DELIVERABLE 5.1

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5.1	**Q-zones-Stockholm**
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Dissemination Level

PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restrictec to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for the members of the consortium (including the Commission Services)	

Nature of Deliverable

R	Report	**R**
P	Prototype	
D	Demonstrator	
O	Other	

SEVENTH FRAMEWORK PROGRAMME

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1. Noise map analysis of indoor noise levels in the Southern part of Stockholm. Comparison between calculations with the standard value $R'_w + C_{tr}$ = 25 dB for façade insulation and the estimated sound insulation values based on the year of construction.

2. Effect of Refined method for annoyance at home

3. Effect of Refined method for annoyance at home using insulation data corresponding to year of construction

0 EXECUTIVE SUMMARY

0.1 OBJECTIVE OF THE DELIVERABLE

This deliverable aims at describing some non-acoustical aspects of the work previously presented within the project. The purpose of that is to expand the factors that have to be considered when measures based on the results from Cityhush are considered. It is also a validation of the improved analysis tool, including a verification of percentage highly annoyed people (%HA) using extended tools for analysis indoors.

0.2 DESCRIPTION OF THE WORK PERFORMED SINCE THE BEGINNING OF THE PROJECT

In WP 1 the basis for how to create Q-zones is described. See Deliverable 1.1.1. "Tools for creating Q-zones" and 1.1.2 "Identification of boundary conditions required to obtain Q-zones". In deliverable 2.2.1 "Refined noise score rating models for residents" an improved method to assess the percentage highly annoyed people is described. The method takes into account the existence of a quiet façade, quiet areas in the neighbourhood, façade insulation and noise frequency characteristics.

0.3 REFINED NOISE VERIFICATION

The refined method for calculating the percentage highly annoyed people (%HA) in Stockholm has been tried with good results. The method considers more factors than just the noise level at the most exposed façade.

A method to assess the actual sound insulation of the façades in Stockholm has been tried. A result is that the year of construction can be used to estimate the sound insulation. There are some uncertainties when doing this. One of the reasons for this is poor quality on some of the actual measurements performed during many years. An improved knowledge of the actual façade insulation is however very useful when using the refined method for calculation (%HA).

0.4 NON-ACOUSTICAL FACTORS AND THEIR IMPORTANCE

Arguments for and against Q-zones are discussed. The possible effects on air quality, accidents and travel times are investigated.

0.5 PARTNERS INVOLVED AND THEIR CONTRIBUTION

This deliverable was produced by SEP as regards the non-acoustical parts and by ACL regarding the refined noise verification.

0.6 CONCLUSIONS

Q-zones may be a powerful tool to improve the noise situation. When implementing a Q-zone it is essential that careful studies, traffic simulations and noise calculations, are done. Only then can the zone be optimized. The studies are also necessary to control potential negative effects.

1 REFINED NOISE VERIFICATION

The results presented in WP1 and WP2 have been verified in regards to percentage highly annoyed people (%HA) using extended tools for analysis indoors. Results showing the change of percentage highly annoyed due to creation of Q-zone are presented in Deliverable 1.2.1

1.1 METHODOLOGY AND BACKGROUND FOR VERIFICATION

1.1.1 IMPROVED ANALYSIS TOOL

The noise evaluation tools for residences stated in the Environmental Noise Directive 2002/49/EC only consider the sound level on the most exposed façade. The sound level on the most exposed façade is used for example to plan the type of windows on a building, that sound level is not necessary corresponding to percentage highly annoyed people. Improvements to the existing evaluation tools have been made within the project CityHush. The Deliverable 2.2.1 introduces a method, which treats several characteristics of noise other than the noise level on the most exposed façade.

The refined method that has been validated considers the following additional acoustic factors:

1. Quiet façade
2. Quiet areas in the neighbourhood
3. Façade insulation
4. Noise frequency characteristics

The actual façade insulation of the building used in the refined method is a fixed value. The calculated correction due to the façade insulation is constant even though a city holds a large variation of buildings with various façade insulations. A Survey of façade insulation for a large variety of buildings was carried out. The methodology on how to include the façade insulation was composed in Deliverable 2.2.3 using the construction year as a basis for information of the construction elements.

The evaluated methods for calculating noise levels and annoyance for residents are:

1. Sound level at most exposed façade
2. Refined Method for annoyance at home
3. Refined Method for annoyance at home using insulation data corresponding year of construction

The added characteristics in the refined methods could indicate whether the sound pressure level on the façade is overestimated or underestimated. Depending on the cityscape, and type of buildings the refined method would indicate worse or better scenarios corresponding to highly annoyed people. Using noise mapping software's the redistribution could be noticed, since a noise map only show sound pressure level and take no account to example quite façade or façade insulation. Calculated noise maps showing overestimated and underestimated sound pressure level are shown in Appendix 1 and 2. The noise maps show buildings in red and green colour. The green buildings indicate that the sound pressure level on the most exposed façade is larger than the recalculated noise level including additional aspects like sound insulation i.e. calculated sound level are overestimated for %HA considerations. The red buildings indicate that the sound pressure level on the most exposed façade is smaller than the recalculated noise level i.e. calculated sound level is underestimated.

1.1.2 EXTERIOR WALL ESTIMATION

Being part of the planning process from 1980 and onwards, window improvements have been performed on certain residential buildings in Stockholm, where the traffic noise have exceeded the requirement of 30 dBA indoors. To determine which buildings that needed window improvements, Stockholm Environmental and Health Administration, SEP, performed, between the years of 2007 and 2009, sound insulation measurements. The year of construction was collected for each building.

The measurements were adjusted to the room acoustics in order to be comparable to the estimated sound insulation. The partition area of the wall was estimated to 9 m^2. By adding the resultant measurement values to the previously produced graph, showing the estimated insulation for both open and closed ventilation, comparisons and verifications were possible.

In addition, the previously produced polynomial equations of the resulting trend lines for both open and closed ventilation were verified.

1.2 RESULTS

1.2.1 ESTIMATED SOUND INSULATION

Since no accurate information exists regarding whether the measurements were performed with open or closed ventilation, the acquired measured values have been compared to both open and closed ventilation, se Table 1. From the resultant graph, se Figure 1, it could be noticed that the measured values varied greatly within the same year of construction period. Noticeable also, is that the majority of the measured values are greater than the standard value of 25 dB, which is in use today, regardless the year of construction. This implies that the standard value has been an underestimate of the sound insulation of exterior walls.

To get an idea of how many buildings that are incorrectly over- or underestimated, a comparison of the standard value of $R'_w + C_{tr}$ = 25 dB and the estimated sound insulation, based on the year of construction, were carried out. The results are presented in a noise map analysis, see Appendix 1. For a more detailed view, see Figure

2. Here, the green buildings represent $R'_w + C_{tr} > 25$ dB and the red buildings $R'_w + C_{tr} < 25$ dB.

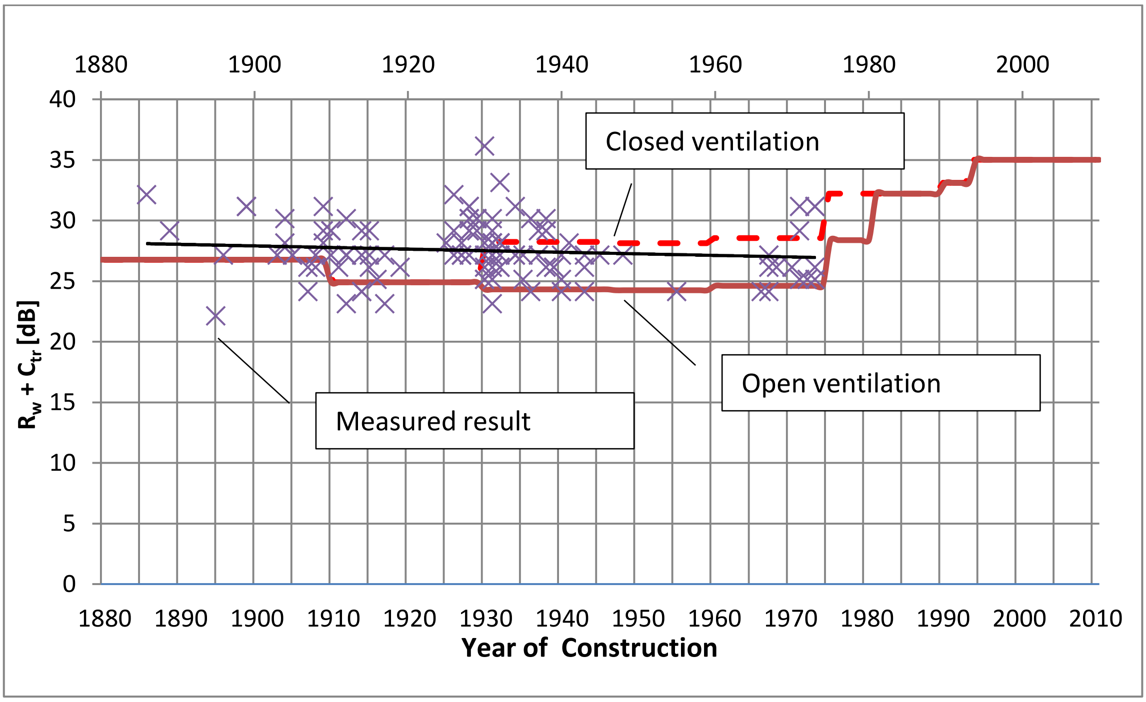

Figure 1.1

Measured values (noted with a cross) and estimated sound insulation as a function of the year of construction for both open (solid red line) and closed (dashed line) ventilation. The black line represents a trend line from the resultant measurements.

Figure 1.2

Measured values and estimated sound insulation as a function of the construction year for both open and closed ventilation. For each building the year of construction is noted.

Table 1. Numerical values of the sound insulation for open and closed ventilation

Start	**End**	***$R'_w + C_{tr,}$* open ventilation**	***$R'_w + C_{tr,}$* closed ventilation**
1880	1909	27	31
1910	1929	25	29
1930	1946	24	28
1947	1959	24	28
1960	1974	25	29
1975	1980	28	32
1981	1989	33	*
1990	1993	33	*
1994	2010	35	*

*central ventilation is not possible to open.

There exist uncertainties regarding whether the measurements were performed with closed or open ventilation, why the measurements are not reliable. Further no knowledge of the type of ventilation or windows exists. Furthermore, the measurement inaccuracy was not documented. No measurements were performed in buildings built after 1975 and therefore no comparisons have been made after that.

1.2.2 PERCEIVED BENEFITS USING EXTENDED DATA

The comparative calculations of the standard and the extended methods where conducted on a calculation model of the island of Södermalm in Stockhoml. The island of Södermalm holds approximately 94 000 residents and the island reaches an area of 5.7 km^2. The result of percentage highly annoyed and number highly annoyed people using the three different calculation methods are presented in Table 2.

Table 2. Comparison of annoyance results using various evaluation methods,

Nr	Method	%HA	HAP
1	Sound level at most exposed façade	5.6 %	5258
2	Refined Method for annoyance at home	4.9 %	4601
3	Refined Method for annoyance at home using insulation data corresponding year of construction	4.3 %	4048

1.3 CONCLUSIONS

Uncertainties of computed noise levels used for %HA for residents are a well-known fact. Discussions of the importance of quite façade, sound insulation, source characteristics and the influence of ambient noise in the neighbourhood are some of the topics that have been discussed over the years. The conducted refined method consider a wider range of aspect that have been proved important for calculating annoyance and the result indicates an obvious difference between the various methods. The initial observation of the results in Table 2 is that the extended evaluation methods calculate less annoyance. The difference between method 1 and method 3 in Table 2 reaches a difference of 1210 persons that are either highly annoyed or not. The difference of 1210 persons that are either highly annoyed or not correspond to 1.3 % of the residents on the island of Södermalm. Introducing further aspects in the calculation method generates a redistribution of buildings that are exposed to unhealthy noise levels, the redistribution patterns are showed in Appendix.

The redistribution of people annoyed is of importance for municipalities when designing action plans and planning urban growth in order to rationalize arrangements and decision-making.

By using the resultant numerical values in table 1, a more accurate estimation of the number of inhabitants annoyed by traffic noise indoors can be made, compared to using the standard value $R'_w + C_{tr}$ = 25 dB, which is used in Stockholm.

Regarding the sound insulation data more measurements are required in order to get more accurate and useful results when verifying the estimated sound insulations regarding traffic noise indoors.

2 NON-ACOUSTICAL FACTORS AND THEIR IMPORTANCE

2.1 ARGUMENTS FOR AND AGAINST Q-ZONES

Some reluctance to implement Q-zones can be foreseen. Possible objections may come from residents, visitors, politicians etc. The main arguments expected are that a Q-zone makes access more difficult, that it is an unnecessary restriction to road traffic and that it makes it harder for shop owners and so on to find customers. Naturally, people may also claim that the noise levels will be increased outside the Q-zone.

Smaller shops and cafés are generally reached by foot or bicycle, rather than by car. At least in Stockholm the most attractive places are in the old town or at pedestrian streets, with a possible exception for very exclusive locations, like viewing points. Shops where you buy large and heavy goods will be more likely to benefit from good accessibility by car, but on the other hand, they are less likely to be found within a Q-zone. It is important to argue that smaller shops and cafés generally benefit from calm surroundings with good accessibility for pedestrians and cyclists.

The main advantage for the inhabitants is obvious, less noise. For inhabitants with a car of their own a Q-zone may mean higher costs, if a charge is applied for non Low Noise Vehicles, non-LNV. That can be dealt with by an exception for inhabitants, at least during an introductory time. The same principle may be used if the Q-zone is regulated by a ban.

The fact that a Q-zone may lead to increased noise levels outside the zone may be harder to argue. Therefore, it is essential that every introduction of a Q-zone be done after careful considerations including traffic simulations and noise calculations. If increased noise levels are expected it is important that they occur mainly on streets with few inhabitants and few other areas where low noise levels are important. Other mitigating actions may be taken, such as improved window insulation at the dwellings concerned. It may however be hard to argue that such actions are needed in order to make it more silent at other places. It has been shown, in deliverable 1.1.2, that the noise level in surrounding areas is slightly reduced or at least kept equal. The explanation for this is that the amount of traffic going through the areas before the introduction of a Q-zone is limited, which in turn depends on the fact that the area is already traffic zoned. This stresses the fact that careful considerations must be done beforehand, not only on how to introduce a Q-zone but more important on where to do it.

The main argument for Q-zones is of course the reduction of noise levels, which in turn leads to less annoyance and health effects. It is important to stress this in discussions about Q-zones. Another advantage is that Q-zones are drivers for better cars, not only regarding noise but also air pollution and the use of fossil fuels. (Depending on how the electricity for the cars is produced.) A higher level of LNV will also be positive outside the zone and globally.

2.2 NON-ACOUSTICAL EFFECTS

2.2.1 AIR QUALITY

There have not been any quantitative studies within the Cityhush project on air pollutions and Q-zones. The main factors influencing the air quality are the polluting performance of the vehicles and the total amount of distance travelled. Since a Q-zone means that LNV are encouraged and all LNV:s up till today are electric cars or hybrids the average polluting performance of the car fleet will be improved. There can be no discussion about that when the electricity is produced in a relatively environmentally friendly way. If the electricity for the cars is produced by burning fossil fuels this is not necessarily true, at least not on a global scale. Inside and near the Q-zones the air-pollution will decrease regardless of how the electricity is produced.

Q-zones work as drivers for the introduction of LNV:s and therefore also for improved air quality in general, not only inside and near the zones.

A Q-zone may lead to an increase in the total distance travelled with vehicles. This means that it is very important to carefully simulate the effects of an introduction in advance, as has been shown in the Cityhush project. Suggested Q-zones that lead to an increase in the total distance travelled with vehicles may have to be revised or even abolished if the advantages are not considered larger and/or more important.

2.2.2 ACCIDENTS

As for air pollution, no studies on accidents have been performed within the project. In every case when a Q-zone is considered the risk for accidents should also be considered. Inside the zone the traffic will calmer which should be positive from this point of view. Less congestion inside the zone could lead to higher speeds but that risk is considered small, due to the type of streets that are most likely to be included in a Q-zone. The streets immediately outside the zone may have an increase in traffic flow, which may mean a risk for more accidents. This possible risk has to be dealt with and necessary precautions taken.

2.2.3 Travel time

Travellers who would have travelled straight through the Q-zone, had it not been implemented, have a choice between two things. They may pay the fee and go their "ordinary" way, or make a detour. This may lead to longer travel time. The simulations done in deliverable 1.1.2 differ quite a lot regarding increase of travel time between the different cities studied. Again, this stresses the importance of careful studies and simulations before a Q-zone is implemented. Even though the average increase in travel time is small, the sum may reach substantial values. This is a cost and has to be considered and weighed against the advantages of the Q-zone in question. A general conclusion is that more congestion there are on the streets surrounding the Q-zone, the higher the increase in travel time will be.

3 OTHER FACTORS TO CONSIDER

3.1 CONTROL OF VEHICLES INSIDE THE ZONE

The project has described two ways of creating a Q-zone, by banning vehicles that are not LNV, or by charging them for travelling inside the zone. This may raise the question of how the charging or banning is done in practice. There is a working technique for that, in commercial use at several places. The closest example is in Stockholm where a congestion-charging scheme is applied. Travelling in the inner city means that you will have to pay this extra cost. At the border of the charging zone, cameras with technique for number plate recognition are mounted and they register every passage. This is done without affecting the traffic flow in any way. The speed does not have to be decreased at the cameras. At the border of a Q-zone both the traffic flow and the speed are likely to be considerably smaller, meaning that this sort of technique will work.

3.2 PARKING

It is likely that people will ask for improved parking facilities just outside the Q-zone. It is however not certain that such facilities can be provided. The question was raised when Stockholm implemented their congestion charge. What was done then was that the parking facilities were improved at such places as stations for commuter trains, at quite a distance from the charging zone. After the implementation the question has not been discussed, there simply does not seem to be any need for extra parking close to the charging zone.

It comes without saying that including major parking facilities in a Q-zone does not seem to be a very good idea.

3.3 IMPLEMENTATION IN SEVERAL STEPS

As has been described in deliverable 1.1.2 an implementation in several steps is likely to be a good idea. This means that the Q-zone can be made larger after some time and/or that a charging system may be replaced by a ban on non-LNV. If the Q-zone is made too big initially, there is a bigger risk of unwanted congestion at bordering streets.

At the introduction of a Q-zone you may want to exempt the households living inside the zone from paying a fee if they drive a non-LNV. Such an exemption should not be permanent or too long, as it will decrease the driving effect of acquiring a LNV. A high level of LNV:s is important to get the full effect of the Q-zone.

3.4 INTRODUCTION IN EXISTING OR PLANNED AREAS

In spite of the good arguments for introducing a Q-zone it may be considered politically hazardous. One way to overcome this could be to start in a completely new area.

When everybody knows that moving in to the area means that you need an LNV, if any vehicle at all, it is less controversial. If you plan your area as a Q-zone from the beginning, you can also optimize the zone and an initial exemption for residents will not be needed.

4 CONCLUSIONS

The concept of Q-zones has been shown to be able to give substantial benefits regarding traffic noise. They can also act as drivers for electric and hybrid cars, which are beneficial for air pollution and the green house effect. The implementation of electric and hybrid cars is a slow process, so every action speeding up the process is welcome.

When introducing a Q-zone some things have to be considered. Most important is to make careful studies beforehand so that you know what you will achieve in terms of noise reduction. The studies should also give answers to the possible effects on traffic congestion, travel time and noise levels outside the zone.

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APPENDIX

Containing noise maps showing redistribution patterns of exposed buildings due to extended data and refined calculation methods

1. Comparison between the standard value R’w + Ctr = 25 dB and the estimated sound insulation values based on the year of construction

Figure 1. Noise map analysis indoors of the Southern part of Stockholm. Comparison between the standard value $R'_w + C_{tr}$ = 25 dB and the estimated sound insulation values based on the year of construction

2. Effect of Refined method for annoyance at home

The green buildings indicate that the sound pressure level on the most exposed façade is larger than the recalculated noise level including additional aspects like sound insulation i.e. calculated sound level are overestimated for %HA considerations. The red buildings indicate that the sound pressure level on the most exposed façade is smaller than the recalculated noise level i.e. calculated sound level is underestimated.

Figure 2. Shows difference of effective sound pressure level at façade. Comparison between sound pressure level at most exposed façade and refined method for annoyance at home.

3. Effect of Refined method for annoyance at home using insulation data corresponding to year of construction

The green buildings indicate that the sound pressure level on the most exposed façade is larger than the recalculated noise level including additional aspects like sound insulation i.e. calculated sound level are overestimated for %HA considerations. The red buildings indicate that the sound pressure level on the most exposed façade is smaller than the recalculated noise level i.e. calculated sound level is underestimated.

Figure 3. Shows difference of effective sound pressure level at façade. Comparison between sound pressure level at most exposed façade and refined method for annoyance at home using sound insulation data corresponding to year of construction.