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ASSESSMENT OF THE NOISE QUALITY EFFECTS OF PEDESTRIANIZATION ON TEHRAN'S HISTORIC CITY CENTER AND ITS SUSTAINABLE DEVELOPMENT

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Abstract

The built environment and consequently vehicular transport has a significant impact on public health and environmental quality. Also vehicular transport as an impact of built environment is one of the most important source for environmental decay such as noise pollution in city centers. So, one of the transport schemes like pedestrianization can have a significant impact on environmental quality and improve noise pollution condition. This paper shows, to what extent the built environment and implementation of pedetrianization scheme has influence on reducing noise pollution level at Tehran' city center.

The high density land development, land use mix, connected street networks and retail floor area ratio can promote physical activity and decrease emissions of air pollutants. But also increased compactness, can increase traffic congestion and exposure of harmful emissions within central areas and increase noise pollution level. Built environment can reduce trip rates, through three principal dimensions, density, land use diversity and pedestrian-oriented designs and encourage people to non-auto travel which this finally lead to increase walkability and reduce air and noise pollution. Therefore, strategies to promote air quality in city centers are required to enable larger health benefits.

The results of the survey suggest that the implementation of pedestrianisation in Tehran's city center has been very successful; environmental conditions and pedestrian safety have improved considerably. As a result was founded an increase in walkability to be associated with an increase in time spent in physically active travel, fewer vehicle miles traveled, fewer level of noise pollution.

Keywords: Environment quality, Noise pollution, Pedestrianisation scheme, Sustainable development.

Introduction

Pedestrianisation implementation is often at historical and central part of city, it's an often scheme at development countries because of specific city center conditions like; traffic congestion, environmental quality problems, aesthetics aspects and etc. the effects of this scheme are the improvement of accessibility at central area's land use, the separation of vehicular traffic from pedestrian flows, improvement of pollution emissions due to traffic, improvement at visual pollutions specially regarding to historical structures. Within the framework of this paper the attempt is made to shows the impact of built environment and pedestrianisation on the noise quality through comparison of before and after pedestrianisation implementation with regards to streets various typology.

Noise is derived from the Latin word "nausea" implying 'unwanted sound' or 'sound that is loud, un pleasant or unexpected'. The sources of noise are usually from human activities, vehicular transport and industries which this pollution is mostly happen in metropolises. Noise is becoming an increasingly omnipresent, yet unnoticed form of pollution even in developed countries. According to Birgitta and Lindvall (1995), road traffic, jet planes, garbage trucks, construction equipment, manufacturing processes, and lawn mowers are some of the major sources of this unwanted sounds that are routinely broadcasted into the air. Singh, N., & Davar, S. C. (2004)

Pedestrian streets also improve public health through physical activity and active transportation. These schemes help to decrease the number of cars, reduce noise pollution and increase the environmental quality level at city center. Finally these methods can create the sustainable, safe and livable city for its residents.
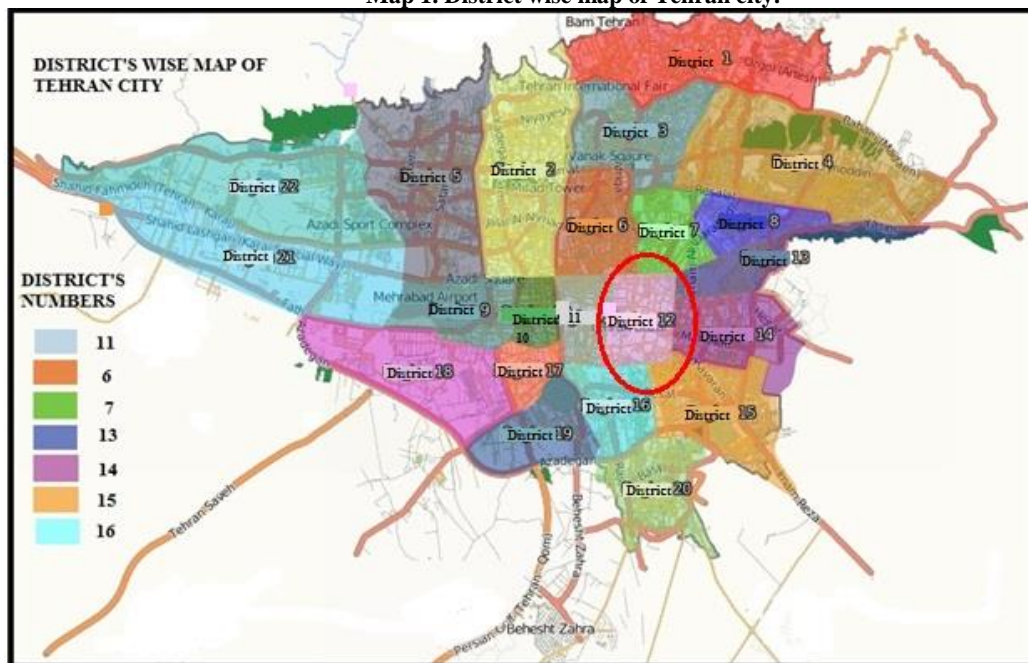
Study Area

The study area is Tehran's city center and oldest core of capital. Tehran city, is consist of 22 municipal districts, with the population of around 9 million. Its climate features a semi-arid climate which is largely defined by its geographic location, with the towering of "Alborz" Mountains at its north direction and the central desert at its south part.

The study area is located in the heart of the capital and within municipal district number 12, with the area of 16.91 (sq.km) also consist of 6 sub districts and 13 Neighborhoods. District 12 is the oldest part and first core of the city that every tourist who come to gain a real understanding of capital has to visit this area. The highest concentration of historical monuments in Tehran is in city center and it's connected to whole directions of capital through subway.

City center is surrounded by seven districts, such as: districts 11, 6, 7, 13, 14, 15 and 16. Also as sample four historical and commercial axes was selected within city center which three of them, "Sepahsalar", "17 shahrivar" and "15 Khordad" streets are pedestrianized axes and at "Laleh zar" street pedestrianisation is not implemented yet. Map 1. Shows the location of district 12 in the middle of its neighbors.

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Map 1. District wise map of Tehran city.

Methodology

This study analyzed the urban noise pollution by using GIS and preparation of interpolation noise map for city center. Noise data were collected at varying intervals; morning, afternoon and evening which 62 centers recognized as critical points with noise pollution above standard limit. These 62 points including of educational centers above standard level, educational centers at critical noise level, hospitals and health clinic centers within district number 12. The spatial distributions of the noise levels during each time interval were evaluated and visualized by geographic information systems. The analytical results indicated that the highest and lowest average noise levels were above 70 dB and 55 dB during summer mornings and winter evenings, respectively. Finally to assessment the pedestrian effectiveness on environmental quality like air and noise quality, the statistical noise pollution interpolation map was prepared through krigging scheme. At next step, the road network map is added to the interpolation results till four sample streets location and their pollutant level be obvious on final maps. Finally existing condition of three implemented streets were comprised with an un-implemented street to show the influence of pedestrianisation scheme toward decreasing noise pollution level.

Study and analysis of noise pollution level within study area

Noise (noise pollution) is cause of neurological diseases, body itching, insomnia, coagulation of blood vessels, heart attack, high blood pressure and other complications. Subsonic sounds (between 12 and 20 Hz) is cause of exhaustion, anesthetics and nausea. In the event that the intensity of these sounds are above 90 decibel is disgusting human balance.

Table 1. Shows the level of noise pollution at different municipal districts of Tehran city. With refer to table districts 1- 7 and 8 are at good condition, districts 2- 3- 4- 5- 6- 17- 21 and 22 are at medium noise level and district are at dangerous condition include of 9– 10– 11– 12– 13– 14– 15– 16– 18– 19- 20, so city center is at weak noise level.

Table 1. Noise level at Tehran's municipal districts.

District	Noise Level
-	Very good
1– 7– 8	Good
2- 3- 4- 5- 6- 17- 21- 22	Medium
9– 10– 11– 12– 13– 14– 15– 16– 18– 19- 20	Weak

Table 2. Shows the standard limit of sound waves according to different types of land use during day and night.

Table 2. Permissible limit of noise pollution in different kind of urban land uses.

Type of land use	Daily average level (7am-10 pm) dB(A)	Nightly average level (10 pm-7am) dB(A)
1- Residential zoning	55	45
2- Mixed land use (commercial-residential)	60	50
3- Commercial-Administrative zoning	65	55
4- Residential-Industrial zoning	70	60
5- Industrial zoning	75	65

Table 3. Describe the influence of noise at different levels on human physiology and its consequences. According to standards 60 dB is the normal level to hear the sound and above this level cause communication disorder even hearing damage side effects.

Table 3. Sound physiological effects on humans.

Impacts Potential	decibel
Voice cannot be heard	20
Sound can be heard in hearing threshold	25
A small amount of sleep disturbances	35
Somewhat sleep disturbances	50
Create persecution	55
Normal level to hear the sound	60
Communication disorder	65
Spasms and muscle inflammation	70
Changes in the coordination of movements	75
Kind of hearing damage	80
High Persecution	85
Stimulate the mental faculties	90
Damage to hearing	95
Thereby waking up man	100

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The maximum intensity of sound that humans cannot tolerate	115
Pain threshold	125
Limiting the scope of speech	130
Very painful	135
Potential of loss of hearing	140

Vehicles and motorbikes are the main sources of noise pollution at metropolises. The main sources of noise pollutants at urban environments are due to the transport which mainly divided into three groups; road traffic, air traffic and railway traffic.

According to obtained statistics from Tehran comprehensive plan, contribution of motorbikes emission is about 49 percent, Automobile (30%), trucks (20%) and buses produce 1 percent emission. Rating of districts according to noise pollution level because of car traffic has brought at below table. According to table. 4 first rate between districts is belong to municipal district number 6 and district 12 is at the fourth place with the highest rate of noise pollution.

Table 4. Rating of municipal districts according to noise pollution due to car traffic.

Rating for production of noise pollution due to cars within Tehran's districts	Municipal district
1th	6
2nd	10
3rd	11
4th	12
5th	7
6th	13
7th	3
8th	19
9th	18
10th	2

Noise level at body of Tehran highways is about 70 – 80 dB, which is more than standard limit at residential regions. Also 76 percent of health centers and 32 percent of educational centers are at critical noise pollution condition and their noise pollution level is above standard level. Table. 5 at below shows the number of educational and health centers with high noise pollution level. There are 250 health centers, 330 health centers at critical condition, 419 educational center above standard limit and 1326 educational centers at critical level of noise pollution within Tehran city.

Table 5. Number of educational and Health centers with noise pollution level above standard limit.

The number of health centers with noise pollution at Tehran	The number of critical health centers out of standard limit at Tehran city	The number of educational centers with noise pollution at Tehran	The number of critical educational centers out of standard limit at Tehran city
250	330	419	1326

District 9 has the highest level of noise pollution at Tehran city which its sound level during day and night respectively is about 76 dB and 75 dB. The main reason for high sound level at mentioned district is because the existence of "Azadi" square and its vehicular traffic also establishment of "Mehrabad" airport within district. Municipal district number 14 is the second polluted area and district 19 is third one between Tehran city's municipal districts.

The highest noise pollution range at district level, in terms of traffic congestion relatively are: district's 6 – 10 – 11- 12 – 13 – 3 – 19 – 18 and 2 which the noise level is above 70 dB and mostly at their main streets.

Transmission of "Mehrabad" airport, installation of sound-absorbing walls on the sidelines of the urban railway, construction of more public parking for prevention of traffic jam, organizing of annoying industrial and business are some of the other possible ways to decrease sound pollution.

In areas of the city center noise pollution reaches to a critical threshold because of vehicles traffic congestion, pedestrian's traffic and urban activities which is very dangerous for human physical and mental health. Textures density and green space shortage and the other audio buffer are also the other reasons. Air quality control Company which is dependent to Tehran municipality measures sound pollution as well as air pollution. The plan already is running that specify the noise level and critical points within the municipal district number 12. According to the results of this review, noise pollution level is very high in some streets at central part of city.

Table 6. Shows the list of schools and hospitals with sound pollution above standard limit within district 12 in following tables from table15 till table 26.

Table 6. Educational centers and schools with noise pollution above standard limit.

Row	Name of center	The existing voice level (dB)	The deviation than standard level (dB)
1	Aalishan	65-70	10-15
2	Rostam Abadi	65	10
3	Jamshid Jam	60-65	5-10
4	Un known	60-65	5-10
5	Teacher Training	65-70	5-15
6	Quranic Science's faculty	65-70	5-15

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7	'Shahid Beheshty' Conservatory	65-70	5-15
8	Faculty of Rehabilitation	65-70	5-15
9	Azad university	65-70	5-15
10	'17 Shahrivar' school	65-70	5-15
11	Doctor Shariati	65-70	5-15
12	Azadi	65-70	5-15
13	Darolfonoon	55-60	0-5
14	Velayat	60-65	5-10
15	Educational center	55-60	0-5
16	Alavi	60-65	5-10
17	Navab Safavi	55-60	0-5
18	Allameh Tabatabai	55-60	0-5
19	Komeili	60-65	5-10
20	Iran	65-70	10-15
21	Salman	65-70	10-15
22	Shahadat	65-70	10-15
23	Imam Sajjad	65-70	10-15
24	Meraj	65-70	10-15
25	Rahian Qods	60-65	5-10
26	Sheikh al Iraqi	60-65	5-10
27	Bayat	65-70	10-15
28	Zarabi	55-60	0-5
29	Tehrani	55-60	0-5
30	The Technical High School of Imam Sadeq	55-60	0-5
31	'Motahari' Teacher Training Center	65-70	10-15
32	Islamic Mohammedia	60-65	5-10
33	Dstghyb	55-60	0-5
34	'Shahed' University	55-60	0-5
35	'Shahid beheshty' Conservatory	55-60	0-5
36	Imam's hope school	55-60	0-5

Table 7. Educational centers and schools with noise pollution at critical limit.

Row	Name of center	The existing voice level (dB)	The deviation than standard level (dB)
1	'payam Gadir' school	above 70	≥ 15
2	University of Medical Sciences	above 70	≥ 15
3	University of Medical Sciences	above 70	≥ 15
4	'Noore Saadat'	above 70	≥ 15
5	'Besaat'	above 70	≥ 15

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6	'Tavangar'	above 70	$\geq$ 15
7	'Shohadaye Azadi'	above 70	$\geq$ 15
8	'Haftom Tir'	above 70	$\geq$ 15
9	Bqyatallh	above 70	$\geq$ 15
10	'Namjoo'	above 70	$\geq$ 15

Table 8. Educational centers and schools with noise pollution at critical limit.

| Row	Name of center	The existing voice level (dB)	The deviation than standard level (dB)
1	'Sina' Hospital	60-65	15-20
2	'Sina' Hospital	60-65	15-20
3	'Torfeh' Hospital	above 70	$\geq$ 25
4	'Motahari' Medical Center	above 70	$\geq$ 25
5	University of Medical Sciences	above 70	20-25
6	'valie asr'	65-70	$\geq$ 25
7	University of Medical Sciences	above 70	$\geq$ 25
8	'Jafari'	65-70	20-25
9	'Pishahang'	above 70	20-25
10	'Vahdat Eslami'	60-65	15-20
11	'Asemani' Clinic	above 70	$\geq$ 25
12	'Rezaee'	65-70	$\geq$ 25

Table 9. Clinic centers with noise pollution above standard limit.

Row	Name of center	The existing voice level (dB)	The deviation than standard level (dB)
1	'Amir Alam' Hospital	55-60	10-15
2	'Razi' Hospital	50-55	5-10
3	'Sevom Shaban'	55-60	10-15
4	'Rey' Remedial	55-60	10-15

Interpolation map of noise pollution level within district 12 at November 2015

Below map shows the level of noise pollution within district 12 based on mentioned pollution centers which are including of educational centers, schools, primary schools, hugh schools, colleges, universities, health clinics, hospitals and etc. some of these centers are next to arterial roads and some are within districts' texture.

"Panzdah khordad", "Lale zar" and "Saf" streets' are located in the (65 – 70) dB noise pollution range and "Hefdah shahrivar" street's range of pollution is between (56.2 – 60) decibels.

Map 2. Interpolation map for noise pollution within district 12 during November 2015
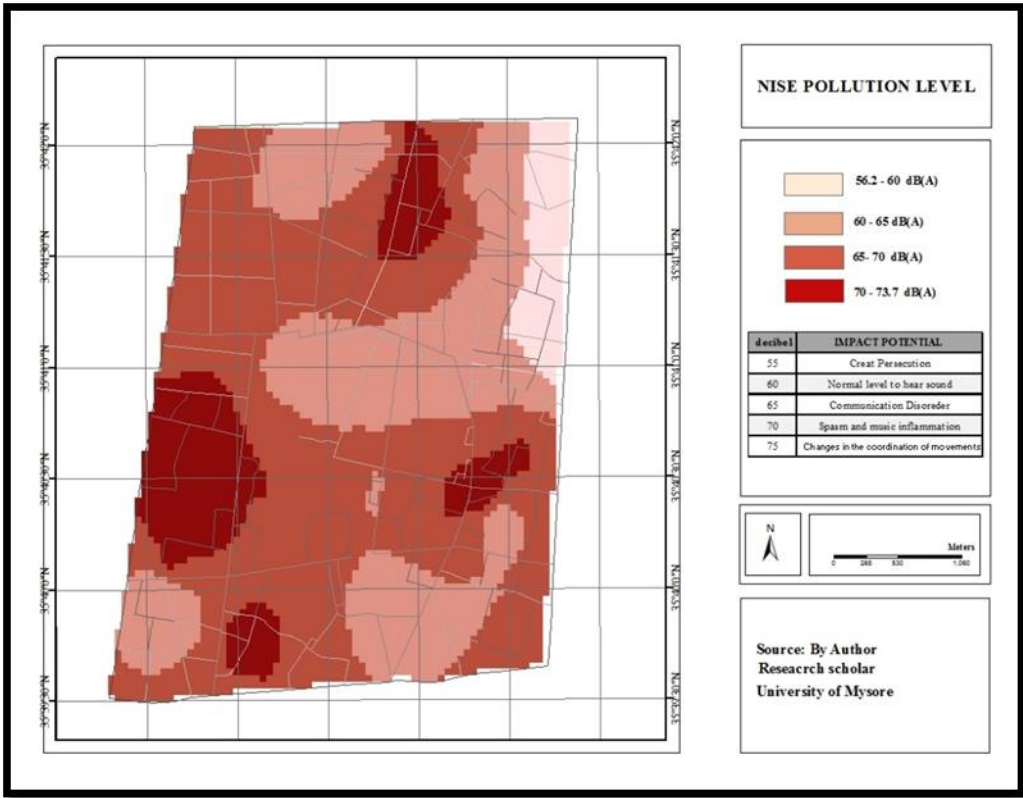
Source: By Author.

Noise pollutant resource at district 12 are vehicular and airplane traffic, industrial activity, commercial activity, constructions and train movement. Also worn-out cars, heavy vehicle traffic and movement at night, lack of standard high ways, failure to follow proper pattern of driving, use of un-proper construction materials in buildings for the streets sound absorption will help to increase the pollution within the district.

Conclusion

Comparison of monitored noise level with regulatory standards revealed that noise standard violation are mostly at educational and health centers with lowest level of 55 dB and highest level above 75 dB Also through preparation of interpolation noise map, could find the level of noise at each streets within city center.

Based on interpolation map, the level of noise at two streets of "Panzdah khordad" and "17 shahrivar" is below 60 db. Also at "Saf" street is below 65 dB but level of noise along un-implemented street, "Laleh zar" street is above 65 dB and at un-healthy condition. Also with respect to documents refer to before implementation of three mentioned streets, level of noise has a significant decrease with previous years.

At final through prepared interpolation map can see the obvious result of pedestrianisation scheme on three implemented streets and existence of high level of noise pollution at an un-implemented street. The findings of this study shows that noise maps and interpolation maps can be useful for investigating noise in urban environments for having a sustainable development of the city.

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