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NOISE INSIDE TRANSIT VEHICLES: MAGNITUDE AND RIDER PERCEPTION

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ABSTRACT
Noise was measured inside 60 transit buses in Kuwait City in order to quantify its magnitude. Simultaneously, a survey of rider's perceptions of noise inside the bus was also carried out. It was found that the Leq levels ranged from a low of 70.6 dBA, to a high of 106.7 dBA. The mean noise levels were 80.9 dBA, indicating a very noisy environment inside the transit buses in Kuwait. More than a quarter of the riders, although all from among low income/low education classes, rated the noise inside the bus as "Bad" and "Very Bad", and were knowledgeable about the negative impacts of noise on the health and welfare of exposed individuals.

1 - INTRODUCTION

Over the last three decades, noise has been recognized as a major deteriorating factor on the quality of life in urban areas of the world (Singhal, 1986; Koushki et al., 1999, [1−5]). Urban traffic has long been identified as a main source of urban noise with concern over its welfare and health impacts on exposed individuals (Beglund and Lindvall, 1995; Carter, 1996; Belojevic et al., 1997, [2−4]). However, most research studies of traffic noise have concentrated on the measurements of traffic-generated noise at some distance away from the source (Ko, 1978; Bjorkman, 1988; Koushki et al., 1993, [6], [8−9]). Research studies of traffic noise inside vehicles, on the other hand, have been very limited at best (Krishan and Jain, 1994, [7]). To the best of our knowledge, the present study is the first study of noise inside bus transit vehicles in Kuwait City. The objectives of this preliminary research study were to:

- Measure noise levels inside the bus transit vehicles in Kuwait,
- Determine bus riders' annoyance with noise inside the bus, and
- Assess their awareness concerning the negative impacts of noise on welfare and health of exposed individuals.

2 - SAMPLING AND MEASUREMENT

Twelve routes were randomly selected from among the bus routes of Kuwait Public Transit Company (KPTC). Buses were then selected systematic randomly from among the bus fleet on a given sample route. Noise levels were measured inside the bus via Bruel and Kejar Precision Sound Level Type. Readings were then taken on seats located approximately in the middle of the bus, with the sound level meter held in the hand at a height of nearly 0.75 meter (2.5 ft.) from the bus floor. The A- weighted noise levels were registered at 10 seconds intervals for the entire time length of the trip. The rider's attitudes

concerning the noise inside the bus were also obtained simultaneously via a structured questionnaire survey.
The questionnaire addressed three types of information concerning riders: socio-economic traits, annoyance with nose inside the bus, and attitudes concerning the welfare and health impacts of noise. A systematic random sample of riders inside the bus were person-interviewed during the commuting trip. Noise was monitored for a total of 23 hours inside sixty sample buses, and a total of 235 completed sample questionnaires were processed for the analysis. The data were compiled in the computer system of the Civil Engineering Department, and SAS software was utilized to process and analyze the data.

3 - RESULTS

The total sample mean equivalent noise level, Leq was 80.9 (dBA). An average sample rider was 34.6 years of age and earned a monthly income of KD 145 (US $ 475). 65% of the sample riders, however, had an income of less than the mean, and only 7.7% earned more than KD 250 (US $ 825) per month. More than 12% were illiterate and another 40.6 percent had a high school education or less. 24% of the sample, however, had college degrees. Only 5.6 % of the sample riders were Kuwaitis. Egyptians comprised over 43%, and another 31 percent were from the Indian subcontinent, with the remaining 20.4% belonging to other nationalities.
Only during 11.1% of the monitoring time, the noise inside the bus was 75 (dBA), or less. The minimum measured Leq was 70.6 (dBA), and the maximum level was 106.7 (dBA), the main source of which was a passing motor cycle. During nearly 12% of the monitoring time, however, the noise levels inside the transit buses were in excess of 90 (dBA).
It was interesting to find out that, despite the noisiness of the inside of transit buses in Kuwait, by far the majority of sample riders stated that noise levels inside the buses in their home cities were even higher. 65.7% of the sample riders believed that noise levels inside the KPTC buses were "much less" / "less", than those of transit buses back in their home countries. For another 29.6% it was the same, and only 4.7%, believed that noise was worse inside the KPTC buses.
79.6 percent of the sample riders stated that they experienced fatigue; 81% felt nervousness; and 80.7%, experienced occasional headaches from the noisiness of the inside bus during their commuting trips. More than 51% said they would have switched to other modes of travel had they been given a choice. 72.9% of the sample riders also believed that, on the long-run, their hearings may be impaired because of daily exposures to high noise levels inside the transit buses.
Category analyses were performed to examine riders' perceived annoyance level, nervousness, and hearing impairment, with the measurements of equivalent noise levels inside the bus. As presented in Table 1, higher measured noise levels were consistently associated with higher levels of perceived annoyance, nervousness, and potential hearing impairment, by the sample riders.
It was also interesting to find out that the younger riders (age 30 or less), rated the noise inside the bus as "Bad" and "Very Bad", more than the riders in all other age groups (Figure 1). The test of Chi-square also confirmed this difference in age and perception of noise ($\chi^2 = 27.6$, df = 16, $p < 0.03$). This finding may be due to higher general awareness levels of younger generations concerning the existence of environmental noise pollution.
Also, interesting, was the finding of the relationship between the rider's perceived annoyance and education levels. As shown in Figure 3, while only 56 percent of those with no formal education stated being annoyed with noise levels inside the bus, 78 percent of those with college degrees, and 100 percent of riders, holding post-graduate degrees, expressed annoyance with the bus noise. The differences in the perceived annoyance levels of these individuals, was again, statistically significant as indicated by the test of Chi-square ($\chi^2 = 9.6$, df = 5, $p < 0.05$).

Variable Name		**Inside Bus Noise Levels (dBA)**		
		Mean Leq	**Std. Dev.**	**Sample Size**
Annoy Level:				
	Very Much	85.0	9.8	84
	To Some Extent	82.5	7.9	119
	Little	80.3	6.4	32
Nervousness:				
	Definitely	82.5	9.0	84
	To Some Extent	82.2	8.8	107
	Little	79.0	4.1	44
Hearing Impairment:				
	Definitely	82.3	8.6	89
	To Some Extent	81.9	8.5	97
	Little	80.4	7.1	49

Table 1: Mean noise levels inside bus and riders perception of impacts.

The perception of fatigue impact of bus noise varied with riders' income levels: those with higher incomes stated experiencing more fatigue due to bus noise. As presented in Figure 2, 66 percent of the riders in the less-than KD 75 per month income group, responded to fatigue impact of bus noise "strongly" and "to some extent". This percentage increased to 96 for riders in the more-than KD 250 income group. This significant increase in fatigue awareness for individuals in higher income groups, may be due to the higher formal education levels of these individuals. A category analysis of the sample bus riders' income and their education levels confirmed this hypothesis. While only 17 percent of those with no education earned more than KD 200 per month, 61.5 and 75.0 percent of riders with college and post-graduate degrees, respectively, had a monthly income of more than KD 200. The differences in education levels and earned incomes, were also statistically significant ($\chi^2 = 52.3$, df = 20, $p < 0.001$), at the 95% significance level.

4 - CONCLUSIONS

Measurements of noise levels inside the transit buses in Kuwait have revealed that noise levels inside these vehicles are quite high. In 90 percent of the time during commuting hours, the inside bus noise levels were higher than 75 (dBA), and in more than 10 percent of the time, the levels were in excess of 90 (dBA). A survey of riders, although mostly from among the low-income, low-education groups, showed that these individuals were aware of the noisiness of the bus environment, and expressed annoyance with the noise during their commuting trips. The majority also stated they would have switched to other modes of travel had they not been captives. The study also showed that younger, and more educated riders were more knowledgeable of the negative impacts of noise, such as fatigue, nervousness, and long-term hearing damage. The same was true of those with higher incomes. The study's implication for the KPTC's management is that the noise inside their buses is quite high; that the riders are aware of- and annoyed by, it; and that they will shift to other modes of travel, as soon as, they have the opportunity to do so. If the increase in bus ridership is an objective of the bus-transit policy makers, they will have to make their buses more quiet.

REFERENCES

1. **Singhal S.**, Noise: A giant environmental pollutant, *J. Scientific and Industrial Research* , Vol. 45, pp. 544-557, 1986

2. **Berglund, B. and Lindvall, T.**, *Community noise*, Archives of the Center of Sensory Research, Stockholm University and Karolinska Institute, pp. 58-67, 1995

3. **Carter, N.**, Transportation noise, sleep and possible after effects, *J. Envir. International*, Vol. 22, pp. 105-116, 1996

4. **Belojevic, G., Jakovljevic, B. and O.Aleksic** , Subjective Reactions to Traffic Noise with regard to some personality traits, *Envir. International*, Vol. 23, pp. 221-226, 1997

5. **Koushki, P.A., O. AL-Saleh, and S.Y. Ali**, Traffic Noise in Kuwait: Profiles and modeling residents perceptions, *J. of Urban Planning and Development, ASCE*, Vol. 125, pp. 101-109, 1999

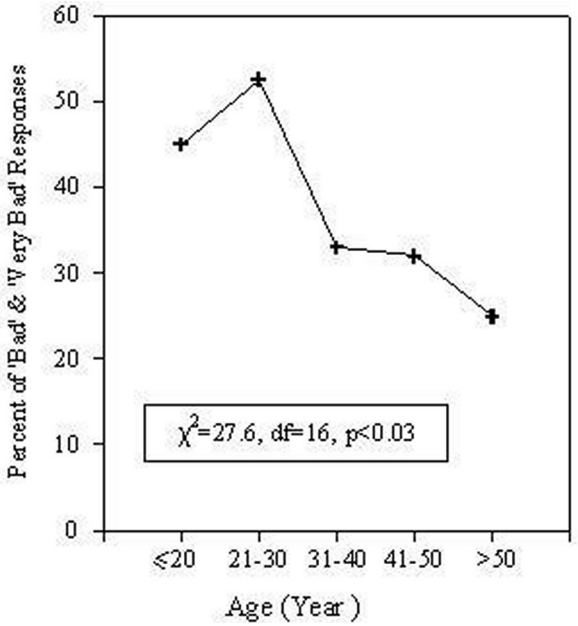

Figure 1: Rider's age and perception of noise inside the bus.

6. **Koushki, P.A., L.F. Cohn, and A.Al-Felimban** , Urban Traffic Noise in Riyadh, Saudi Arabia: Perceptions and attitudes, *J. of Transp. Engg. ASCE*, Vol. 119, pp. 751-761, 1993

7. **Krishan, K and K.Jain**, A study of Noise in various modes of transport in Delhi, *J. of Applied Acoustics*, Vol. 43, pp. 57-65, 1994

8. **Ko, N.**, Traffic Noise in high rise city, *J. of Applied Acoustics*, Vol. 11, pp. 225-239, 1978

9. **Bjorkman, M.**, Maximum noise levels in road traffic noise, *J. of Sound and Vibration*, Vol. 127, pp. 583-587, 1988

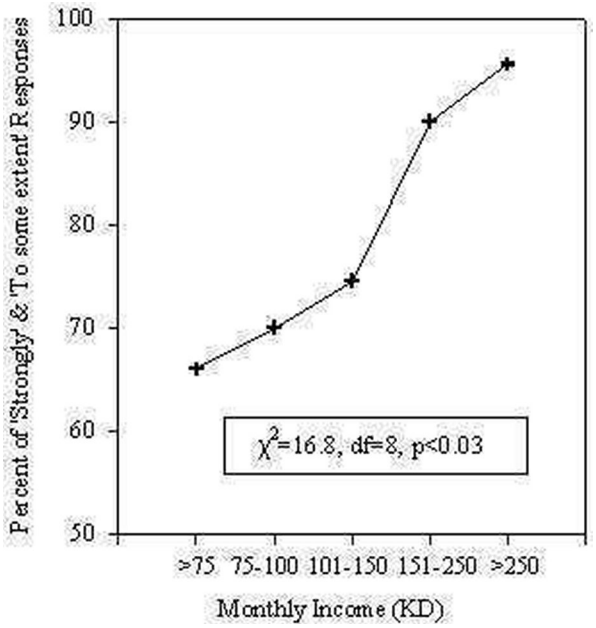

Figure 2: Rider's income and perception of fatigue impact of noise.

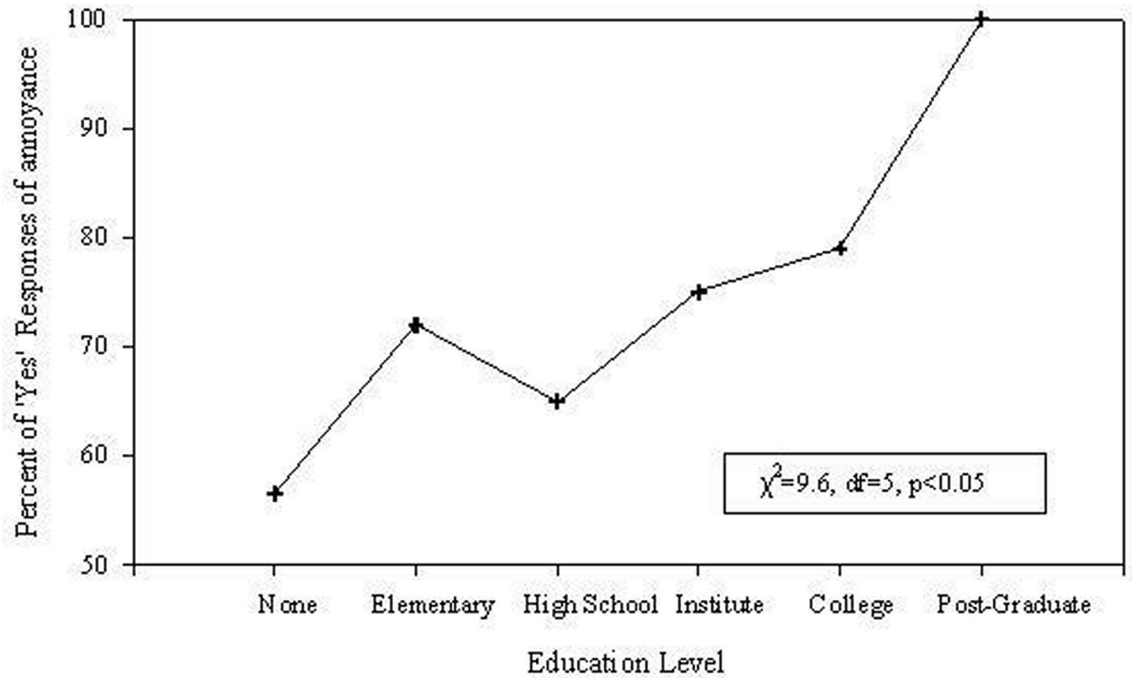

Figure 3: Rider's education level and annoyance with noise inside bus.