

# OBSERVING PEOPLE'S REACTIONS AND RESPONSES TO URBAN ROAD TRAFFIC NOISE (RTN) IN JORDAN

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**Abstract** — The subjective aspect of assessing Road Traffic Noise (RTN) in urban agglomerations is crucial, as it takes into consideration the sensitivity and specific reactions of residents to Road Traffic noise (RTN) in their living environments. This paper aims to present a detailed sociological study initiated to measure the level of public awareness regarding RTN and estimate the impact of RTN disturbance on RTN disturbance their daily activities. For this purpose, an attitudinal survey was conducted using a predesigned questionnaire with limited noise measurements. The questioners were distributed to the neighboring residents of one of the most congested arterial roads in Amman, Jordan's capital. The questioner firstly focused on evaluating the awareness of respondents of the problem magnitude and its environmental and health impacts, and secondly, assessing the effects of RTN as perceived by the respondents on different daily activities. The analysis of the collected data found that around 50% of respondents believe that RTN impacts the environment, and 60% believe that RTN affects human health, while 38% consider changing their place of residence and moving to a quieter place. The main results of the study showed that RTN causes annoyance to people while performing their daily activities, especially while studying and resting. Further main reported impacts included causing fatigue (64%), anxiety (75%), nervousness (87%), focus reduction (89%), and discomfort (90%).

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**Keywords:** Amman, road traffic noise, attitudinal survey, public awareness, traffic noise impacts

## 1.0 INTRODUCTION

Noise is defined as unwanted or excessive sound [1]. Road traffic noise (RTN) is one of the main environmental problems faced by the human population of many cities globally, including Amman, the capital of Jordan[2]. Road traffic noise has been highlighted as one of the primary contributors to the rise in noise pollution in metropolitan areas, and it may have significant consequences for people's quality of life[2,3]. This issue is growing increasingly serious because of the increase of heavy vehicles usage on urban streets. Furthermore, the poor urban planning of many countries, particularly in third-world countries. Traffic noise is the main common type of noise pollutants in urban cities, which constitutes 80% of all potential factors [4] as shown in Figure 1. According to the International Union of Railways (UIC), the railway has the lowest noise level compared to car (700–1300 cm<sup>3</sup>), motorcycle, and heavy cargo truck with 82, 90, and 103 dBA respectively in urban areas.

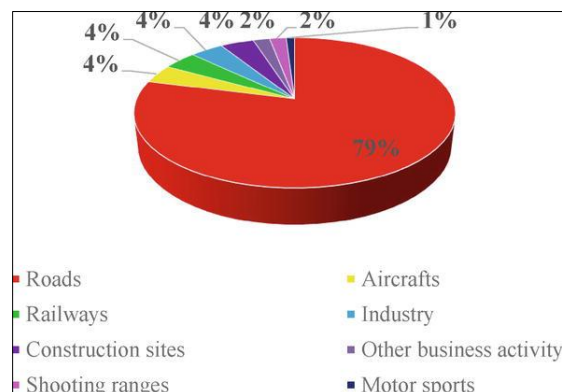


Figure 1 The Distribution Of Human Annoyance Factors By Noise Types [4]

This paper aims to evaluate the awareness of RTN problem magnitude and its environmental and health impacts and secondly investigate the effect of RTN on residents on their daily activities. University of Jordan arterial road in Amman, Jordan's capital, was selected for the research aims. The road was selected because it is a dynamic site characterized by traffic congestion, especially during peak hours and midnight due to the increasing number of cars and a large number of unauthorized and unwarranted bus stops causing noise due to the voices of bus owners.

A social survey in the form of handed questionnaires to neighboring residents of University of Jordan road to study the reactions and attitudes of residents towards RTN problem. The questionnaire included the social characteristics of individuals, and their attitudes towards RTN, and how it impacted their daily activities.

This article is structured as follows: Section 2 describes the literature concerning RTN. Section 3 provides a general overview of the RTN problem in the city of Amman. Section 4 explains in detail the methodology used. Section 5 presents and discusses the results established from the performed survey. Finally, section 6 summarize the research finding in the conclusion.

## **2.0 LITERATURE REVIEW**

Traffic noise has become a recognized global problem. Many studies were carried out in different countries into the various aspects of traffic noise and its health, social and economic impacts. Several studies focused on increasing noise levels on human health, such as annoyance reactions, sleep disturbance effects, and discomfort. Recent studies have shown that noise can negatively affect human health and behavior on short and long scales [1, 5, 6, 7].

Epidemiological studies have investigated the relationship between road traffic noise and hypertension. A study by [18] has investigated more clearly the relation between different road traffic noise frequency components and the incidence of hypertension in central Taiwan [8]. The results of this study have shown that exposure to low-frequency and hearing-sensitive road noise may be associated with high blood pressure.

Many field studies concluded that excessive noise might decrease social interaction and responsibility, verbal disinhibition, increased aggressive disorder, and mental illness [9, 10, 11]. However, [12] reported no psychological disorders due to noise among workers of different industries [12]. Evaluating traffic noise impact on the quality of life among residents in India revealed that more than half of the total studied sample expressed annoyance with traffic noise during daily activities, causing headaches and nervousness [13]. A study in Sweden examined the effects of road traffic noise during the night; the results showed a significant decrease in subjective sleep quality, with 50% of the test persons experienced difficulties in falling asleep [14].

Several studies have also focused on the economic impact of traffic noise and found that noise levels have high costs on surrounding properties as an indirect negative effect [15,16]. One of the studies evaluated the monetary effect of traffic noise on property values in Seoul Korea using Hedonic price models, and the annual cost per kilometer due to traffic noise was estimated to be about \$347 thousand [16].

A study in Europe [17] showed that over half of Europe's population is exposed to unacceptable noise levels, with noise from road transport being the primary source. This study illustrated that the health of millions of Europeans is affected by traffic noise, and the social cost of it is over 40 billion Euros yearly, and that passenger cars and Lorries are mostly responsible for the bulk of costs.

A predictive study done in the city of Gothenburg, Sweden, by [8] examined how noise reduction measures would influence the response to noise at several scenarios from 2015-2035 and revealed that the implementation of low-noise tires or pavements is the most effective noise-reducing measure with values between 13% and 29% [18].

The main conclusions from these studies are the negative consequences of noise on human life; and the stress-related illnesses as anxiety, headaches, and difficulty in sleeping that occurred as a result of noise. The indirect negative impacts of road nuisance are financial and social losses. This article will reflect the negative impacts collected from previous research around the University of Jordan sample in order to address how inhabitants are impacted by the RTN issue throughout the day and at night, as well as the major activities affected. The significance of this paper is that it examine the primary sources of road noise by determining the degree of annoyance for each

source from the point of view of inhabitants, assess the simplest measures to decrease this problem, and measure the RTN values in certain hours and investigate what majority thinks about the highest annoyance periods hours of day.

### 3.0 AN OVERVIEW OF TRAFFIC NOISE IN AMMAN, JORDAN

Jordan, with an area of 93000 sq. km. has a total population of about 6 million inhabitants, 85% of which live in urban areas. Nearly half of the population live in the capital city, Amman, which hosts about 85% of the total large industrial development and 71% of small ones.

Few studies were carried out on traffic noise in Jordan, which measured public awareness of the problem, quantified the current and future noise levels along Jordanian urban arterials, and identified the need for and the type of required noise mitigation measures. However, all these studies reported that levels of noise pollution in Amman continue to exceed the maximum threshold of 63 dB(A).

The studies revealed that there is a high level of awareness among Jordanians of the traffic noise problem and its environmental and health effects where 80% of survey respondents consider traffic noise an environmental pollutant, and 79% believe it is a public health problem.

One of the earliest studies of traffic noise in Jordan was that of Abu Hadbain in 1995 [19]. Measurements of traffic noise levels and affecting factors were collected at seven sites adjacent to selected arterial roads in Amman and reported an average level of about 76dB(A), with more than half of the interviewed residents considering moving to quieter places. The study recommended 3m noise barriers to reduce the noise levels below the maximum acceptable level of 63 dB(A). Further measurements in 2005 showed an average noise level of 69 dB(A) during daytime and 58 dB(A) during night-time. A more comprehensive study by [20] concluded that, compared to 2005, the noise levels had increased significantly where the daytime noise level L10 (1hr) throughout Amman ranged between 64 dB(A) and 80 dB(A) with an average of 72 dB(A). The night-time average was found to be 69 dB (A), with a range between 56 dB (A) and 80 dB (A). This increase was attributed to increased traffic over the years, damage to the pavement structure, and old vehicles that produce high exhaust noise.

A study by [15] have measured the Statistical noise index L10(18 hr) at nine selected sites in Amman in 2012. Measurements of noise level have been reported at selected locations along busy arterials from 6:00 am to midnight using Bruel and Kjaer (B & K) sound level meter in compliance with the method specified by the manufacturer.

The British method of calculation of road traffic noise (CRTN) method was used in almost all the previous studies to predict noise levels. The method was evaluated by comparing the measured and predicted levels. The prediction difference, which is the predicted minus the measured values were calculated, and the results are shown in Table 1.

The accuracy of the prediction method was judged by the mean of the prediction difference, which was found to be 2.2 dB(A), and its standard deviation of 0.96, indicating that CRTN can be used satisfactorily to predict traffic noise levels in Amman.

**Table 1** Measured and Predicted Noise Levels l10 (18 hr)

Site Number	Current measured levels (X)	Current predicted levels (Y)	Prediction differences (Y- X)
S1	76.6	79.2	+2.6
S2	78.5	79.9	+1.4
S3	72.7	75.7	+3.0
S4	77.8	81.2	+3.4
S5	75.8	77.0	+1.2
S6	74.6	78.2	+3.6
S7	75.1	78.3	+3.2

Most recently, new models for the prediction of traffic noise under Jordanian conditions were developed using different techniques, including Artificial Neural Network (ANN) [21,22]. It was shown that compared to the CRTN Model with an average error of 8%, the ANN produced a much lower average error of 2.4%.

A recent study used several costing scenarios, including the hedonic pricing technique, besides other methods, and produced a min-max band of the annual cost of traffic noise at about \$ 81-240 million [23].

To conclude, the majority of studies found that Jordanians are quite aware of the traffic noise problem. The authorities in Jordan must be aware of the impacts of RTN on the environment and health as over the years, the issue increases. The barriers are recommended to alleviate the problem.

#### 4.0 METHODOLOGY

The dB Decibel Meter Pro application was used for measuring L10 (1hr) noise level. Readings were taken during eleven 1-hour periods between 8:00 am and 10:00 pm, thus covering morning and evening peak and late-night periods. A sociological study was conducted in the vicinity of the University of Jordan, which is considered a dynamic site characterized by traffic congestion, especially during peak hours and midnight. The study was based on a predesigned questionnaire distributed to a random sample and receiving 100 respondents with a 25% response rate.

The questionnaire addressed five categories. The first category included three questions related to the traffic noise sources during the day and night period spent at home; the scale points are (Very Annoyed), (Annoyed), (A Little Annoyed), (No At All Annoyed), and (Do not know). The second category included four questions to evaluate the impact of TN on the environment and health; the evaluation was based on the following scale, (strongly agree), (Agree), (None, Disagree), and (Strongly Disagree). The third category specifically evaluates the impact of traffic noise on residents while performing their daily activities during the day and night period. The scale is based on a Yes/No question. The fourth category evaluates how the activity daily is affected by TN during the day and night period; the evaluation was based on Yes/No questions.

The questionnaire contains 57 questions that may be grouped as follows:

- Identification of the socio-economic characteristics of respondents.
- The level of annoyance caused by various traffic noise sources.
- The environment and health impact of traffic noise.
- The effect of traffic noise on the daily activities of residents.
- The hours of high noise levels between 6 am and midnight.

#### 5.0 RESULTS

The noise level measurements at University of Jordan street locations for both day and night time are listed in Table 2. The results show that the noise levels are significantly high and exceed the maximum allowable noise level adopted in Jordan, of 63 dB(A).

**Table 2** Measured Day-Time and Night-Time Level L10 (1 Hr) at University of Jordan Street

Time	L10 dB
8.00-9.00a.m	75
9.00-10.00a.m	73
10.00-11a.m	72
2.00-3.00a.m	80
3.00-4.00a.m	77
4.00-5.00a.m	74
5.00-6.00p.m	76
6.00-7.00p.m	75
7.00-8.00p.m	76
8.00-9.00p.m	79
9.00-10.00p.m	77

Table 3 shows the Socio- economic characteristics of respondents. The sample distribution by gender shows 33% males and 67% females with age distribution showing 77% between 18-25 years, 17% between 26-36 years, and only 5% between 36-45 years. The educational distribution showed 63% of respondents were university graduates, and 34% with a postgraduate degree. Only 44% of the respondents were employed.

**Table 3** Socio- Economic Characteristics of Respondents.

<b>Occupation</b>	<b>%</b>
Graduate(University)	63
Employed	44
Unemployed	56
Diploma	2
Postgraduate	34
High school	1

Table 4 shows a summary of the opinions of respondents regarding the source of annoyance. It can be seen that 31% of the respondents were annoyed by light vehicles, 46% by heavy vehicles, while 51% indicated that transportation stations were very annoying.

**Table 4** The Reported Level of Annoyance by The Noise Source

<b>Noise Source</b>	<b>Degree</b>	<b>%</b>
Transportation Stations	Very Annoyed	<b>51</b>
	Annoyed	23
	A Little Annoyed	11
	Not At All Annoyed	11
	Do Not Know	4
Heavy Vehciles	Very Annoyed	<b>46</b>
	Annoyed	35
	A Little Annoyed	15
	Not At All Annoyed	4
	Do Not Know	0
Light Vehciles	Very Annoyed	30
	Annoyed	<b>31</b>
	A Little Annoyed	26
	Not At All Annoyed	12
	<b>Do Not Know</b>	1

The effect of noise sources on respondents during the night is shown in Table 5. It can be seen that the annoyance level is lower than during the day but still severe, with 33% of respondents indicating that light vehicles annoyed them, 42% of respondents were very annoyed by heavy vehicles at night, and 28% of them answered that transportation station does not annoy them at night because of lower activity level.

**Table 5** Proportion of Responses for Question No2: “Indicate The Degree Of Annoyance Generated by The Following TN, During The Night Period Spent at Home”

<b>Noise Source</b>	<b>Degree</b>	<b>%</b>
Transportation Stations	Very Annoyed	<b>24</b>
	Annoyed	17
	A Little Annoyed	21
	Not At All Annoyed	28
	Do Not Know	10
Heavy Vehciles	Very Annoyed	<b>42</b>
	Annoyed	26
	A Little Annoyed	14
	Not At All Annoyed	15
	Do Not Know	3

	Very Annoyed	24
	Annoyed	33
Light Vehicles	A Little Annoyed	24
	Not At All Annoyed	15
	Do Not Know	4

Figure 2 indicates that most of the respondents expected that TN affects the environment and human health most of the time. The highest percentage is 50% of respondents who think RTN impacts the environment, 60% indicated that RTN impacts human health and 38% consider moving to a quieter place. In addition, 46% agree to close the window to avoid TN during the day spent at home, and 37% agree at night period, as shown in Figure 3.

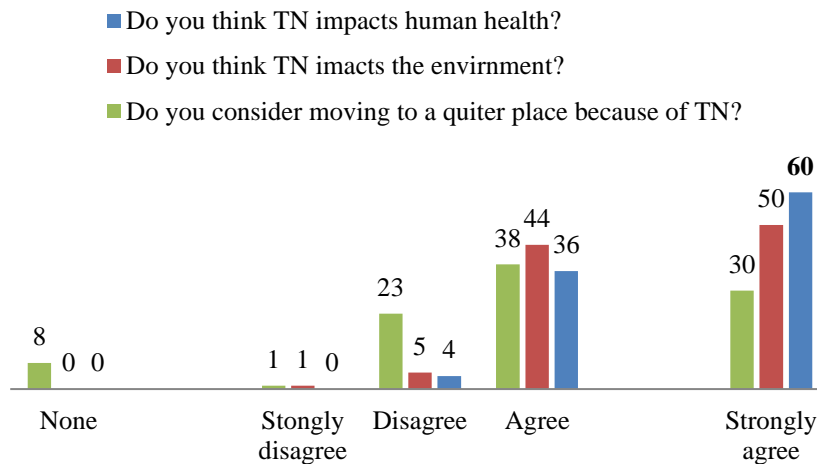


Figure 2 proportion of Responses Regarding The Environmental and Health Impacts of Traffic Noise

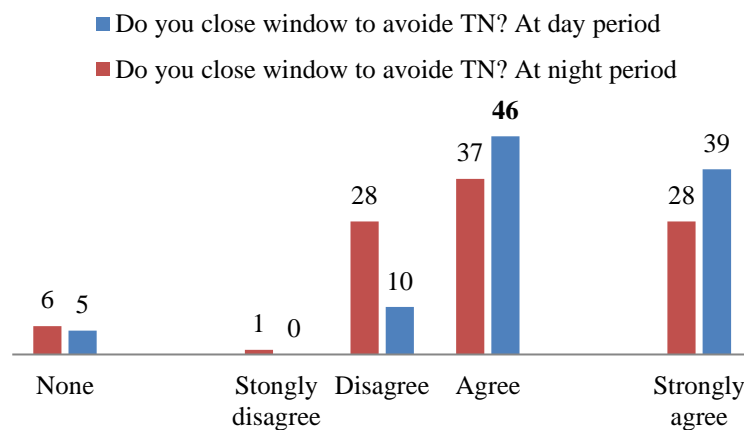
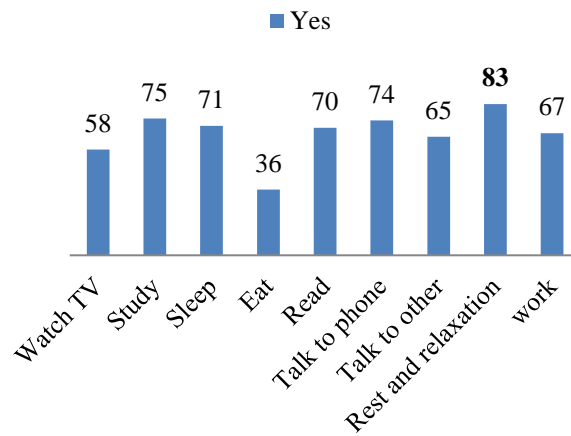
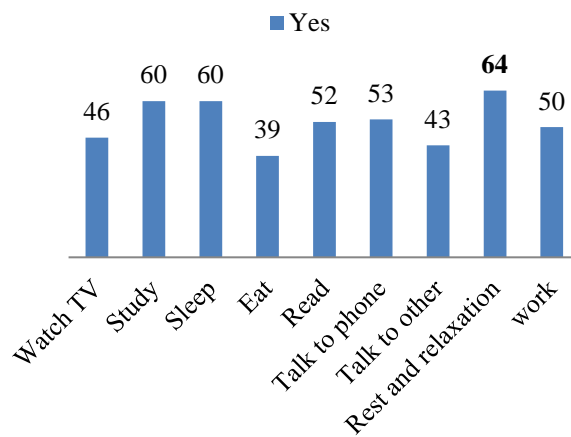


Figure 3 Proportion of Responses For Question No 3: "Indicate The Impact of TN"

Regarding the impact of RTN on the daily activities of residents during day time and during night, Figures 4 and 5 show that most of the respondents agree that TN annoyed them while resting (83%) during the day, (64%) during the night, (74%) talking on the phone during day, (70%) while reading during the day, (52%) during the night period and (75%) while studying during the day, (60%) during the night period. The impact seems to be more severe during the day.

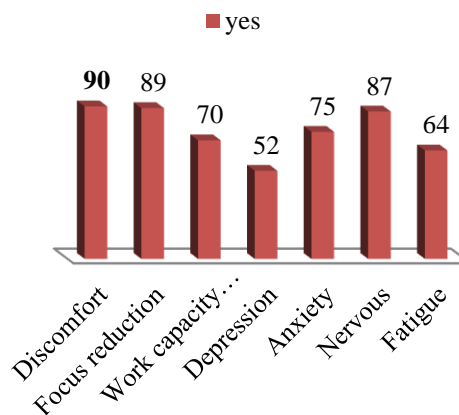


**Figure 4** The Impact of TN on The Daily Activities During The Day Time

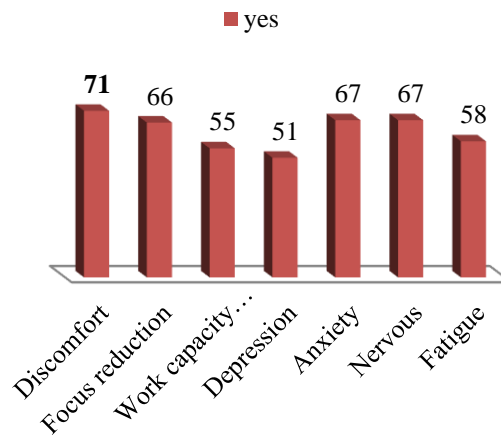


**Figure 5** The Impact of TN on The Daily Activities During The Night-Time

Figures 6 and 7 show the proportion of people reporting adverse reactions caused by RTN that affected their daily life during the day and night periods, respectively. It can be seen that 89% of respondents reported Focus Reduction, (90%) Discomfort, (87%) Nervousness, (64%) Fatigue during day period while the corresponding proportions of these reactions during the night are (66%) Focus reduction, (71%) Discomfort, (67%) Nervousness, and (58%) Fatigue.

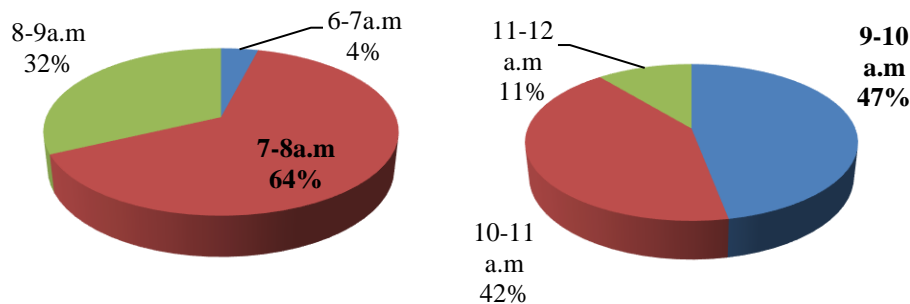


**Figure 6** Proportion of Adverse Reactions Caused by TN During Day Time.

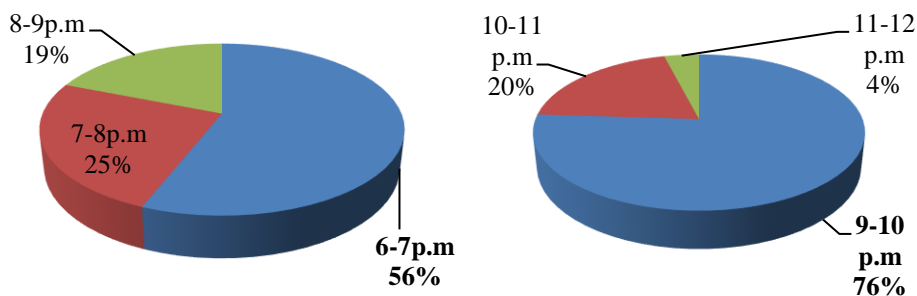


**Figure 7** Proportion of Adverse Reactions Caused by TN During Night-Time.

Regarding the hours of day or night when TN levels are most severe, 64% of respondents reported the 7-8a.m. hour during the day and 76% reporting the hour 9–10 pm during night time as shown in Figures 8 and 9.



**Figure 8** The Hours During The Day When TN Level Is Most Severe



**Figure 9** The Hours During Night Time When TN Level Is Most Severe.

## 6.0 DISCUSSION

The maximum noise level occurred in the daytime on 2.00–3.00 am hour since this period presents traffic congestion as it represents the departure time mainly of employees in Jordan. Also, the second greatest level of noise was shared by night time at 8–9 pm, due to several areas in Amman such as the 5th Circle, 8th Circle, Abdoun Mall, and Suweifah exposed to higher night-time noise than daytime because of the prevailing manner of life in such places in Amman [24]. Transportation stations and heavy vehicles scored the highest annoyance types by residents, especially since some buses make unauthorized stops in most of Amman's neighborhoods, where they abruptly drop off or load passengers. Noise measurements at 34 locations in Amman show that noise levels at all sites exceeded the maximum acceptable limit of 60 dB(A) adopted in Jordan, The results of the social study reflect high public awareness of the road traffic noise problem, and its impacts on residents of Amman as 80% of the interviewed people consider its environmental pollution and a public health problem. The social survey results



reveal that 63% of the neighboring residents are annoyed by road traffic noise during their daily activities to the extent that 65% of respondents considering changing their place of residence. Residents are aware of the effects of traffic noise on public health and take straightforward measures to avoid the problem, such as windows closing, as this issue affects the rest and time of study and leads to a reduction in concentration, as most stated that noise levels rise in the early morning hours (7–8 am) and (9–10 pm) and evening hours (6–7 pm) and (9–10 pm); since these periods were among the times in which the RTN measurement findings were high as presented previously in Table 2. The level of annoyance was found to have increased during the last decade, mainly due to increased vehicular traffic. These results should benefit decision-makers and dictate the need to apply necessary noise mitigation measures.

## 7.0 CONCLUSION

Road traffic noise (RTN) is drawing increasing attention due to its growing magnitude and various impacts as a result of the high increase in vehicular traffic. However, few RTN studies were conducted in Jordan. This study further investigates the issue to provide a better understanding of the problem's magnitude and impacts. Traffic noise measurements made in the vicinity of Jordan University show that noise levels during the day and night times exceeded the maximum allowable limit of 63dB(A) adopted in Jordan, reaching 80 dB(A) during the 2–3 pm peak hour. The results of the social study revealed high public awareness of the road traffic noise problem and its impacts on residents as 50% of the respondents consider it environmental pollution and 60% consider it a public health problem. The social survey results reveal that 51% of residents are annoyed by transportation stations during the day period, 38% of them are considering changing their place of residence. The increased level of annoyance is mainly attributed to the increase of vehicular traffic (Light and Heavy vehicles), illegal parking in the bus station, which leads to increased sounds of buzzer and loud noise of the bus drivers, where the noise level reached 80dB(A) at 2.00–3.00 pm peak hour.

### Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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### References

- [1] Ioana, D., & Fabiola, I. (2010) The Reaction and Response of People to Urban Noise., Technical University of Cluj-Napoca, Faculty of Machine Building.
- [2] Piccolo, D. & Plutino, G.C. (2005) Evaluation and analysis of environmental noise of Messina, Italy, Applied acoustics, 66, pp. 447-465.
- [3] Korfali, S.I., & Massoud, M. (2003) Assessment of community noise problem in Greater Beirut Area, Lebanon, Environ. Monit. Assess. 84, pp. 203–218. <https://doi.org/10.1023/A:1023322507415>.
- [4] Helene A., & Klæboe, R. A. (2005) Nordic Perspective on Noise Reduction at the Source. TØI report806
- [5] Jadaan, K., Gammoh, H., Ammoura, R. & Al-Nabulsi, Z. (2014). Evaluation of Social Impact of Traffic Noise in Amman, Jordan, The Proceedings of The 4th Annual International Conference Syiah Kuala University, 4(1), 22-24.
- [6] Jadaan, K., Al-Dakhlallah, A. & Goussous, J. (2008). Traffic Noise in Amman and Its Impact on Residents. Master thesis. Al-Isra PrivateUniversity, Faculty of Engineering.
- [7] Abo-Qudais, S., Abohadba, M., & Jadaan, K. (2002) Prediction and Management of Traffic Noise Along Urban Arterials, Proceedings of International Conference on Environmental Problems of the Mediterranean Region, Nicosia, North Cyprus, June 2002.
- [8] Ögren, M., Molnár, P., & Barregard, L. (2018). Road Traffic Noise Abatement Scenarios in Gothenburg 2015-2035Environmental Research, 164, 516-52. <https://doi.org/10.1016/j.envres.2018.03.011>.
- [9] Juang, D.F., Lee, C. H., Yang, T., & Chang, M. C. (2010). Noise Pollution and Its Effects on Medical Care Workers and Patients in Hospitals, Int. J. Environ. Sci. Tech, 7, 705-716. <https://doi.org/10.1007/BF03326180>.
- [10] Mishra, R. K., Parida, M. & Rangnekar, S. (2010). Evaluation and Analysis of Traffic Noise Along Bus Rapid Transit System Corridor. Int. J. Environ. Sci. Tech, 7(4), 737-750. <https://doi.org/10.1007/BF03326183>.
- [11] Omidvari, M. & Nouri, J. (2007). Effects of Noise Pollution on Traffic Police. Int. J. Environ. Res. 3(4), 645-652.
- [12] Mokhtar, M., Kamarudin, S., Khan, Z. & Malick, Z. (2012) A Study on the Effect of Noise on Industrial Workers in Malaysia, Jurnal Teknologi, 46(A), 17-30. <https://doi.org/10.11113/jt.v46.279>.

- [13] Nandanwar, D.R., Parbat, D.K. & Deshmukh, S.K. (2009). Study on Residents Perception and Attitudes Towards Urban Traffic Noise in Nagpur City, Emerging Trends in Engineering and Technology Conference (ICETET). <https://doi.org/10.1109/ICETET.2009.216>.
- [14] Ohrstorm, E. (1995). Effects of Low Levels of Road Traffic Noise During the Night a Laboratory Study on Number of Events, Maximum Noise Levels and Noise Sensitivity, *Journal of Sound and Vibratio*, 179(4), 603–615. <https://doi.org/10.1006/jsvi.1995.0040>.
- [15] Banihani, Q. & Jadaan, K. (2012). Assessment of Road Traffic Noise Pollution at Selected Sites in Amman, Jordan: Magnitude, Control and Impact on the Community, *Jordan Journal of Civil Engineering.*, 6(2), 287-278.
- [16] Kim, K., Park, S. & Kweon, Y. (2007). Highway Traffic Noise Effects on Land Price in an Urban Area, *Transportation Research Part D: Transport and Environment*, 12(4), 275-280, <https://doi.org/10.1016/j.trd.2007.03.002>.
- [17] Den B. L.C. & Schrotten A. (2007). Traffic Noise Reduction in Europe, CE, Delft, Report.
- [18] Yuan, C.T., Beelen, R., Fei, L.S.I, Chen, T., Ju, L.Y., Ying, B.B. & Shong, L.C. (2014). Road Traffic Noise Frequency and Prevalent Hypertension in Taichung, Taiwan: A Cross-sectional Study, *Environmental Health*, 13(37), <https://doi.org/10.1186/1476-069X-13-37>.
- [19] Abu, H.M. (1995). Prediction and Management of Traffic Noise Along Urban Arterials, MSc Thesis, Civil Engineering Department, University of Jordan.
- [20] Jadaan, K. & Obaid, M. (2012). Current and Modeled Traffic Noise Along Amman Road Network. Research report, Civil Engineering Dept., University of Jordan.
- [21] Jadaan, K. & Okasha, A. (2016). Developing a Traffic Noise Prediction Model For Jordanian Condition. *Journal of Geotechnical and Transportation Engineering*, 2(1).
- [22] Jadaan, K. & Okasha, A. (2017). Development of a Traffic Noise Prediction Model Using Artificial Neural Network(ANN). 8th Traffic Safety Conference / Jordan 2017, Amman, 12-13.
- [23] Goussous, J., Al-Dakhlallah, A., Jadaan, K. & Al-Zioud, M. (2014). Road Traffic Noise in Amman, Jordan: Magnitude and Cost Investigation, “. *Journal of Traffic and Logistics Engineering*, 2(2), 104-107, <https://doi: 10.12720/jtle.2.2.104-107>.
- [24] Jamrah, A., Al-Omari, A. & Sharabi, R. (2006), Evaluation of Traffic Noise Pollution In Amman, Jordan, *Environmental Monitoring and Assessment*, 120(1-3), 499-525, <https://doi: 10.1007/s10661-005-9077-5>.