Sustainable scenario-building process: Evaluation of acoustic design techniques and heritage conservation, the case of traditional houses in Algeria

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ABSTRACT

Our architectural heritage is a force that should link and connect the past to a sustainable future. Most Islamic and Arab cities introduced contemporary urban structures imported from western countries and therefore, lost their urban and architectural valuable heritage. They lost their identity and hence, missed the opportunity to a sustainable heritage. As a result, historic styles are ignored and the impact of modernization has led to a rupture of continuity between the inherited morphology and more recent urban structure. On the other hand, western designers are impressed by Medinas and old Arab and Islamic cities; they are seeking and investigating established techniques and ways of construction which have proved their effectiveness as sustainable solutions for heritage conservation. The traditional house in Algeria is the perfect example to promote the effective design process and conventional methods which proved the local know-how of our ancestors. Besides its social heritage values, the traditional house is an integrative part of the local life as well as an example of architectural inheritance. It appears evident and necessary to open up different perspectives for the future of this traditional historic house for a sustainable use with contemporary standards and modern facilities. We are aiming to reach an idealistic house type according to the parameters of strong sustainability. This paper presents scenarios for the adaptive use of the traditional house design as “an architectural lesson” in investigating interdisciplinary methods in the evaluation of acoustic design; it focuses on techniques used for reducing noise in traditional local buildings and identifies how to integrate sonic quality to architectural sustainable design. This may provide an alternative approach for designers and developers who are able to create architecture that will be the heritage of tomorrow and to promote traditional ways of construction towards sustainable heritage.

Keywords: Sustainable heritage, design techniques, sonic quality, Medina, scenario building process, house design, heritage conservation.

INTRODUCTION

In our time, while architectural design shows considerable respect for norms and regulations concerning thermal insulation procedures, there is less or no concern over sonic quality. This domain of interest in architecture is not the first concern in developing nations. So far acoustic comfort, considered to be a non-priority topic twenty years ago, is now an important concern for designers and even more for residents. Indeed, today, noise becomes a significant pollution, generating stress, tiredness and irritation. In fact, it is at the top of the harmful effects listed by the inhabitants of cities.

According to Amphoux (1993), acoustical remedies are
often introduced to correct rather than prevent a problem. In this piece of work, we aim to demonstrate how traditional building methods and techniques give beneficial results regarding acoustic comfort and sonic quality in the living environment. Referred to the achieved research work on inhabitants behaviour to sound pollution, Debache (2003) reported that the existing sound literature, both in research and practice is dominated by a technically-normative approach; one which looks to measurements and regulations rather than human feelings and perceptions. Criteria for assessment of the harmful acoustic effects due to a variety of noise sources inside and outside buildings still remain a mystery and an enigma for many designers (Chelkhoff, 2003).

It is rather amazing to report that with the 21st century innovative design and construction practice, we still are concerned by how people protect themselves from noise pollution. It is why this research focuses on sound environment characteristics and demonstrates how the sonic qualities of traditional building environments were much more desirable than in buildings produced by modern construction practices. The results from occupant interviews and measurements in the old city of Constantine, called Medina, show that traditional techniques were and still are much more effective in reducing noise transmission from the outside environment to inside buildings.

STUDY APPROACH

Three traditional houses were selected for this study. Similar investigations, involving noise measurements and qualitative descriptions of complex sound situations were carried out several times daily in order to compare the different houses studied. The relationship between the organization of space and the effect of this on noise caused by the occupants and subsequent transmission through the spaces were also investigated. In addition, interior and exterior noise environments of the Medina and contemporary areas were compared. Tenants were surveyed by questionnaire to evaluate noise, its level and times of occurrence, etc near residential properties. The object was to get a general overview of the most common noise irritations for residents. The information gathered was used to explore the traditional building methods and techniques and their effectiveness in reducing noise inside houses.

It was important to understand how the building envelope influenced the practices of comfort and adaptation within the interior environment (Boubezari, 2000). For this reason, we:

1) Established the overall acoustic context of the buildings;
2) Obtained an assessments of the acoustical environments as perceived by the inhabitants;
3) Identify specific noise problems and their relationship with building quality and construction method;
4) Detail the behaviour of inhabitants vis-a-vis noise issues and noted actions they took towards controlling the noise.

DESCRIPTION OF THE MEDINA

Founded by the Carthaginians, Constantine was originally settled by Phoenician migrants and renamed in the 4th century of the Roman Empire, who rebuilt the city to its original splendour after it had been destroyed. It was then conquered by the Arabs in the 7th century; their coming does not change the city structures very much, but Arabian houses and buildings were added. Since 1529, it was discontinuously part of the Ottoman Empire which greatly embellished it and built the majority of the Islamic buildings, still visible today. The city itself bears so many conflicting architectural and urbanistic indications. French buildings constitute the facades of main streets hiding the inner original traditional fabric and buildings (Figure 1).

The traditional Arab Medina of Constantine is a very compact site, where houses screen each other from outside noise (Figure 2). The old parts of the medina are dominated by narrow, winding thoroughfares and traditional buildings. It is surrounded by the modern city, comprising
French style buildings and newer quarters with modern Algerian buildings. The Casbah, a Roman fortress, the 18th century Mosque, the Medersa and the 19th century Bey Palace are Constantine’s most important landmarks (Figure 3). The city thus has a variety of contrasting architectural and urban features. The traditional Arab medina has narrow, faceless, unadorned streets with no windows on the street and only small doors that open into opulently ornamented courtyards. The medina public spaces were influenced by changes introduced mainly during the colonial period and these European urban styles inside the medina have created differentiated quarters.

Measurements were taken in houses with different locations, shopping streets, alleys, passage ways and dead ends (Figure 4) with an emphasis on capturing the sonic quality of the traditional environment.

**ACOUSTIC REGULATION**

The new acoustic regulation (NRA) was adopted by European countries in 1996; dealing with a range of human activities such as:

- Building acoustics: minimum performance levels for insulation in many types of buildings (Hotels, Schools, Residential Buildings, Industry, Commerce and Services).
- Urban acoustics: definition of quiet and noisy places;
- Traffic: limitations to noise produced by vehicles;
- Environment: limitation of noise levels produced by “noisy activities”.

Generally, European Union Member State regulations define the maximum total sound level due to services and appliances that could be measured in the different spaces of dwellings. Values range from 20 to 30 dB(A) in bedrooms, 25 to 35 dB(A) in living rooms, 30 to 40 dB(A) in kitchens and 35 to 45 dB(A) in other spaces (Oliveira, 1998). These values indicate the maximum total sound level produced by the services and appliances which generate noise of long duration. For noise of short duration, these values can be increased by 5 dB(A) (Kihlman, 1995).

Local authorities in Algeria use the same ways of evaluating environments as in France. The measured values (LnAT in the French regulation which means Lp adapted to a standard reverberation time of 0.5 s) must not be higher than between 30 dB(A) to 45 dB(A) in the living room and between 35 dB(A) and 50 dB(A) in the kitchen. The minimum values found deviate from 25 to 35 dB depending on the type of building and on the classification of the
Figure 3: The Medina’s Important Landmarks; the Medersa (source: authors).

Figure 4: Dead ends and passageways of the Medina of Constantine (source, authors).
neighbourhood (ranges from quiet to very noisy), (NRA, 1996).

UNDESIRABLE EFFECTS OF NOISE

Noise can be defined for our purposes as intrusive sounds that disrupt, distract or detract from regular functioning. It has a negative impact on the health and productivity of people. Many studies have looked at the effects of noise on health and wellness, and the results have shown that noise has its main impacts on productivity and health (Chelkhoff, 2003). Productivity as noise can be distracting (J.A.P, 2002). One study by Hygge et al. (1996) examined children exposed to airport noise and found that their reading ability and long-term memory was weakened. Those working in noisy office environments were also found to be less cognitively motivated and to have higher stress levels, according to a Cornell University study by Hygge et al. (1996).

Health and perhaps the most serious problem created by noise is the impact it has on our health because it can trigger the body stress response. As a result, noise is also linked to heart disease and high blood pressure. Noise pollution can also impact sleep quality by keeping people awake and disrupting sleep cycles. And, perhaps most significantly, because chronic stress can lower immunity to all disease, noise is a general threat to health and wellness (J.A.P, 2002).

INVESTIGATION AND MEASUREMENTS

The study was initially directed towards discussions on the concept of noise intrusion and its significance for the inhabitants. The first aspect of the research was to explore the possibilities and the methods of collecting information on the sonic environment. Surveys were carried out in order to evaluate the inhabitants’ impressions and intuitive approaches and practices for achieving acoustic comfort. In the traditional Medina, measurements were taken in three houses in different neighbourhoods, where noise intensity varies according to the area (shopping or residential streets) (Figures 5 and 6). The living environment of the Medina is characterized by compact houses with typical and very distinctive passage ways, streets, dead ends and skiffas (passages leading to the inside of houses). These architectural and urban elements act as screens and buffer zones against the outside noise.

This variation of noise levels and the transition along passages from the outside to courtyards (Figure 7) is the result of a hierarchy of passages in the traditional environment; from an open and noisy space, with a diversity of sound sources (mechanical and natural) in the street to an alley and then to the skiffa, which acts as a real screen against outside noise (Table 1).

RESULTS AND DISCUSSION

The results suggest that:

- Sonic comfort requires more than usually considered in terms of acoustic insulation;
- It shows that houses of the medina provide a level of acoustic comfort which can be identified in terms of architectural conception and in terms of criteria determined by those who use the space;
- Noise intensities recorded are rather uniform and evolve in a variety of about 10 dB (A). This reflects an environment in which a whole series of signals (footsteps, voices, etc) emerge in a constant background noise;
- This research confirms that traditional ways of buildings attest their ability to achieve acoustic comfort. In fact, the design of the traditional house and the role of certain elements in screening and shielding against noise are actions that should be taken into consideration during the design of modern residential buildings. This underlines the need for planners and decision-makers to apply such tools which allow them to manage and control the intrusion of external noise into housing.

Conclusion

This research intended to consider acoustic design techniques and heritage conservation; to demonstrate the values of some traditional building forms for contemporary planning and architecture as a sustainable scenario-building process.

More attention and actions are dealt with such as:

- Double glazing;
- Isolated materials used to solve acoustic problems (inhabitants are not convinced by these actions, they are rather persuaded by methods used by their ancestors);
- An overview of acoustically successful traditional housing methods can serve the contemporary designer who is interested in acoustic comfort (Debache, 2004).
- Traditional measures have developed a synergy between the acoustic capabilities of constructions and cultural characteristics depending upon the period and the place where the inhabitants reside;
- Nowadays, noise mapping helps in determining issues for preventing disturbance from external noise. However, sonic comfort does not exist in isolation but results from a process. Research shows that this comfort has a much larger significance than what is usually considered in terms of acoustic insulation and that the occupier as stated by Deletré (2008) is known to be an active participant in this process.

Among further research questions is how architects and engineers take advantage of traditional design and construction practices? How can we adopt these methods
Figure 5: Map of the Medina of Constantine: location of the three houses 1/2000.
Table 1: Detailed sound measurements in the 3 case study houses: July, 2014.

<table>
<thead>
<tr>
<th>Space-time</th>
<th>Street</th>
<th>Alley</th>
<th>Dead End</th>
<th>skiffa</th>
<th>patio</th>
<th>Gallery</th>
<th>Room 1</th>
<th>Room 2</th>
<th>House plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>7.00 am</td>
<td>7.30 am</td>
<td>7.35 am</td>
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<td>8.00 am</td>
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<td><img src="image" alt="House plan" /></td>
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<td>House on a Shopping street. Measures in dB.</td>
<td>71 dB</td>
<td>68 dB</td>
<td>55 dB</td>
<td>49 dB</td>
<td>46 dB</td>
<td>45 dB</td>
<td>41 dB</td>
<td>50 dB</td>
<td><img src="image" alt="House plan" /></td>
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<tr>
<td>Time</td>
<td>7.30 am</td>
<td>7.35 am</td>
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<tr>
<td>House on an Alley. Measures in dB.</td>
<td>----</td>
<td>67 dB</td>
<td>49 dB</td>
<td>43 dB</td>
<td>42 dB</td>
<td>42 dB</td>
<td>42 dB</td>
<td>50 dB</td>
<td><img src="image" alt="House plan" /></td>
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Figure 6: Sonic Filters of the Medina: Dead ends (Source: author).
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<td></td>
<td>69 dB</td>
<td>63 dB</td>
<td>57 dB</td>
<td>45 dB</td>
<td>43 dB</td>
<td>41 dB</td>
<td>42 dB</td>
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</table>

House on a passage way.
Measures in dB

and ways of constructing towards sustainable buildings with local resources and according to international standards? We should take advantage of our valuable heritage: the future of the acoustic design might be in tradition, history and ways of building.

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