

SOLUTIONS TO NOISE PROBLEMS FOR SMART CITIES

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ABSTRACT

Cities worldwide are looking for creative and innovative solutions to reduce energy consumption and protect the environment from pollutants, while developing culture, creativity and economic activity. In the smart cities approach, there is space for intelligent solutions for noise control and comfortable urban soundscapes design; awareness campaigns can help find smart solutions as final results of participative design projects. A collection of strategic experiences and technologic solutions for noise reduction, quiet areas preservation and acoustic quality improvement in urban areas is presented, as well as some possible ideas for including them in integrated urban plans, towards building a holistic way of thinking about and implementing for the cities.

1.INTRODUCTION

The development of a society has always increased its levels of urbanization, industrialization, transportation network, in terms of dimension, intensity, density.

The growing number of cities and of population in cities requires a growth in urban performance that currently depends not only on presence of hard infrastructure but also, and increasingly so, on availability and quality of communication and social infrastructure, that sounds decisive for urban competitiveness.

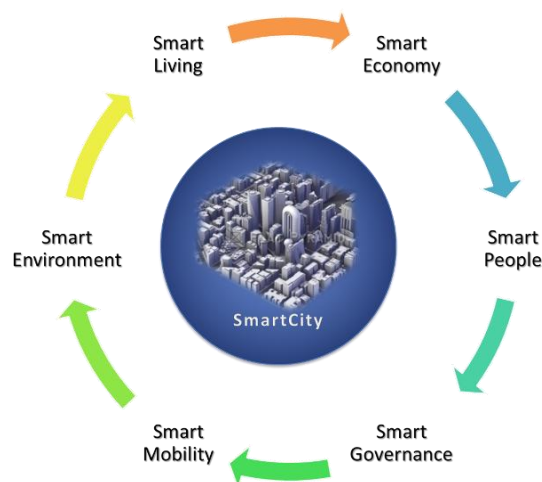
Urban development is often connected to environmental problems for citizens: among them, exposure to traffic noise is one of the most diffused. The main source of urban noise is represented by the emissions of vehicles, which are commuting over large distances every working day. Smart and sustainable urbanization means the application of smart cities approach and sustainable development concepts to urban planning, with special regards to traffic noise control, mitigation, masking. In many cities there are different plans regarding traffic, housing, land use, services but no harmonization is established among them. Some basic principles must be applied in order to achieve a smart and sustainable urbanization: compactness, completeness, conservation, comfort, co-ordination and collaboration. That means, in a word,

integration, dealing also with energy, resource limits, mitigation of environmental pollution. A good and correct environmental noise management policy can contribute to achieve these goals. In the following of this paper some links between environmental noise management and smart sustainable urbanization are described, navigating in the urban planning framework investigating how environmental noise management can contribute to sustainable urbanization. Quality of life has to be considered as a funding element in managing sustainable urban growth. Cities worldwide are looking for creative and innovative solutions to reduce energy consumption, preserve environment by pollutants, while developing culture, creativity and economic activity [1].

2. SMART CITIES APPROACH

The smart cities approach is a radical new way of thinking planning and design urban areas. It can be applied to large cities, small towns and neighborhoods. It integrates new thoughts on urban complexity, drawing on the principles of self-organizational and responsive environments. The concept of “smartness” can be applied to 6 interlaced main areas: smart mobility, smart economy, smart environment, smart living, smart people and smart governance [2]. The common way to represent these areas is a kind of “rotating” structure called “Smart city chain”, as reported in figure 1.

Figure 1: Smart city chain



A smart city is a place where innovative measures allow to city itself to reach a good global level of comfort and sustainability, with low carbon use and high quality of life, high economic value, well networked technical energy and low fossil fuel use as well. A smart city can play its role with the help of ICT technologies to achieve better energy and resource efficiency through better management and monitoring of transport, buildings, electricity and industry.

In general smart designing is researched and applied at different scale: single object, building or urban context.

In a smart approach, urban fabric objects are conveniently designed with a double function. As an example, a billboard can be both a bench or a cantilever roof (see figure 2); a building can have a sun oriented skin to produce energy or it can be a dynamic system showing ability to adapt to environment (see figure 3); a urban district can be energetically self-sufficient and with zero emission (see figure 4).

Figure 2: Smart design of objects for cities [3].

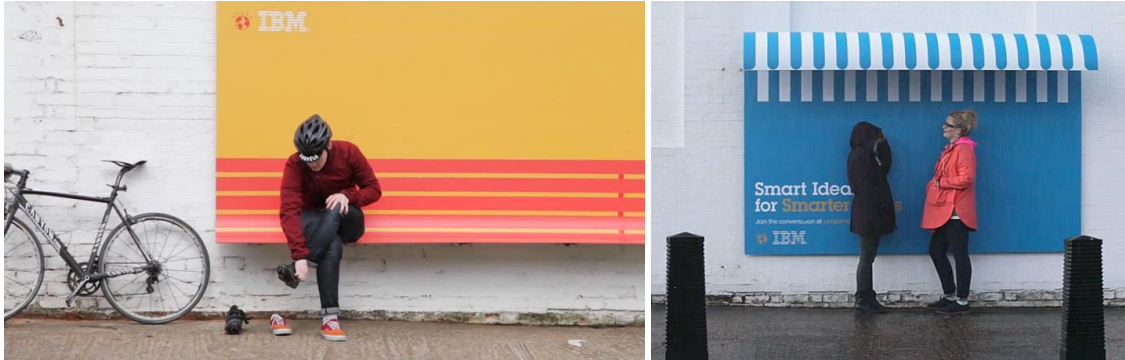


Figure 3: Smart design of buildings: the example of ENDESA Pavilion [4].



Figure 4: Smart design of buildings: examples of rotatable buildings following sun [5].



Figure 5: Smart urban design: the example of the BedZed in Sutton (London) [6].



3. SMART ACOUSTIC SOLUTIONS FOR NOISE REDUCTION

Noise reduction policies and actions can be quantified in a smart context based on the capability of producing positive effects on health and positive side-effect on quality of open spaces, buildings, transportation. In all the fields of smart cities classification, a possible connection with acoustics can be found either in terms of noise reduction or in terms of soundscapes design [7].

3.1 Intelligent noise barriers

A noise barrier, as its main function, reduces the propagation of environmental noise toward buildings and public spaces. However a barrier can have also complementary functions related to a particular contest: urban equipment, energy, information and communication, sometimes also in interactive mode. Intelligent barriers use these needs and hotspots transforming them in benefits.

An example is given by the acoustic barriers placed along the Italian highway A22, fully assembled with solar panels. This kind of barrier use energy produced to light up the road and for distribution to closer residential areas as well.

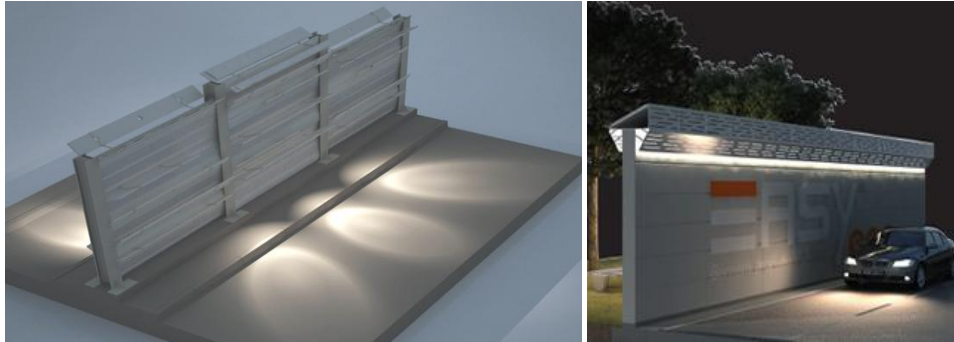
Some projects are studying the way to reverse the idea of road as environmentally aggressive, in a smooth energy producer that exploits both natural factors present in the site (sun, wind ...) and the passage of vehicles, to produce renewable energy. Through the use of smart technologies and smart solutions environmental impact is reduced and safety for drivers increased.

Figure 6: Noise barrier to produce energy [8].



Some ICT dedicated systems allow smart monitoring and control of noise and air pollution, at the same time an intelligent and balanced use of photovoltaic and wind-turbines modules can help road safety in terms of better visibility and anti-frost asphalt with electro-heated.

Figure 7: Noise barrier integrates the function to light roads up [9].



In the pilot case of the EU funded project Life+ HUSH (Harmonization of Urban noise reduction Strategies for Homogeneous action plans) a noise barrier has been built with a continuous bench very useful as a part of a playground area for children and as a seat for teachers and parents as well.

In the pilot case of the EU funded project Life+ QUADMAP (QUIet Areas Definition and Management in Action Plans) a noise barrier includes blackboard for lessons in the garden of the school.

Figure 8: Noise barrier as furniture in school gardens [10,11].



A barrier can help in communication: barriers with textile applications are commercially available for advertising. The micro-perforated layer thanks to an innovative mounting system can be simply and timely changed.

3.2 Smart urban design to create pleasing soundscapes

Urban design shows the smart side when considers the acoustic features and configuration of the space as well.

Some smart ideas can be implemented in the requalification of the urban space around airports, with special reference to solutions for school gardens: as an example, elements of urban furniture may create a safer and more comfortable playground area.

Figure 9: Noise masking and urban sculpture: the example of “P.Uccello” School in Florence

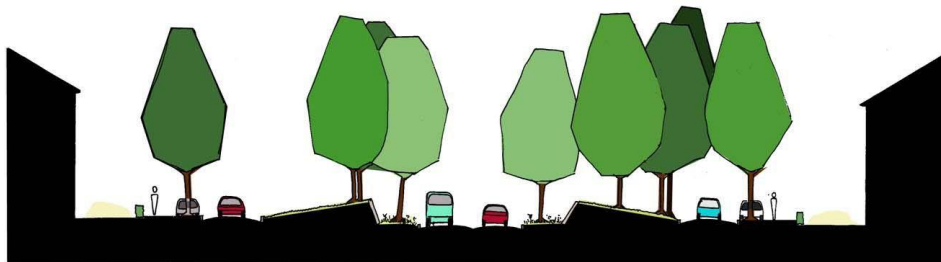


Figure 10: Smart solutions for airplane noise: the example of the Hounslow Heath infants' school in London [12].



Strategic long range interventions on urban fabric can have positive aspects on acoustic climate. A borough can achieves its smartness reshaping the urban configuration, the geometry of the buildings, changing the claddings or working on the system of the infrastructure.

Figure 11: Smart urban design: the example of Graafseweg (Wijchen) [13].



A change in the viability in urban areas and the creation of low speed zone can contribute to a better acoustic quality in the urban area.

Blurring the boundary between street and sidewalk, the so- called woonerfs combine innovative paving, landscaping and other urban designs to allow for the integration of multiple functions in a single street, so that pedestrians, cyclists and children playing share the road with slow-moving cars.

The configuration of the "living street," with paving patterns, subtle grade changes, landscaping elements, and other suggestive guides for movement, compels participation in "psychological traffic calming". The same effect has also the low speed zone as 30km/h area.

Figure 12: Smart urban design: examples of woonerf in Holland [14].



3.3 Evaluation about acoustic solutions according to smart city approach

In the most developed countries policy makers are facing the problem of smart governance of cities, considering environmental and energetic aspects combined with social issues like education, cohesion, inclusion. Technology and resources should be consequently integrated into a comprehensive and sustainable approach to urban planning. Good strategies and good practice for noise reduction and control in urban areas can be connected to the development of greener and sustainable urban environment. It can be possible to find experiences of smart environmental planning and original solutions for noise reduction and control in urban areas, including: noise from transportation, neighbourhood noise and contribution to a better acoustic climate of cities.

All aspects of acoustic planning and design that can be connected to the development of greener and sustainable cities can be considered. The idea is to explore different scenarios and approaches to noise reduction and quiet areas protection in a widespread context of urban plans and to discuss common problems enlightened by project results, orienting future noise policies and joint activities among different cities with similar problems as well. It is possible to use a Global Smartness Index, that is a system composed by several smartness indicators relative to every category of smartness (economy, mobility, environment, people, living and governance).

The Global Smartness Index GSI is then defined as:

$$GSI = F(S_1, S_2, \dots, S_6) \quad (1)$$

In the formulas (1) S_1, S_2, \dots, S_6 are the indicators for the six categories of smartness. They consider other specific variables articulated in sub-categories $S_{i1}, S_{i2}, \dots, S_{im}$. Each relative smartness indicator value is calculated as:

$$S_i = F_i(S_{i1}, S_{i2}, \dots, S_{im}) \quad (2)$$

This index can be used to assess the smartness of a city and to design possible intervention in this direction, working on weakest link respect to the six categories of smartness in the cities [1].

4. CONCLUSION

Environmental noise in cities worldwide is a complex combination of unwanted, harmful sounds mainly generated by traffic and other transportation system. Several solution for smart planning of urban areas have been proposed by city planners, looking for creative and innovative

solutions to reduce energy consumption, preserve environment by pollutants, while developing culture, creativity and economic activity.

New descriptors of smartness can be found for a more coherent development of new solutions, capable to estimate costs and benefits of different solutions. These indicators should move from a combination of quantitative and qualitative data with a general background of global comfort objectives. In this scenario, a Smart City can be defined as a well performing city, built on the “smart” combination of endowments and activities of self-decisive, independent and aware citizens. In the frame of Smart Cities agendas, including both strategies and practical tools to help administrations and their technology providers in building their smart cities. Noise reduction plans and strategic action plans for noise control gives opportunities to find and apply smart solutions in connection with acoustics.

5. REFERENCES

- [1] S. Luzzi, *Urban noise management and its practical implementation*, Proceedings of ICSV 20, Bangkok, 7-11 July 2013
- [2] G. Rudolf, C. Fertner, H. Kramar, R. Kalasek, N. Pichler-Milanovic, E. Meijers , *Smart cities – Ranking of European medium-sized cities*, available on line: <http://www.smart-cities.eu/>. Vienna: Centre of Regional Science. Retrieved 2009-11-11.
- [3] available on line: <http://www.design-dautore.com>
- [4] G.Grasso, *Endesa Pavilion*, in *Opere- La città dialogante*, anno XI, march 2013.
- [5] E.Bozzola, *Edifici che ruotano per seguire il sole: tre esempi storici*, available on line: www.architetturaecosostenibile.it
- [6] available on line: <http://inhabitat.com>
- [7] S.Luzzi, R.Natale, R.Mariconte, *Acoustics for smart cities*, Proceedings of AIA-DAGA, Merano, March 2013.
- [8] available on line:<http://www.autobrennero.it/it/Area-Tecnica/Sviluppo-sostenibile/Fotovoltaico>
- [9] available on line: <http://europaconcorsi.com/projects>
- [10] available on line: <http://www.hush-project.eu>
- [11] available on line: <http://www.quadmap.eu>
- [12] available on line: <http://bigstory.ap.org/article/uk-school-uses-domes-silence-airport-noise>
- [13] available on line: <http://www.eea.europa.eu/themes/noise/the-europeansoundscape-award>
- [14] available on line: <http://en.wikipedia.org/wiki/Woonerf>