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Proceedings of

LIFE MONZA PROJECT FINAL EVENT

Methodologies fOr Noise low emission Zones introduction And management

Online event

12 June 2020

Indice

Proceedings of

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LIFE ENV/IT 00586 MONZA - *Methodologies fOr Noise emission Zones introduction And management* - objectives and actions carried out in the pilot area

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LIFE ENV/IT 00586 MONZA - Methodologies fOr Noise emission Zones introduction And management: objectives and actions carried out in the pilot area

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Abstract

The implementation of urban areas subject to traffic restrictions in order to ensure compliance with the limit values for air quality set by the European Directive 2008/50/ EC - Low Emission Zones - is widespread in practice administration of cities, especially in Europe and particularly in Italy, and the positive impacts on air quality have been widely analyzed, whereas the effects and potential benefits regarding the reduction of noise pollution have not yet been fully analyzed.

LIFE MONZA (Methodologies fOr Noise low emission Zones introduction And management - LIFE15 ENV / IT / 000586) project, co-financed by the European Commission, aims at developing and testing a methodology, easily replicable in different contexts, for the introduction and management of the Noise LEZ, an urban area with low noise emissions, subject to road traffic restrictions, whose evaluation of the positive effects regarding noise pollution has been carried out in the pilot area of the Liberty District of the Municipality of Monza, where the effects induced on air quality and the benefits on the quality of life of the residents are also analyzed.

The project is completed and in this short paper, in recalling its main objectives, the different activities undertaken in the pilot area are briefly described, the results and effects of which formed the basis of the guidelines, presented to institutional bodies and stakeholders, contributing to the definition of the general criteria for the introduction and management of the Noise Low Emission Zones.

1. The Low Emission Zones

The Low Emission Zones (LEZs) established in European cities[1] are hundreds and continuously increasing, adopting many different types of road traffic restriction and related urban mobility planning measures. They are introduced in compliance with Directive 2008/50/EC, being mitigation measures suggested by this in drafting local, regional or national plans for improving air quality. Currently in Europe there are many and different LEZs implementation and management procedures and the need to define common policies and criteria is highlighted by many stakeholders. Sweden, Germany, Denmark and the Netherlands have adopted rules governing their LEZs establishment, while a national law has not yet been enacted in Italy. The restrictions may concern the prohibition of access to the most polluting vehicles, speed limitations, the type of vehicle, heavy or light, the different time periods, access for a fee or not, and these conditions are decided and undertaken at municipal level. LEZs are introduced in large European agglomerations, as in small cities. London has a complex system of restrictions, with the existence of LEZ, Ultra LEZ and Congestion Charge, while recently, since January 1, 2020, Barcelona has established the largest LEZ in Southern Europe, which affects the entire metropolitan area with its suburbs, aimed at reducing pollution and redeveloping public spaces. Italy uses this measure especially in the north, in large and small urban centers. The LEZs allow the reduction of road traffic, a better planning of public and private mobility, cause positive effects on the environmental components, on urban regeneration, on the conditions of well-being and quality of life of citizens. Numerous studies have been conducted on the impacts on air quality, whereas those relating to the potential reduction of noise pollution are insufficient. The Directive 2002/49/CE, relating to the assessment and management of environmental noise (Environmental Noise Directive) asks Member States to draw up action plans designed to manage noise problems and their effects and indicates, among the measures to be taken, those relating to traffic planning, to which the introduction of Noise Low Emission Zones – NLEZs- can be traced. LIFE MONZA project rises from the need to make the introduction and management criteria of the NLEZs homogeneous at European and national level and in order to allow local political decision-makers to know the different environmental and social effects induced by its introduction.

2. LIFE MONZA objectives and activities carried out in pilot area of Libertà District in Monza

The LIFE MONZA project, which started in 2016 and it is concluding in June 2020, has as its main objective the development and testing of a methodology, easily replicable in different contexts, for the introduction and management of the Noise LEZ, urban area with low noise emissions, whose impacts and benefits regarding noise pollution have been tested in the pilot area of the Municipality of Monza, where also the effects induced on air quality and the potential benefits on well-being conditions of residents were analyzed. A further objective of the project concerns the actions undertaken by the Municipality capable of transforming the pilot area into a permanent Noise LEZ (*top-down measures*), such as the choice of road traffic restrictions, the replacement of road pavement with materials that guarantee a low sound emissivity, the introduction of two protected pedestrian crossings. Various activities were dedicated to the information and involvement of the residents and users of the pilot area, to share more sustainable lifestyle choices relating to noise and air pollution and the conditions of well-being in the living and working environments (*bottom- up measures).* The pilot area of the project is the Libertà District, located in the North-East area of the Municipality of Monza, a densely populated area whose main road, Viale Libertà, is used as the axis of the East-West crossing of the city and is identified as a critical area in the noise action plan prepared in compliance with Directive 2002/49/EC. The main interventions insured by the Municipality, in order to permanently establish the NLEZ, were the gradual and progressive prohibition of transit for heavy vehicles, the design of two pedestrian crossings, with the redevelopment of urban spaces, and the replacement of the asphalt of Viale Libertà, which took place in September 2018, with a bituminous conglomerate whose grain size characteristics are able to reduce the noise caused by the contact of the wheels with the road surface. Vehicles over 3.5 t were forbidden from December 2018 to June 2019, and vehicles over 7.5 t are restricted from July 2019 to July 2020. Numerous activities aimed at involving citizens, with their constant active participation, from the lessons held in the schools of the Libertà District, to the competition of ideas for the NLEZ Libertà logo which saw the students as protagonists, at the start of

[1] http://urbanaccessregulations.eu.

the pedibus, at the compilation questionnaires, with the availability offered to be interviewed. The monitoring activities, in the phases before and after the interventions, have been constant and widespread [1]. The monitoring of noise pollution is carried out using both Class I instrumentation and standard methods, and through a smart and low cost system of ten acoustic sensors developed within the project and distributed in the pilot area, on the facades of public buildings, such as schools and the civic center and on the light poles, which will remain in management to the Municipality, after the conclusion of the project. Monitoring made it possible to verify an effective reduction of noise during the day and, to a greater extent, during the night. The project foresees four air quality monitoring campaigns, conducted by ARPA Lombardia, before and after the interventions, inside the pilot area through a mobile laboratory, and outside the area at a fixed site belonging to the regional monitoring network. In order to compare the spatial variability of traffic-related air pollutants before and after the implementation of the NLEZ, regression models of toluene and benzene were developed in an area of 4 sq km around the NLEZ. Benzene and toluene, as indicators of traffic sources, were measured in 25 positions, using the passive sampling technique inside and outside the NLEZ. In order to study the effects of the actions foreseen by LIFE MONZA (infrastructural interventions, awareness activities) on the local social system, it was decided to adopt research methods aimed at detecting, analyzing and evaluating judgments, perceptions and attitudes of the population involved, towards various aspects related to environmental and social well-being conditions. To this end, a diachronic survey on the social perception of living conditions, noise and air quality in the Libertà district of Monza was designed and launched, through a path that includes two surveys: the first, aimed at defining the situation ex ante, the second, aimed at defining the conditions detectable after the implementation of the infrastructural interventions and other measures envisaged by the project, in order to evaluate the changes that have taken place.

It is possible to find positive results, thanks to the implementation of the top-down and bottom-up measures envisaged by the project, particularly regarding the noise reduction in the pilot area, during the day period and with most evidence during the night, and it also due to the different traffic conditions. Based on results of the methods tested in pilot area of the project, guidelines on Noise Low Emission Zones introduction and management have been realized, aim at defining operative procedures for the policy makers and for technicians and able to define common criteria to be adopted in different contexts and territorial scales.

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The top-down interventions carried out in the Libertà district

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The top-down interventions carried out in the Libertà district

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Abstract

The European project Life Monza has set itself the objective of identifying both top-down and bottom-up interventions, combined with each other as to produce measurable effects, with the aim of identifying a method that can be replicated in other contexts aimed at verifying the effectiveness of actions that have the specific objective of reducing the impact from noise. The top-down interventions carried out in the context of the Libertà district concerned the laying of asphalt with low sound emission, the creation of an area closed to the transit of heavy vehicles and the construction of two staggered pedestrian crossings.

The low noise emission paving asphalt concerned the road section of viale Libertà between via Bosisio and via Sant'Anastasia and involved the remaking of the binder layers and wear of the road package. The creation of an area forbidden for the transit of heavy vehicles took the form of road signs that prohibited vehicles with a capacity of more than 3.5 t in the same stretch of Viale Libertà affected by the laying of asphalt. Still in the same section, two pedestrian crossings were upgraded, which were offset in the middle of the road in order to reduce the crossing distance by vulnerable users, and consequently the speed and sound emission of vehicles in transit. The aforementioned interventions have the objective to reducing noise emissions from vehicular traffic, together with the other actions envisaged within the Life Monza project

1. Introduction

The life quality in densely populated urban areas depends increasingly on the acoustic impact of anthropic activities. The sources of noise emission (mainly vehicular traffic) are normally made of appropriate shielding or specific measures in order to contain the sound pressure level perceived by the so-called sensitive receptors. Often these interventions are performed in an uncoordinated way, individually and without a multidisciplinary approach capable of measuring their effects, avoiding their overlap, which does not allow to distinguish unequivocally which intervention is responsible for a given and measured reduction in the level of sound emission measured in one point, before and after the intervention. The Life Monza project has set the objective of identifying both top-down and bottom-up interventions, combined with each other in such a way as to produce measurable effects, with the aim of identifying a replicable methodology in other contexts aimed to verify the effectiveness of actions that have the specific objective of reducing the impact from noise.

This article aims to illustrate the top-down interventions that have been carried out within the Life Monza project, highlighting the innovative and contextual aspects that have characterized the design and implementation of the same.
Paragraph 1 briefly describes the content of the article. Paragraph 2 describes the asphalting intervention carried out in Viale Libertà using sound-absorbing material. Paragraph 3 describes the design and implementation of the creation of a no-transit area for vehicles with a capacity not exceeding a predetermined value. Paragraph 4 illustrates the construction of two staggered pedestrian crossings along Viale Libertà. Paragraph 5 focuses on the conclusions and possible future developments of the actions described, in order to replicate them

2. Asphalt paving in Viale Libertà

The road section of viale Libertà between via Bosisio and via Sant'Anastasia was Interested by asphalting works by laying a wear mat made with low sound emission material, suitably certified for the purpose by means of sample analyzes of the material laid in course of work, in order to certify its compliance with the UNI legislation in force. The works began at 9:00 pm on September 17, 2018 and ended at 8:00 am on September 22, 2018, with work performed during the night, closure to vehicular traffic (except residents and bus) and reopening to traffic every day from 6:30 in the morning. The work took place through the opening of two opposing intervention fronts, which started simultaneously from the two extremes west and east of the intervention area. The work consisted in milling the wear layer and the binder and subsequently laying the same layers, at a rate of 5 cm for the binder and 4 cm for the wear mat. The binder laid is traditional, while the wear mat was made, as specified, in low sound emission material. The work took place putting 30 people, 2 cutters, 2 compacting rollers, 2 pavers and 8 trucks to transport the waste material every night.

The intervention area affected by the works measures 14.050 m²; work was carried out every night on approximately 3.000 m² of paving, milled and then paved. The operating procedures for laying the low-noise mat had to be changed compared to laying a traditional mat: the compacting of the low-noise mat had to be carried out only after the laid material had cooled down, thus entailing the need to lay the binder in the next section, waiting for the mat to reach the appropriate temperature for compaction.

The cost of the intervention was around € 400.000 (economic framework). The cost of the low noise emission mat was 1 € / m² higher than the cost of the traditional mat, with an incidence of approximately

12%. However, the impact on the overall cost of the intervention is actually less than 5%, since all other costs are fixed. The replicability of this solution is to be verified according to the results that the experimentation will provide in terms of reduction of noise emissions, taking into account the fact that the contextual limitation to heavy traffic and the adoption of complementary measures (e.g. pedibus and information actions, which in turn lead to a reduction in vehicular traffic) generates an overlap of effects that must be carefully evaluated in order to give each intervention the correct weight on the final result. The durability of the wear mat is another potentially critical element, which can only be considered at the end of its useful life, obviously depending on the characteristic parameters of use of the same, therefore taking into account the quantity and type of traffic that It affected.

3. Creation of ban zone of transit of heavy vehicles

Viale Libertà in Monza, from the point of view of the road hierarchy, is a diametrical axis that connects the axis of the SP60 Concorezzo-Monza with the network made up of the route Cantore-Boccaccio-Regina Margherita-Battisti and viale Brianza. At the same time, however, the road section of the avenue is not always coherent with the role that the road plays within the network: the stretch involved in the project, between via Bosisio and via Santa Anastasia, in particular has only one lane per direction running width varying between 3.75 and 4.50 m, with a parking strip at the side of the road from 2 m, in some sections not present due to the reduced overall width that does not allow it to be inserted. The road section interested, as clearly visible in Figure 2, is part of the road network which performs a medium-range distribution role in the urban sector represented by the Municipality of Monza and neighboring areas. The section limited to the transit of heavy vehicles is highlighted in the figure in blue. The structure of the network is such that the limitation to heavy traffic (vehicles with a capacity greater than 3.5 t) involves the alternative route highlighted in red in Figure 2.The purpose of the limitation is to reduce traffic noise, which heavy vehicles produce in proportion to their payload. Exhaust emissions, proportional to the flow of vehicles, also undergo a reduction that the limitation on transit aims to

Figure 1 – Signage of ban zone of transit of heavy vehicles

reduce significantly. The signs placed on the roads are illustrated in Figure 1, which shows the exceptions relating to urban and suburban buses, which, although exceeding the imposed weight limitation, can obviously pass through the area subject to intervention.

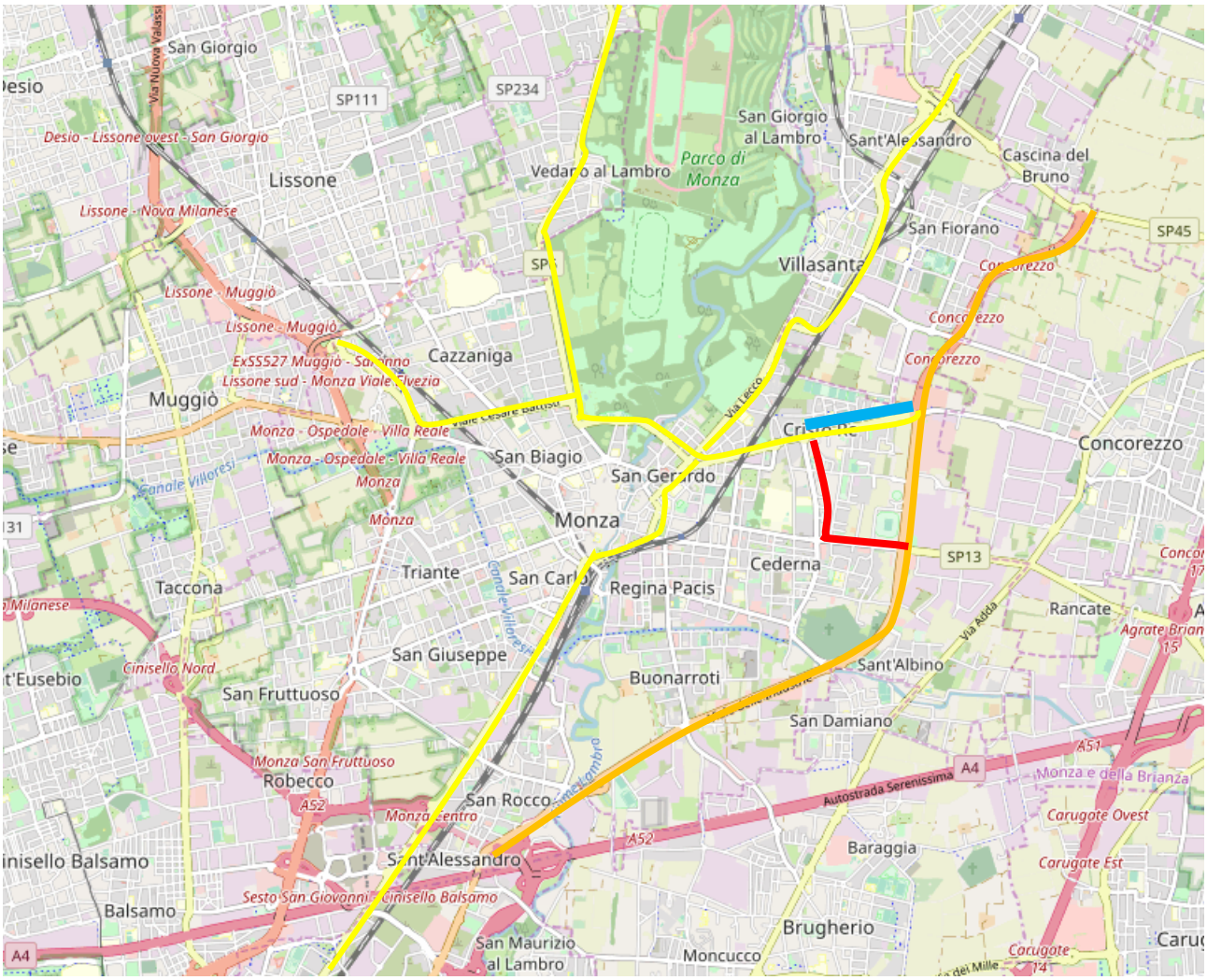

Figure 2 – Heavy vehicle traffic limitation: the forbidden route in blue, the possible alternative route in red

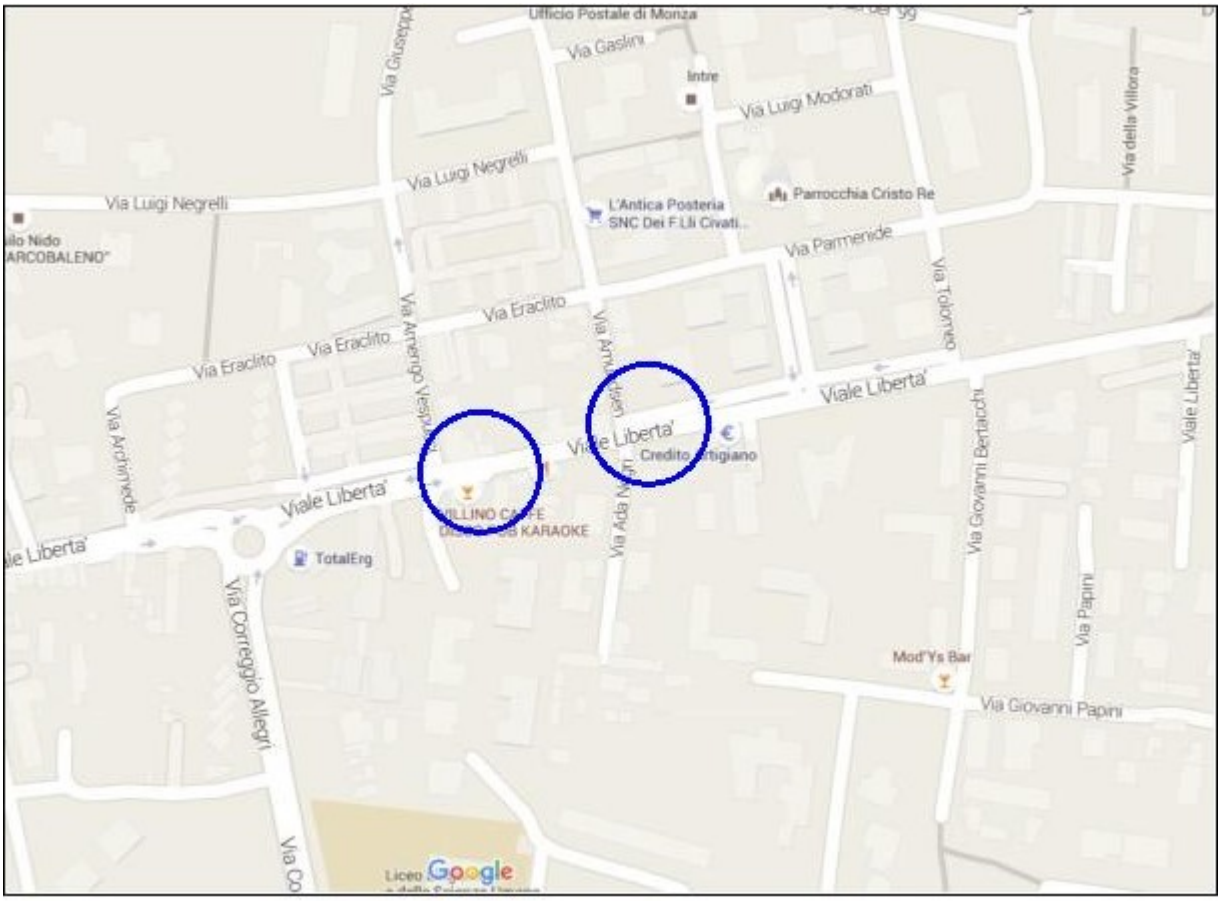

Figura 3 – Location of pedestrian crossings subject to the improvement intervention

4. Staggered pedestrian crossings

In Viale Libertà there are two pedestrian crossings, which prior to the upgrade operation had no any shape of protection for pedestrians in the center of the roadway.The width of the roadway, the characteristics of the traffic that affects this artery and the presence of points of interest located on both sides of the road suggested the opportunity to carry out interventions to improve the safety perceived by the vulnerable users who used these crossings. For this purpose, two staggered pedestrian crossings were designed, through the creation of a "safety area" located in the center of the roadway, with the dual purpose of reducing the distance travelled by pedestrians when crossing each lane and helping to reduce the average speed of vehicles engaging the crossings, by virtue of the smaller width of the lanes, since the creation of these areas actually creates a narrowing. In fact, there is a linear correlation between the average speed of a vehicular current and the perceived width of the lane by the user: as this width decreases, the average speed tends to decrease according to a linear law.

The intervention concerns the pedestrian crossings located in Viale Libertà at the height of number 114 and at the height of the civic center.

Figura 4 – Fact status of pedestrian crossing – – Viale Libertà, Civic n.114

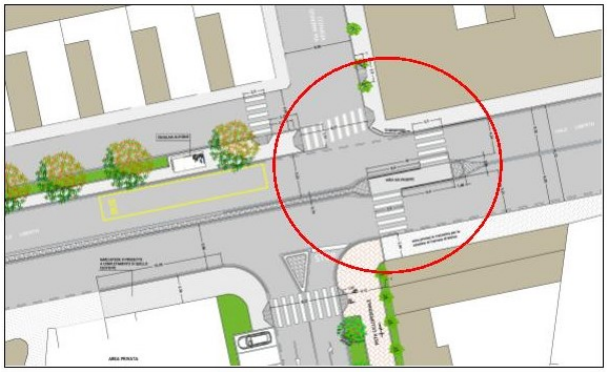

Figura 5 – Project status of pedestrian crossing – – Viale Libertà, Civic n.114

Figure 7 –Fact status of pedestrian crossing – Civic Center, Viale Libertà

Figure 6 – Project status of pedestrian crossing – Civic Center, Viale Libertà

The intervention obtained the goal to securing two pedestrian crossings that presented critical issues connected with the safety perceived by vulnerable users in the context of Viale Libertà. The action had the additional secondary objective of reducing the speed of vehicles in transit from the relevant road sections and consequently the acoustic impact of the same on the surrounding environment, since the noise emissions are proportional to the travel speed. The intervention cost a total of € 34.550,08 and was carried out in 40 natural and consecutive days. The works were completed on 3 October 2017.

5. Conclusions and future developments

The top-down interventions carried out within the Life Monza project concerned infrastructural and regulatory aspects relating to road infrastructure, capable of producing a significant impact on the level of noise emissions in the reference area, consisting of the Libertà district of the city of Monza. These interventions, together with other actions foreseen within the Life project, can be used and replicated in other contexts in order to allow the mitigation of noise coming from the emissive source constituted by vehicular traffic. The determination of the level of contribution of each individual noise mitigation intervention to the abatement of the same, by separating the overlap of the effects, is the subject of possible future research, aimed at determining the effectiveness of each intervention compared to the others.

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Noise monitoring carried-out with the prototype network of smart sensors

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Noise monitoring carried-out with a prototype network of smart sensors

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1. Abstract

Within the LIFE MONZA project, it is foreseen the realization of numerous activities of noise and air quality monitoring in order to verify the effects of the interventions carried out in the pilot area.
In particular, referring to the noise monitoring activities, as far as noise monitoring is concerned, both weekly monitoring with precision class I measurement chain and long-term monitoring using a prototype network of low cost sensors specifically designed and built by the Department of Industrial Engineering of the University of Florence are foreseen. The network of low cost sensors has been developed for continuous monitoring in ex ante and ex post scenarios, but at the end of the project, the prototype will be delivered free of charge to the city of Monza which will use it for monitoring activities at least in the three years following the end of the LIFE MONZA project.

2. Smart noise monitoring network: design

The pilot area, identified in the Libertà district of Monza, is crossed by a main street with high road traffic (Viale Libertà) on which secondary streets of the district are inserted. The noise pollution levels are on average so significant that the Libertà district has been identified as a critical area in the Action Plan of the city of Monza. The strategic noise map of the city of Monza in 2012 showed that, within a radius of 30 m from Viale Libertà, 100% of the buildings were exposed to levels above 65 dB(A) during the day and 55 dB(A) at night.
The network of smart noise sensors and their position were defined primarily in order to adequately cover the different types of roads that characterize the pilot area. Secondly, in the choice of the position of the sensors, the possibility of having a connection to the power grid avoiding the use of solar panels has been privileged. In summary, 10 control units were defined and installed in the pilot area of the Libertà district (Figure 1), three of them along Viale Libertà, while the others were distributed evenly along the other roads within the pilot area.

Figure 1 – Distribution of smart sensors in the Libertà district.

3. Smart noise monitoring network: specifications

The technical specifications of the smart sensors have been defined taking into account the objective of long-term monitoring with reference mainly to the A-weighted continuous equivalent sound pressure level and the outcome of the state of the art analysis described in [1, 2, 3]. The following main specifications of the monitoring units have been defined:

- Acoustic parameters: overall A-weighted continuous equivalent sound pressure level, 'LAeq' and continuous equivalent sound pressure level, 'Leq', as 1/3 octave band spectrum data;
- data recording times: data are acquired with a time base of 1 second to allow the recognition of unusual events during possible analysis;
- timing for data transmission: data are sent to the remote server every hour;
- data transmission network: the data are transmitted over the 3G mobile phone network;
- power supply: small solar panel (30cm x 20cm) and battery for energy storage or direct connection to the power grid;
- position of the sensors: on the streetlamp or façade, 4 m above ground level;
- sensor type: low-cost ¼ or ½ inch microphone with removable rain protection;
- background noise < 35 dB(A);
- frequency response at nominal frequencies of 1/3 of an octave within class I ± 1dB specifications.

Starting from the required specifications of the system, the architecture of the monitoring system has been defined with main reference to the low cost monitoring units developed in the Life DYNAMAP project [4] which comply with the required specifications, but adapting the data transmission, storage and post-analysis modes to the needs of the LIFE MONZA project.

As far as the hardware components are concerned, each monitoring unit has been defined to achieve high energy efficiency and low computational load. In particular, it has an average power consumption varying between 180 mW and 250 mW, depending on the transmission power and distance from the nearest radio base station of the cellular network and the type of transmission protocol used (2G, 3G). They can therefore be powered by solar panels (dimensions 30cm x 35cm) and are equipped with an

integrated power supply battery, with the possibility of being connected directly to the electricity network.
To achieve this high energy efficiency performance, MEMS digital microphones have been used that do not require the use of an external ADC. The MEMS microphones have been adapted on a ½ inch cylindrical plastic stand to allow the insertion of a standard acoustic calibrator.
These units are also equipped with a low power microcontroller capable of calculating the A-weighted continuous equivalent sound pressure level, "LAeq", by means of digital IIR filtering and, by means of FFT, the 1/3 octave continuous equivalent sound pressure level, "Leq".
The units currently connect periodically (every hour) to the Internet and transfer the collected acoustic data, together with statistics on battery level and transmission signal quality. The data populates a dedicated database, optimized for handling large amounts of data. In addition, a web application has been developed to display the position of the control units on a navigable map, display the data and download it.

4. Procedures for verification of correct functioning

The smart noise monitoring system was installed in the Libertà district of Monza continuously recording data (LAeq,1s in terms of broadband value, and Leq,1s in terms of 1/3 octave bandwidth values) acquired by the 10 sensors.
A web interface has also been developed with the aim of making it possible to view and download data referring to a user-defined period of time.
So far, the system has proven to be robust. There have only been two microphone failures downstream of a significant meteorological event and malfunctioning problems related to battery discharge of the control units on pole. From the web interface it has been possible to easily verify the breakages and malfunctions and to quickly proceed to the replacement of the sensor or battery, which in any case represent the low-cost components of the system.
In addition, the system has been subject to periodic on-site checks, generally every 4 months, which have allowed to verify the operating status of the system over time. The checks were carried out both through traditional calibration procedures (using a class I calibrator that emits a 94 dB amplitude sinusoidal signal at 1 kHz) and dedicated ones.
Through periodic verifications it was possible to analyze the performance of the system over time and any changes in microphone sensitivity. In general, after 30 months from the installation, the network of low-cost sensors has proved to be robust and effective with performance comparable to that of class II measurement chains consistent with the initial objectives.

5. Using of data acquired with the smart sensor network

Data acquired by the 10 sensors can be used to verify the trend of sound levels in the study area. Above all, the analysis of the time series of sound levels to verify the effects of the implementation of interventions is of particular interest. For example, from the time series of data acquired by the hb101 sensor (Figure 1), located along Viale Libertà on the facade of the Civic Centre, it is possible to analyse the results of the re-paving intervention with new low-noise pavement made on Viale Libertà.

In particular, Figure 2 shows the contribution of the laying of the new pavement: on the left of the graph there is the A-weighted continuous equivalent sound pressure level, "LAeq", for one week before the intervention, in the centre of the diagram there is the sound pressure level recorded during the phase of the intervention realization and on the right of the graph there is the time history starting one month after the end of the work. The month following the works has not been considered for the analysis because it is a necessary period for the stabilization of the new pavement. Focusing on these first

processing data, it is possible to observe a visible noise reduction due to the laying of the new low-noise pavement.

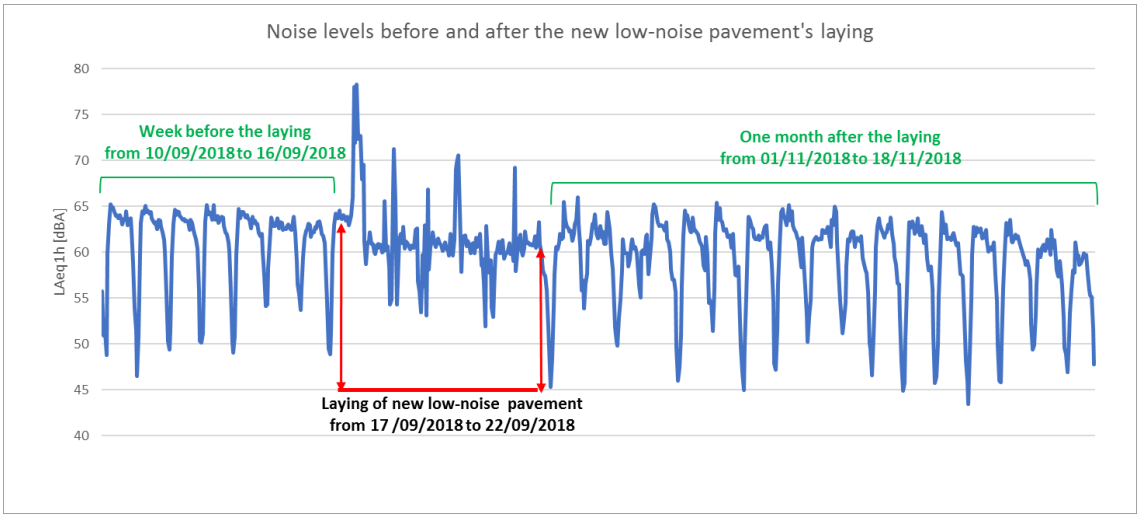

Figure 2 - Noise levels recorded by the hb101 sensor before, during and after laying the new paving.

What is more, the comparison of the benefits obtained and verified on the smart sensors is absolutely similar to those obtained with a weekly monitoring unit in class I [5, 6].
Even the absolute levels acquired by the low cost sensors and the class I chain, adjusted for a deviation related to the different position of the sensors, are certainly aligned, demonstrating the reliability of the data collected through the monitoring network with smart sensors.
The data collected by the smart sensors are then used to calculate the sound pressure levels in terms of weekly LAeq, a comparison parameter with the noise limits set and used, together with other environmental indicators, to monitor the environmental acoustic quality within the pilot area of the Life MONZA project.
Moreover, always starting from the data acquired in high resolution (every second) from the low cost sensors, during the post-processing phase, the value of the index called "Harmonica" [7] published and made available with real time update (every hour) through the "App" developed within the Life MONZA project is also determined for each sensor.

6. Analysis of noise trends during the period January – March 2020

Due to the spread of the COVID-19 pandemic, it has been deemed of interest to analyse LAeq data provided by the smart monitoring units in the trimester from January to March 2020.

In fact, due to the progressive adoption of restrictive measures at national level and at local level by the Municipality of Monza, a reduction in terms of noise levels is expected to be spontaneously achieved. Coherently, a noise reduction of 6.1 – 6.7 dB in terms of Lden has been envisaged by sensors located along Viale Libertà in the period after the second week of January 2020 (the first week of January has not been considered being a week when schools were closed and many activities stopped because of the holiday period) coherently with the adoption of restrictive measures. A higher noise reduction (up to 9.7 dB in terms of Lden) has been measured by sensors more distant from Viale Libertà.

In figure 3 an overview of the noise levels reduction, expressed in terms of Lden, is provided for all the smart sensors.

Figure 3: Noise levels reduction (Lden) measured by each smart sensor between the II week of January 2020 and the III week of March 2020.

In figures 4 and 5, noise level trends measured respectively by a smart sensor placed at the facade of the civic centre on the main street “Viale Libertà” (hb101) and by a sensor placed in a usually less busy area (hb160) in the considered trimester are shown.

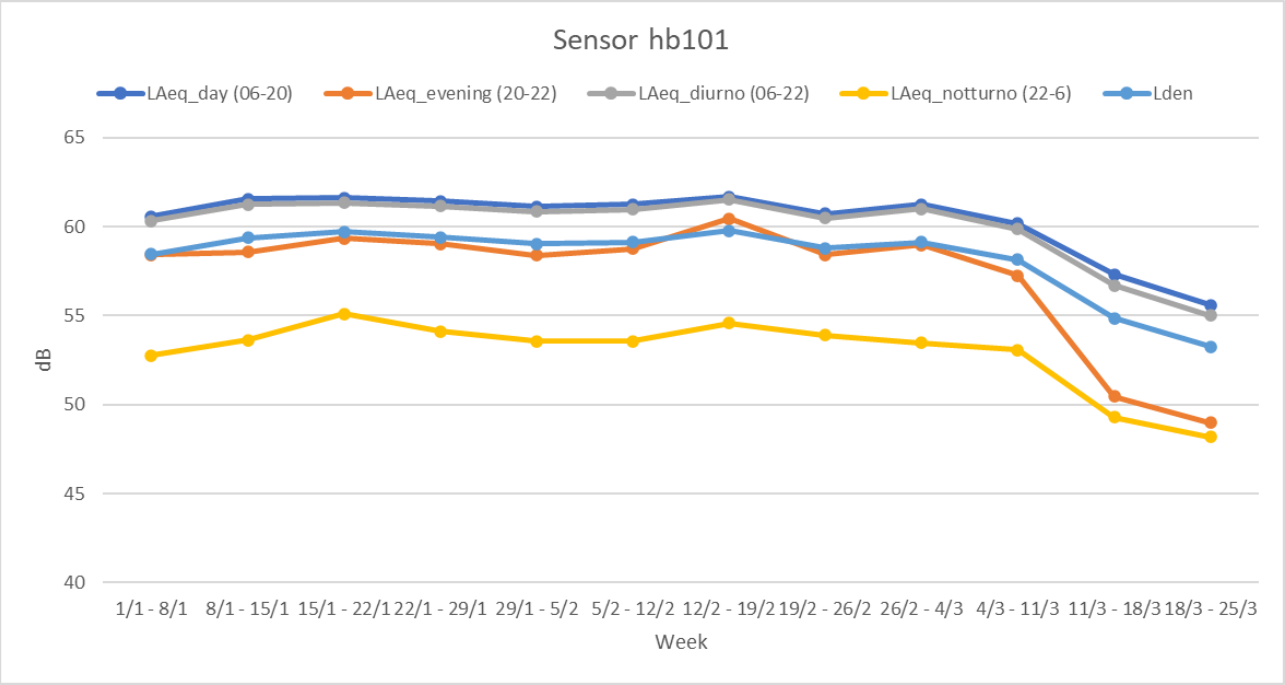

Figure 4: Weekly noise levels trends in the periods January – March 2020 for sensor hb101.

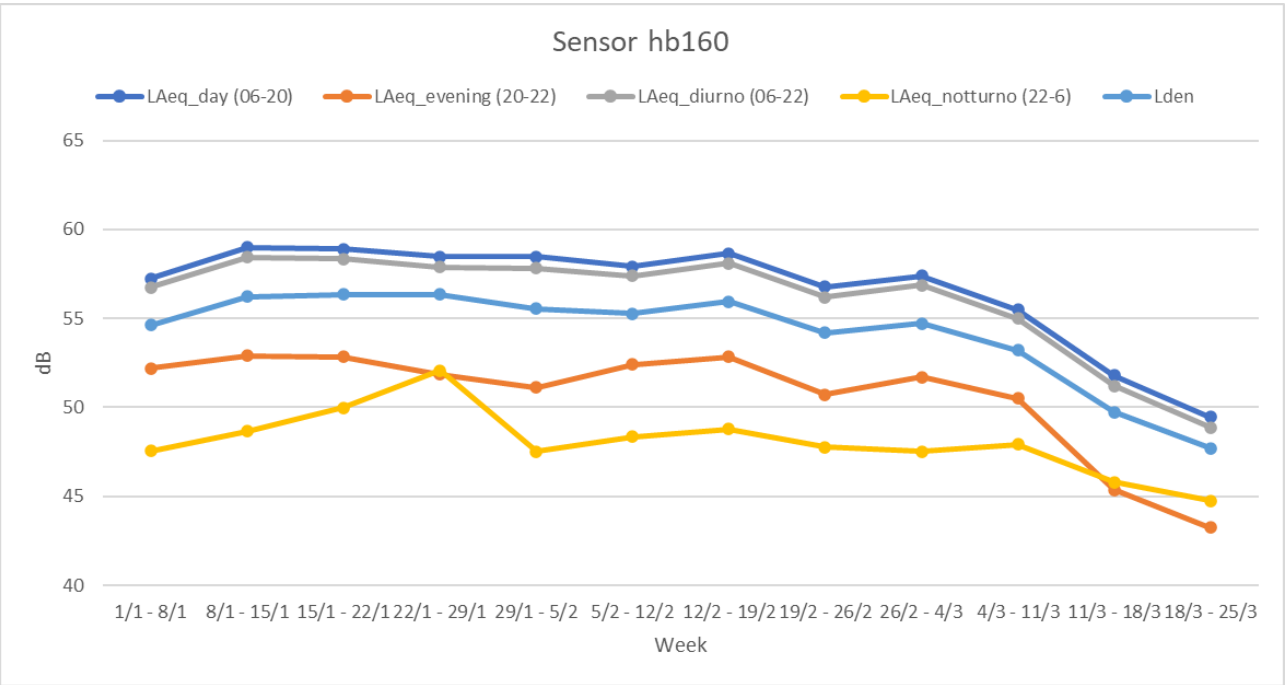

Figure 5: Weekly noise levels trends in the periods January – March 2020 for sensor hb160.

It is interesting to point put that in the city of Monza since February 23rd, it has ordered the immediate activation of a series of measures, in full accordance with the indications of the Lombardy Region.

In particular, events or initiatives of any kind, events and all forms of meetings in public or private places, including those of a cultural, recreational, sporting and religious nature, have been suspended. All schools

of all levels are closed, including nursery schools; master's, professional courses and courses for the health professions are also suspended, with the exception of trainees. Also museums, exhibition spaces, the Villa Reale, city libraries, cinemas, theatres and other places of culture are closed to the public.
In order to avoid dangers for the most fragile users, the Municipality has decided to close also the elderly and disabled day centres. The courses scheduled at the Civic City Centre have also been suspended.

Coherently, since the 23rd of February a decreasing trend for measured noise levels has started. Moreover, an even more marked decreasing trend is present after the entry into force of the D.P.C.M. of 11th March 2020 which approved the closure of many commercial activities.

The described trends are, as expected, more accentuated in the data achieved on Viale Libertà than in those provided by other sensors.

7. Conclusions

A low-cost monitoring network was designed, developed and tested as part of the LIFE MONZA project. In addition, innovative procedures were proposed and tested for the periodic verification of sensor performance. Based on the results of the periodic verification, 30 months after installation, the low-cost sensor network proved to be robust and effective with performance comparable to that of class II measurement chains consistent with the initial objectives.

With regard to the use of low cost sensor data, these are of interest both for the calculation of sound pressure levels in terms of weekly LAeq, to be used for monitoring the environmental quality of the pilot area and for the determination of the acoustic quality index called "Harmonica", calculated and made available through the "App" still developed within the Life MONZA project.

8. Acknowledgement

The authors would like to thank all those who supported the project, in particular the European Commission for its financial contribution to the MONZA project under the LIFE+2015 programme.

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Results of ante and post operam phonometric and traffic flow monitoring

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Results of ante and post operam phonometric and traffic flow monitoring

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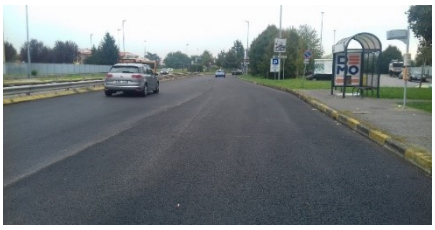
1. Abstract

One of the aims of the LIFE MONZA Project is reducing noise average levels within Libertà neighbourhood in Monza, a city in the northeast of Italy. The applied interventions for this purpose are both bottom-up and top-down actions. In the following essay, results obtained from the implementation of top-down actions are reported. The latter consist of the definition of a Limited Traffic Zone – no entry to heavy vehicles –, the implementation of measures for speed limitation in vehicles and, the replacement of the tarmac with low-noise asphalt.

2. Top-down actions

Top-down actions consist of the spreading of new low-noise asphalt and the ban on access to heavy vehicles in the street 'Viale della Libertà'. For the first action, the optimized weaving dense-graded typology was chosen, and the process was concluded in September 2018 (Figure 1). This typology is nonporous and guarantees a noise reduction of 3-4 dB(A) in flowing traffic conditions, moreover, its efficiency lasts for at least 5 years. An analogous road surface was designed and tested by Regione Toscana within the project "Progetto Leopoldo" [1]. This latter intervention was carried out in some provincial roads characterized by flowing traffic conditions. Concerning the ban on access to heavy vehicles in the street 'Viale della Libertà', the resolution n.223/2018 of the City Council, established the threshold of 3.5 tonnes.



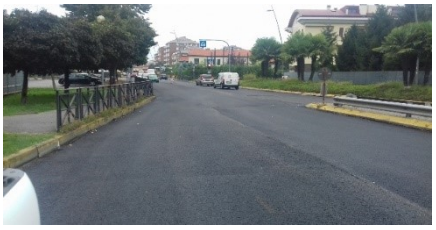


Figure 1 – Spreading of low noise asphalt.

3. The acoustic monitoring within the pilot area

The acoustic monitoring within the pilot area was planned in both the ante-operam and post-operam scenario, using both the measurement chains (class 1) and a new low-cost monitoring system developed within Life MONZA Project.

Monitorings with measurement chains in class 1 were provided for weekly measurements and accompanied by traffic measurements during spring/summer and autumn/winter. These measurements include weekly monitoring campaigns with phonometric control units as well as one-hour short-term measures (SPOT). Whereas, concerning the low-cost sensor network, ten sensors were installed, three of which in correspondence of 'Viale Libertà' and the others were arranged within the neighbourhood. The above-mentioned sensors monitor noise from June 2017 continuously. Technical specifications are listed in [2].

4. Achievements

In this paragraph, a comparison between average noise levels measured with the low-cost system and with the traditional system is presented. Both the results ante-operam and post-operam are studied (Paragraph 4.1). Moreover, achievements in the reduction of average noise levels, following the spreading of low-noise asphalt on Viale della Libertà, were measured with class 1 system and explained (Paragraph 4.2). In the end, the reduction of traffic flow between light and heavy vehicles was considered (Paragraph 4.3).

4.1. Comparison between results achieved with the low-cost system and class 1 system

In Table 1 results are listed. They are achieved ante and post-operam with the low-cost system and class 1 system, in the same week of monitoring. The results of noise monitoring, achieved during the post-operam measurements, show an equal and constant difference of about 3 dB, between sound pressure levels measured with the low-cost sensor and the class 1 system in all the analysed periods (*day*, *evening*, *night*). The above-mentioned difference is explained by microphones' different position: one on the façade of the Civic Center building (low-cost sensor), the other on the roof of the same building (class 1 system). On the other hand, measurements carried out in November 2017, show a difference of 3 dB only during the *night*, whereas during the *day* and the *evening* differences are more emphasized. This latter aspect may be explained as the low-cost sensor was arranged close to activities. In the light of these observations, results achieved during the *day* and the *evening* are not used for the results' comparison (Table 2).

Table 1 - Results achieved with the low-cost system and class 1 system.

	Period	L_{day} (6 a.m. - 8 p.m.) [dB(A)]	$L_{evening}$ (8 p.m. - 10 p.m.) [dB(A)]	L_{night} (10 p.m. - 6 a.m.) [dB(A)]
Class 1 system	Nov-17	59.5	58.8	56.5
Low-cost sensor	Nov-17	64.6	62.5	59.2
Difference		5.1	3.7	2.7
Class 1 system	Jan-19	57.5	53.7	50.3

Low-cost sensor	Jan-19	60.4	57.0	53.0
Difference		2.9	3.3	2.7

Table 2 - Results achieved with the two systems for ante-operam and post-operam monitoring.

	Period	L_{day} (6 a.m. - 8 p.m.) [dB(A)]	$L_{evening}$ (8 p.m. - 10 p.m.) [dB(A)]	L_{night} (10 p.m. - 6 a.m.) [dB(A)]
Class 1 system	Nov-17	59.5	58.8	56.5
	Jan-19	57.5	53.7	50.3
Difference		2	5.1	6.2
Low-cost sensor	Nov-17			59.2
	Jan-19			53.0
Difference				6.2

4.2. Results achieved with traditional measurement system method

A comparison between the monitoring activity during the summer and the winter in the ante-operam (November 2017, May 2017) and post-operam (May 2019, January 2019) intervals was conducted in terms of noise levels, which were measured by the sensor positioned in the street 'Viale della Libertà'. This comparison was possible thanks to the results achieved during the measurements' campaign conducted using traditional measurement system (Class 1 system).
Concerning the average weekly levels, Table 3 shows the levels measured during the four measurements' campaigns, two of which during the winter and two during the summer (ante-operam and post-operam). In Table 4, the average reduction of sound pressure levels - measured ante-operam and post-operam - is displayed. It is 2,5 dB(A) during the *day* [D], 4,9 dB(A) during the *evening* [E] and 5,9 dB(A) during the *night* [N].

Table 3 – Measured levels achieved during the weekly monitoring's campaign ante-operam and post-operam.

	month-year	**Noise Indicator L_{eq} dB[A]**		
		D	**E**	**N**
ANTE OPERAM	May-2017	**59,2**	**58,5**	**55,8**
	Nov-2017	**59,5**	**58,8**	**56,5**
POST OPERAM	Jan-2019	**57,5**	**53,7**	**50,3**
	May-2019	**56,2**	**53,8**	**50,2**

Table 4 – Noise reduction in dB[A] achieved during three reference periods (winter, summer and mid-season campaign)

Nov17 / Jan19 dB[A]	**May17 / May19 dB[A]**	**Average difference Post operam - Ante operam dB[A]**

DAY	EVE	NIGHT	DAY	EVE	NIGHT	DAY	EVE	NIGHT
-2,0	-5,1	-6,2	-3,0	-4,7	-5,6	**-2,5**	**-4,9**	**-5,9**

4.3. Reduction of traffic flow in 'Viale della Libertà'

Concerning the traffic flow data, elaborated thanks to the control units, it is possible to notice a good correspondence between the summer and the winter measurements' campaigns, both in the daily and nightly conditions. A smaller correspondence is observed during the *evening*, but it cannot be considered significant as it interests a span of 2 hours.

The difference between the data measured in the ante and post-operam campaigns, shows a spread and coherent reduction of traffic flow of approximately 5%, referring to the so-called TGM. TGM stands for average daily traffic. The percentage is even higher with reference to heavy vehicles: about 17% comparing winter data and 29% comparing summer data.

This outcome proves that the attenuation is due to the actions carried out for the optimization of 'Viale della Libertà'.

Concerning the average weekly levels, the traffic flow data and the relative percentage reduction are shown in Table 5. The data were measured during the four measurements' campaigns, two of which during the winter and two during the summer (ante-operam and post-operam). In Table 6, traffic flow concerning heavy vehicles and the relative percentage reduction are displayed. Traffic flow is measured during the above-mentioned four measurements' campaigns

Table 5 – Average daily traffic flow measured during the weekly monitoring's campaign ante-operam and post-operam.

Ante and post-operam comparison of traffic flow (average daily traffic)									
	ANTE OPERAM			POST OPERAM			ANTE/POST		
TGM	May 2017	Nov 2017	AVERAGE	Jan 2019	May 2019	AVERAGE		Nov 2017/ Jan 2019	May 2017/ May 2019
D	12781	13519	13150	12675	11774	12225	D	6,2%	7,9%
E	1272	1537	1405	1529	1326	1428	E	0,5%	-4,2%
N	1607	1757	1682	1772	1721	1747	N	-0,9%	-7,1%
TOT	**15659**	**16813**	**16236**	**15976**	**14821**	**15399**	**TOT**	**5,0%**	**5,4%**

Table 6 – Heavy vehicles' traffic flow measured during the weekly monitoring's campaign ante-operam and post-operam.

Ante and post-operam comparison of heavy vehicles' traffic flow									
	ANTE OPERAM			POST OPERAM			ANTE/POST		
HEAVY VEHICLES	May 2017	Nov 2017	AVERAGE	Jan 2019	May 2019	AVERAGE		Nov 2017/ Jan 2019	May 2017/ May 2019
D	217	180	198	146	155	150	D	-19%	-29%
E	11	9	10	11	8	10	E	28%	-23%
N	14	9	12	8	7	8	N	-17%	-46%
TOT	**241**	**198**	**219**	**164**	**170**	**167**	**TOT**	**-17%**	**-29%**

5. Conclusions

In conclusion, the actions carried out in 'Viale Libertà' provide excellent results in terms of noise reduction from road traffic. Particularly, the class 1 system for measurements shows a reduction of sound pressure levels of 2 dB(A), measured during the *day* between ante and post-operam. During the *night* and the *evening*, the reduction reaches 5-6 dB(A).

Concerning the traffic flow data, the introduction of a Limited Traffic Zone – no entry to heavy vehicles – involved a significant reduction in terms of vehicles' transit: 17% during the winter campaign and even 30% during the summer one. Light vehicles' traffic flow is decreased as well: the data show a reduction of about 5% between ante and post-operam.

6. Acknowledgements

The authors want to thank who supported the project, particularly the European Commission for the financial contribution for the MONZA Project within the LIFE+2015 Programme.

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Monitoring air quality ex-ante and ex-post noise LEZ implementation: results and assessment.

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Monitoring ex-ante and ex-post noise LEZ implementation: results and assessment.

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Abstract
Assessing the effect of traffic limiting actions in an urban area on air pollution levels is not a trivial task due to several confounding factors: weather conditions, regional background levels of pollutants, other concomitant planning measures concerning air quality.
The action B5.3 of the project aims to assess the air quality in the area where the Noise Low Emission Zone (NLEZ) was implemented, compare it with the surrounding areas and to determine on the basis of the comparison of the results of measurement campaigns carried out before (ex-ante) and after (ex-post) the implementation of the NLEZ, any tangible effects on the quality of the 'air.
To this end, monitoring campaigns were carried out in different seasons before and after the implementation of the NLEZ, using a mobile vehicle located in Viale della Libertà and passive samplers located in 25 points inside and outside the NLEZ. A generalized additive statistical model (GAM) which allows to estimate with high spatial resolution (20x20 m) was developed. Statistical "change point analysis" was applied to the meteorologically adjusted time-series in order to quantify the even little change on concentrations that was attributable to the NLEZ.
Results made it possible to characterize the chosen site with respect to the influence of vehicular traffic on the temporal and seasonal modulation of the observed levels.
The effect of the NLEZ estimated on the meteorologically adjusted time-series, accounted for around 1% decrease in mean NO_2 concentrations and around 7% for PM_{10}.
The GAM models explained pretty well the spatial variability of pollutants with covariates representative of traffic flows and building volumes, allowing to highlight the existence of a statistically significant spatial gradient on the microscale.

1. Introduction

Low Emission Zones (LEZ) have been introduced, in several European countries, to reduce emissions of air pollutants and to improve urban air quality. LEZs usually regulate access to an area according to the emission standards of the vehicles or the type of vehicle (heavy vehicles, light vehicles, scooters, etc.). A LEZ can cover a variable area ranging from a minimum of some roads to most of an urban area. LEZs mainly aim to reduce the exhaust emissions of traffic-related pollutants, in particular PM and nitrogen oxides (NOx). Measures (such as LEZs) aimed at reducing traffic, by prohibiting circulation for the most polluting vehicles, are generally able to reduce circulating vehicles, but have provided conflicting results in terms of impact on air pollution.

Evaluating the effect of a LEZ on air pollution levels is not a trivial task due to several confounding factors: weather conditions, regional background levels of pollutants, other concomitant planning measures relating to air quality (Holman C. et al., 2015). To assess the impact of LEZs, taking into account confounding factors, it is therefore necessary to remove the influence of non-local sources of traffic pollution. Meteorology has a great impact on the annual and daily variation of PM levels in the air and therefore a statistical adjustment is generally necessary to remove the seasonal distortions present in long-term analyzes.

The objectives of action B5.3 of the project were the following:

- Evaluate the concentration levels of the main air pollutants and some components of the particulate material (organic carbon, elemental carbon, black carbon) to characterize the area in question and compare it with the rest of the urban area of Monza and with the agglomeration of Milan which the city belongs to.

- Assess the spatial and seasonal variability of pollutants by estimating in particular, through the use of empirical models, the distribution on the microscale (i.e. in the territory delimited by the noiseLEZ) of some pollutants tracing the emissions of internal combustion engines.

- Evaluate, on the basis of the comparison of the results of the campaigns carried out before (ex-ante) and after (ex-post) the implementation of the noise LEZ, any tangible effects, on a local level, on air quality.

Methods

The campaigns carried out by the ARPA Lombardia Regional Center for Air Quality Monitoring (CRMQA) were divided into four monitoring periods distributed over the different seasons both in the ex-ante phase (2017/2018) and in the ex post phase (2019). The concentrations of airborne particulate matter (PM2.5, PM_{10}), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), benzene (C_6H_6), carbon monoxide (CO) and ozone (O_3) were determined. To characterize the spatial variability in the area of some pollutants mainly related to emissions from vehicular traffic (benzene, and toluene), measurements were made using passive samplers.
The monitoring was carried out using a mobile vehicle located in Viale della Libertà; the results were compared with those found at the control units of the Lombardy air quality monitoring network. The passive samplers were placed in 25 points variously distributed according to the distance from the main roads in the study domain (4 km^2) both inside and outside the noiseLEZ.
A generalized additive statistical model (GAM, Zuur et al., 2009) has been developed which allows to estimate with high spatial resolution (20x20 m) in the study domain the concentration of pollutants monitored with passive samplers. The effect of the NLEZ on air pollution for combustion related pollutant and carbon fractions of PM, can be hard to detect due both to the moderate spatial effects of the measures undertaken and confounding factors due to concomitant emission sources and meteorology.
In order to evaluate confounding factors related to the pollutants temporal pattern (drive by meteorology) and other possible difference due to contemporary city and region wide measures

undertaken to tackle air pollution in 2019 (not already in force in 2017/2018), we compared the ex post vs ex ante averages calculated over all the monitoring campaigns and we cross checked the differences found at monitoring stations inside the NLEZ and outside. However, the effect of the NLEZ on air pollution was likely to be negligible for combustion related pollutant and carbon fractions of PM, due both to the moderate spatial effects of the measures undertaken and confounding factors due to concomitant emission sources and meteorology. To address this topic, a statistical approach, based on machine learning random forest algorithm (Grange et al., 2019), allowing to meteorologically normalize the pollutant concentrations time series, were used. Then the statistical "change point analysis" (Zeileis t al., 2002) was applied in order to quantify the even little change on concentrations that was attributable to the NLEZ.

2. Results and discussion

NO_2, benzene, PM_{10}, $PM_{2.5}$ and Black Carbon time series showed a marked seasonality with much higher concentrations during colder months. This is due both to the additional pollution sources during winter (e.g. heating) and to weather conditions, that favor pollutants accumulation. SO_2 and CO generally have such low concentrations, close to the method's limit of detection or to the natural background, that they do not present equally significant variations.

The NO_2 concentrations measured at the Viale della Libertà site are comparable with those measured at the Via Machiavelli station and show typical trends of urban traffic stations in the Milan agglomerate, where in many cases the average annual legal limit (40 µg/m^3) was exceeded. An interpolation of the data made it possible to estimate the annual average concentration value at the temporary site of Monza-Libertà.

From the joint analysis of the various carbonaceous fractions (BC, OC and EC), the measurement station located in Viale Libertà in Monza is comparable to a typical urban traffic station in the province of Monza and Brianza.

Monitoring with passive samplers has made it possible to highlight the existence of a statistically significant spatial gradient on the microscale (the study domain is very small, only 4 km^2). The average concentration of benzene varies between 0.20 (urban background, within a park) and 0.83 µg/m³ (street side, Viale della Libertà 93), while in winter values ranging from 0.94 to 1.67 µg/m³. The average concentration of toluene was between 2.4 and 5.4 in the summer and between 2.6 and 6.0 µg/m³ in the winter.

The results are comforting in terms of the capacity of the GAM model developed to describe the spatial variability of pollutants and to identify the variables that "explain" at least in part this variability.

Variables included were the sum of buildings volumes in a 75 m radius buffer and the ratio between the average daily traffic and the distance from the nearest road (vehicle/day*m).

For benzene, the summer model, ex ante phase, explains 80% of the deviance (adjusted-R2 = 0.76, RMSE = 0.14 µg/m³) while in winter, 77.8% (adjusted-R^2 = 0.69, RMSE = 0.18 µg/m³). A very similar pattern was found in the ex post phase, respectively in summer (R^2 = 70.1%, adjusted-R^2 = 0.65, RMSE = 0.19 µg/m³) and in winter (R^2 = 70.5%, adjusted-R^2 = 0.66, RMSE = 0.12 µg/m³).

The same variables as for benzene were found to explain the toluene spatial variability. However, the toluene GAM models showed a lower explained deviance compared to that found for benzene.

The results of the change point analysis applied to the meteorologically adjusted time-series shown that the reduction achievable with the implementation of the NLEZ, at microscale (i.e. within the NLEZ small domain), on the targeted pollutants (PM and NO_2) was around 1% for NO_2 and 7% for PM_{10}.

Our results seem to agree very well with other studies aimed to evaluate the impact of LEZs at least on a scale local or on the microscale (C. Holman et al., 2015). Indeed when studies focused on parameters related to vehicle exhaust emissions the strength and spatial coverage of the establish blockages or restrictions on circulation (particularly those regarding heavy vehicles powered by diesel) appear to be a key factor in order to achieve larger air pollution improvements (Jones at al., 2012).

The other concomitant specific policies undertaken in the study area, on air quality, sectoral transport and energy policies (e.g. change in the composition of the park in circulation, etc.), represent important

confounding factors which therefore influence the evaluation process and which make it challenging to isolate the impact of single local measure to improve air quality.

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Life conditions and environmental quality perception data, through the eyes of the inhabitants of "Libertà" district - 1. Questionnaire's first section and key witnesses' interviews

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Life conditions and environmental quality perception data, through the eyes of the inhabitants of “Libertà” district - 1. Questionnaire’s first section and key witnesses’ interviews

Manlio Maggi (Ispra), **Antonio Fasanella** (La Sapienza University of Roma), **Andrea Amico** (Censis) and **Giampiero D’Alessandro** (Ph.D) [1]

Introduction

To study the effects of the actions (infrastructural, organizational and awareness raising interventions) on local social system provided by “MONZA” project, it was decided to use research methods aimed at detecting, analyzing and evaluating judgments, perceptions and attitudes of the population involved, with regard to a series of aspects related to the livability of the district and to the conditions of environmental and social well-being.

For this purpose, a diachronic sample survey was carried out on the social perception of living conditions, noise and air quality in the “Libertà” district of Monza, with a *quasi-experimental* design (see Campbell and Stanley, 1966) which involved two surveys: the first (pre-test) aimed at defining the *ex-ante* situation; the second (post-test) aimed at recording the conditions found after the implementation of the infrastructural interventions and other measures provided.
The target was to evaluate the changes occurred.

The data were collected by administering semi-structured questionnaires to samples of representative population residing in the "Libertà" district, distinctly selected for the two phases. Both the pre-test and post-test questionnaires have in common almost all the questions, in order to allow a proper comparison between the ex-ante and ex-post situation; besides the socio-personal structural data, they are related to thematic areas like housing, perception of life quality in the district, air pollution and noise, health, mobility and knowledge of the MONZA project and its possible impacts on some aspects of the local system. A second section has been added to the first part, containing a test on health and life quality - taken from the WHOQOL-Bref standard questionnaire - proposed by the Occupational Medicine group of the University of Florence, which independently supervised the analysis and will report about it in its own specific speech.

The questionnaires were sent by post - it was not possible to administer them "door to door" as hypothesized in the design phase, as it was not possible to involve the students in external activities - filled out in self-administration mode and returned directly by respondents to the collection centers set up for this purpose. A second filling method through internet was also made available, with direct access to the questionnaire.

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"MONZA" project); principal, teachers and students of a classroom of "Carlo Porta" high school of Monza, involved through a school-work programme.

Regarding the extraction of the sample, both for the pre-test and post-test, a random sampling strategy has been adopted, stratified by gender (M / F), age class (18-35 / 36-60 /> 60) and spatial location over Libertà avenue (≤30 meters /> 30).

Besides the administration of a structured questionnaire to a sample of residents, the general design of the research planned face-to-face interviews with some key subjects of the municipal administration, merchants and the third sector operating in the territory involved in the redevelopment intervention.

Main results of the diachronic survey

In both administrations the sample achieved represented a rather limited portion of the theoretical sample. As to the **pre-test (T1)**, whose survey period ran from February to June 2018, 177 questionnaires were collected, approximately 31% of the cases envisaged by the sample design.
Table 1 shows the distribution of respondents according to the 12 types-profiles defined by the stratification variables.

Subjects reached in the pre-test survey					
Gender	**Spatial collocation**	**Age**			**Total**
		18-35	*36-60*	*61-80*	
Female	*≤30 mts*	10	10	7	27
	>30 mts	12	27	21	60
Male	*≤30 mts*	5	7	5	17
	>30 mts	7	24	29	60
Total		30	68	62	**164**

Missing: 13 (7,3%)

Tab. 1. - Subjects reached in the pre-test by stratification class

Observing the number of subjects reached cell by cell, it is possible to appreciate the presence of all the types foreseen by the sampling plan, as well as a certain proportionality, although far from the objective, especially for subjects with a spatial location over 30 meters from Libertà avenue. An element of interest is the high share of participation among the sampled subjects for the class referring to the spatial location that identifies the subjects with their home within 30 meters from Libertà avenue: over 97%, i.e. 44 subjects out of 46 sampled. It seems extremely plausible that the daily proximity to Libertà avenue has sensitized them to the problems to which the LIFE "MONZA" project is dedicated, thus creating a greater level of interest and greater willingness to participate in the survey.

The post-test (T2), which was carried out between April and July 2019, recorded an even lower level of coverage (26% of the extracted sample) for a total of 148 respondents. Table 2 shows the breakdown by types.

Subjects reached in the post-test survey					
Gender	**Spatial collocation**	**Age**			**Total**
		18-35	*36-60*	*61-80*	

Female	*≤30 mts*	5	7	5	17
	> 30 mts	11	31	22	64
Male	*≤30 mts*	-	5	7	12
	> 30 mts	6	20	29	55
Total		22	63	63	**148**

Tab.2. Subjects reached in the post-test by stratification class

The structure of the reached sample shows that, unlike the pre-test, not all types foreseen by the sampling plan are represented. Particularly, the cell that crosses the male gender with the class of under 35 and the residence within 30 meters far from Libertà avenue remains empty. Proportionality for subjects located over 30 meters far from Libertà avenue, maintained in the pre-test despite the lack of participation, also failed in the post-test.
The reasons for the insufficient coverage occurred in both surveys are mainly due to the already known difficulties of the postal system of administration. To be noted also the complexity, length and "delicacy" of the questionnaire which, both in the first and second test, to the part summarily analyzed (section I) added a second section focused on health and life quality, that have probably constituted a further obstacle in compilation.

Here we will focus *only on some elements of synthesis*, examples of the comparison between the judgments expressed in the two stages, for which the analytical illustration refers to the final report that will be available in the next days.

A significant example is given by the concept of satisfaction with the quality of life in the district, measured at both **T1** and **T2** on some social and environmental constitutive dimensions.
The questionnaire was constructed to allow different operational definitions of this concept when analyzing data:

definition 1 (S1) - the most common operational definition, which detects satisfaction on a battery of indicators, recomposed (with the same weight) in second place into a single summary satisfaction index:

$$S_1 = \frac{\sum_{j=1}^{k} s_j}{k}$$

definition 2 (S2) - definition which, in determining overall satisfaction, takes into account the different weight of the indicators, i.e. their importance according to the scores expressed by the respondents:

$$S_2 = \frac{\sum_{j=1}^{k} (s_j p_j)}{\sum_{j=1}^{k} p_j}$$

The query about interviewees' life quality took into account the following aspects: quiet, safety / legality, hygienic conditions, adequacy of green areas (parks, gardens, etc.), variety of commercial offer, social relations. For each aspect, the interviewees were asked to express a score from 0 (*completely negative*) to 10 (*maximum positive*).

For the weighted index (S2) the next question asked to rate, for each aspect, the relative importance, from 0 (*completely irrelevant*) – to 10 (*of the utmost importance*).

To analyze the changes related to the perception of respondents, the scores of life quality indexes (in the two forms S1 and S2) as recorded in the two moments of observation were linked with the use of the analysis of variance: T1 - before the redevelopment interventions and T2 -after them.

From **table 3** it can be seen that, both by looking at the index S1 and S2, following the redevelopment interventions envisaged by the Life Monza project, there is an increase in the average of perceived life quality. Looking at the S1 index it goes from an average of 5.81 tenths to one of 6.01 (+0.21), while using the weighted index (S2) the increase is 0.26 tenths (it goes from the average of 5.85 at the first observation to 6.1 at the second).

ANOVA – Life quality indexes in the neighborhood by the distance from Libertà avenue			
Observation		**Life quality index in the neighborhood** (S1)	**Life quality weighted index in the neighborhood** (S2)
Pre-test	Average	5,8075	5,8493
	N	170	152
	standard deviation	1,45505	1,45956
Post-test	Average	6,0144	6,0951
	N	146	140
	standard deviation	1,53303	1,47796
Total	Average	5,9031	5,9671
	N	316	292
	standard deviation	1,49277	1,47103
ANOVA	**F**	**1,510**	**2,042**
	Sig.	**,220**	**,154**

Tab. 3. Life quality indexes in the neighborhood by the distance from Libertà avenue

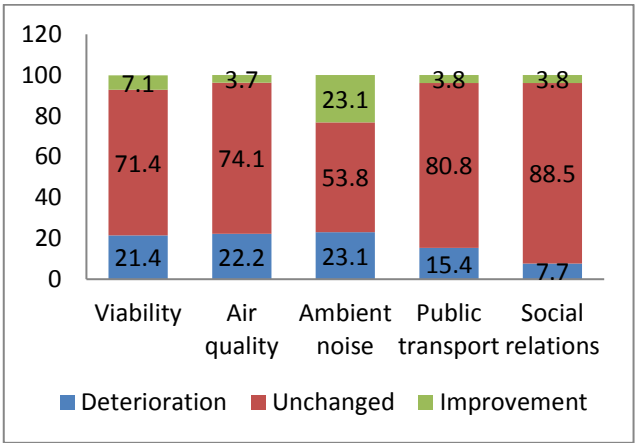
A certain improvement of life quality in the neighborhood was reported by respondents - asked before and after the interventions – but, using the two indexes, it is not statistically significant.

This effect could be determined by several factors, among which certainly the survey which, originally envisaged on a fully representative group of the resident population, was then limited for the reasons set out above.

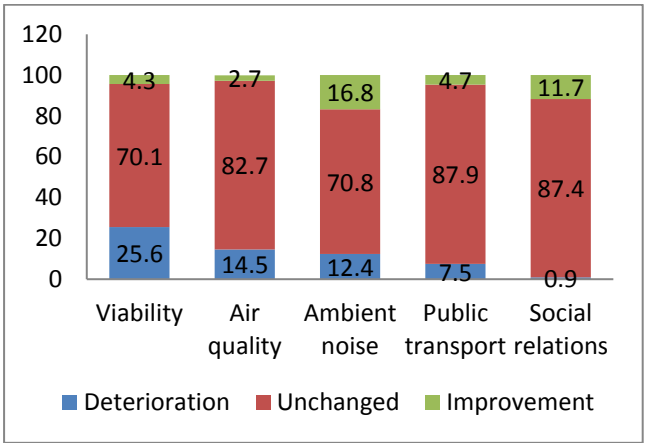
Compared to the pre-test questionnaire, *some more questions have been added in the post-test, in order to detect the respondents' perception of the change occurred in some fundamental aspects for a good life quality* (viability, air quality, noise of the environment, public transport and social relations).

Figure 1 graphically represents the distribution of the responses related to the *perceived change in the last 6 months*: it is possible to note that for the group residing within 30 meters and for those residing beyond 30 meters from Libertà avenue *the situation in the aspects investigated has remained almost unchanged*. However, **a significant improvement is reported about the environmental noise**, mostly in the group within 30 meters from Libertà avenue. This improvement is certainly an indicator of the effectiveness of the new low-emission road pavement and in general of the operation of the " Low Noise Emission Zone".

Fig. 1. Perceived change in the district by last 6 months



Within 30 mt from Libertà avenue

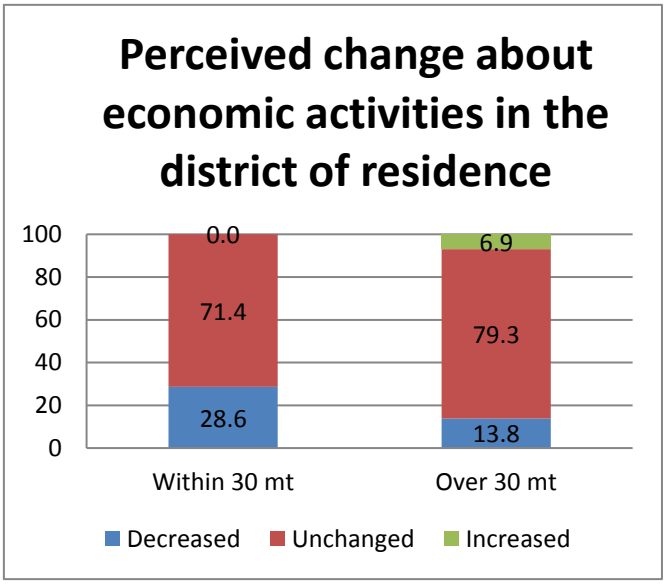


Over 30 mt from Libertà avenue

Another monitored aspect, although only through indirect perceptions, has been focused on commercial activities and their variation during the last period.

In both groups, the widespread perception was that of a substantial invariance in the commercial and economic activities of the neighborhood.

To be noted that the respondents who live within 30 meters from Libertà avenue perceived a decrease of the number of commercial activities almost double compared to those who live on the edge of the neighborhood.



Discursive interview to key witnesses

To integrate the information obtained from the diachronic sample survey, an interview was conducted through 19 "discursive interviews" (Rositi 1993, Cardano 2003) to some local "qualified witnesses" (Del Zotto 1988), carried out between May 13 and June 11 2019. A brief summary of the emerged context is reported below.

The intervention considered the *most positive* and that found the *maximum consensus among the interviewees due to its effectiveness* was the **low-emissive repaving**, which for 15 subjects led to a **significant reduction in traffic noise**.

Even the **Pedibus**, despite some initial difficulties, is universally **appreciated as positive and effective** among all people aware of it (11 cases), especially for children **socialization and pollution prevention**.

In many cases there has been an **appreciation of protected pedestrian crossings**, which improved **social relations and livability in the neighborhood**, by increasing pedestrian safety and partially overcoming the "barrier effect" of Libertà avenue.

Contrary to the previous points, judgments made by the majority of respondents (**13** people) underline the **lack or no effectiveness of the blocking of heavy vehicles**, mainly due to the lack of accurate controls. Furthermore, 4 witnesses do not comment, 1 notices a decrease of circulating trucks despite not knowing

the "MONZA" project, and another one points out the **reduction in heavy traffic** - and therefore the positivity of the action.

The **awareness, information and involvement initiatives** - certainly shareable in principle by everyone - were **hardly visible** for most of the witnesses. Some respondents said to be aware of initiatives carried out at schools, that were certainly **positive** but **limited to the institutions involved**; others point out long periods of **absence o**f **information and people involvement**, others underline the **positivity of the attempts** and of the hypotheses of bottom-up intervention, as well as the need for a "**greater commitment of the local administration**"; the most optimistic witness (1 case) indicates the **positivity of the "dissemination of good practices"** and the acquisition of a new awareness on the critical aspects of the neighborhood in a part of the population.

The shared perception emerging from the conversations is that the **traffic** has remained substantially **unchanged**. Several respondents underlined the historical difficulties of managing the passing traffic and the need for much more "systemic" interventions, concerning the public transport system and travel alternatives, in addition to the need for substantial changes in the way people and things move.

According to most of the respondents (**13 people**) the actions of the project **did not affect local business activities**. To this finding someone adds that "there is a structured and historical neighborhood trade that has not undergone changes", someone else points out that there is a quick opening/closing of new businesses in a short time, while "historic" businesses resist , and those who want to emphasize that the actions of the project **have not affected local economic activities neither have there been any effects on employment**. Furthermore, no significant effects were reported on the **real estate market**.

The overall opinion on the "MONZA" project is **generally positive** (the expressions used range from "moderately positive" to "excellent"), but in many cases it is accompanied by clarifications and critical reports. The opinion is often characterized by phrases such as "useful but not sufficient interventions", "positive, well-studied (...), perhaps optimistic in the sense that there are things to be solved at local level (...) structural interventions" (e.g. the public transport), "an excellent opinion on the project, which - however - has not developed all its potential". We also note the failure to implement some interventions, such as "Zone 30", bike sharing, biciplan: one of the witnesses points out that LIFE, at least so far, has proved to be "an incomplete puzzle".

The most cited critical issues relate to two aspects: almost all respondents, after an initial "virtuous" phase, would have needed more incisive information, as well as the **involvement of the district people**. These aspects of communication have been reported as a symptom of how the importance of the neighborhood's participation has not been properly understood and underlined.

Beyond the critical remarks, the talks **did not reveal any reports of obstacles or people's opposition to the measures taken**. Some of them, such as the Pedibus, seem to be rather accepted as **new positive models of sustainable behaviour, both from social and environmental point of view, for carrying out daily activities.**

Even if more extensive structural measures are expected to solve the long-standing mobility problems, the improvement of the district livability, albeit limited, mainly attributable to the reduction of traffic noise in Libertà avenue and the attenuation of the "barrier effect ”of the avenue itself by means of protected crossings, may instead constitute a positive factor for the growth of the social and cultural activities in the neighborhood and, in the medium-long term, to its qualitative and quantitative appreciation, also from the point of view of economic values.

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LIFE MONZA PROJECT FINAL EVENT

12 June 2020

Data on the perception of living conditions and the quality of the environment by "Liberty District" ' residents- 2. Second section of the questionnaire

Dott. Veronica Traversini, Dott. Chiara Lorini, Prof. Nicola Mucci, Prof. Guglielmo Bonaccorsi, Prof.

Giulio Arcangeli

Data on the perception of living conditions and the quality of the environment by the "Liberty district" 'residents - 2. Second section of the questionnaire

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Abstract

The protracted exposure from noise leads to hearing loss, cardiovascular, gastrointestinal, nervous-psychic changes and annoyance. Recent estimates state that around 125 million Europeans experience average annual noise levels above 55dB. Thus, the LIFE MONZA project was born, to reduce noise in a Monza' district, through limited traffic areas, interventions on infrastructures and analyzes on the quality of life of residents. The project provides semi- structured questionnaires to neighborhood residents with a "pre-test" phase, to define the ex- ante situation, and a "post-test", after the implementation of the interventions. The statistical analysis of the data was carried out for both phases. The sample consisted of 177 and 140 questionnaires, in first and second phase respectly; the subjects are mostly women (77), married / living together (95) and employed (62). They report a good quality of life (60%), a fair level of concentration and a satisfactory quality of sleep (43%). In relation to the home, 75% of the subjects most exposed to noise positively evaluate their quality of life, they report satisfactory health conditions (60%) and enjoy life enough (78%); concentration levels are defined as good or very good in 62.5% and 31.3% respectly and 46.9% are satisfied with how they sleep. Finally, 65% of the sample report negative thoughts on rare occasions. From the first analysis, we believe that the structural interventions made to the neighborhood have improved the quality of life of the residents in general; in fact, contrary to the first phase, we did not find a significance between the typical noise-related psychophysical symptoms and the location of the houses in post phase after interventions.

Introduction

The Law of October 26, 1995, n.447 and subsequent amendments defines noise pollution as "noise in the living environment or in the external environment such as to cause discomfort or disturbance to rest and human activities, danger to health, deterioration of ecosystems, material goods, monuments, the external environment or such as to interfere with the use of the rooms themselves "(1). In urban areas, this type of pollution can mainly derive from vehicular traffic, railways, air transport, construction works, industries and recreational activities, etc (2). Recent statistics estimate that as many as 125 million European citizens are exposed to road traffic noise levels above average annual levels of 55 dB but these figures could actually be significantly higher. This exposure leads to the perception of discomfort for 20 million inhabitants, the appearance of sleep disturbances for 8 million and is responsible for over 40 thousand hospitalizations. In addition, some 8000 children in Europe have difficulty reading and concentrating, in areas with air traffic noise near to school buildings (3). It is now known that prolonged exposure to noise can lead to damage both at the auditory level, with the onset of perceptive hearing loss, and at the extra-auditory level, with alterations mainly affecting the cardiovascular, gastrointestinal, nervous-psychic and annoyance systems. In fact, studies report that around 25% of the EU population experience a deterioration in quality of life due to annoyance and between 5-15% suffer from sleep disturbances (4). Continuing economic growth, the increase in industrial production, growing urbanization and related transport needs, noise levels will

continue to increase in European countries, with consequences for the health of all citizens. It therefore becomes essential to encourage the collection of data on exposure to noise, encourage various countries to develop their action plans and focus on reducing sources. With these purposes, the LIFE MONZA project was born, to develop and evaluate the management of a "Noise Low Emission Zone" (Noise LEZ), a low-noise urban area subject to road traffic restrictions and improvements, regarding the quality of life for “Liberty district” ‘residents of Monza. The project included several strategies to reduce noise in the neighborhood, including the creation of a restricted traffic area for trucks and interventions on roads system and public buildings. In addition, we have analyzed the effects on air quality and well-being conditions of residents in the neighborhood.

Methods

We have launched a diachronic sample survey, through the administration of semi-structured questionnaires to representative samples of the residents of the Liberty district. The project involved two surveys: a "pre-test", aimed at defining ex-ante situation and a "post-test", for the analysis of the conditions after infrastructural interventions. The questions were divided into a general section (with socio-personal data and concerning housing, the perception of quality of life, air pollution, noise, mobility and knowledge of the project) and a more specific section (on quality of personal life, annoyance, social relationships). The "pretest" questionnaires were administered in February-March 2018; they were sent by post and delivered directly by the interviewees to designated collection centers (Liberty Civic Center and Carlo Porta High School). The same methods of administration (April-June 2019) and delivery were provided for the "post-test" questionnaires. The statistical analysis of the data was then carried out, both in the "pre" and in the "post" phase. In particular, through the Chi Square, T-Student and Anova tests, any associations were sought between two "key" variables ("does your home overlook Liberty Avenue?"/"Approximate distance of the home from Liberty Avenue") and informations about to socio-personal data, house, quality of life, air pollution, noise, health and annoyance.

Results

The "post-test" questionnaires were 140 in total, of which 93 were paper, 34 online and 13 not belonging to the sample but to residents of the neighborhood. The analysis shows that the sample has an average age of 55.5 years (SD 16.9), 77 subjects are female (55%), 68 (49.8%) have obtained a high school diploma and 41 a degree, 95 are married / cohabiting (69.8%) and 24 (17.6%) are unmarried; finally, 62 (44.9%) have a job, 9 are unemployed and 67 (48.5%) are retired, students or housewives.

Below, we report the main results by analyzing each item of the questionnaire concerning the state of health (physical and psychological) and some characteristics of the homes of the sample examined.

Does your house overlook Liberty Avenue?	Yes No	32 (23%) 107 (77%)
Distance from Liberty Avenue (in meters)	0-30 31-100 >100	28 (20%) 71 (50.7%) 41 (29.3%)
Is there something wrong with your health?	Yes No	33 (23,6%) 83 (59,3%)
How do you evaluate your quality of life?	Bad Not bad Not good Good Very good	4 (2,9%) 33 (23,6%) 85 (60,7%) 9 (6,4%)

Can you concentrate on the things you do?	Not much Enough Much Very much	7 (5%) 61 (43.6%) 46 (32.9%) 17 (12.1%)

Are you satisfied with how you sleep?	Very dissatisfied Dissatisfied Not dissatisfied- Not satisfied Satisfied Very satisfied	1 (0.7%) 18 (12.9%) 34 (24.3%) 61 (43.6%) 16 (11.4%)
Do you ever experience negative feelings (bad mood, anxiety or depression)?	Never Rarely Quite often Very often	15 (10.7%) 87 (62.1%) 26 (18.6%) 1 (0.7%)

Analyzing the individual questions in relation to the house'position, some frequencies must be highlighted. For example, among those who overlook Liberty Avenue, as many as 75% evaluate their quality of life positively, 62% report satisfactory health conditions and 78% enjoy life enough. The reported levels of concentration are good ("quite" in 62.5% and "very" in 31.3%), 46.9% are satisfied with how they sleep but it should be emphasized that over 18% are not. Finally, 65% report negative thoughts only rarely.

In relation to the distance of the house from the avenue, other aspects are highlighted. Residents within 30 meters report more often something wrong with their health (21.4% vs 12% over 100m); in fact, those who live at a distance from the boulevard report "very good / good" physical health conditions more frequently than the nearest inhabitants (12.2% vs 3.6%).
The 67.9% of the sample within 30 meters enjoys life enough but the percentage drops for higher levels (3.6% vs 14.6% in over 100 meters), concentration levels are higher among those overlooking the avenue ("enough" 46% vs 36% in the over 100 meters), as well as the quality of sleep (42% are satisfied within 30 meters vs 36% over 100). Finally, those who live within 30 meters most often report negative feelings ("often / very often" 28.6% / 3.6% vs 19.5% in over 100).

Subsequently, the items of the quality of life questionnaire were analyzed in relation to the location of the home and the distance from Liberty Avenue, giving a score to the quality of life responses.
Below are the main results, in terms of significant associations to the Pearson Chi-Square test.

Does your house overlook Liberty Avenue?	Can you concentrate on the things you do?			
	Not much	Enough	Much/Very much	Not know
Yes	12.5%	78.1%	6.3%	3.1%
No	29%	44.9%	17.7%	8.4%
	Value	gl	P value	
Chi-Square	11.750[a]	5	0.039	

Does your house overlook Liberty Avenue?	Are you satisfied with the support of your friends?			
	Dissatisfied	Not Dissatisfied Not Satisfied	Satisfied/Very	Not know
Yes	18.8%	37.5%	43.7%	0
No	5.6%	23.4%	58.9%	12.1%
	Value	gl	P value	
Chi-Square	14.000[a]	5	0.016	

Distance from Liberty Avenue	Are you satisfied with the ability to engage in activities?			
	Dissatisfied	Not Dissatisfied Not Satisfied	Satisfied	Not know
0-30 m	7.1%	10.7%	75%	7.1%
31-100	2.8%	9.9%	81.7%	5.6%
>100 m	14.6%	19.5%	51.2%	14.6%
	Value	gl	P value	
Chi-Square	16.249[a]	8	0.039	

Conclusions

Despite the limitations of the study in question, such as the small size of the sample, the sub-optimal mismatch between the "pre" / "post" phase and the lack or incompleteness of some responses from the interviewees, we want to highlight some important aspects that emerged from this evaluation. In the "pre" phase, a significant association emerged between some negative symptoms related to poor quality of life (sleep disturbances and difficulty concentrating) and the house's position near the Avenue (5). In fact, the subjects most exposed to urban noise presented the typical symptoms of the phenomenon in question. In the "post" phase, this significance is not found.

We could therefore hypothesize, or at least not exclude, that the structural interventions on the neighborhood had a positive impact on the lives of the residents.

Instead, other aspects have always been highlighted in relation to the home's position, such as a greater social network, a more positive attitude in enjoying life, satisfying relationships with friends.

However, we believe that these reported aspects are attributable to many and heterogeneous factors to be investigated, including socio-economic factors, income, age.

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12 June 2020

LIBERTÀ PEDIBUS | Action of active involvement of the school for the promotion, implementation and monitoring of the Pedibus initiative

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Abstract

The Libertà Pedibus initiative is defined within the Life Monza project as a "bottom-up intervention" aimed at the active involvement of the school. The Pedibus, from "Regulations of the Pedibus of Monza-Libertà", is presented as a school bus on foot. It is a participatory action that promotes mobility on foot in the home-school journey. Children enrolled in the Pedibus, are organized in small groups and accompanied by parents and/or grandparents volunteers. They go from home to school following precise itineraries. The Pedibus, therefore, does not correspond exclusively to the logic of a "service" proposed to the school community, but as a participatory educational experience to be carried out with the support of the school and the local community.

The reference model, proposed by ABCittà, and endorsed by the Administration - Ufficio Mobilità del Comune di Monza - recognizes the Pedibus as a real "common good for the city". From this point of view, the experience realized in the period November 2018 - June 2020, has allowed the definition of a "Neighborhood Pedibus" where, to take care of the accompaniment of children are not only the parents directly interested, but volunteers engaged in local associations that have recognized, in this simple weekly practice, a concrete commitment to improve the quality of life in the neighbourhood.

Introduction: the first year of Pedibus

During the promotion and the subsequent start-up of the initiative, the Consulta of Libertà District (a formal group of citizens who collaborate with the Public Administration) has been reached and recognized as the main link with associations and informal groups of citizens who have found in the Pedibus a new and simple opportunity to relaunch social relations. The school is one of the centres of such relations. Families, children, parents and grandparents meet and actions, such as the Pedibus, allow the school institution to collaborate with the Administration, families, associations and local initiatives in order to define a wider educational context.

In the first months of 2019, the Pedibus was presented in school and during the Consulta of Libertà District. The results of a survey on school mobility, promoted by the "Rodari" School, were shown in order to view the home-school trip habits and introduce the Pedibus as an alternative daily route (see "box" section below). In January 2019, 312 questionnaires were distributed to all pupils of the school and then 229 completed questionnaires were collected and analyzed (73% of the distributed).

BOX | Survey on school mobility in the Libertà District | The survey described home-school trips as follows: ***(1)*** the number of children who go to school by car is always higher than the number of those who walk to school, both during the summer season (116 by car versus 114 on foot) and during the winter months (134 versus 94). Few children use bicycles (5-2) or public transport (5); ***(2)*** mothers mainly accompany their children (49%), followed by fathers (32%) and grandparents (11%); ***(3)*** the reason why you take the car is "because then you need it to go to work" (35%), due to the home-school distance (24%), because you are in a hurry (15%), reasons related to the weather (8%); ***(4)*** the "distance" is the reason why you do not walk (23%) followed by "dangerousness of the journey" (18%), "weight of the backpack" (17%), "traffic" (11%) and "weather" (8%). In terms of promoting the Pedibus: ***(1)*** 27% of those interviewed said they were interested in enrolling their child in the Pedibus (a total of 63 families); ***(2)*** only 3% were willing to become an accompanying person (7 parents).

It emerged that school mobility in the Libertà district does not have a good level of sustainability and children's autonomy is very limited. A good number of those interested in the "Pedibus service" do not correspond to an equally substantial number of parents who are available as "accompanying adults" and immediately ready to devote time and effort accompanying groups of pupils.

The Consulta has therefore considered the local context, determined on the basis of the survey, and has defined the starting point of a new model of Pedibus for the neighbourhood. It has not been possible to create an action that starts from the school to reach a wider local community, but it has been preferred to define a community of volunteers willing to activate the action with the aim to consolidate the collaboration with parents and the school itself. The informal and recognized groups such as the "Gruppo del Controllo del Vicinato" and the "Gruppi di Cammino" have immediately understood and adopted the values of the Pedibus as an action capable of supporting the idea of sustainable school mobility. They recognize the strong impact of the action on the social relationships that are established between children of different ages (children enrolled in the Pedibus are divided into groups not according to ages, but to housing positions), parents, grandparents and volunteers (who do not necessarily have children and/or grandchildren enrolled in school).
In April-June 2019, a group of about ten volunteers formed the "Pedibus del quartiere Libertà". The initiative served the school community and was largely appreciated by parents. At the same time, the school recognized the educational and social value of the action by **including the Pedibus in the Three-Year Plan of the Educational Offering**.

After the first year of the Pedibus, the traffic in front of the school during the hours of entry and exit was interpreted as a "sign of a need" which the local community itself took charge of. The number of cars in front of the school can be reduced, thanks to the Pedibus, as it is not strictly necessary to accompany children to school. It is possible to reach any of the "pick-up points" or "Pedibus stops" and then rely on the

helpers. In this way, three objectives are achieved: guaranteeing more autonomy to children and teenagers, reducing the number of cars in front of the school and reaching the workplace in advance.

The ongoing experience

The collaboration between School, Local Administration, Volunteers and Parents Association has allowed improving the model, during the summer break between the first and the second year of experimentation. Two aspects have been considered above all: the realization and positioning of Pedibus signs, along the routes tested in the first year, and the attention paid to **safety and insurance of children and adults involved**. Safety and insurance have immediately been pointed out by the school as possible critical areas. In fact, in addition to the certification of the routes, guaranteed by the Administration and carried out with the support of the Local Police, the insurance cover has been guaranteed to children on the home-school route (already provided for by the school insurance), but also to the volunteers, recognizing their commitment in the realization of a project included in the PTOF – Italian acronym for Three-Year Plan of the Educational Offering - and their strong collaboration between school and community institutions. In the first year of start-up, a collaboration with the Parents' Association (to whom we would like to express our heartfelt thanks) has been activated. The association has extended the insurance policy also to Pedibus volunteers, whereas, from the second year, it has been possible to insert the Pedibus in the municipal insurance that covers volunteers involved in the care of common goods.

Another crucial aspect of the Pedibus action was the contribution of **awareness-raising and education to sustainability**. Not only the children enrolled in the Pedibus, but also all the others had the opportunity to reflect on increasingly topical environmental issues, thanks to the inclusion of the Pedibus in the PTOF. The proximity of environmental issues to everyday life has been underlined during the informative and formative meeting organized and carried out for the entire teaching staff of the two schools, on 21st October 2019. The theme was "School mobility, Pedibus and environment": the educational value of the project was presented to the teachers and the realization of workshops in classes was proposed. In this regard, a development programme of the action for the period January-June 2020 was shared and the "Kit di Schede didattiche Pedibus" (Pedibus Teaching Card Kit) was presented for the autonomous implementation of exercises and activities. The teachers will receive the kit and carry out 14 workshops in the classes participating in the project. The work will be conducted independently, but with the constant support of ABCittà. The results of the activities will be presented to the school community in a **Pedibus event scheduled for spring 2020**.

In conclusion, the objectives of sustainability of Pedibus Libertà will be the continuation **beyond the support offered by the LIFE project** and the configuration of the new Pedibus of the city as a reference model, which, thanks to this two-year experience, will be able to propose new forms of activation in other districts.

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App description and operation

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Abstract

In August 2019, the Municipality of Monza entrusted Wonderlab srl, an innovative startup in Salerno, with the realization of the Life Monza project app.

The software provides to acquire information on the activities of Life Monza, use the Pedibus service for children in the Libertà district, collect the Green Points that reward healthy behaviours and the use of good practices in relation to responsible and sustainable mobility.
The app, available both for Android and iOS, represents an important tool to stimulate the involvement of citizens (the so-called "bottom-up" measures) in the activities of their Municipality and in the acquisition of eco-friendly lifestyles.

Introduction

Life Monza is a European project, coordinated by ISPRA, aimed at introducing an easily replicable methodology for the identification and management of a Low Noise Emission Zone (Noise LEZ).

The city of Monza, in collaboration with the University of Florence and Vie en.ro.se Ingegneria srl, has identified a location in the municipal territory (the Libertà district) to be transformed into a LEZ area. A LEZ area is an urban area subject to traffic restrictions and low noise emissions, through specific measures concerning the road infrastructure (top-down actions) and the involvement of the population (bottom-up actions), encouraging the adoption of lifestyles linked to the improvement of health and air quality.

The bottom-up actions include the creation of an app, which is a collector of information and communications related to the project, as a support tool for project's initiatives and as a system of awareness-raising on sustainable mobilization and improvement of air quality.
The realization of the app of Life Monza was entrusted to Wonderlab srl, an innovative startup from Salerno, that won the Call for Proposals promoted by the Municipality of Monza in August 2019.

The company that will implement the app operates in all areas of technological innovation, with particular reference to the development of web and mobile software, video games and digital entertainment solutions, augmented reality and virtual reality systems, artificial intelligence projects and/or big data processing, multimedia content creation, social and web TV campaigns, cloud management and process dematerialization platforms.

The Life Monza project App

The realization of the Life Monza project App is based on the principles of software engineering, with the following main phases: requirements analysis, design, development and testing, release, testing and commissioning, go-live, maintenance, management and assistance.
All the activities are carried out in close cooperation with the Municipality of Monza in order to agree with choices and operational strategies and have been conducted in compliance with the directives and guidelines for the implementation of information systems for Public Administrations.

In particular, the design has been based on the arrangement of graphic prototypes (wireframe) that allowed to determine the graphic model of the software and define the functionalities and interaction systems of the users before proceeding with the actual development, optimizing the time and ensuring the achievement of expected objectives and quality standards.
Overall, the app can be represented as a set of four macro-areas of action:

- Information Section, which contains the documentation functionalities on the Life Monza project. It is possible to visualize data related to general information, objectives and results, the history of the acoustic monitoring of the Libertà district.
- Pedibus Section, which allows parents to book the stops for their children and check that the route to school has not presented any kind of problems.
- Green Points Section, where you can start collecting points that reward sustainable mobility choices within the pilot district
- User Section, which allows you to check/update your data and view the balance of collected green points

Since the services supported by the app include the participation of children (within the "**Pedibus**" project) and the monitoring of actions that, through geolocation lead to certain rewards ("**Green Points**"), particular attention has been paid to the respect of privacy and personal data protection. The

aim of the project is to encourage healthy lifestyles, not to monitor people's behaviour and, therefore, it is important to specify that all information is managed exclusively for the specific purposes of the functionalities and no storage is made over time of data relating to the location of people or children's activities. This latter category is not expected to be among users of the app, as access to Pedibus services is allowed by adult parents. For the authentication to the app, it was decided to use the tax code in order to ensure the uniqueness of each profile as well as the immediate age control of the subject.

The system is provided with a web application that acts as a Control Panel for the City of Monza, through which you can check the proper functioning of the app, authorize users with relevant roles (e.g. Pedibus volunteers), view reports and statistics on the use of the software.

The app certainly represents a model that is strictly referred to the Libertà district of Monza and designed to operate within the reference perimeter. As envisaged by the project objectives, the software is designed with a view to great scalability, so it is sufficient to redefine the area of interest and the repository of access to monitoring data for expanding the area or applying the logic of the project in a different location.

The platform is also developed to be fully compatible with Android and iOS devices, ensuring maximum effectiveness with the latest versions of operating systems.

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