



Acoustic comfort evaluation for hypermarket workers

Sabrina Della Crociata*, Antonio Simone, Francesco Martellotta

Dipartimento di Scienze dell'Ingegneria Civile e dell'Architettura, Politecnico di Bari, via Orabona 4, I-70125 Bari, Italy

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ABSTRACT

The paper presents the results of an on-site measurement procedure to assess acoustic comfort for hypermarket workers. The assessment is based on the collection of both objective measurements of environmental parameters as well as subjective ratings of acoustic comfort. The study was carried out in a hypermarket located in Southern Italy, in which four sub-spaces having similar acoustic characteristics were identified. Workers were asked to move to selected measuring points and fill in a questionnaire to rate their subjective perceptions. Measuring points were chosen to represent the typical conditions inside the hypermarket. Factor analysis and linear regression analysis were used to pick up, among the many noise indexes available in the literature, those that could better describe the staff subjective attitude towards the acoustic environment. Finally, by comparisons with subjective “comfort” thresholds, optimal intervals for selected parameters were defined. Analysis showed that the A-weighted equivalent sound pressure level L_{eqA} and the percentile level L_{A90} could be used to describe subjective auditory sensations in most situations.

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1. Introduction

The concept of “health”, according to the WHO, is the result of psycho-physical and social well-being, rather than simply “lack of illness”. It is extended to include global comfort, which depends on several factors such as thermal environment, indoor air quality, visual and acoustic conditions, and is difficult to characterize. Acoustic comfort evaluation is very important in office-like workplaces, in which risk of hearing impairment is often low but annoyance induced by noise noticeably influences subjective health. Moreover, environmental noise causes mental stress and loss of concentration, which can adversely affect worker's performance [1]. By means of collection of both objective measurements of environmental parameters and subjective perceptions, a lot of research has been carried out to study disturbance due to office noise [2–10], the effect of acoustic, thermal and visual environments on indoor comfort in offices [11], and acoustic comfort in urban open public spaces and in noisy and quiet roads [12–16]. Acoustic comfort in schools is very important because noise, in combination with thermal and visual comfort, causes annoyance, and impairs communication, learning and concentration [17,18]. Only a few researches studied acoustic comfort in large-scale retail

trade buildings, investigating in particular the acoustics of large public spaces, like atrium spaces and shopping arcades [19].

Large-scale retail trade buildings include supermarkets, hypermarkets, department stores and shopping malls in ascending order of complexity and dimension. They are characterized by a huge range of products and their environment is not homogeneous, consisting of several sub-spaces with different thermal, acoustic and visual conditions which have to be studied individually. The spread of hypermarkets at the expense of small trade retailing means that greater attention must be paid towards the assessment of comfort conditions in these commercial buildings both for customers and staff. In fact, fixed workplaces for the staff and longer stays for the customers require a greater attention to the global comfort conditions. Hypermarkets' acoustic environment depends on a lot of external and internal acoustic sources, work activities, as well as on customers' confluence.

To evaluate hypermarket's acoustic comfort thoroughly, objective measurements of environmental parameters were collected together with workers subjective perceptions (as they are regular users and know very well their work environment). The aim of this study is to investigate acoustic comfort conditions for workers in hypermarkets, in particular in different acoustic environments, identifying, among many noise indexes found in literature, those that could better describe the staff subjective attitude towards the acoustic environment and that, by comparison with suitable “comfort” thresholds, might ensure an acoustically satisfactory workplace.

* Corresponding author. Tel.: +39 080 5963631; fax: +39 080 5963419.
E-mail address: s.dellacrociata@poliba.it (S. Della Crociata).

2. Method

2.1. Building description

The acoustical environmental survey was part of a research [20] carried out in a hypermarket located in Bari, a city in Southern Italy facing the Adriatic Sea. The shopping center is located in a suburban area, it is situated at road level and consists of a shopping arcade and a hypermarket. The arrangement of different goods on sale is outlined in Fig. 1. The total area was divided into four acoustically homogeneous sub-spaces: warehouse, “quiet” sales area (which includes optician and pharmacy, personal healthcare products, clothing and foot-wear, stationary, TV/video, household appliances and utensils, sports wear), “noisy” sales area (which includes beverages, non-perishable goods, refrigerated decks, fishmonger’s, fruit and vegetables divisions, the frozen food section, full and limited service divisions like butcher’s, delicatessen, bakery and confectioner’s, home cleaning products, brico and seasonal), and checkouts. The checkouts lead into the shopping arcade and hence receive noise from the many cafes, restaurants, non-food stores located nearby.

2.2. Data acquisition

Data were collected from February 2010 to July 2011. Continuous physical measurements were carried out on working days, for time intervals from one to 5 h at each measurement point. At the same time, employees were randomly invited to answer a questionnaire, while they were occupied in their work, moving to the measurement station closer to their usual workplace. Anyway, they were asked to answer considering their subjective sensations when and where the questionnaire was filled in, even if it was not their

customary workplace. The questionnaire was anonymous and it was filled in avoiding any influence from members of the survey team, co-workers, or superiors. Most employees have dynamic jobs and they move between many different areas, so it is hard to define a “reference” fixed workplace. Moreover, as the research included thermal environment measurements, using instruments that are characterized by a slow response time, monitoring and evaluation points were kept fixed (Fig. 1). Their location was decided taking into account the hypermarket layout, the nature and organization of each job and the need for characterizing every workplace [21].

For acoustic measurements, a sound level meter with real-time frequency analyzer and digital recorder was used (0.1 dB resolution and 0.7 dB accuracy). The random incidence microphone was placed at a distance of 1.0 m from any reflective surface and 1.5 m above the floor. Before and after every measurement session the microphone was calibrated with a 94 dB acoustic calibrator. Measurements and sound recordings were taken continuously, allowing the determination of A-weighted equivalent continuous sound level (L_{eqA}), C-weighted peak sound pressure level (L_{Cpk}), time-history in one-third-octave bands from 20 Hz to 20 kHz, and A-weighted statistical levels (L_{A99} , L_{A90} , L_{A50} , L_{A10} , L_{A5} , L_{A1}). In order to correlate objective parameters with subjective responses, acoustic measurements were averaged considering the 10-min interval before the end of questionnaire filling [9].

2.3. Noise indexes

A large number of noise indexes have been defined by many authors in order to describe various aspects of community noise. From time to time, and in varying contexts, each noise index proved to be appropriate to describe subjective auditory sensations of perceived intensity and annoyance, noise sources and environmental

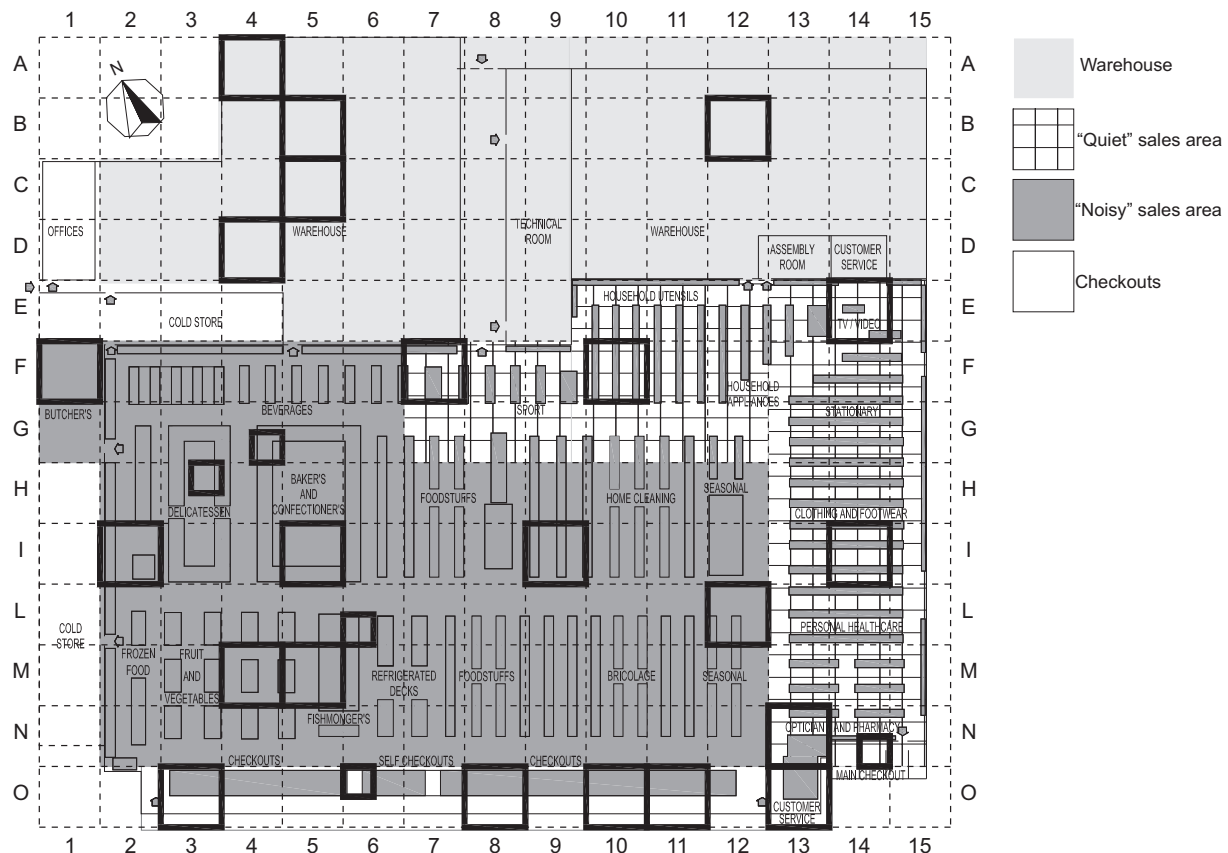


Fig. 1. Hypermarket plan with an alphanumeric reference system to locate surveyed points quickly. Bold squares represent surveyed points. The reference system unit is 10 m.

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