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ANNOYING NOISE LEVELS AT HOME: A COMPARISON AMONG DIFFERENT KIND OF SOURCES

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ABSTRACT
The statistical analysis of 267 cases of complaints addressed to local authorities of the city of Modena (I) makes it possible a comparison among average noise levels, by different kind of sources, causing annoyance at home. Data were pooled according to the type of source and comparisons were carried out taking into account the period of the day and the condition of open or shut windows. Significant differences have been found among average noise levels from different kind of sources.

1 - INTRODUCTION

Numerous studies have been carried out on relations between noise levels from transportation systems and people reaction, but not much has been written about other types of sources as machinery, industrial plants and air moving systems which emissions are widespread cause of annoyance [1]. Through social survey authors found thresholds for different type of transportation noise; overtaking these thresholds means people annoyance reaction. On these thresholds Governments base noise law limits. Through statistical analysis of noise levels measurements, taken inside dwellings of complaining people, the present work trys to assess noise level thresholds causing annoyance reactions according to the type of source.

2 - METHODOLOGY

A sample of 267 cases of complaints addressed to the local authorities of Modena (I) since 1987 to 1999 has been studied. Noise measurements have been taken by environmental agency engineers to check limit respect. Noise limit inside the dwellings is based on the difference between noise equivalent level, disturbing source being on, and "residual noise", that is sound equivalent level disturbing source being off: this difference has not to overtake 3 dBA during nightime and 5 dBA during daytime.
To compare noise levels causing complaints the data set has been divided according to four types of sources [2], pooling noise levels from sources having similar emission characteristics [2]. An average value of measured noise equivalent levels has been assumed as descriptor of central trend of data concerning each type of source. Comparisons between two different types of sources average levels have been carried out through "test"; comparisons among more than two average levels have been carried out through variance analysis followed by Student-Newman-Keuls test (SNK).

3 - DATA SET COMPOSITION

Four types of sources have been set: 1) industrial sources, 2) music, 3) road traffic, 4) rotating and reciprocating machines (R&RM). "Industrial sources" are machinery (different from these belonging to type 4) or operations related to factories and workshops. "Music" means reproduced or live music coming from dancing halls, discotheques, clubs, pubs, gymnasiums. According to law, measurements of "road traffic" noise has been taken in facade of buildings: to estimate noise levels inside the dwellings, as well as other sources, noise levels in facade have been decreased of 5 dBA. "R&RM" type includes fans, air compressors, refrigerators, air conditioning systems working into industrial cycles, shops and residential buildings.

Figure 1 shows complaints distribution according to the type of source: "R&RM" type is the most frequent source, counting 53 % of cases; the second is "industrial sources " with 22 % of cases. "Road traffic" is at third place (15 %), perhaps because of its believed ineluctability.
Nighttime complaints are 42 %; 62 % of complaints are referred to an open windows condition. We can associate perceived annoyance, according to this last condition, to noise coming from external sources; in case of hut windows condition noise comes from sources placed inside the building where the dwellings take place.

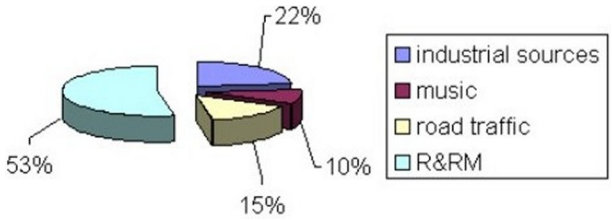

Figure 1: Complaints data set composition according to the type of source.

4 - ANNOYANCE NOISE LEVEL THRESHOLDS

Table 1 and figure 2 show a comparison of average noise levels from different types of source during ***daytime***. With open windows average noise levels are significantly different (ANOVA followed by SNK test, p $\leq$0,05).
So we can say that, during daytime with open windows, "R&RM" cause complaints at lover levels than "industrial sources" and these ones at lover levels than "road traffic". "Road traffic" noise average level causing complaints is 67,5 dBA in facade of building, corresponding to average exposure level of "very often annoyed" people, in the same period of the day and in the same condition of windows, as the Modena survey carried out in 1991 [3] shows.
Average noise levels caused by "industrial sources" and "R&RM" with shut windows are respectively 39,4 and 38,7 dBA with not a significant difference.
The statistical analysis of residual noise levels, available for "industrial sources" and "R&RM" (table 2), shows not significant differences.
Table 3 and figure 3 show a comparison of average noise levels from different types of sources during ***nightime***.
Whether with open or shut windows average noise levels of "music" and "R&RM" are significantly different (t test, p $<$ 0,001 with open windows; p $<$ 0,05 with shut windows).
So we can say that during nightime, with open windows "R&RM" cause complaints at lower levels than "music". The same happens with shut windows: average level is 35,1 dBA for "R&RM" and 40,0 dBA for "music" (t test, p $<$ 0,05).

Source	N.	Average LEQ (dBA)	DS (dBA)
Industrial sources (open w.)	23	56,1	5,2
Road traffic (open w.)	39	62,5	5,2
R&RM (open w.)	53	51,8	5,6
Industrial sources (shut w.)	32	39,4	4,1
R&RM (shut w.)	15	38,7	5,6

Table 1: Average noise levels and descriptive statistics − daytime.

Source	N.	Average LEQ (dBA)	DS (dBA)
Industrial sources (open w.)	20	45,9	6,1
R&RM (open w.)	47	43,2	5,2
Industrial sources (shut w.)	28	34,0	3,4
R&RM (shut w.)	10	33,6	5,4

Table 2: Average residual noise levels and descriptive statistics − daytime.

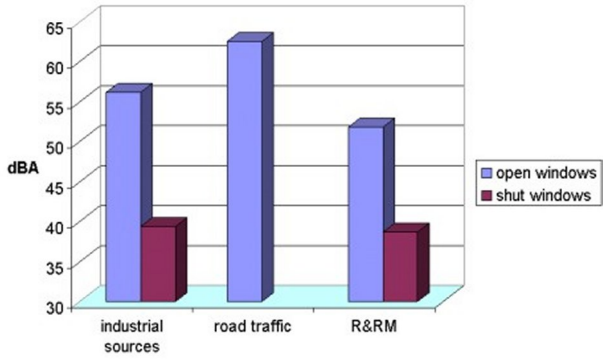

Figure 2: Average noise levels comparison during daytime.

Source	N.	Average LEQ (dBA)	DS (dBA)
Music (open w.)	22	58,1	7,6
R&RM (open w.)	44	47,4	6,3
Music (shut w.)	10	40,0	6,7
R&RM (shut w.)	38	35,1	5,7

Table 3: Average noise levels and descriptive statistics − nightime.

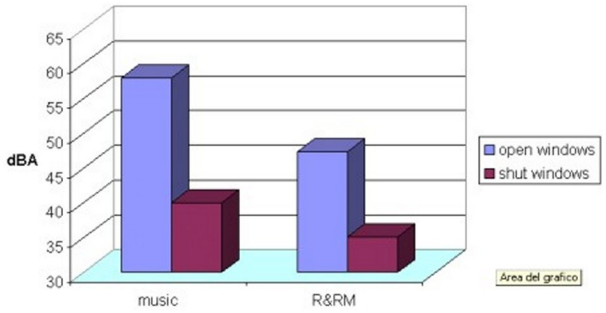

Figure 3: Average noise levels causing annoyance during nightime.

Table 4 shows an average residual noise levels comparison during nightime. Average residual noise levels of "music" and "R&RM" are not significantly different with shut windows; with open windows, people complaining for "R&RM" are affected by residual levels lower than people complaining for "music" (t test, $p < 0{,}001$).

Source	N.	Average LEQ (dBA)	DS (dBA)
Music (open windows)	16	45,8	5,4
R&RM (open windows)	39	38,9	5,5
Music (shut windows)	5	29,2	1,5
R&RM (shut windows)	32	29,1	3,3

Table 4: Average residual noise levels and descriptive statistics − nightime.

5 - CONCLUSIONS

Average noise levels annoying people at home by different types of sources causing complaints have been found. A statistical analysis shows significantly different noise thresholds according to the type of source. This supports the hypothesis that physical characteristics of noise and emission types lead to different people reactions. Steady and cyclic noise from "R&RM", often dominated by tonal component, causes annoyance at lower level than noise due to industrial sources; road traffic noise shows higher threshold levels, confirming results reached in Modena social survey carried out in 1991.

REFERENCES

1. **Berglund B., Lindvall T.**, *Community Noise*, WHO, pp. 16-19, 1995

2. **Bertoni D., Barchi A.**, Il rumore causa di disturbo nelle abitazioni, In *Congresso AIA, Trento*, 1996

3. **Bertoni D, Franchini A, Lambert J., Magnoni M., Tartoni P.L., Vallet M.**, *Gli effetti del rumore dei sistemi di trasporto sulla popolazione*, Pitagora ed., Bologna, pp. 104-116, 1994