested areas of public busses, such as the bus station or at bus stops.

Suggested reading

Programma van Eisen: openbaar vervoer concessie Haarlem / IJmond:
In this document all the demands of the tendering for the concession in Haarlem-IJmond can be found (written in Dutch).

Langer, S. (2014). Field test for inductive electric bus charging in the Netherlands. *http://www.eltis.org/discover/case-studies/field-test-inductive-electric-bus-charging-netherlands:*
In this short article the pilot with electric busses in Den Bosch can be found. A short description is given about the electric busses that are implemented in the inner city in Den Bosch.

Miles, J. & Potter, S. (2014). Developing a viable electric bus service: The Milton Keynes demonstration project. *Research in Transportation Economics 48: 357-363.*
In this article more information is provided about the development of sustainable public transport.

Chong, U., Yim, S.H.L., Barrett, S.R.H., Boies, A.M. (2014). Air quality and climate impacts of alternative bus technologies in Greater London. *American Chemical Society 48: 44613-4622*
Article about different propulsion technologies for busses and their costs and benefits of the environmental impact.

7.1 Measure

In the Netherlands each province is responsible for all public transport within the area. By law it is determined that urban and suburban transport can only be performed by companies who have received a permit, also known as a concession. A concession gives a public transport company the exclusive right to provide public transport in a certain area for a certain time. There are some conditions for this concession, which are recorded in the Program of Demands (Programma van Eisen). A Program of Demands is always set up before the tendering starts. In this Program of Demands minimum requirements for public transport, concerning all aspects of public transport, are documented. By the establishment of this document different parties like participating communities and consumer associations were involved and even a consultation with the public transport market was done. The Program of Demands is made public for two months before the tendering starts. In this way everyone can see the plans and comment to them. These comments are taken into account and can lead to changes in parts of the program. When the Program of Demands is finalized by the Provincial Executives (Gedeputeerde Staten), public transport companies can make an offer for the tendering process.
After four months one public transport company will be selected as the winner of the tendering. This company has at least met the criteria of the Program of Demands and on top of these criteria some extra possibilities. The company that wins the public tendering will be checked periodically whether they fulfil the criteria of their concession plan. When these criteria are not met, a penalty will be given.
The first public tender was coming up for the region Haarlem-IJmond (concession period from 2016-2025). The province Noord-Holland has the ambition to create a healthy environment for all residents. This is why this tender will be used to introduce low emission busses in the province, starting in the region Haarlem-IJmond.
http://www.noord-holland.nl/web/Themas/Verkeer-en-vervoer/Openbaar-vervoer/Aanbestedingen.htm

7.1.1 Examples

The EU has set strict rules about air quality for now and in the future. To meet the set criteria for air pollution, sustainable transport with zero emission will be introduced in whole Europe. At the moment all types of sustainable public transports are under investigation for their environmental impact. For example, in London a study took place to investigate the impact of different powered busses on air quality. In this study the environmental impact of several alternative propulsion technologies were examined for their environmental costs and benefits (Chong *et al.*, 2014). Other studies are working on technology improvements of electric busses (Miles & Potter, 2014). In the Netherlands the province of Noord-Holland is not the only province that is tendering for sustainable public transport in the near future.

Groningen

The province Groningen has prolonged the concession period with two years. It was financially beneficial to prolong the concession period and to introduce sustainability in the upcoming tender. On different routes Euro 6 emission busses will be driving and in the inner city of Groningen a pilot will be done with two fully electric powered busses. Next to these improvements of the public transport another pilot will be done with hydrogen busses that will be driving between Delfzijl and Groningen. This pilot will be introduced to provide all regional transport with hydrogen busses in 2020.
Fuel consumption of Euro 6 busses is 6-8% lower then Euro 5 busses. Furthermore, new busses are also quieter then old busses. Relative to Euro 5 busses, the Euro 6-busses will produce 80% less NO_2 and 50% less particular matter.
http://www.provinciegroningen.nl/fileadmin/user_upload/Documenten/PS_Voordracht/2014-73.pdf

Utrecht

In the province Utrecht a public tender is also taking place for the upcoming concession (period 2016-2023). In this tender especially zero emission has the attention. May 18th the tender is closed and it is expected that June the 30th it will be made public which company has received the concession.

http://www.ovpro.nl/bus/2015/02/10/aanbesteding-busvervoer-provincie-utrecht-op-de-markt/

7.1.2 Co-benefits

A co-benefit of the implementation of low emission busses is that the province will also improve the infrastructure in within urban areas. Implementations that can be made are green waves and separate bus lanes for a better flow of public transport. This may lead to an improvement of the air quality in bottleneck areas in the region Haarlem-IJmond.
Another benefit of the tender with a transition towards zero emission is that the province has set stricter demands than the EU has for emissions. With this tendering the province is ahead of EU legislation, due to the ambition to create a healthy environment for all inhabitants of the province.

7.2 Description

7.2.1 Process description

Onset of the process

Several factors contributed to the process of designing a 'green' concession for the public tender of Haarlem-IJmond. The onset of this tender was the possibility of participating in the JOAQUIN project. The province Noord-Holland aspires a healthy environment with a good air quality and the JOAQUIN project provided knowledge to achieve this goal. Another onset factor were some questions from the local government about sustainability of public transport. The Chairman of the parliamentary party 'Ouderenpartij Noord-Holland' questioned whether the current public transport tenders were about reducing CO_2 and whether all purchases were 100% sustainable. All these aspects together were the onset for improving air quality in the province by introducing a 'green' bus tender, starting with the region Haarlem-IJmond. Region Haarlem-IJmond was chosen because of the moderate air quality in this region and wants to improve its air quality. Next to this, a public bus tender was coming up in this region in a couple of years. Together, these factors lead to early contact with different departments and organisations that would be involved in the tendering process. This early contact gave insight in the possibilities and wishes for the public transport sector for the upcoming tender.

Management of the process

The manager of the whole process was the province Noord-Holland. The province is responsible for public transport and is obligated to provide a public tender for the ten-year concession period. Three departments of the province Noord-Holland were involved in the process. Department of Traffic & Transport was responsible for providing the possibilities of traffic and transport and the guidelines for the program of demands. The department of Environment was responsible for translating the ambition of the province into functional ideas of sustainability. The third department that was involved was the department of Purchases. This department is responsible for all purchases of the province. The purchasing advisor of this department that was involved in the tendering process was also project leader of sustainable procurements, which had positive influence on the implementation of the 'green' concession tender.
Extern involvement in the process of the public bus tender came from the local community, public transport companies and the federation of the environment. Due to active research in the wishes of the local community about public transport, the tendering process included directly the customers' basic wishes in the Program of Demands. Another consultation process with public transport companies showed what the companies could deliver during the concession period and what the possibilities were of today and in the future. In this way the province gained insight in available materials of today and what the possibilities of purchases could be during the concession period.

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The tendering process is based upon the law for Personal Transport 2000 (Wet van Personenvervoer 2000, Wp2000). This law was introduced in 2000 and states that all public transport in the Netherlands can only take place when the public transport company has received a concession of that area. Documents that were formatted before the tendering started were: the Program of Demands and assessment forms. The Program of Demands contains the minimum demands for the upcoming concession period and an assessment form was also set up before the start of the tendering. In this assessment form the points that would be accredited for the different aspects of the Program of Demands were registered.

Resources and activities

Different resources were used for the tendering process of a 'green' concession. Knowledge from several projects with a similar background was used. The Province of Noord-Holland participated in the pilot on Texel of the project E-mobility. This pilot was set up to investigate the possibilities of electric busses in regional areas. Electric busses are now only used in cities and not yet in a regional setting. Busses in regional areas have to drive larger distances with higher speeds than in cities. This pilot showed that there are still some problems with electric transport that need to be solved before it can be used in regional areas. From this project the province has learned that there is not yet an optimal electric bus that could be used in the region of Haarlem-IJmond.

Introducing sustainable public transport enough funding is necessary. Due to retrenchments in public transports there would be not enough money available for introducing sustainable public transport. However, the province aspires a cost-effective public transport system that fulfils the demands of the public and supports their own ambition of sustainability. To accomplish this, the government provided more money for the establishment of sustainable public transport. €18 million was made available for this tender.

One of the activities that had to be done before the tender started was to develop an assessment form. Sustainability can be judged in many different ways. Due to the possibility of different types of busses that would be used during the concession period, a new assessment form had to be developed. To judge the different tenders the province has chosen to use a simplified assessment system. In this assessment system the sustainability factor of a bus type will be expressed as a factor. As a reference the current natural gas bus was used. These sustainability factors can be found in table 5. Each year of the concession period a weighed value is calculated, based on the scheduled kilometres per bus and bus type. All factors of the years of the concession are taken together for the final value. For each concession year the sustainability factor has to be at least 1.20. When a concession year is below this factor of 1.20 the mobilisation plan does not meet the minimum demand and this tender will not be taken into account. The bus company with the highest value has the most sustainable mobilisation of their material.

Table 5. Sustainability factors of different bus types

Bus type	Factor
Euro 5/ EEV Diesel	0.8
Euro 5/ EEV Gas	1.0
Euro 6 Diesel	1.6
Euro 6 Natural Gas	1.8
Euro 6 Biogas/green gas	1.9
Euro 6 Hybrid	2.0
Zero Emission	3.0

Connections with other projects

Due to connections with other project the province Noord-Holland gained enough information and background support for their own sustainable concession tender.

This tender process to reach the 'greenest' concession achievable has connections to three other projects within the Netherlands. These projects all concern sustainability of public transport or purchases. The Province of Noord-Holland is involved in the E-mobility project to test electric busses in

different areas, like on the island of Texel. With this project the possibilities of electric busses in regional areas will be mapped.
Another project that has a direct connection to this tender is the project of sustainable purchases of the Province of Noord-Holland. To tender for a concession with a transition towards zero emission new vehicles have to be purchased. Due to the project sustainable purchases, the purchase of low or zero emission busses falls within the projects contents and are accepted by the province.
The third project with a connection to this public tender is the foundation of Zero Emission. This is a project in which electric busses are provided to run in the inner centre of cities. For a pilot the cities Utrecht and 's Hertogenbosch (Den Bosch) are used. Due to the differences in speed and capacity of these busses, this was no solution for the region Haarlem-IJmond (Langer, 2014).

7.2.2 Interview

Background information about the process before the public tendering started was provided by Karin van Hoof. Manager of the tendering process was the department of Traffic & Transport, which received guidance from the department of Purchases and Legal Advice. Karin van Hoof was involved in this process by advising, writing and assessing the sustainability of the concession.
The interview took place February 19th 2015. The questions asked during this interview can be found in appendix ID.

7.3. SWOT-analysis

Each process knows its strengths and weaknesses. Introducing a public bus tender with a transition towards zero emission is no exception to this. In the developing process of the Program of Demands, some steps were taken easy while others were slightly more difficult and involved more risk taking. To analyse the strengths, weaknesses, opportunities and threats of this process a SWOT-analysis has been done. In table 6 an overview of all the result can be found.

7.3.1 Strengths

Due to participation with the Joaquin project the Province of Noord-Holland started in 2011 with making plans for a 'green' concession plan for 2014. This had lead to more time for investigation of the wishes of several different parties that were involved with the process. Next to this, the early start gave more time to gather background information about the subject and all possibilities. This early start resulted in insight in different wishes of involved parties and possibilities, which lead to an open bus concession plan for the public tender.
Strength of the process was that the Province of Noord-Holland had a useful network of other projects in a similar subject. This gave more openness for the idea of low emission busses in the province, more knowledge about the subject and more insight in the possibilities of today. Use of this network for the project showed that there is not yet a good solution available for zero emission busses, which was also a reason for an open bus concession plan.
Because there was a long period before the public tendering should start, this project showed great perseverance. It caused a lot of effort to keep the subject on the agenda of all participants and keep them at work for the project. Because of this perseverance a concession plan was set up, in which all ambitions of the involved parties were processed. The main strength of this project was that, despite the fact that they could not introduce zero emission from the start; they invested time to make a transition plan towards zero emission. In this way public transport would improve towards zero emission within ten years. Now public transport companies have more time to adjust to these rules, rules that are tighter then EU legislations for vehicles at the moment.

7.3.2 Weaknesses

During the tender process there were a couple of weaknesses and difficulties. Difficulties during the project were keeping the subject on the agenda and to find middle ground for the different wishes and ambitions of involved parties. A practical difficulty was developing an assessment form for accrediting points to each part of the transition plan. It was rather difficult to judge on qualities that have not been used in a setting like this before. This was mainly due to the differences between the different emission class (Euro classes) busses that would be driving during the concession period in the region Haarlem-IJmond.
The province Noord-Holland had several points for the 'green' concession on the agenda, which were not all taken into account. A measure for noise reduction was one of these points and was not specifically included in the Program of Demands. The main reason for this was that there are no tight rules for noise and thus no strict demands can be asked. Due to the lack of official rules about noise in the EU, this ambition subject could not be taken into account in the final Program of Demands. However, the Program of Demands shows the ambition for noise limits.
Another weakness of the process was that no modelling was done about the old and the new situation. This is why there is no insight in the possible improvements the low emission busses will bring for the air quality in congested areas. Noord-Holland chooses not to model the new situation, because of the variety of modelling methods that could be used and the endless discussion about how the measurements took place. However, not modelling the old and new situation did not have major consequences for the process.
The original plan of the Province of Noord-Holland at the start of the JOAQUIN project was to implement low emission busses and evaluate the reduction of air pollution and the implementation process. However, there was no direct implementation of zero emission busses. This is mainly due to the fact that such a fast transition towards zero emission is not reachable. It should be too expensive to replace all existing busses with zero emission busses. Moreover, there is also no optimal replacement yet for the current bus that fulfils all the criteria of a future zero emission bus.

7.3.3 Opportunities

During the process of the public bus tender procedure there were a lot of opportunities that were used for the benefit of the project. Air quality is currently a 'hot' topic in the community; the region Haarlem-IJmond has bad air quality and wants to improve this. The decision of participation in the JOAQUIN project was a great opportunity to improve the air quality in the province. The JOAQUIN project was the onset for the 'green' bus concession.
Participation of Noord-Holland in other projects, like E-mobility of Interreg and in the foundation of Zero Emission were great opportunities to get familiar with the topic. The E-mobility project is piloting different types of electric transport in several regions. Noord-Holland was involved in the pilot on Texel, where electric busses are tested on the island. Due to this project Noord-Holland was already familiar with the existence and possibilities of electric public transport. Next to familiarity with the subject, this pilot showed what the possibilities are at the moment with electric busses. The Zero Emission foundation has implemented zero emission busses in the city of Utrecht and Den Bosch as a pilot. These electric busss drive in the centres of these cities, which is different from regional traffic. This is also the reason why this type of bus could not be used in the region of Haarlem-IJmond. However, knowledge from the Zero Emission foundation and E-mobility helped with the openness for new ideas regarding sustainable public transport and gave insight in the possibilities of today.
Participation in the projects of Zero Emission and E-mobility brought the province the opportunity to plead for a pilot project in the region Haarlem-IJmond, to introduce zero emission right from the beginning of the concession period in certain areas of the region. With the connections of the province a pilot project could have been set up in the region of Haarlem-IJmond. However, the province did not use this opportunity. This is quite reasonable, because electric transport is still in development and there are still some defects of electric transport. Participating in a pilot project could make public transport unreliable for customers. This could result in a shift towards car use instead of public transport. In this regard, it was a safe choice to tender for a transition towards zero emission instead of zero emission right from the start. In this way public transport companies can look for the best low and zero emission public transport options and grant reliability for customers.

7.3.4 Threats

The process of the 'green' concession plan had also a couple of threats that might cause a different outcome than the ambition of the Province of Noord-Holland. During the set up of the bus tender, different parties were involved. All these parties had different agenda points they tried to pursue. A possibility existed that none of the ambitions of the province would come true, so compromises had to be made. To make the plan a success all involved parties had to share the same goal.
Due to the openness of the Program of Demands the province was dependent of the submission plans of different bus companies. Because public transport companies were given the freedom to design their own concession plan, the possibility existed that the ambition of the province of a transition towards zero emission should not be met. This was a great risk that was taken by the province. When all competing bus companies delivered no plans for a transition towards zero emission at the end of the concession period, than the main priority of the province should fail. However, the Province of Noord-Holland was optimistic and had faith that the competing bus companies should deliver a plan that would fulfil their ambitions.
Another threat for the tendering process was the financial support of the bus concession plans. The Province of Noord-Holland wanted to introduce sustainable public transport with high quality and liability. However, the province had to improve the public transport with the same budget as the former tender. This was a major threat for the project, because there had to be invested in new busses to obtain a low emission public transport fleet. Luckily, Provincial Executives provided more money to support the transition towards zero emission.
Concerns of the customers about the liability of transport and the prices of journeys with the new busses were a minor threat for the success of the concession plan. This could result in less use of public transport by customers. However, the province saw this as a minor threat because in the future everyone is accustomed to the idea of sustainable transport and this threat is not thought of as a major concern.

Table 6. Summarizing overview of the SWOT-analysis of the bus tendering process in the Province Noord-Holland. All items are explained in the text above

Strengths	**Weaknesses**
• Early start of concession plans • Taking the interests of different parties into account • Taking into account the demand and supply of the market • Involvement in the subject by participating parties • An open concession plan • Useful network with similar subjects • Keeping the project up-to-date • Timing of introducing the topic • Using the opportunity to introduce zero emission faster then the norms • Influence on were to insert zero emission busses	• Not included noise in their concession plan • No implementation of zero emission from the start • Air quality effects unknown Difficulties • Keeping the different parties harmonized • Keeping everyone interested and up-to-date • Keeping the project on the agenda • Making an algorithm for accrediting points

Opportunities	Threats
• Connection/participation with projects in similar subject (E-mobility, foundation Zero Emission) • Pilot in Texel with electric busses • Use of the different participating parties and knowledge • Joaquin project for data/knowledge and onset • Questions about clean public transport from policy makers • Community that wants to improve their air quality • Pilot Den Bosch with electric busses	• Companies can provide a plan that will not fulfil the ambition of a transition towards zero emission • Different participating parties, all with different agenda's -> keep them as one group • Dependant of different parties • Not enough financial backup • Media attention about the possibility of an unfair winner of the concession • Concerns of the customers can have negative effects

7.4 Recommendations

Public transport tenders will take place now and in the future in the Netherlands and other European countries. Due to strict legislations about air pollution in Europe, more and more public transport tenders will be about providing sustainable transport. To provide a swift and easy public transport tender with an ambition towards zero emission, recommendations from this public tendering process can be taken into account (https://www.tfl.gov.uk/cdn/static/cms/documents/uploads/forms/lbsl-tendering-and-contracting.pdf).
By performing a SWOT-analysis insight was gained in the strengths and weaknesses of this tendering process. This analysis showed several aspects that contributed to a successful setup of the tendering procedure. The SWOT-analysis showed that starting at least 2 years ahead of the actual tender, would give enough time to design an open public bus tender. Due to participating with the JOAQUIN project this tender started 3 years before the tender started. Because of this early start, there was enough time for extensive research in the ambitions and wishes of all participating parties. However, a disadvantage of this early start was that it was quite difficult to keep all participating parties involved. Due to this, the Province of Noord-Holland had to actively involve all departments to keep working on the public bus tender. To keep all participating parties in the same direction, regular meetings should be scheduled. In this way the project stayed topical and knowledge and ideas of different aspects can be shared.
Luckily, there was enough social and political support for a tendering for the 'greenest' concession with a transition towards zero emission. The extra money that became available from the government to implement the sustainable public bus tender also demonstrated this support. The extra time that was gained from participation in the JOAQUIN project was necessary to investigate all wishes and ambitions of all involved parties, which are needed before setting up the documents that are necessary for a public bus tender. In this way the province could respond to several wishes and ambitions of the whole group, which resulted in an open minded Program of Demands.

The Province of Noord-Holland also gave some recommendations for future tendering procedures. One of these recommendations was starting at least two years before the actual concession period starts. Due to the possibility of participating with the JOAQUIN project the province started three years in advance with consulting the different participating parties. Consulting with different participating parties about the tendering process was also a recommendation of the province Noord-Holland. These consultations lead to a public tendering for a 'green' concession with an open character instead of a planned concession. This open character was experienced as an honest public tender.

Recommendations for future implementations of public tendering are:

- Start at least 3 years before the concession period starts with preparing the Program of Demands and Assessment forms that are needed for the public tender.
- Eight months before tendering the Program of Demands and Assessment Forms are finished to make them public for two months.
- Consult with the local community, public transport companies, department of Traffic & Transport of the community, the Environmental department and the department of Purchases to gain insight in possibilities and wishes.
- It is important to have social and political support for the ambition of sustainable public transport before the tendering starts.
- Use connections of projects with similar contents, these projects can provide knowledge and insight in the possibilities for setting up the Program of Demands.
- Schedule monthly meetings with participating parties to discuss the progress.
- Share all knowledge with all participating parties for an open honest character of the project.

8. The implementation of small scale tailored measures in the City of London

Measure

Cleaner Air Champions

Description

A pilot project Cleaner Air Champions was started to find and recruit local residents in three boroughs of London to raise awareness and promote actions to reduce air pollution at a local level. 21 volunteers were recruited from Hackney, Havering and Redbridge. These volunteers were trained and supported to raise awareness of local air quality issues within their communities and actions that locals could take to reduce their exposure to air pollutants. Actions like anti-idling campaigns, information talks, led walks and rides were held.

Effect

Activities of the Cleaner Air Champions in the three boroughs have lead to remaining local awareness and behavioural change.

Suggested reading

The final report of the Cleaner Air Champions project, including background information and actions taken by the volunteers:
Cleaner Air Champions – pilot project. http://www.sustrans.org.uk/volunteer/our-volunteers/cleaner-air-champions

Laumbach, R., Meng, Q. and Kipen, H. (2015). What can Indiviuals do to reduce personal health risks from air pollution? *Journal of Thoracic Disease 7 (1): 96-107:*
An review article about what people can do theirselves to reduce exposure to air pollutants.

8.1. Measure

A volunteer project called "Cleaner Air Champions" was started by the Greater London Authority (GLA) and the charity organisation Sustrans to raise awareness about air pollution in the local community and to promote ways in which exposure to air pollutants can be reduced. Sustrans was engaged by the GLA as a 3rd party contractor following a public procurement process. The GLA scoped and procured the Cleaner Air Champions service as a direct project JOAQUIN partner. The GLA, consisting of the Mayor of London and London Assembly, is responsible for different aspects of the local government. Sustrans, on the other hand, is a leading United Kingdom (UK) charity that enables people to make smarter travel choices that are possible, desirable and inevitable (Sustrans I, 2014). Sustrans has a volunteer network of 4000 people all over the UK.
The Cleaner Air Champions project tackled the air quality issues at a local level. The champions of this project were recruited from within the local community and they took action to raise awareness of the air quality problems. Boroughs with Air Quality Management Areas (AQMA) could participate with this project. Three boroughs of London were selected: Hackney, Havering and Redbridge. Within these three boroughs the aim was to recruit 10 volunteers per borough. However, 11 volunteers were recruited from Hackney, 5 from Havering and 5 from Redbridge. The Champions were trained to carry out different levels of engagements with the local community to raise awareness. Engagements with local community happened through promotion work, promotion in a local target area and in depth engagements with local schools about air quality.
The volunteers of the Cleaner Air Champions project carried out several actions, an overview of all actions can be found in table 7.

Table 7. Overview of all actions done by volunteers of Cleaner Air Champions project in the three boroughs

	Hackney	Havering	Redbridge
Advice and Promotional actions	• Anti-idling campaign at Hoxton Square • Play out days on Roding road • Sound mapping of interviews • Promotion of issues and positive actions people can take at local events	• School air monitoring project with Upminster Junior School • Attending local events to promote cycling and walking and raise awareness of air quality • Information stands at local events	• Attending local events to promote cycling and walking and raise awareness • Campaigning locally to raise awareness • Setting up a Geocaching trail with information on air quality
Active travel actions	• Parent cycle training scheme • Cargo bike workshops for businesses • Cycle showcase day at London Fields • Bike breakfast events	• Local walks • Leading local cycle rides and promoting local routes	• Bike recycling scheme

8.1.1 Examples

Air quality problems are not limited to London. In many other cities and countries air quality is a major problem. If people were aware of the adverse health effects of air pollutants, then there would be a

motivation for changes in individual behaviour and in public policy (Kelly & Fussell, 2015). To improve public awareness there are several volunteer projects to raise public awareness in different countries over the world. Some examples of volunteer actions to raise awareness are given below.

Delaware

In the state of Delaware, of the United States, there are air quality outreach opportunities for volunteers. Students can earn 1 credit point when they do 90 hours of volunteer work (www.volunteerdelaware.org) and other volunteers can win awards or scholarships. The actions or projects volunteer groups or individuals can do include: developing brochures, factsheets, environmental education and programming in schools and community groups. There are even special events like the Delaware State Fair, Coast Day and Ag Day that can be attended to raise awareness about air quality. http://www.dnrec.delaware.gov/volunteer/Pages/AQoutreach.aspx

Hong Kong

The governmental project "Clear the Air" has several actions to raise awareness about air pollution and to improve air quality. Volunteers can participate in idling-engine patrols, smoky vehicle spotting and smoky vessel spotting facilitated by the Environmental Protection Department of the Hong Kong government. Other actions of the Clear the Air project organisation are free educational presentations by air quality experts in primary schools. Furthermore, the economic costs of Hong Kong's air pollution in relation to public health impact is published to make the general public aware of the financial costs of this problem. (http://www.cleartheair.org.hk/).

Maricopa County

Clean Air Make More is an educational outreach project that is created to inform the Maricopa County in Phoenix, United States, about the air quality in the county and provide them with tools that are needed to take action (http://cleanairmakemore.com/clean-air-champions/). This project has introduced the Clean Air Champion program, in which volunteers air improving the air quality in Maricopa county. The program is funded through fines collected from violations of air quality. The Clean Air champions take large and small actions to improve the air quality in their county. The volunteers introduce carpooling, make an example by biking to their work, give energy-reducing tips or manage dust stabilization at construction sites. Furthermore, the Clean Air Make More project has a mobile app in which real-time information about the air quality in Phoenix is given (Fig. 13). This app provides air quality forecasts, restrictions and the ability to report a Phoenix air quality problem.

Figure 13. Mobile app for air quality forecasts

8.1.2 Co-benefits

Besides more awareness about air pollution and actions to reduce exposure to air pollutants in the local community, there are several other co-benefits of the Cleaner Air Champions project. Due to the anti-idling campaign at Hoxton Square in Hackney there is now also less noise of idling cars. Furthermore, people who learned how to ride a bicycle are still cycling to work or school with their children. This could lead to more cycling paths in the city for a safe journey. The Mayor of London has already launched four-cycle superhighways, cycle paths that give a cyclist a safe and fast way from outer London into and across central London (http://tfl.gov.uk).

Another co-benefit is that the word about air pollution has travelled far within the volunteers' network of this project. About 1743 beneficiaries were engaged with the project. Next to this, more volunteers stayed on with Sustrans after the Cleaner Air Champions project was finished. These volunteers have now other responsibilities as well, like assisting in classroom lessons about air pollutions or alternative ways of traveling. Moreover, some volunteers are still involved on activities of the Cleaner Air project. Sustrans still supports these volunteers with their work, but not as intensively as during the project.

8.2 Description

8.2.1 Process description

Onset of the process

Air quality is a major problem in London. The knowledge about air pollution is limited among local residents. The Mayor of London has the ambition to improve air quality of London, by tackling air quality at a local level. To reach this goal, awareness of the local community should be raised. By making the local community aware and to show them possibilities to reduce exposure to air pollution, the GLA wants to improve human health. The onset of this project was procurement of Sustrans and discussing the air quality problems by the GLA with Sustrans. Together they introduced the Cleaner Air Champions project to raise more awareness at a local level.

Management of the process

Day-to-day management of the Cleaner Air Champions project process was performed by Sustrans and reviewed by the GLA. Sustrans was responsible for providing training documents for the volunteers, regular feedback sessions with the volunteers and support of the volunteers' ideas. GLA provided information for the work packages that were made to provide volunteers with enough background information about air pollution when needed.

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The Cleaner Air Champions project was based upon an earlier Sustrans' project, called Active Travel Champions. Both of the projects focused on using volunteers to disseminate information to the general public; however Active Travel Champions' main focus was sustainable travel whereas Cleaner Air Champions (the brain-child of the GLA) also promoted messages about air quality and measures to reduce exposure to pollution. Despite the similar objectives of the projects, several guide documents had to be developed before the project started. First training modules and toolkits had to be developed for training of the newly recruited volunteers. These training modules exist of background information of air quality and pollutants, facts and statistics about air quality, what the government is doing about air pollution and what people can do to do to protect their health from air pollution (Factsheet Information Guide, can be found in appendix II).
Next to development of toolkits, publicity material had to be developed; like flyers and posters (Fig. 14). Due to difficulties with developing an online volunteer platform were volunteers can sign-up, as a Sustrans volunteer was online after the Cleaner Air Champions project was finished. Through this volunteer platform people can easily see vacancies for volunteer jobs and apply for these projects online. Sustrans also introduced a Facebook page for volunteers; pages were news, pictures, and experiences can be shared by Sustrans and volunteers (www.facebook.com/sustrans).

Figure 14. Poster in the borough Redbridge to recruit volunteers

Resources and activities

Different resources were used for the Cleaner Air Champions project. The GLA delivered background information about air quality and pollutants. Next to this the GLA was involved in selecting the three boroughs for participation. The JOAQUIN project indirectly supported the Cleaner Air Champions by providing funding to the GLA and provided facts about the subject air quality. Directly involved were the local authorities. Local authorities funded several local actions of volunteers, including: the school monitoring project, parent training scheme and the anti-idling campaign. There were also some funded actions from local organisations; Hackney Cyclist funded the Cycle Showcase Day and Cycle Logistic the Cargo Bike Workshop. Furthermore, the local authorities were involved in requests for example for play out days.

The first activity of the Cleaner Air Champions project was to select three boroughs in London. Boroughs that could participate in the project were boroughs with Air Quality Management Areas (AQMAs). AQMAs are areas were the air pollution limits are far above the set limits and action has to be taken by the boroughs. The boroughs Hackney, Havering and Redbridge have AQMAs and they came forward to receive help from Cleaner Air Champions project to improve their air quality.

Next activity was to recruit volunteers from each of the participating boroughs. The aim was to recruit 10 volunteer champions for each borough. Volunteers were recruited through local schools, businesses, community groups and other organisations. Different kind of organisations were addressed, especially organisations or companies who have an interest in air quality and active travel. Furthermore, existing Sustrans volunteers and supporters in these boroughs were asked whether they wanted to participate in the Cleaner Air Champions project. Volunteers participated with the project from personal conviction, to do something for their local community.

After recruitment of the volunteers, the training took place, in which the volunteers received background information about the history of air quality, sources of pollution and the effects of air pollutants. The training culminated with an action planning activity where volunteers formed their initiatives to tackle local air pollution problems. This was divided in two training sessions; the first took 3 hours, the second 2 hours. All volunteers received five factsheets or toolkits with background information to read at home (see appendix II for these factsheets/toolkits). Sustrans helped the volunteers to create their initiatives within the criteria of the program. Figure 15 shows what kind of actions can be taken during the pilot.

Figure 15. Type of actions that could be taken by the volunteers

The project Cleaner Air Champions project had a total calculated budget of €33.315. This budget was used for management of the volunteers, development and execution of training sessions, monitoring of volunteers and volunteer expenses. However, the project exceeded the budget with €8000. This was mainly due to under calculation of monitoring and salary costs. Volunteers could use the budget for banners, stalls or other materials that they needed for their actions.

Champion coordinators from the Sustrans organisation supported volunteers. They supported volunteers with help when needed and guided the volunteers through their actions. Volunteers had to

report on their actions as well. Via a website volunteers could report the type of activity, setting of the activity, time spent and beneficiaries (new and existing) that were reached by their action. The outcomes of the volunteers' activities were evaluated by focus groups and feedback sessions. Focus groups consisted of beneficiaries or volunteers. These focus groups evaluated the what they had learned, how the project was involved in their learning process, activities done by the project and the impact of these activities. These focus groups gave feedback about the whole process. Feedback sessions were scheduled with all volunteers. In these feedback sessions volunteers could talk with the Champion coordinators and with other volunteers about their actions. Only 33% of all volunteers attended the feedback sessions that were scheduled.

Figure 16. Anti-idling sign at Hoxton Square

Several activities have been done by the Cleaner Air Champions volunteers (table 7). One of these actions, carried out by a volunteer in Hackney, was an anti-idling campaign around Hoxton Square. Near this square a local primary school is located. Working together with the local council, school and businesses a number of actions were taken to tackle idling around Hoxton square. At the local primary school children started to discuss the problems and made posters for local businesses. Together with the local champion children visited the companies around the square to raise awareness and putting up their posters. Next to these small actions the Borough Officer from Hackney was involved and as part of their Zero Emission Network initiative anti-idling signs were put up around the square (Fig. 16).
Other actions that were taken included promoting active travel to reduce their own emissions; parent cycle training schemes; and cargo bike workshops for businesses. In Havering active walks and cycle routes were promoted and in Redbridge a car free road day was held (table 6). The cargo bike workshop was set-up in partnership with Cycle Logistics and there were two workshops for local businesses to attend. Cargo bikes could be tried out and viable options for using them as part of everyday working practices were discussed.

Connections with other projects

The Cleaner Air Champions project was roughly based upon an earlier project of Sustrans, "active travel champions". Although the set up was of a similar type, Active Travel Champions was focused on promotion of active transport (walking and cycling) rather than air quality. Active Travel Champions also involved volunteers, which in that case gave advice about walking and cycling and introduced activities with walking or cycling for their local community. This volunteer program was such a success that Sustrans received the Queen's Diamond Jubilee award (Sustrans II). From the project Active Travel Champions Sustrans learned how to work with volunteers in projects, which formed the base for the Cleaner Air Champions project.

8.2.2 Interview

Background information about the process behind the Cleaner Air Champions project was provided by Sandra Jarzebska from Sustrans. She was not directly involved with the pilot project Cleaner Air Champions, but is involved in the follow-up project in another borough of London, which has the same

goal as the Cleaner Air Champions project. The project leader of Cleaner Air Champions was not available for an interview, but Sandra was well informed about process behind Cleaner Air Champions. Interview took place on April the 17th 2015. The interview questions can be found in appendix IE.

8.3 SWOT-analysis

To gain insight in the strengths, weaknesses, opportunities and threats of the Cleaner Air Champions project a SWOT-analysis has been done. An overview of the results can be found in table 8.

8.3.1 Strengths

Strength of Sustrans as managing party is that this organisation is familiar with working with volunteers. Sustrans is a charity organisation that especially works with volunteers. Due to this character of the organisation, it has a large network of 4000 volunteers all over the UK. For the Cleaner Air Champions project this familiarity of working with volunteers resulted in enough connections for an easy recruitment of volunteers for this project. Next to a large network of volunteers and understanding of where to find them, Sustrans has plenty of experience from earlier training programs and knows how to train volunteers.
For the Cleaner Air Champions project local volunteers were used from the three participating boroughs. This was a major strength for the success of this project. Local volunteers are experts in the local area and are more involved with local air quality problems. The message from a local community member can be far more powerful then when someone else gives the same message. Actions and information given about air pollution by a local volunteer reached on average 85 other persons in the borough. A successful spread of the word was reached by using volunteers instead of authorities or professionals.
Another major strength of the Cleaner Air Champions project is that it created legacy where some volunteers are still working on their actions of the project. The Cleaner Air Champions project was only for 6 months. Many volunteers were not yet finished with their work or are still involved in improving their local air quality. Due to the Cleaner Air Champions project the local volunteers have now the confidence to do something to improve air quality in their environment. Sustrans still provides those volunteers with support when necessary. The fact that volunteers are still working on their actions, even when the project is finished, shows that the goal of the project is reached: raise awareness of local residents.

8.3.2 Weaknesses

Working with volunteers has also its weaknesses. When volunteers are of major importance for the project, the success of the project is also dependent of the commitment of volunteers. Volunteers are not paid for their work and time. In most cases, volunteers have a fulltime job next to their volunteering work, which could result in a second place for their volunteering work due to other priorities. For Cleaner Air Champions this resulted in a longer period before all actions were actually executed.
The project was bound to a limited time of six months. This was a major weakness of the project. In these six months the volunteers had to be recruited, trained and do their activities to raise awareness and promote ways to limit exposure to air pollution. This short period resulted in that not all initiatives of the volunteers have been done. Some volunteers had a slow start and needed more time to come to action; other projects took time before it could start. Furthermore, recruiting and training of the volunteers already took 3 months of the project time. However, unless the short project period a lot of initiatives have been done by the volunteers and the word has spread to many others from the boroughs.
21 volunteers of the boroughs Hackney, Havering and Redbridge reached together 1743 people, which is an average of 83 people by each volunteer. In comparison with the total inhabitants of the three boroughs together, only a tiny part of the population of the boroughs was reached by volunteer actions. This shows that the volunteer actions have only a limited range. However, these volunteer actions

caused some awareness in groups of people. Without these actions those people would not be informed about air quality issues and at Hoxton Square in Hackney there would be no anti-idling sign.
Another weakness of the project was that volunteers did not have some short of branding, like a t-shirts from Sustrans. This would have helped the volunteers to feel more official when they would be speaking to people in their community. Next to this it would have given the local community an idea for who and what kind of organisation the volunteers were working.
A difficulty of the project was scheduling feedback sessions with the volunteers. 21 volunteers of three different boroughs participated in this project. Due to personal commitments, large geographical area and the short timeframe of the project, it was difficult to bring all the volunteers together.

8.3.3 Opportunities

The Cleaner Air Champions project made use of several opportunities. Sustrans ran the funding with organisation the GLA. Involvement of the GLA gave the Cleaner Air Champions project more status and was taken more seriously by volunteers and the local community. The GLA was also interested in to see what the volunteers learned and which initiatives they have taken. Furthermore, the GLA selected the boroughs for participation with the project. Another positive opportunity for the Cleaner Air Champions project was the involvement of the Joaquin project. Joaquin provided the GLA and Sustrans with background information about air pollution, which was needed for the training program of the volunteers.
Active Travel Champions of Sustrans was another great opportunity for this project. In the successful Active Travel Champions project, Sustrans learned how to recruit and work with volunteers. These skills gave a solid base for developing the Cleaner Air Champions project. Although, Cleaner Air Champions has a different content then Active Travel Champions it gave Sustrans the knowledge and skills to use volunteers for a new project.
An untouched opportunity is the possibility to give the volunteer program a higher impact level. The involvement of the GLA gave already status to the project, but it could have given the project much more. The GLA could have raised more attention for the air quality problem by, for example, linking the Cleaner Air Champions project to a campaign about air quality and measures the GLA takes to improve the air quality in London. With this campaign it would show residents that the bad air quality affects everyone in London. Such a connection would encourage people to do something about air quality themselves and join the Cleaner Air Champions project, which could lead to a greater impact of the volunteer actions than it has now.

8.3.4 Threats

Working with volunteers had also some threats for the success of the project. The whole project of Cleaner Air Champions relied on work of volunteers from three selected boroughs. A major threat for this project could be that there were no applications of volunteers to participate. Without volunteers the project could not be executed. Luckily, 21 volunteers were recruited in different areas of the boroughs.
Another threat for the project was the possibility of drop out of volunteers or deliver bad quality actions. Volunteers are free to do what they want and can quit the project whenever they want. Luckily, the attrition rate of the Cleaner Air Champions project was only ~20%. Most of the volunteers fulfilled their task of raising awareness in their local area and many volunteers stayed on as volunteer at Sustrans. Cleaner Air Champions resulted in the most volunteers who stayed on after the project was done.
The goal of Cleaner Air Champions was raising awareness of the local community about air pollution. When volunteers would take no actions to raise awareness the whole project would be a failure and the goal would not be reached. However, the volunteers have done a lot of different activities during the project. Activities like an anti-idling campaign around a local school, learning how to ride a bike, bike workshops for businesses, bike breakfast events, local walks and play out days on local busy roads.

Table 8. Summarizing overview of the SWOT-analysis on the implementation and evaluation process of the Clean Air Champions programme in London. All items are explained in the text above

Strengths	**Weaknesses**
• Use of volunteers • Familiarity of working with volunteers • Volunteers are still working on the project • Volunteers staid on with Sustrans • Actions still used by local people • Focus groups with volunteers and beneficiaries	• Dependent of volunteers • Limited time of project (6 months) • No branding for volunteers • Limited range of the word from volunteers Difficulties • Scheduling feedback sessions
Opportunities	**Threats**
• Involvement of GLA • Involvement of JOAQUIN • Active Travel Champions	• Drop out of volunteers • No application of volunteers • No successful actions done by volunteers

8.4 Recommendations

Air pollution is a serious public health problem (Laumback *et al.*, 2015). Measures implemented by the government on national and international level only will not be enough to improve air quality. Local communities have to become aware of the air quality in their environment and how to reduce their exposure to air pollutants. Raising awareness of local members of different communities will be one step closer towards a healthy environment. To provide future projects an easy start, recommendations from Cleaner Air Champions can be taken into account.
The SWOT-analysis of the Cleaner Air Champions project gave insight in the strengths and weaknesses of the process behind Cleaner Air Champions. This analysis showed that the use of volunteers could result in a major impact on the local community and the volunteers. The volunteers became more aware of the local air quality problems and felt more confident to talk about air quality issues with other people of their community and introduce actions. Due to their gained knowledge volunteers and local community members changed their behaviour. For example, some people will no longer take a seat on a terrace near a busy road with their children, while others will walk short distances instead of using the car. Another good example of a successful action of volunteers is the anti-idling campaign at the Hoxton Square near a local primary school. This campaign has resulted in awareness about the consequences of idling at the square and vehicles are no longer idling when they are waiting or (un)loading. This shows that with help of an organisation volunteers can make a change in their community.
From the Cleaner Air Champions project can be learned that support from the local government and a wider organisation results in more status of the project. When volunteers are spreading the word this will give local residents more confidence of trusting the content of the volunteers actions. For raising awareness about a problem with such impact, this support is necessary. The impact would be even greater when the work of volunteers was in line with other policy measures about the issue. The weaknesses of this project showed that volunteers need guidelines for their work. Arrange deadlines for the volunteers, in this way they know they have to take action before a set date. Perhaps this would result in even more actions taken by volunteers and volunteers know when they have to deliver results. Focus groups with volunteers and beneficiaries gave a lot of insight in the outcome of the project. Both, volunteers and beneficiaries, found the project worthwhile and rewarding. Some minor recommendations they gave were that the volunteers would like some sort of branding to feel more official during their volunteer work. Another recommendation they gave was that the volunteers wanted

more opportunities to work with other volunteers. Cleaner Air Champions was such a success that Sustrans has already started a follow-up project in another borough. The lessons learned from the Cleaner Air Champions are already taken into account. The limited time period of the Cleaner Air Champions project is now extended into 2 years. There is now enough time to recruit and train volunteers before they start their action planning. Due to the smaller geographical area, the volunteers can easily meet for feedback sessions and there are more opportunities to work with other volunteers in the borough.

Recommendations for future volunteer projects are:

- Schedule a duration of at least 2 years for a project with volunteers
- To raise awareness in a local community about, for instance, air quality, use local volunteers from that community
- To create more impact of volunteer work, have a local authority behind the project
- Volunteer work should be in line with policy measures about the subject
- Schedule monthly meetings with volunteers to discuss and support their work
- To obtain results, schedule monthly deadlines for volunteer actions

9. Discussion

The JOAQUIN project supported health-oriented air quality policies in five hotspot areas of North-western Europe. Air quality measures in Antwerp, London, Leicester, Amsterdam and the Province of Noord-Holland were evaluated, focusing on air quality improvement and the implementation process. During this project three hotspot areas have implemented health-oriented air quality measures and two hotspot areas made preparations and decided to implement their air quality measures soon.
Several types of measures can be implemented to improve air quality or to reduce exposure to air pollutants. The five pilots described in this report can be roughly divided into three types of policy measure groups: tackling the source of air pollution, the system and raising awareness. These three groups are chosen because of the types of measures that are taken in this part of the JOAQUIN project. Source policies contain measures to reduce emissions of the source of air pollution. In this case, reducing the emission of vehicles itself. Source policy measures include: introducing cleaner busses, implementation of low emission zones or providing grants for purchasing low emission vehicles (Bergen *et al.,* 2006; AQAP Gent 2010). The second group of measures tackles the system that causes traffic-related air pollution. For example, reducing congestion of vehicles at junctions, improving the infrastructure to provide a better traffic flow or reducing speed limits at highways. The last and third type of policy measures involves raising awareness; measures that direct or indirectly protect the health of the people by making them more aware of air pollution. Examples of measures to raise awareness are education, measurements that show the actual pollution concentrations and encouraging good practice of businesses and people (Islington, 2014).
In Air Quality Action Plans (AQAP) of different cities of Europe all three types of policy measures are used in environmental policy. However, preferred strategies by environmental policy makers are source measures. Source measures provide the most generically and structural solution for bottlenecks and is frequently the most cost-effective measure (Bergen *et al.,* 2006). The World Health Organisation (WHO) provides air quality guidelines for air concentrations of NO_x, NO_2 and particulate matter (WHO, 2005). On European level there are also air quality directives, in which the required limit values are stated that have to be achieved by, for example, 2020 (Holman *et al.,* 2015). There are even European emission standards, which define acceptable limits for emission of new vehicles. Each year these emission standards are upgraded and used as an example for entrance guidelines of low emission zones by cities. This shows that both, the EU and cities, want to tackle air pollution with source measures that are most cost-effective.
In the next paragraphs each of these three measure types will be evaluated and compared with research found in literature. This will give more insight in the different possibilities of these three measure types to improve air quality in the future.

9.1 SWOT-analysis

To make a structured analysis of the three different types of policy measures the SWOT-analysis tool has been used. With help of this tool insight is gained in the strengths, weaknesses, opportunities and threats of source measures, system measures and awareness measures. Table 9 gives an overview of the SWOT-analysis of the three policy measure types.
Source measures have the strength that they tackle the source of air pollution itself, this results in the largest impact effect that can be expected of measures. Source measures are cost-effective and can give good results for air quality. However, source measures have their limits. Individuals cannot be forced to purchase new and cleaner vehicles. Furthermore, source measures do not reduce the amount of vehicles in that area, which could result in an insufficient effect of the measure. Opportunities for source measures are improved technologies for cleaner vehicles. Another opportunity that can be a benefit for source measures is the use of grants to stimulate the purchase of cleaner vehicles. Despite source measures in a city, the air quality standards can still be breached. Due to this, cities would like more support from the EU for all their measure types (Venema, 2011).

System measures can reduce traffic on congested roads, improving the mobility and air quality. However, system measures have high financial costs. And, when traffic capacity grows, it may cause new congestion. The threat of system measures is that they may not have a large impact on the air quality. However, with system measures there is a chance that the infrastructure improves and that the use of public transports grows. When infrastructure is improved, travelling time by public transport can be forshortened. People may want to make the shift from their private car to the public transport system.
The third type of policy measures: awareness measures, has its strength that it will increase public awareness with an indirect individual approach. On the other hand these types of measures depend on actions that will be taken by individuals with their new gained knowledge. Opportunities that could be used to raise more awareness about air pollution are campaigns or actual air quality monitoring sites. Awareness measures also have the opportunity to introduce behavioural changes in individuals, which may lead to further improvement of the air quality.

Table 9. Overview SWOT-analysis different types of policy measures

	Source measures	System measures	Awareness measures
Strengths	Tackles the source itself Largest impact effect Cost-effective	Reduces congestion Improved mobility	Public awareness Individual approach
Weaknesses	Has limits Dependent of others Insufficient effect	More traffic capacity High financial costs	Dependent of individuals Dependent of available resources
Opportunities	Improved technologies Use of grants More EU support	Improving public transport Improving infrastructure	Campaigns Behavioural changes Monitoring sites
Threats	High individual costs Increase of vehicles	No improved air quality	No use of gained knowledge No financial support

9.2 Source measures

9.2.1 Zero emission from public transport

The first type of measure to improve air quality and reduce exposure is to tackle the source of air pollutants; in this case vehicles will be addressed. One of the pilots in this research was tendering for a bus concession with a transition towards zero emission at the end of the concession period in 2026. This pilot wants to tackle one of the groups of vehicles of traffic-related air pollution sources, namely public transport. With this transition towards zero emission the Province of Noord-Holland wants to introduce low or zero emission public transport faster than official legislation about air pollution prescribes.
Not only the Province of Noord-Holland wants to invest in sustainable public transport. Several studies are taking place to introduce zero emission vehicles in the traffic sector. Promising technologies that will reduce traffic emissions are electric vehicles (Poullikkas, 2015). However, there are still some hurdles to overcome. Urban public transport vehicles consist mainly of busses with the capacity to transport many passengers and drive around 200-300 kilometres per day (Miles & Potter, 2014). Which means that electric busses need to have a large electric battery capacity. A disadvantage of a large electric battery capacity is that these batteries are expensive, making an electric bus twice as expensive as a normal diesel bus (Miles & Potter, 2014). An option would be to install smaller electric batteries into the busses but this will limit the range of the bus service. This smaller range would make them more dependent of the locations with recharging facilities. To solve this problem optimal recharging points could be at busstations were busses are waiting. (Hosseini & MirHassani, 2015).

Examples

Electric busses might be the solution for zero emission transports in the future, when battery and charging technologies of electric busses have improved. However, for now there are other solutions as

well. To reduce the air pollution impact, several cities have introduced alternative bus fleets. In New Delhi public transport switched from diesel fuel to natural gas (Reynolds & Kandlikar, 2008). New Delhi was not the only city were they tried to improve their air quality by changing the fuel of their public transport fleet. In 2013 Los Angeles introduced a bus fleet on compressed natural gas (CNG) (Weikel, 2011). Not only CNG busses were introduced as public transport, but also hybrid-electric busses. New York city introduced in 2009 hybrid-electric busses. However, these hybrid-electric busses did not perform as was expected and New York switched to diesel busses with soot filters instead (Chong *et al.*, 2014). For a pilotproject in the Netherlands, in the city Den Bosch a 12-meter electric bus runs 288 kilometres a day (Wechlin and Kusch, 2012). This is one of the first pilots in which busses of 12-meter are operating in a daily bus service. An inductive charging station at a busstop charges this bus. The charging station is barrier-free and provides no hurdles for other vehicles. In the United Kingdom pilots with a similar technological and operational approach can be found; the study Milton Keynes (Miles & Potter, 2014). Together, the pilot study in Den Bosch and Milton Keynes project, show the possibilities of zero emission transport in the form of electric transport and how to deal with recharging of the batteries.

Evaluation

The Province of Noord-Holland shows ambition to implement zero emission. Although the goal of the clean bus tender was to implement zero emission from the start in 2016, Noord-Holland now aims at a transition period to zero emission in 2026. The province could have made more requirements for their bus tender, regarding the different pilots that exist all over the world for sustainable public transport. With the knowledge from these different testing projects the province could have introduced zero emission right from the start. However, due to the lack of financial support, the province has decided to give the public transport company more time to adjust their fleet to zero emission. Offering this transition period is a successful move of the province in one way. The region Haarlem-IJmond will reach its goal and give travellers the security of a reliable transport and the buscompany the time to purchase the newest technologies possible. On the other hand the province missed the chance to introduce an electric bus pilot in their own region. With financial backing there was an opportunity to have a fully electric bus route operational in the Province of Noord-Holland. London for example invested €700 million into an electric bus fleet (TfL, 2015).

9.2.2 Reducing emission

Tackling the source of air pollution can be done in many ways. Another possible source policy is to reduce emissions. Implementing a LEZ can reduce emissions. In this project one LEZ has been implemented in Amsterdam and another will be implemented in Antwerp in the fall of 2016. With the implementation of these LEZ the air quality will improve as the current vehicle fleet will change. On top of this, most polluting vehicles will be banned. In Amsterdam the LEZ has only been implemented for heavy-duty vehicles, while Antwerp will have a LEZ for all types of vehicles. Implementation of a LEZ is a common policy in Europe, but also in other countries like Japan and China (Boogaard *et al.*, 2015). There are 152 cities in nine EU countries which have a LEZ implemented (Wolff & Perry, 2010).

Examples

There are many examples of other LEZ. Each LEZ has its own restriction criteria and enforcement system. LEZ are mainly implemented to reduce emissions of NO_x and particulate matter. Emission of diesel vehicles contains more NO_x than petrol vehicles, which is also the main reason for stricter criteria for diesel vehicles than for petrol vehicles (Holman *et al.*, 2015). In 2000 a LEZ was implemented in London. Ellison *et al.* (2013) investigated the effects of this zone on vehicle fleet composition and air quality. In 2006 there were 51.4% pre-EURO II vehicles registered, which decreased to 46.2% at the end of 2007. Air quality improvement of particulate matter have been seen with reductions of 2.5-3%. For NO_x the reductions do not show a significant difference (Ellison *et al.*, 2013). Other LEZ showed larger reductions of NO_x and PM10. In Berlin for example, NO_2 concentrations were reduced by 4% and particulate matter concentrations by 5-10% (Lutz, 2009). Amsterdam showed reduction of NO_x of 6% (Panteliadis *et al.*, 2014).

Another example of a system measure is to promote the use of Park and Ride (P + R) places outside cities. P + R have been implemented as a way to create a more sustainable city and provide drivers the opportunity to leave their cars outside the city and travel further with public transport. This measure has been introduced to reduce the number of cars entering urban areas and this has indirectly an effect on air quality (Dijk *et al.,* 2013).

Evaluation

LEZ have been implemented in many other cities in Europe already and show reductions in traffic-related air pollutants. The LEZ of Amsterdam has been successfully introduced for heavy-duty vehicles. A success factor of this LEZ is that the city implements the LEZ step by step to create acceptance and familiarity of the zone for residents of Amsterdam. Antwerp on the other hand, will implement the first LEZ in Belgium for all vehicles together with P + R around the city to give people the opportunity to park outside the city.

9.2.3 Future of source policy

Source policy measures are a good way to tackle the actual source of pollution. There are several different ways to tackle the source of the problem and these types of measures will give most cost-effective results. However, to reduce the source of traffic-related air pollution in a most efficient manner, there has to be enough financial and technological support. This can be seen with the implementation of zero emission in public transport. Without a large financial backup no low or zero emission vehicles can be purchased. Furthermore, technology is still developing and improvements will be made each year. In the near future, mostly source policies like implementation of LEZ or congestion charging schemes will provide the fastest result in reducing air pollutants. Long-term improvements will lie with the actual improvement of the polluting source itself.

9.3 System measures

Another way to improve air quality is to tackle the system that causes the air pollution. For example, congestion at junctions or major traffic jams. In this summary report one system measure has been introduced. The improvement of a traffic lights system to reduce congestion at a busy junction in Leicester. Due to improved traffic flow there is now less congestion, which has resulted in an improved air quality at this junction. The system SCOOT that has been used to improve the traffic lights system is a recognised system by many countries in the world.

Examples

Improving the traffic lights system for a better traffic flow is not the only measure that can be taken to improve the system that is causing pollution in a specific area. Another possible measure is adjustments to the infrastructure. The improved traffic lights system in Leicester was part of a larger project, the Bus Corridor project, in which not only traffic light systems were improved but also the infrastructure (http://www.leics.gov.uk/a426_bus_corridor_project). These improvements will lead to an indirect improvement of the air quality, due to less congestion at busy areas. Another benefit is that the journey will be faster without traffic delay.
Another example of a system measure is changing speed limits at highways. Reducing the speed limits at highways was introduced to reduce the concentration levels of air pollution. A lower speed results in lower traffic emissions (Bel *et al.,* 2015). Speed management is also done on urban motorways in the Netherlands. At some urban motorways a speed limit of 80 km/h has been introduced to improve the air quality of NO_2 and PM_{10}. In the cities Amsterdam and Rotterdam the effect of these speed reductions have been investigated. Emission reductions in a range of 5-30% for NO_x and 5-25% for PM_{10} could be seen (Keuken *et al.,* 2010).

Evaluation

The improved traffic lights system at the Glenhills Way junction in Leicester is already part of the large Bus Corridor project. Due to this, infrastructural changes have already been made at this junction to improve the traffic flow and reduce the air pollution. Another possible improvement that could have

been chosen at the Glenhills way junction was the introduction of a green wave between junctions. Green waves can reduce air pollutant emission up to 40% in optimal conditions (De Coensel *et al.*, 2012). The improved traffic lights system in Leicester has resulted in a larger capacity on this junction with a better traffic flow and less air pollution.

9.3.1 Future of system measures

System measures can provide small and large adjustments that will improve indirectly the air quality at that location. Less congestion at junctions and reduction of speed limits in certain areas can have a large impact on the air quality. In the future a combination of improved traffic lights signalling systems, improved infrastructure and the use of speed limits can give extra support to source policy measures. Together, an even bigger impact on air quality can be reached. In the future several system measures have to be done simultaneously to improve the air quality. Just as in the Bus Corridor project in Leicester were the infrastructure was improved together with traffic lights sequencing system.

9.4 Awareness measures

The third group of policy measures are awareness measures. These measures are introduced to raise awareness among the general public. In this project one of the awareness measure was make people more aware of air pollution. In three boroughs of London several actions have been taken by local volunteers to raise awareness in their community about air pollution. Actions like active walks, learning how to ride a bike and anti-idling campaigns have lead to behavioural change.
Air pollution is a social problem. Improvement of air quality can only be achieved when one changes their personal behaviour, and in case of traffic-related air pollution, especially in their mobility choice (Bickerstaff & Walker, 2001). When people become aware that the air quality that they breathe in can have adverse health effects because of air pollutants, then there will be a greater drive or motivation for changing their personal behaviour. Public awareness is dependent of fundamental education, air pollution monitoring, forecasting and reporting (Kelly & Fussell, 2015). Public awareness can help to create a cleaner environment which can lead to a healthier population.

Examples

In the volunteer project Cleaner Air Champions of London several actions have been taken to raise awareness in the local community about air pollution. These actions are only a few examples of awareness measures that can be taken. Other actions are to reduce personal exposure to air pollution by staying indoors or avoiding outdoor activities when ambient air pollution concentrations are high (Laumbach *et al.*, 2015).
An information campaign by the government and businesses about air quality was used in Atlanta, United States, to change certain habits. In this campaign driving habits were addressed. In this campaign air quality alerts were used for an effective change in driving behaviour. The results of this campaign were that drivers significantly reduced their car journeys when air quality alerts were given (Henry & Gordon, 2003). There are different air quality alert programs for mobile telephone which people can use to know more about the actual local air quality and what it means for their health.

Evaluation

The Cleaner Air Champions project in London reached ±1800 people with their volunteer actions in three boroughs. Some permanent awareness can be seen in the form of anti-idling road signs or businesses that are using cargo bikes for their deliveries. At some schools even some monitoring was done during this volunteer project, which resulted in hard evidence of the real air quality situation of their school surroundings. However, the government of London could have made use of a greater campaign to raise more awareness and to activate people to change their own behaviour. As is shown in the research by Henry & Gordon (2003) that air quality alerts are an effective method for raising awareness and behavioural change.

9.4.1 Future of awareness measures

A profound improvement of air quality can be achieved by a switch in personal behaviour. Basis public education about air quality can teach people about health effects related to air pollutants. Data from air quality monitoring stations are important to inform people about the actual local pollution.
Perhaps in the near future personal monitoring devices can be used to check ones actual exposure and health impact. Those devices can be linked to data of weather conditions and personal health information. This could lead to personal motivation to change behaviour.
In the future volunteer actions and governmental campaigns to raise awareness about air pollution can create a healthier environment with a healthier population. Actions to reduce air pollution and exposure can give a handle for individuals to change personal behaviour in favour of environmental health.

10. Conclusion

Health-oriented air quality measures have been implemented in five hotspot areas of North-western Europe. These air quality measures have dealt with the source of traffic-related air pollutants, changed systems to reduce traffic-related air pollutants at hotspot areas and raised awareness about air quality in local communities. A combination of the three different policy measure types will have the greatest impact on air quality. Successes and failures of the air quality measures in the five pilots can be translated into recommendations for future successful implementation of health-relevant air quality policies in North-western Europe and further abroad.

Recommendations

- Perform a feasibility study about the measure
- Create political and social support for the measure
- Use connections of projects with similar contents
- To support the main measure introduce small accompanying measures
- Schedule monthly deadlines for participants
- Schedule monthly meetings with participating parties to discuss the progress
- To raise awareness in a local community about a problem, use local volunteers
- Volunteer work should be in line with policy measures
- Combine different measure types for a greater impact

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12 Appendix

12.1 Appendix IA

12.A.1 Feasibility study questions Antwerp

1. How is the action plan for the LEZ established?
2. What does the implementation of a LEZ mean?
3. What are the expected results of the LEZ?
4. What are the co-benefits of the implementation of a LEZ?
5. Can you give a process description of the feasibility study?
6. Are feasibility studies always done before a measure is implemented?
7. Antwerp is not the first country that will implement a LEZ. Were other countries an example for the feasibility study? What were advantages/disadvantages for this feasibility study? Which countries were an example?
8. Which examples from which countrie were used in this LEZ?
9. Was there a lot of available data for the different aspects of the feasibility study?
10. Was there enough knowledge about the subjects?
11. Were there usefull connections with other organisations or people? Which were used and why?
12. Was there influence of the governement on the feasibility study? Or only from the city of Antwerp?
13. How did the feasibility study contribute to the implementation process of the LEZ? What were positive aspects and what negative aspects of this study?
14. Who were involved in this feasibility study? What parties or organisations?
15. What was the influence of the JOAQUIN project?
16. What was the role of the government in this feasibility study? Positive or negative influence?
17. There are high costs connected to a LEZ, has this any negative influence for the implementation process?
18. What was the duration of the feasibility study? A recommendation to do the same another time?
19. Recommendations for the future? What should you do again or not for the implementation of a LEZ?

12.A.2 Implementation LEZ

20. What was your role in this process?
21. What kind of documents had to be prearranged?
22. Which steps had to be taken? Can you give a process description of the implementation process?
23. Was there a lot of knowledge and data available that could be used?
24. Which connections are used for the implementation process of the LEZ?
25. Which parties/stakeholders were involved in the process?
26. What was there task in the process?
27. Which parties were helpful or not? And why?
28. Was there any influence of the JOAQUIN project in this part of the process?
29. Were there any difficulties with the implementation of LEZ? Difficulties with politics or government?
30. What went successful?
31. What gave resistance? Failures?
32. What is the reason that the LEZ will be implemented in 2016 and not earlier?
33. Do you have any recommendations for future implementations of Lez? What would you recommend other cities in Belgium?

12.A.3 Execution LEZ

34. In 2016 the LEZ will be introduced, what are the steps that have to be taken now? What has to be organised? And what is needed for this organisation?
35. Which parties/organisations/stakeholders are involved?
36. How is the partnership of these groups and the LEZ? Which organisations are cooperative, and why/why not?
37. What are the advantages/disadvantages of involvement of many different parties in the execution of the LEZ?
38. What had to be settled on the legal field? What was your approach?
39. Can you give a process description?
40. Is there a lot of data available for the execution of such measures?
41. Has a comparable measure been implemented before? Or is this measure the first of its kind?
42. Is there influence of the community, government or the EU?
43. Is there any financial pressure of these LEZ plans? Or is there enough financial backup?
44. Are there special techniques used for commucation about the LEZ? LEZ Campaigns?
45. Is there enough public support for the LEZ or are there many opponents?
46. Are there recommendations for future implementation of LEZ in other cities in Belgium?

12.1 Appendix IB

12.B Interview questions output Amsterdam

1. What was your role in this process?
2. What was the onset for the implementation and evaluation of a LEZ? And what was the influence of the JOAQUIN project?
3. Who was the project leader? And what was his/her task?
4. What had to be prearranged? And what time did it cost to prepare those documents?
5. Were there useful sources for the implementation? Other LEZ as an example in the Netherlands/other countries?
6. Are there relations with other projects of the same subject?
7. Who were involved? Which stakeholders? What was there influence?
8. Was there enough financial support?
9. How can the situation of Amsterdam be compared with other cities?
10. How was the response of policy makers towards the LEZ implementation?
11. Was therre enough support from the community? Was this of influence on the implementation?
12. Why only two measuringpoints within the LEZ and not more?
13. How was the enforcement system received? As a positive thing/negative?
14. Are there many applications for exemptions? Has this any influence on the air quality?
15. What went successful during the implementation process?
16. What were failures of the process or threats?
17. Are the results as expected?
18. Will there be a LEZ for personal vehicles as well in the future?
19. Looking back to the process, do you have any recommendations?

12.1 Appendix IC

12.C Interview questions output Leicester

1. What was your role in this process?

2. Is this plan performed earlier? Somewhere else perhaps?
3. What is expected from this measure/pilot? Air quality improvements? The effects?
4. Are there co-benefits from this pilot/measure?
5. Can you give a process description?
6. What were the used means?
7. Who was the manager of the process?
8. What went well? What was difficult?
9. What was the old situation? Perhaps an old illustration of the old situation vs. new situation?
10. What were the 7 stages? And what the new 5 stages?
11. Would you recommend this action in other areas? Why? And why not?
12. What would you do differently or the same?
13. How much time was needed for the modelling of the junction options?

12.1 Appendix ID

12.D Interview questions output Province of Noord-Holland

1. What is the content of this actionplan?
2. What are the expected results? And are there also co-benefits?
3. Is this tendering process the same as others? Or are there other rules?
4. Are the minimum demands new or already used in other bus tenderings?
5. What were the pros and cons for using only minimum demands for this bus tender?
6. When only minimum demands are asked from companies, will the set goal of zero emission in 2026be achieved?
7. Will the province settle for less than reduced emission?
8. How will bus companies be checked on their promisses?
9. What are the punishments for not delivering their promises?
10. Has media attention a large influence on the process?
11. Is the new situation modelled to see what the effects would be of the low emission busses?
12. Do you make use of the electric busses that are used in the pilot in Den Bosch?
13. How is this actionplan established?
14. What was the main goal of this actionplan; tackling air pollution or climate change?
15. Are there examples of other places were this plan has been executed?
16. Which steps had to be taken? How was the process? Can you give a process description?
17. Who were involved in this process? And what types of organisations or stakeholders?
18. What was their role in this process?
19. How long did it take before this plan could be executed?
20. What went successful?
21. Was there any resistance? Failures?
22. Do you have any recommendations for future similar processes?

12.1 Appendix IE

12.E Interview questions output London

1. What is the air quality action plan/measure? Describe briefly
2. Short description of the measure/action plan?
3. What will be achieved with this policy or air quality action plan? Are there expected results?

4. Is this plan performed earlier? Or a similar plan like this?
5. Are there examples of other places where this plan is established?
6. Why the use of volunteers? And not trained/hired people?
7. What is the advance of volunteers participating in the project? And disadvantages?
8. How were the cleaner air champions recruited?
9. Were there any other people involved next to the volunteers? Companies/professionals?
10. What was there role in this process?
11. Who was the "manager" of this process?
12. How were the participating boroughs selected?
13. What went easy? What not during this proces?
14. Did the volunteers do everything according to plan? Or were there difficulties?
15. Were the champions instructed for their activities or did they come up with the activities themselves?
16. What were the main goals of the champions during this project? Did they have to reduce air pollution in their borough? Or only raise awareness?
17. Several different actions were done by the champions, are some actions (like cycling to school) still used by the local people?
18. Active Travel Champions program looks like this program, what was used from the former program?
19. Which steps were taken to start this project?
20. What is the main goal of the action plan: tackling air pollution or climat change?
21. Are there any other co-benefits of this project?
22. Are there policy measures made for air quality? Or only raising awareness?
23. What were the steps that were taken to introduce the action plan?
24. Which persons were involved with this process? And what kind of organisations/stakeholders?
25. What was their function in this process?
26. What were successes with the performance of this plan?
27. What were the strengths of the process?
28. Was there a lot of experience with the process?
29. Did people involved have a lot of background information about the subject?
30. Did people that were involved participate in similar kinds of projects?
31. Were there useful connections with people from other similar projects?
32. Are there already similar kinds of pilots?
33. Are there developments in the community useful? What kind of developments?
34. What gave resistance to the action plan? What were failures?
35. The project was only for 6 months, did this gave resistance to the project? Or benefits?
36. Was there a limitation in resources? Or were there plenty of resources that could be used?
37. Was there interference of politics? Or no interference at all (while that was needed)?
38. Was there financial pressure? Or enough financial backup?
39. How was the Joaquin project involved?
40. Were there any other projects that had a influence on this project?
41. Looking back at the project, are there any recommendations for future similar actions like this? What should be done next time different? And what not?

13. Appendix II

TOOLKIT

Information Guide
The air quality problem

Air quality is an important Public Health issue in London, it contributes to shortening the life expectancy of all Londoners, disproportionately impacting on the most vulnerable.

This factsheet will give you an overview of the air quality problem in London. For futher information please contact:

cleanerair@sustrans.org.uk
0207 780 7201
https://champions.sustrans.org.uk

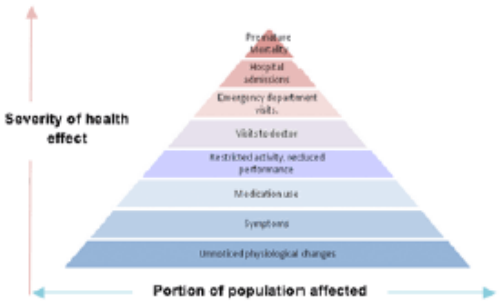
The Greater London Authority (GLA) estimated that in 2008 there were 4,267 deaths attributable to long-term exposure to small particles.

Air pollution is caused predominantly by road transport, construction sites and heating buildings. The majority of air pollutants are now at concentrations within London that do not affect human health.
Despite the reductions in the majority of air pollutants in London, levels of fine particles known as particulate matter (PM10) and nitrogen dioxide (NO_2) continue to exceed the national air quality standards and objectives which are based on recommendations from the World Health Organisation.

For the majority of the population the effects of air pollution are not usually immediately obvious, although some individuals may notice symptoms such as irritation to eyes and throats when pollution levels are elevated.

However, smaller numbers of the population are more vulnerable to the effects of air pollution, as exposure to pollution can exacerbate existing health conditions including cardiovascular and respiratory disease. This can lead to restricted activity, hospital admissions and even premature mortality.

The long term impacts upon health of air pollution can be represented by a pyramid structure, as shown below



Some facts and statistics

- Fumes from diesel engines have now been classed as carcinogenic. Research shows that exposure can cause lung cancer and possibly tumours to the bladder.
- There are approximately 690,000 asthma sufferers in London
- Those living in more deprived areas are exposed to higher concentrations of air pollution, often because homes and residences of these groups are situated next to roads with higher concentrations of emissions.
- Car occupants are typically exposed to higher levels of air pollution than cyclists or pedestrians. This is, in part, because cyclists and pedestrians can use quieter streets with lower traffic volumes, which are less heavily polluted.
- Government estimates that the annual health costs of air pollution to UK citizens is £15 billion, this is comparable to the growing annual health costs of obesity at £10 billion.
- Taking action to reduce air pollution can also reduce CO_2 emissions responsible for contributing to climate change and save money (through reductions in fuel).

CLEANER AIR FOR LONDON

sustrans
JOIN THE MOVEMENT

What the Government is doing

The Mayor and the London boroughs are doing a lot to tackle air pollution, including:

- Setting an age limit for black cabs and private hire vehicles that will retire the oldest and most polluting vehicles;
- Investment in cycling and walking
- Cleaner hybrid and hydrogen buses;
- Tighter standards for the London Low Emission Zone;
- Making construction and demolition sites cleaner to improve local air pollution;
- Using the planning system to reduce emissions from new developments;
- Improving energy efficiency in 55,000 homes and 400 public buildings;
- Raising awareness amongst Londoners to the impacts of air quality and what they can do to help deliver Cleaner Air for London.

Stay Informed

Londoners can find out when air pollution is elevated by signing up to receive pollution alerts from the airTEXT service or via the LondonAir smartphone apps

When air pollution is high it is advisable to plan bike rides and walks to avoid busy main roads – use quieter side roads instead, ensure you keep your asthma inhaler with you and do what you can to reduce emissions from your own activities.

What to do to protect your health from air pollution

- Do what you can to reduce emissions from your own activities
- Try to use quieter roads when cycling, walking or jogging
- Use airTEXT and other local services to find out when and where the air pollution is bad
- If you have asthma make sure you carry your inhaler

Useful websites

For more information on the Mayor's air quality work:
www.london.gov.uk/airquality

For information on air quality campaigns and pressure groups
www.healthyair.org.uk
www.cleanairinlondon.org

A useful website run by King's College which includes annual and daily air quality maps:
www.londonair.org.uk

Information from DEFRA on air quality
http://uk-air.defra.gov.uk