IAQ evaluation of educational buildings

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ABSTRACT
The paper presents the first and the second phases of a work in progress aimed to prepare a guide for the IAQ evaluation of the real estate of the Politecnico di Milano University, intended for the technicians of the university building department.

The overall work is structured in four phases: (1) census and classification of the construction and technical features of the buildings; (2) preparation of a check-list for the detection of hazards based on homogeneous category of building; (3) monitoring of representative building of the Politecnico real estate; (4) proposal of techniques and materials to be used for improving the IAQ.

INDEX TERMS
Control; IAQ assessment; Schools; Construction; Air quality

INTRODUCTION

The real estate of 'Politecnico di Milano' constitutes a very representative example of the complexity that the educational buildings can achieve and, concerning the building technology, we can affirm that this is an out and out catalogue of all kinds of building constructions and technical elements of the last century.

Nowadays, the Politecnico's real estate consists of building types from the historic site in Piazza Leonardo da Vinci, the main seat of Politecnico di Milano dating back to the 30s, until the last realizations into the Milan–Bovisa district. Moreover, the properties include particular locations like the Politecnico's new premises in Piacenza, in the 16th-century building known as 'Caserma della Neve' and some restoration factories in the district at Bovisa (Milan).

The university's administration in April 2001 decided to finance a research titled 'Building policies and management', to investigate all the real estate problems.

In this research, our group worked in the 'Indoor air quality control' section, in order to prepare a guide for the IAQ evaluation. This guide will be particularly intended for the technicians of the university building department but also, together with the proper adjustments, will be able to support any other staff of university's real estate management department.

METHODS

The guide is divided into four parts related to the work phases:

- the first part consists of census and classification of the construction and technical features of all buildings;
- the second part is related to the preparation of a check-list for hazards detection based on a building's homogeneous category;
- the third part concerns the monitoring of some representative buildings of the Politecnico's real estate;

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- the fourth part is related to our proposal about techniques and materials for improving IAQ in the buildings.

For the first part, some cards have been elaborated as follows:

1. Building's evaluation description:
    1.1 Identification of the investigated building.
    1.2 Site evaluation.
    1.3 Climatic evaluation of the district.
    1.4 Building techniques and materials, with maintenance's notes.

A preliminary action is to make a record of the building under assessment in order to obtain basic information, as shown in Table 1.

Table 1 1.1 Identification card of the investigated building

Address
Year of construction
Restoration year
Functional destination
Layout

A very important pointed seen with this card is the functional destination: a building turned into classrooms, with the presence of more than a 100 students, certainly presents a different and more complex problem compared to the office buildings and this factor has been taken into account during the phase of the hazards detection.

Once the building has been identified, the next step is to evaluate the area in which it is located, in order to define how the zone features can contribute, positively or negatively, to the health of the building (Table 2).

Table 2 1.2 Site evaluation

	Yes	No
Heavy road traffic		
Pollution sources in proximity (max 500 m)		
Industrial activities		
High tension line		
Presence of public/private vegetation		
Presence of radon in the soil		

Moreover, it is very important to evaluate the climatic conditions to check in which way the climatic features can have an influence on the building indoor quality: very sunny buildings can be favoured in winter but, without the necessary fencings and/or shadings, also by the surrounding vegetation, these buildings can be penalized in summer; excessive exposure to winds can cause some indoor microclimatic problems (Table 3).

Table 3 1.3 Climatic evaluation of the district

Location features of the district
Belonging to a climatic zone
Presence of predominating winds (yes/no)
Presence of solar radiation in winter (yes/no)

After having achieved more general information about the investigated building, the next step concerns the technical description of the same building, aimed to obtain data for

implementing the second phase, related to the preparation of a check-list for the detection of hazards. In Table 4, we show a compilation example, referred to a specific building known as 'Nave' ('Ship').

Table 4 1.4 Building techniques and products

			Notes about conditions[a]
Building components	Load-bearing structures	Mixed Concrete and iron vertical and horizontal frames	Good
	Exterior walls	Brick masonry	Good
	Exterior finishes	Clinker	Sufficient
	Roofing	Concrete flat roof	Sufficient
	Horizontal structures	Concrete and brick masonry	Good
	Interior partitions	Cavity brick masonry	Good
	External frame windows	Iron	Sufficient
Finishes	Floors	Ceramic tiles, PVC, parquet	Ceramic tiles: good PVC: bad Parquet: sufficient
	Wall coverings	Water based paint, wood panels	Good
	Ceilings	Water based paint, aluminium lath work	Good
Furniture		Plywood elements Upholstered	Sufficient

[a]Good, 5; sufficient, 3; bad, 1.

At the end of this first phase, one has obtained, for each building, the necessary data in order to identify the risk factors with regard to the site, the layout, technical features, building materials and finishing products.

In the second phase all these data are organized: homogeneous category of buildings are identified and, for each, some cards in which we list the risk factors are elaborated (Table 5) and the critical elements referred to the use conditions, to the product exposure and to the maintenance and cleaning operations (Table 6).

Tables 5 and 6 are examples and are referred to a specific building category in which are contained the same characteristic of the building that we described Table 4.

Table 5 2.1 Risk factors

	Risk factors	Risk for IAQ
Site	Outdoor pollutants	SO_2, NO_2, CO, CO_2, PM_{10}
Building age	Material decay	Particle release
	Water infiltration	Microbiological agents
Configuration	Basement	Radon
Building components		
Load-bearing structures	Protection against fire	Fibres release
Closures	Walls-thermal insulation, adhesive, sealing	Particle and VOCs release
Roofing (flat roof)	Water infiltration	Microbiological agents
Internal finishes		
Floors	PVC, parquet	VOCs release, dust
	Wear and tear,	VOCs and formaldehyde release
	Maintenance and cleaning	VOCs release
Interior partitions	Wood panels	VOCs and formaldehyde release
	Surface treatment	VOCs release
Ceilings	Lath work, inaccessibility for cleaning	Dust release
Furniture	Plywood elements	Formaldehyde release
	Upholstered	Fibres, dust release and sink-effect

Table 6 2.2 Critical elements

Critical elements	Risk factors	Risks
Use conditions	Large presence of people	Microbiological agents, CO_2
	Shelf factor and load factor	Release of adsorbed pollutants
	Wear and tear,	Particle and fibres release
	Hygiene and cleaning	Particle release
		Microbiological agents
Building product exposure	Exposure to the air movements	Transport of pollutants in the air
	Exposure to the humidity and high temperature	VOCs release, microbiological agents
Maintenance and cleaning	Inaccessibility to the elements	Dust deposit
	Wet cleaning	VOCs release, microbiological agents

Considering the identified factors, we developed the plan for monitoring the indoor air quality of some buildings with critical situations. The plan contains:

- the procedure for choosing the building-sample to investigate;
- the identification of the parameters to point out;
- the choice of the instruments and the procedures more suitable;
- the data collection;
- the data analysis.

The concluding part of the work, in progress like the previous, consists of the assessment of the results obtained and of the successive identification of some corrective/preventive measures for improving not only the indoor air quality, but also the indoor environmental quality (IEQ).

CONCLUSIONS

The work is in progress—in this paper we presented the first and the second phases—so we are not able to make any definitive conclusions.

However, we can make some remarks: once more it is evident how the many factors that contribute to determine, positively or negatively, the indoor air quality in the building, are so linked that it is difficult to do any kind of accurate assessment.

The difficulty increases when the work's field, as in our research, contains a lot of variables: localization, building shape, year of construction, type of use, etc.

Even though there are difficulties, with this work we intend to offer to the technicians of the university building department an effective support to solve the IAQ problem during the maintenance and restoration operation of the real properties, considering that up until now this aspect was often disregarded.

To offer a healthy indoor environment to the students, future engineers, architects, and also to the university personnel; it is already one way to increase information and awareness about IAQ. Moreover, it may be a starting step in order to train future professionals involved in the building sector.

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