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Research Article

CITY CENTER NOISE LEVELS, ANNOYANCE AND CONTROL IN ASSIUT CITY, EGYPT

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ABSTRACT
Assiut is the largest city in Upper Egypt and lies about 234 miles south of Cairo. The goals of this study are to carry out measurements to evaluate noise levels in center of Assiut city (commercial, administrative and city center areas), are these levels exceeded permissible levels set by Egyptian noise standard and policy to protect public health and welfare?, to carry out experiments for reducing noise levels, to examiner respondent's attitudes towards noise, to know relationship between city center noise levels and degree of annoyance. Results of measurements showed that L_{dn} varied from 82.7 dB to 96.8 dB. Experiments were carried out for reducing noise levels in cases of absence of road traffic noise, railway noise, and loud speaker noise. Results of experiments showed that noise level was reduced by 14.2 dB in case of absence of road traffic noise. Noise level was reduced by 12.3 dB in absence of railway noise. Noise was reduced by 11.6 dB in case of absence of loud speaker noise. This shows that town planner can use various strategies to achieve quieter city center environments. Annoyance of respondents showed that 43.6 % were highly annoyed. There was a strong relationship between city center noise levels and percentage of highly annoyed respondents.

Keywords: *City Center Noise Levels, Annoyance, Control, Assiut, Egypt*

INTRODUCTION
Depending on noise duration and volume, the effects of noise on human health and comfort are divided into four categories; physical effects, such as hearing defects; physiological effects, such as increased blood pressure, irregularity of heart rhythms and ulcers; psychological effects, such as disorders, sleeplessness and going to sleep late, irritability and stress; and finally effects on work performance, such as reduction of productivity and misunderstanding what is heard (Ahrlin, 1998; Schultz, 1978). There no literature reviews about city center noise and its affects in Egypt. Other studies were carried out about relationship between noise sensitivity and reaction to noise and other environmental conditions (Miedema, 2004; Miedema and Vos, 1998).
City center area in Assiut city (commercial, administrative and city center areas) is about nine kilometers square. It is obvious clear that city center noise in Assiut city causes much nuisance to inhabitants. They have headache, increasing their blood pressure, cannot relax, and try to sleep, or concentrate in their activities. In 2006 Assiut was estimated to have populations of three million (Fidell and Teffeteller, 1976).
Daily approximately hundred thousand populations go to the center of city, clogging roads and rail lines. So there are traffic jam and traffic noise problems. It contains dense pattern of constant activity as commercial, administrative, business establishments, governmental offices, hotels, and residential which together create a dense pattern of constant activity; there are concentrations of shops, markets, and clustered buildings with high population and traffic volume. Noise emits from road traffic (due to bad engine and using horn), railway and loud speakers (major noise source due to continuous music, announcements and advertising) are too high. Intrusive noise sources include noise from record players, loud speakers, hawking and human conversation contribute majority to city center noise. All these are responsible for high noise exposure levels. City center noise disturbs many activities and it is an urgent problem in Assiut. The purpose of this study are: (1) to carry out measurements to evaluate city center noise levels, are these levels exceeded the permissible levels set by Egyptian noise standard and policy to protect public health and welfare, (2) to carry out experiments for reducing city center noise levels, (3) to

examine respondent's attitudes towards noise, and (4) to know relationship between city center noise levels and degree of annoyance.

MATERIALS AND METHODS

Methods

Locations Investigation Areas

Locations investigation areas were taken in 10 sites represent different kinds of shops in center of Assiut city. Criteria for classified shops are numbers of customers and types of service, characteristics of every type of shop and its area (big shops are more than 1000 m^2, medium shops are more than 500 m^2 – 1000 m^2, small shops are less than 500 m^2). Three locations were measured in of the biggest shops: as (Omer Afandy, Sednawy, and Shekorl shops). Three locations were measured in medium shops: as (Torkey, Dar El Rada, and Frgany shops). Four locations were measured in small shops as (Aday, Meged, Salam, and Oroba shops).

Description of Measured Points

Measured points are shown in Figure 1.

- Point No. 1 Aday shop: located in Sabet Street. This street has medium traffic, many commercial shops, private offices, restaurant, banks, hotels, and clinics. It connects 26 July road with 23 July road.
- Point No.2 Oroba shop: located in Helaly Street. This street has medium traffic, many commercial shops, private offices, restaurant, hotels, and clinics. It connects train station square with Nile river road (Cornish road).
- Point No. 3 Shekorl shop: located in intersection of 23 July road with Sabet Street. This intersection has crowded traffic, commercial shops, private offices, clinics, and restaurant.
- Point No. 4 Torkey shop: located in intersection of Raghieb road with Thora Street. This intersection has crowded traffic, commercial shops, private offices, clinics and school.
- Point No. 5 Dar El Rada shop: located in intersection of Raghieb road with Post Office Street. This intersection has very crowded traffic, commercial shops, private offices, and clinics.
- Point No. 6 Omer Afandy: located in intersection of 26 July road with Banks street. This intersection has very crowded traffic, commercial shops, private offices, banks, and hotels.
- Point No.7 Sednawy shop: located in intersection of 23 July road with Geish road. This intersection has very crowded traffic, commercial shops, clinics, and private offices.
- Point No. 8 Meged shop: located in intersection of Galaa road with Gomhoria road. This intersection has very crowded traffic, commercial shops, restaurant, private offices, and clinics.
- Point No.9 Salam shop: located in intersection of 23 July road with Geish road. This intersection has very crowded traffic, commercial shops, private and public offices.
- Point No. 10 Frgany shop: located in railway station square. This square has very crowded traffic, commercial shops, restaurant, private offices, and clinics. Figure 1 shows location investigation areas.

Figure 1: Location investigation areas

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Field Measurements

Noise measurements were carried out at locations investigation areas at center of Assiut city from7 am to 22pm (day time) and from 22 pm to 7am (night time). The Sound exposure level was measured automatically by a precision integration sound level meter Bruel & Kjaer type 2230. The noise level meter was positioned at a height of 1.2 m above the floor at least 1 m from all reflecting surfaces. The relative humidity and temperature at the sites varied from 50 % to 60 % and 20° to 30° C, respectively, at the time of measurements. Measurements were carried out in April 2013 (Licitra and Brambilla, 2012).

Social Survey

The subjective response to city center noise was measured by means of a social survey (Schultz, 1978; Schultz, 1982). The respondents were in shops at each location of noise measurement. Criteria of selecting respondents were to represent men and women, literatures and illiterates respondents, every type of educations of respondents. The survey was carried out simultaneously (same year, month, day, hours) with measurements and at the same sites. The goals of the social survey are to examine respondent's attitudes towards noise and to determine the relationship between noise levels and degree of annoyance. The questionnaire contained questions about demographic data, educational level, sources of noise, annoyance, influence of noise on activities, psychological and physiological effect, sleep disturbances and reactions against noise; whether agencies should control city center noise. The questionnaire was distributed by hand. The respondents completed the questionnaire themselves. A total of more than 300 questionnaires were distributed (30 questionnaires in every site) and 186 questionnaires were collected: (with average 19 respondents at every site).

Results of Measurements

Measurements were carried out from 7: 00 am to 7: 00 am of the next day. Levels were measured each 10 min in mentioned time.

$L_{Aeq\ 7–22}$ (day time) and $L_{Aeq\ 22\text{-}7}$ (night time) was calculated for the 10 different sites by using the following equations:-

$$L_{Aeq\ 7\text{-}22} = 10 \log_{10} 1/n \left(\sum_{i=1}^{n} 10^{LAeqi/10} \right) \text{(Schultz, 1982). (n of this period) (1)}$$

$$L_{n\ 22\text{-}7} = 10 \log_{10} 1/n \left(\sum_{i=1}^{n} 10^{LAeqi/10+10} \right) \text{(Schultz, 1982). (n of this period) (2)}$$

Where, *n* is the number of 10 min measurements of every period.

Day – night noise levels L_{dn} have been calculated for all the sites from the formula: -

$$L_{dn} = 10 \log_{10} 1/24 \left(15 \left(10^{Ld/10}\right) + 9 \left(10^{(Ln+10)/10}\right)\right) \text{(Schultz, 1982). (3)}$$

Where L_{Aeq} and L_n represent the daytime and night – time average sound levels, respectively.

Results showed that some L_n were higher than 80 dB (A). Figure 2 shows measured city center noise levels for selected sites at night time.

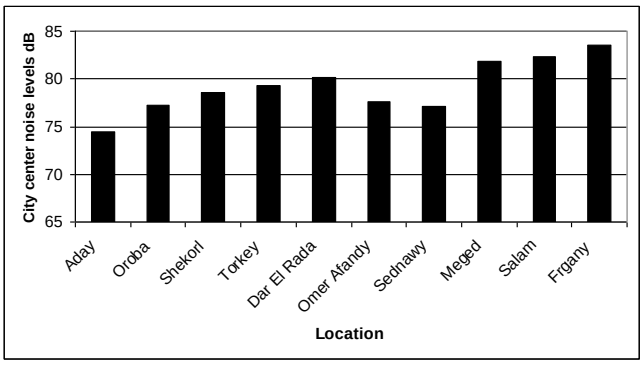

Figure 2: Shows measured city center noise levels for selected sites at night time L_n

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Results showed that some L_{dn} were higher than 90 dB (A). Figure 3 shows measured city center noise levels for selected sites at day and night time. The noise levels of Assiut are similar to those reported for other cities around the world in Jordan, Spain, Brazil, Greece, and India (Georgiadou *et al.*, 2004; Ahamad *et al.*, 2006; Panadya, 2003; Zannin *et al.*, 2002).

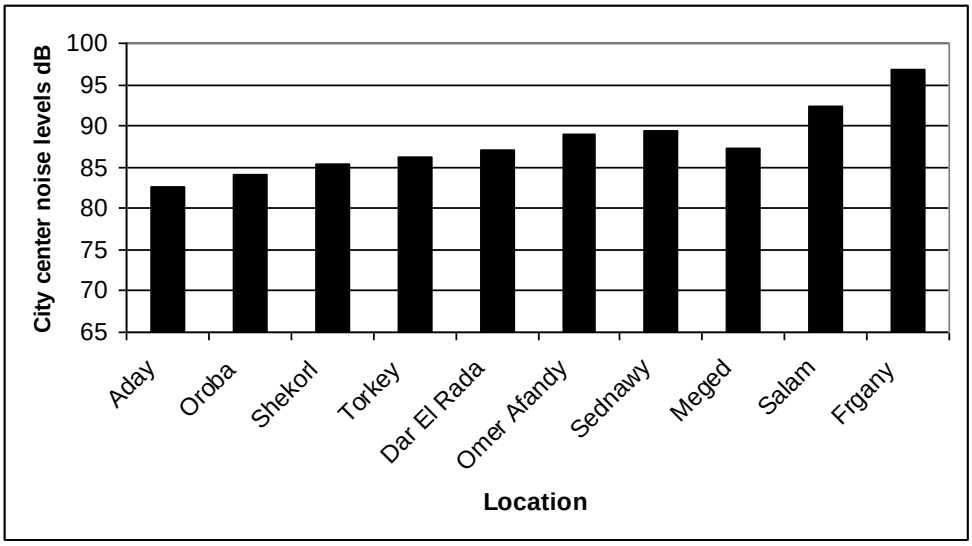


Figure 3: Shows measured city center noise levels for selected sites at day and night time L_{dn}

Maximum Noise Levels Permitted by Egyptian Law

As shown in table 1, the maximum permissible noise level for center of the city (commercial, administrative and city center areas) to protect public health of inhabitant is 65 dB [*Egyptian environmental law No. 4 of year 1994*] while the measured noise level were ranged between 82.7 dB to 96.8 dB. Ln is ranged from 72.4 to 83.6 dB while maxim level is ranged from 45 to 55 dB. Table 1 indicates the maximum noise levels permitted by Egyptian law for different land use areas [*Egyptian environmental law No. 4 of year 1994*].

Table 1: Range of permissible noise levels (L_{Aeq} dB) for different land use areas (Ahamad, 2006**)**

Type of area	**Range of permissible noise levels (L_{Aeq} dB) for different land use areas**					
	Day		**Evening**		**Night**	
	From	**To**	**From**	**To**	**From**	**To**
Commercial, administrative and city center areas	55	65	50	60	45	55
Residential areas with some workshops or commercial establishments or located on a main road	50	60	45	55	40	50
Residential areas in the city	45	55	40	50	35	45
Residential suburbs and educational area with low traffic	40	50	35	45	30	40
Residential rural areas, hospitals and gardens	35	45	30	40	25	35
School areas (heavy industries)	60	70	55	65	50	60

Day from 7 a.m to 6 p.m, evening from 6 p.m to 10 p.m, night from 10 p.m to 7 a.m

Experiments

By studying characteristics of city center noise in Assiut, we assumed that noise levels were too high due to many reasons as: (i) noise emits from road traffic, (ii) noise emits from railway, (iii) noise emits from loud speakers. Experiments were carried out in May 2013. The aims of this experiment are to evaluate how many are the reduction of noise level when carrying out every type of restriction. How the town planner can use various strategies to achieve quieter city center environments.

L_{dn} was measured without restrictions and repeated next day with restrictions. Descriptions of carrying out restrictions were as follows:

- To study effect in absence of noise emits from road traffic. Experiments were carried out at arterial and collector roads at 26 July road, Ragheib road, and 23 July road. Roads are with different characteristics of traffic composition (the most crowded roads in city center). Measurement point was very close to a busy road but far away from the loudspeakers and railway line. First day measurements were carried out without any restrictions. Next day at the same time and same places, with help of traffic administration measurements were carried out with absence of traffic road.
- To study effect in absence of noise emits from railway. First day measurements were carried out without any restrictions. Next day at the same time and same places, measurements were carried out in case of no trains pass on railway at time measurements beside railway. Measurements were carried out at Galaa road and Geish road (located beside railway).

To study effect in absence of noise emits from loud speakers. First day measurements were carried out without any restrictions.

Next day at the same time and same places, with help of city hall, measurements were carried out in case of no noise emits from loud speakers. Measurements were carried out at Sabet Street, Helaly Street, and Ragheib Street (the loudest speaker's streets).

Results of Restrictions

Results of restrictions to improve environmental conditions found that, in case of absence of road traffic noise, maximum reductions L_{dn} were 14.2 dB as shown in table 2. In case of absence of railway noise, maximum reductions L_{dn} were 12.3 dB as shown in table 3. Noise levels were reduced by 11.6 dB in case of absence of loud speaker noise as shown in table 4.

Table 2: Absence of road traffic noise

No.	Name of location	Restrictions of road traffic noise	
		Levels before restrictions	Levels after restrictions
1	26 July road	96.8 dB	82.6 dB
2	Ragheib road	88.9 dB	76.2 dB
3	23 July road	85.3 dB	75.1 dB

Table 3: Absence of railway noise

No.	Name of school	Restrictions of railway noise	
		Levels before restrictions	Levels after restrictions
1	Salam shop	92.4 dB	80.1 dB
2	Sednawy shop	89.5 dB	79.3 dB
3	Meged	87.3 dB	78.4 dB

Table 4: Absence of loud speaker noise

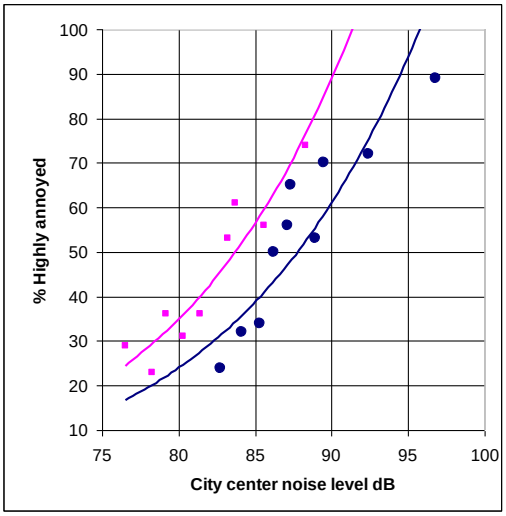
No.	Name of location	Restrictions of speaker noise	
		Levels before restrictions	Levels after restrictions
1	Sabet street	85.3	75.7
2	Helaly street	84.1	74.5
3	Makarem street	89.5	77.9

Results of Social Survey

The majority of the respondents were male 67 % and 33 % were female. The ages of interviewed people exhibit a wide range: 24 % were 20 – 30 years, 36 % were 30 – 40 years, 21 % were 40 – 50 years, 13 % were 50 – 60 years, and 6 % more than 60 years old. 8 % were illiterate, 24 % were educated in up to prep schools, 47 % in intermediate schools (technical schools), and 21 % in higher education (universities).

68 % of respondents were annoyed by city center noise, the rest said that they are not annoyed because they consider that is the consequence of that area in the city and they must be patient related that matter. Attitudes to city center noise were elicited by means of a five step semantic scale. 43 % of the respondents declared themselves to be "highly annoyed", 14 % "rather annoyed", 8 % "moderately annoyed", 3 % "little annoyed", the rest "not annoyed".

By assuming that noise level at one point is valid to noise exposure of the respondents in an investigation area. Figure 4 shows comparison between city center noise levels, annoyance in Assiut city, Egypt and other countries (Jordan, Spain, Brazil, Greece, and India) there was strong Relationship between city center noise levels and percentage of respondents who felt highly annoyed (Ahmed, 2013; Yvonne, 2013). The percentage of respondents who were highly annoyed increased with increasing city center noise levels.



___ Egypt
___ Other countries (Jordan, Spain, Brazil, Greece, and India)

Figure 4: Comparison between City center noise levels, annoyance in Assiut city, Egypt and other countries (Jordan, Spain, Brazil, Greece, and India)

Road traffic noise was the most annoying sources of noise due to using horn, traffic jam and crowded roads with pedestrians, 79 % of respondent declared that. Loud speakers were the second noise due to distribution of loud speakers in city center, 55 % of respondent declared that. 45 % of respondent declared that railway noise the third noise sources.

Function of City Center Noise Exposure

53 % of respondents said that city center noise interfered with their activities. 41% of them said that city center noise interfered with their conversation, 27 % poor of performance, 18 % Negative of perceptions. It noticed that interference with activities depends on the city center noise levels.

Related psychological and physiological effects of city center noise. Figure 5 illustrates % of respondents that felt noise disturbs their peace of mind at different levels. Noise disturbs peace of mind was increased with increasing noise level. 47 % of respondents contended that city center noise "disturb their peace of

mind". 36 % of them said that it "makes sleep disturbance". 31 % of them said that it "makes them angry / upset".

Related physiological effects were considered significant. 5.8 % of respondents stated that it "harms their hearing". 27 % stated that it "gives them headaches". Figure 6 indicates % of respondents that felt noise gives their headache at different levels. Headaches increase with increasing noise level. Table 5 shows that for psychological and Physiological. Related sleep disturbances 68 % of respondents said that city center noise disturbs their sleeping especially at after noon and at night time.

Table 5: Psychological and physiological effects of city center noise

Percentage of respondents reporting specific types of disturbance from city center noise				
Psychological			**Physiological**	
Disturbs their peace of mind	**Sleep disturbance**	**Make them angry / upset**	**Harms their hearing**	**Gives them headaches**
47	36	31	5.8	27

Respondents were asked "should city center noise be legally controlled?" Table 6 shows that 87 % of respondents said that city center noise should be legally controlled. 2 % of respondents said that noise should not be legally controlled. 5% of respondents said that it doesn't matter (in different) to city center noise control. In response to "what agency do you think should control city center noise? 12 % of respondents wanted local government to control city center noise. 79 % of respondents wanted ministry of environment. 6 % of respondents wanted any agency as national or international agencies to control city center noise.

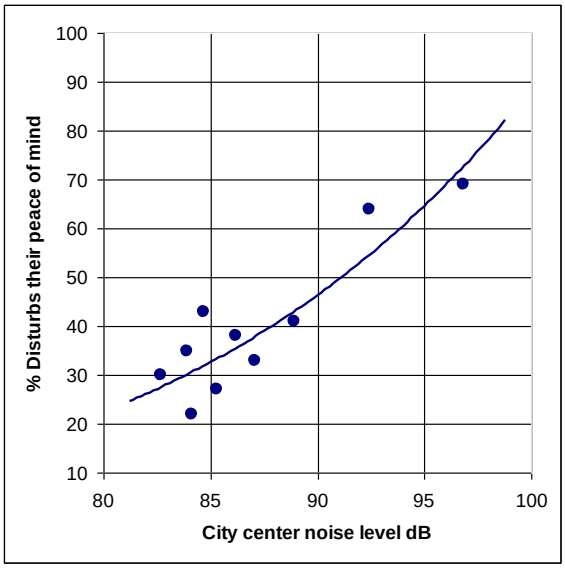


Figure 5: % of respondents that felt noise disturbs their peace of mind

Table 6: Should City center noise be legally controlled? and "what agency do you think should oblige?

Percentage of respondents that felt					
In-different to noise control	**Noise should not be controlled**	**Noise should be controlled**	**The agency that should oblige owner to control City center noise**		
			LG	**MV**	**AN**

5	2	87	12	79	6

LG – local government; MV – Egyptian Ministry of Environment; AN – any agency

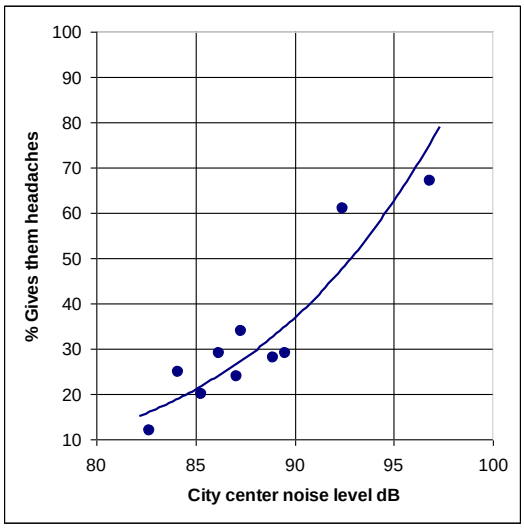


Figure 6: % of respondents that felt noise gives them headaches

About reactions against city center noise, Figure 7 illustrates the reactions of respondents against city center noise. 41 % of respondents said that they like to complain to responsible authorities. 23 % of respondents said that they like city center to move to a quieter area. 17 % of respondents said that they like city center building sound-insulated.

Respondents suggest countermeasures for noise source are by: (1) Changing road traffic of roads with pedestrians only. (2) Forbidden using record players, loud speakers, and hawking in city center. (3) Railway must put underground in tunnel especially inside city center, or change its pass to be outside the city.

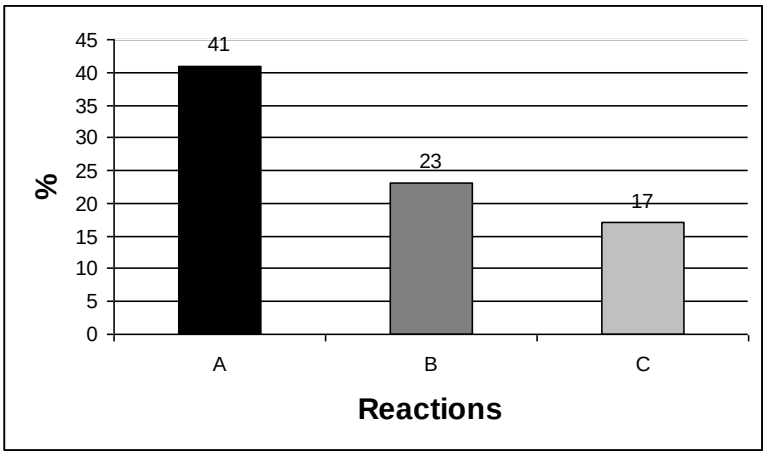


Figure 7: Reactions of respondents against city center noise: (A) 41% like to complain to responsible authorities; (B) 23 % like city center to move to a quieter area; (C)17 % like city center building sound- insulated

Discussion

- Results of measurements showed that city center noise L_{dn} were higher than 90 dB were recorded. It is found that the most sources of noise were noise emits from road traffic, railway and loud speakers.

- L_n was too high due to road traffic noise, railway noise and shops open up to midnight. City center connects parts of city. Railway station and bus station those connect parts of Egypt find in center of the city.
- The percentage of respondents who were highly annoyed increased with increasing city center noise levels.
- 87 % of respondents said that city center noise should be legally controlled. 79 % of respondents wanted ministry of environment to control city center noise.
- Road traffic noise was the most annoying sources (79 % of respondent). Loud speakers were the second noise (55 % of respondent). Railway noise was the third noise (45 % of respondent declared that).
- In absence of road traffic noise, maximum reductions L_{dn} were 14.2 dB, this due to absence of traffic, using horn and traffic jam. So it is recommended to change road traffic of roads with pedestrians only in city center.
- In absence of railway noise, maximum reductions L_{dn} were 12.3 dB so must build high barriers beside railway, or change its pass to be outside the city or put it in tunnel.
- Noise levels were reduced by 11.6 dB in case of absence of loud speaker noise. So it is recommended forbidden to use record players and loud speakers in city center. This shows that town planner can use various strategies to achieve quieter city center environments.

Conclusion and Remarks

- Effects of noise on human health and comfort are too bad on physical effects (hearing defects); physiological effects (increased blood pressure, irregularity of heart rhythms and ulcers); psychological effects (disorders, irritability and stress); and finally effects on work performance (reduction of productivity and misunderstanding what is heard).
- Sources of noise in center of Assiut city were noise emits from road traffic, railway and loud speakers. Intrusive noise sources include noise from record players, loud speakers, hawking and human conversation contribute majority to city center noise.
- Measurements showed that City center noise L_{dn} were higher than 90 dB were recorded.
- L_n was too high due to road traffic noise, railway noise and shops open up to midnight.
- Results of social survey showed that 43 % of the respondents declared themselves to be “highly annoyed”. By increasing noise levels the percentage of respondents who were highly annoyed were also increased. 53 % of respondents said that city center noise interfered with their activities.

41% of respondents said that city center noise interfered with their conversation. Related psychological effects 47 % of respondents contended that city center noise "disturb their peace of mind". Noise disturbs peace of mind was increased with increasing noise level. 31 % of them said that it "makes them angry / upset". Related physiological effects 27 % of respondents stated that noise "gives them headaches". Headaches increase with increasing noise level.

- Road traffic noise was the most annoying sources (79 % of respondent). Loud speakers were the second noise (55 % of respondent). Railway noise was the third noise (45 % of respondent declared that).
- Results of restrictions to improve environmental conditions in center of Assiut city found that, in case of absence of road traffic noise, maximum reductions L_{dn} were 14.2 dB.

In case of absence of railway noise, maximum reductions L_{dn} were 12.3 dB. Noise levels were reduced by 11.6 dB in case of absence of loud speaker noise. This shows that town planner can use various strategies to achieve quieter city center environments.

- Respondents suggest countermeasures for noise source are by: (1) Changing road traffic of roads with pedestrians only. (2) Forbidden using record players, loud speakers, and hawking in city center. (3) Railway must put underground in tunnel especially inside city center, or change its pass to be outside the city.

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