Road traffic noise levels, restrictions and annoyance in Greater Cairo, Egypt

S.A. Ali*, A. Tamura

Department of Architecture, Faculty of Engineering, Yokohama National University, 79-5 Tokiwadai, Hodogaya-Ku, Yokohama City, 240-8501 Japan

Received 18 October 2002; received in revised form 3 February 2003; accepted 5 February 2003

Abstract

This study concerns road traffic noise in Greater Cairo, the capital and the largest city in Egypt and the eleventh biggest city in the world. Extensive measurements were carried out in 21 sites in Greater Cairo. Restrictions were introduced to improve environmental conditions including: (i) a ban on horns, (ii) a ban on horns and trucks, (iii) a ban on horns, trucks and noisy buses. Equivalent noise levels ($L_{Aeq}$) were measured before and after these restrictions. The equivalent noise level was considerably reduced by the bans. This shows that the town planner can use various strategies to change the traffic composition in order to achieve quieter city environments. The degree of annoyance was measured by means of questionnaire. The results showed that there was a strong relationship between road traffic noise levels and the percentage of highly annoyed respondents.

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Keywords: Road traffic noise; Restrictions; Annoyance

1. Introduction

Road traffic is the most significant source of noise in the city. Road traffic noise problems arose in Greater Cairo in 1970's due to population increase stemming from accelerated growth, internal immigration, and the increasing number of vehicles, which pour into and add to the already overcrowded streets [1,2]. In 1996 Greater Cairo was estimated to have a population of 18 million. An additional two million workers flow into the city from surrounding area daily, clogging roads and
rail lines every morning and evening [3]. So there are traffic jams and traffic noise problems. The Greater Cairo metropolitan area is spread across three administrative authorities; Cairo, Al Qalyobiyah, and Jizah. Recently the urban blocks of three administrative authorities have joined together and become one block. Many areas contain activities such as commercial, administrative, tourist center, cultural institutions, business establishments, governmental offices, universities, and hotels, which together create a dense pattern of constant activity. So the roads are too crowded and there are traffic jams everywhere. Old Cairo has a very high density of population, about 150 000 person/km$^2$ [1].

2. Road traffic noise measurements

Extensive road traffic noise measurements have been carried out recently by the authors at 21 sites covering different types of roads with different width, number of vehicles/hour, and speed. Details of the noise measurements, recording procedures and site selection have been published previously [4].

Day–night road traffic noise levels $L_{dn}$ have been calculated for all of the 21 sites as follows:

\[
L_{dn} = 10 \log_{10} \frac{1}{24} \left( 15 \left( 10^{L_d/10} \right) + 9 \left( 10^{L_n + 10/10} \right) \right) \quad [5]
\]

where $L_d$ and $L_n$ represent the daytime and night-time average sound levels, respectively.

The daytime period runs from 07:00 to 22:00 and the night-time period from 22:00 to 07:00, or, more strictly, for a midnight-to-midnight measurement, from 0:00 to 07:00 and from 22:00 to 24:00. Table 1 indicates day–night road traffic noise levels $L_{dn}$ [dB] at 21 sites in Greater Cairo during the period of measurement last year.

<table>
<thead>
<tr>
<th>Area</th>
<th>Road no. 1$^a$</th>
<th>Road no. 2$^b$</th>
<th>Road no. 3$^c$</th>
<th>Road no. 4$^d$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$L_{dn}$ (dB)</td>
<td>$L_{dn}$ (dB)</td>
<td>$L_{dn}$ (dB)</td>
<td>$L_{dn}$ (dB)</td>
</tr>
<tr>
<td>Centre of the city</td>
<td>–</td>
<td>85.3</td>
<td>75.8</td>
<td>70.6</td>
</tr>
<tr>
<td>Naser City</td>
<td>87</td>
<td>86.4</td>
<td>74.6</td>
<td>68.2</td>
</tr>
<tr>
<td>El-Ahram</td>
<td>86.8</td>
<td>81.4</td>
<td>72.4</td>
<td>66.6</td>
</tr>
<tr>
<td>Hulwan</td>
<td>85.2</td>
<td>79.5</td>
<td>71.2</td>
<td>65.7</td>
</tr>
<tr>
<td>Garden City</td>
<td>–</td>
<td>79.9</td>
<td>73.2</td>
<td>64.2</td>
</tr>
<tr>
<td>Old Cairo</td>
<td>–</td>
<td>81.8</td>
<td>73.9</td>
<td>64.5</td>
</tr>
</tbody>
</table>

$^a$ Road No. 1 with width 30–40 m, six lanes or more, more than 10 000 vehicles during rush hours [6].

$^b$ Road No. 2 with width 24–30 m, four to six lanes, more than 5000 vehicles during rush hours.

$^c$ Road No. 3 with width 20–24 m, four lanes, more than 3000 vehicles during rush hours.

$^d$ Road No. 4 with width 12–16 m, two lanes, more than 1000 vehicles during rush hours.
3. Restrictions

Restrictions were introduced to improve environmental conditions including: (i) a ban on horns, (ii) a ban on horns and trucks, (iii) a ban on horns, trucks and noisy buses. The equivalent noise level ($L_{Aeq}$) before and after restrictions was measured in various types of sites, including a downtown area, an industrial area, a tourism area, and a residential area. A brief description of each site is given below.

3.1. Downtown area

Two sites were selected to represent downtown areas. The first was along Ramsis Street, a one-way street, 25 m wide, with its inside lane carrying 1200 vehicles during the peak hour. It is a main shopping street with heavy pedestrian movement served by two sidewalks on either of the road, each 3.5 m wide. The second site was chosen at El-Attaba Square, which is the intersection of two-way major roads of width 25 m, each of them accommodating 1000 vehicles an hour on the inside lane during the peak traffic hour, a mixture of taxis, private cars, bikes, minibuses, buses and a few trucks. It is a main shopping area with heavy pedestrian movement served by two sidewalks on either side of the road, each 4 m wide.

3.2. Tourism area

The site chosen to represent the tourism land use is the El-Haram area in the south west of Greater Cairo city. The location for field measurement was along El-Haram Street. The road is a multi-lane divided Arterial two-way street, 40 m wide, accommodating 800 vehicles an hour on the inside lane during the peak traffic hour, of which 30 per cent are trucks and buses.

3.3. Industrial area

The site chosen to represent industrial land use is located in Hulwan a major industrial suburb to the south east of Greater Cairo. The location for field measurement was along Hulwan Street. The road is multi-lane divided highway, 25 m wide, accommodating 550 vehicles an hour on the inside lane during the peak traffic hour, of which 40 per cent are trucks, truck/trailer combination and pick-up trucks.

3.4. Residential area

Two sites were selected to represent residential land use. The first was located along Sallah Salm Street, a two-way main arterial road, 55 m wide, separated by a green island 15 m wide. Pedestrian movement is served by two sidewalks on either side of the road, each 5 m wide. It connects the collector roads from the city and other arterial roads with the main highway located outside Greater Cairo. The traffic flowing along the road is mixture of private cars, taxis, minibuses, buses and a few trucks, reaching 1500 vehicles an hour on the inside lane during the peak traffic
hour. The second location selected was Dokki square. It is the intersection of two arterial roads; El-Tahrir Street with width 25 m, El-Dokki Street with width 25 m. The pedestrian movement is served by two sidewalks on either of the road, each 4 m wide. The roads accommodate 900 vehicles an hour on the inside lane during the peak traffic hour. The traffic includes a mixture of taxis, privates, bikes, and buses.

4. Results of restrictions

Results of restrictions are shown in Table 2. During the ban on horns, the equivalent noise level decreased at all sites. The maximum reductions of 9.4 dB and 10.8 dB occurred in the downtown areas, Ramsis Street and El-Attaba Square, respectively, where there are no buses or commercial vehicles. With larger sidewalks, pedestrians will not walk in the street and motorists will not abuse their horns.

A considerable decrease of 4.8 dB in the equivalent noise level was achieved in Hulwan Street, the industrial area, during the measurements when the horns were banned, and a greater decrease of 7.6 dB was achieved during a ban on horns together with limiting the commercial vehicles to 10%.

Banning buses from residential areas gave a further reduction in the equivalent noise level varying between 2.6 and 3.7 dB at Sallah Salm and Dokki Square, respectively. The reduction is mainly dependent upon the number of these buses presently in operation at each site.

During a ban on horns, trucks and noisy buses, the equivalent noise level decreased at Sallah Salm and Dokki Square in residential area between 6.0 and 10.2 dB. So restrictions such as a ban on horns, trucks, noisy buses and a limit on the commercial vehicles can decrease traffic noise level in the city significantly.

4.1. Social survey

The subjective response to road traffic noise was measured by means of a social survey. The survey was carried out simultaneously with road traffic noise measurements at

<table>
<thead>
<tr>
<th>Case study</th>
<th>Residential area</th>
<th>Downtown area</th>
<th>Industrial area</th>
<th>Tourism area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sallah Salm</td>
<td>Dokki Square</td>
<td>Ramsis Street</td>
<td>El-Attaba Square</td>
</tr>
<tr>
<td>Without restrictions</td>
<td>87.9</td>
<td>87.1</td>
<td>84.9</td>
<td>87.8</td>
</tr>
<tr>
<td>During ban on horns</td>
<td>85.2</td>
<td>80.7</td>
<td>75.5</td>
<td>77.0</td>
</tr>
<tr>
<td>During ban on horns together with limiting the commercial vehicles to 10%</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>During ban on horns and trucks</td>
<td>84.5</td>
<td>80.6</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>During ban on horns, trucks and noisy buses</td>
<td>81.9</td>
<td>76.9</td>
<td>–</td>
<td>–</td>
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</tbody>
</table>
the same sites (21 sites represented six different areas), and it was performed in order to investigate the individual's attitude to road traffic noise the city. The investigation was carried out by using the traditional techniques generally applied in studies of this kind. The questionnaire contained the usual questions on noise nuisance. The survey was introduced openly as road traffic noise survey when the questionnaires were given to the respondents.

The people to be interviewed resided on roadside where the road traffic level measurements were carried out. Consequently, it can be assumed that all of them were exposed to the same noise levels as measured in the road traffic noise survey. Questionnaires were distributed by hand. The respondents completed the questionnaire themselves. A total of 1000 questionnaires were distributed. The distributors returned later to collect the completed questionnaires. Some questionnaires were returned through the post office to our address. A total of 837 questionnaires were finally collected (139 Center of City, 143 Naser City, 145 El-Haram area, 141 Hulwan area, 134 Garden City, 135 Old Cairo).

5. Results of social survey

The respondents were male (62%), female (38%). The ages of interviewed people exhibit a wide range: 20–30 years (17%), 30–40 years (23%), 40–50 years (27%), 50–60 years (15%) and older than 60 (18%). 95.3% respondents heard road traffic noise. 81.7% of respondents were annoyed by road traffic noise. The type of vehicles that produce most noise annoyance was identified as “buses and heavy vehicles” by the respondents in all zones. It is interesting to stress that buses and heavy vehicles are the most bothersome vehicles for all age groups (37.5%).

Attitudes to road traffic noise were elicited by means of a five point semantic scale. About 53.5% of the interviewed people declared to be “highly annoyed”, 11.8% “rather annoyed”, 7.3% “moderately annoyed”, 9.1% “little annoyed”, 13.6% “not annoyed at all” and 4.7% had not heard noise. In this study we concentrated on analyses of the percentage of respondents who were “highly annoyed” to study relationship between road traffic noise levels and annoyance. Table 3 indicates percentage of respondents feeling “highly annoyed” in the Greater Cairo area. This

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentage of respondents feeling “highly annoyed”</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Road no. 1</td>
</tr>
<tr>
<td>Center of city</td>
<td>–</td>
</tr>
<tr>
<td>Naser city</td>
<td>88.6</td>
</tr>
<tr>
<td>El-Haram</td>
<td>86.1</td>
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<tr>
<td>Hulwan area</td>
<td>78.8</td>
</tr>
<tr>
<td>Garden City</td>
<td>–</td>
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<tr>
<td>Old Cairo</td>
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feeling appeared strongest in the most crowded activity areas (Center of city and Naser city and in roadside of major roads (roads No. 1 and No. 2).

6. Relationship between levels and annoyance

The relationship between the road traffic noise levels $L_{dn}$ shown in Table 1 and the percentage of respondents feeling “highly annoyed” shown in Table 3 has been investigated. Results are shown in Fig. 1. There is a strong relationship between road traffic noise levels in $L_{dn}$ and the percentage of respondents feeling “highly annoyed”. By increasing road traffic noise levels, the percentage of the respondents that feeling highly annoyed was also increased.

7. Comparison annoyance in Cairo with annoyance in other surveys

Fig. 2 indicates comparison of annoyance in Greater Cairo with annoyance in other surveys in relation to noise levels ($L_{dn}$) as Schultz study, (included 11 surveys, in London Street, Paris Street, U.S Street, Swiss road, and others) and in Pamplona, Spain [7,8]. Greater Cairo is a big city, 20 million residences and 11th biggest city in the world, so annoyance is a little higher than annoyance in other cities. In general the annoyance found in Greater Cairo agrees with annoyance in other surveys carried out in other countries.

There is a strong relationship between road traffic noise level and the percentage of respondents feeling “highly annoyed”. By increasing road traffic noise levels, the percentage of respondents feeling “highly annoyed” is also increased.

8. Concluding remarks

Recent measurements of road traffic noise levels in Greater Cairo indicate that noise levels in the city are higher than those set by Egyptian noise standards and policy to protect public health and welfare in residential areas ($L_{Aeq}=80 \text{ dB}$ and higher were recorded, while maximum permissible level is $65 \text{ dB}$) [9].

Restrictions were introduced to improve environmental conditions including (i) a ban on horns, (ii) a ban on horns and trucks, (iii) a ban on horns, trucks and noisy buses. The equivalent noise levels ($L_{Aeq}$) were measured before and after these restrictions. The results of this study showed that:

- During a ban on horns, the equivalent noise level decreased at all sites. The maximum reductions of 9.4 dB and 10.8 dB occurred in the downtown area, where there are no buses or commercial vehicles. With larger sidewalks, pedestrians will not walk in the street and motorists will not abuse their horns.
- A considerable decrease of 7.6 dB was achieved during a ban on horns together with limiting the commercial vehicles to 10%.
During a ban on horns, trucks and noisy buses, the equivalent noise level decreased in the residential areas between 6.0 and 10.2 dB. So restrictions such as a ban on horns, trucks, noisy buses and a limit on the commercial vehicles can decrease traffic noise level in the city significantly.

This shows that the town planner can use various strategies including changing the traffic composition in order to achieve quieter city environments.

Fig. 1. Relationship between road traffic noise levels in $L_{dn}$ and percentage of respondents that feel “highly annoyed” in Greater Cairo, Egypt.
The results of social survey showed that most residents consider road traffic noise as an environmental nuisance (72.6%) of all respondents feeling highly or moderately disturbed by it, 53.5% of respondents were highly irritated. This feeling appeared strongest in the most crowded activity areas and alongside of major roads.

Fig. 2. Comparison of annoyance in Cairo with annoyance found in other studies including the Schultz study (in London Street, Paris Street, US Street, Swiss road, and others) and in Pamplona, Spain.

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Acknowledgements

The authors are grateful to Yokohama National University, for supplying us with a precision sound level meter type Ono Sokki LA-5120, and digital printer, type Ono Sokki RO-110. This study was financially supported by The Egyptian Ministry of Higher Education.

References