HEALTHY INDOOR ENVIRONMENTS: HOW TO ASSESS HEALTH PERFORMANCES OF CONSTRUCTION PROJECTS

Extended abstract

Stefano Capolongo¹, Maddalena Buffoli¹, Alessandra Oppio²,
Dario Nachiero¹, M.G. Barletta³

¹Politecnico di Milano, Dipartimento ABC, Facoltà di Architettura e Società, via Ponzio 31, 20133, Milano, Italy
²Politecnico di Milano, Facoltà di Architettura e Società, Dipartimento DAScU, via Bonardi 3, 20133, Milano, Italy
³ASL Milano, corso Italia 19, 20122, Milano, Italy

Background

The indoor environments, designed as integrated systems of physical and anthropogenic factors, have a significant impact on the health of communities and are currently one of the major environmental risk factors for humans. The health risk due to a low indoor air quality was strongly acknowledged in the last century when numerous health and hygiene laws have been adopted in order to ensure a higher level of indoor safety and comfort. In recent years, however, (in developed countries) there is a radical evolution of hygiene and well-being needs related to building systems in which individuals live and work, but at the same time laws and regulations have not been upgraded for meeting the emerging needs. The key factors that affect the state of health of individuals and, more generally, of a population are now numerous, interrelated and sometimes conflicting with each other. In the construction field, for example, the energy efficiency is considered a more and more important requirement for the sustainability, but it causes low permeability to air and reduced spontaneous flow of natural ventilation, thus increasing the concentrations of pollutants within the environment (Capolongo et al., 2001). The current welfare needs nowadays more than ever require architectural, technological and engineering solutions, with the aim of protecting the health and actively participating in prevention by parameters no longer associated with perceived well-being as temperature and humidity, lighting, sunshine, humidity control, water supply, waste removal and air quality. However this awareness has not been received into regulations for addressing and controlling the design practice, that have not been updated mostly from the 70s and 80s, with the result that the references contained therein are not anymore comprehensive (Buffoli et al., 2007).

In recent years, the World Health Organization has focused its policies and directives towards strategies aimed at enhancing indoor and outdoor conditions that promote the well-being and protect health in its broader definition (“complete physical, mental and social health and not just the absence of disease”). It is therefore confirmed that health is the result of different socio-economic, cultural and environmental issues directly or indirectly related to the specific characteristics of the environments in which we live. The importance of considering all aspects that contribute to the indoor well-being as driving forces for the human health is also emphasized by the fact that, on average, everyone spend more than 90% of their time in confined environments (home, place work, meeting places, public transport).

According to this strong relationship between built environment and health every government should adopt more significant strategies for the achievement of well-being in this context. In Italy the local health authorities (ASL) are required to verify the compliance of construction projects with health and hygiene regulations. This assessment mainly consists in a mere verification accompanied by opinions often considered as subjective.

This context highlights the importance of defining an instrument in order to objectively evaluate the quality of indoor spaces in terms of health, comfort and prevention and to effectively address designers towards high performance buildings. This instrument called Multicriteria Evaluation Tool for Health (METH) was defined in a

* Author to whom all correspondence should be addressed: e-mail: stefano.capolongo@polimi.it
study carried out by the ABC Department (Politecnico di Milano) in collaboration with the ASL Milano, which currently uses it for the evaluation of all construction projects (new construction and rehabilitation) (Oppio, 2007a, b).

The tool evaluates the strategies adopted at the building scale with a special focus on the air indoor quality, while the health impacts at the urban scale have been considered in a specific complementary tool, always defined in synergy with the ASL Milano (Capolongo et al., 2011).

**Objectives**

Aim of this work is to define an assessment tool, effective and objective for the drafting of opinions regarding healthy housing projects in order to ensure a high level of indoor comfort. In Italy, in fact the local health authority (ASL) are required to verify the compliance of construction projects through health and hygiene, with the regulations and the drafting of subjective evaluations of the project. However, this assessment is often reduced to a mere verification of certain specific regulations recently updated (Building Regulations, Regulations Sanitation) no longer sufficient to ensure a high indoor comfort accompanied by opinions often too subjective.

In the instrument called Multicriteria Evaluation Tool for Health (METH), will also be included strategic directions to guide designers towards technologies and best solutions to wellness.

Through the use of METH, it is expected to improve the living conditions of indoor environments and design processes to trigger more virtuous and encourage a more conscious attitude towards issues of prevention and quality.

**Outline of the work**

The methodology followed for the definition of the assessment instrument was divided into three consequential phases.

The first phase required the comparative analysis of most frequently used assessment tools for environmental quality in Italy and abroad (Itaca, CasaClima, Ecolabel, LEED, BREEAM, HQE, SBTool, Nabers, CASBEE, Sustainable Building), in order to select widely shared parameters for assessing the quality of buildings, the indoor well-being and their effects on the individuals’ health. Since there are not many tools focused solely on health, the research was addressed to the analysis of the buildings’ environmental sustainability assessment systems. In order to better compare the criteria used by the evaluation systems investigated, it was therefore defined a matrix that highlights the importance attached to each parameter and the frequency with which the same parameters are considered within the different instruments. The matrix consists of 84 total parameters divided into 5 main thematic areas and it represents the outcome of the preliminary selection of the large amount of information collected.

This phase has played a fundamental role for the next stage of the process that consists in identifying the thematic areas and in the choice of the criteria for the evaluation of building systems (definitively 15 divided into 5 areas), that has been carried out with the technicians of the ASL.

Specifically, the instrument considers the current regulatory provisions as a minimum standard, assuming that if these were not satisfied the project under evaluation would not be considered entirely appropriate (Signorelli et al., 1999). However, according to a logic shared by the local health authority and aimed to increase the quality of design practice, the mere compliance with the above regulations has not be considered sufficient.

During this second phase, characterized by many focus groups designed to open a dialogue with the technicians of the ASL Milano, was also confirmed the need to differentiate the evaluation system according to the function and the typology of the building to be analyzed. The third phase of the research involved the testing and implementation of the Multicriteria Evaluation Tool for Health (METH). The test was conducted on a sample of 50 case studies located in the city of Milan, selected from an initial sample of 100 projects submitted to the mandatory hygiene opinion of ASL Milano. In order to get relevant feedback on the results obtained for all the different functions, the choice of the projects included in the sample was made with reference to the following building types: hospitals, nursing homes, schools and similar, housing, recreational activities and similar. According to the outcomes of the trial step, the instrument was then developed and improved in some of its critical features and has been developed a specific software. During the three stages of development of the METH has been given great importance to the experience of the technicians of the ASL by brainstorming and focus groups aimed to deeply discuss the emerging issues in the hygiene and health evaluation of plans and projects.

**Methods**

The METH is hierarchically divided into macro thematic areas, each of them is in turn divided into criteria. The thematic areas represent the main aspects of the construction project that may have direct and indirect impacts on health, while the criteria examine a more specific theme. The system developed and tested consists of 15 evaluation criteria grouped into five thematic areas according to the following scheme:

1. Indoor environmental quality - health (1. Thermohygrometric Comfort, 2. IAQ and ventilation, 3. Lighting natural/artificial and views, 4. Noise, 5. Ionizing and not ionizing radiation);
2. Outdoor quality (6. Parking, 7. Green areas, 8. Quality and efficiency of the open spaces);

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5. Quality of service (15. Building management).

For each criterion has been prepared an explanatory tab containing all the information necessary for evaluating the construction projects. These tabs also include a special section dedicated to the best practices in order to guide the designer. The explanatory tabs of each criterion are articulated in the following points: description of the criterion, health effects, goal, evaluation according to different functions, best practices, technical standard and regulations.

The definition of the performance judgment for each criterion has been carefully designed in order to minimize the subjectivity of the reviewer. Consequently, for each criterion has been specified three different qualitative performance judgment:

- a good judgment in the case of a significant improvement of hygiene performances compared to the standards established by the laws or regulations in force and to the common practice;
- a critical judgment in the case of a moderate improvement of hygiene performances compared with the standards established by the laws or regulations in force and to the common practice;
- poor judgment in the case of mere compliance with the minimum hygiene standard defined by the laws or regulations in force.

Each qualitative judgment has been linked to a quantitative score: 3 for good level, 1 for the critic and 0 for the poor. It is clear that the end of this kind of articulation of the judgment is to improve the current design practice beyond the legal requirements, assuming that if these are not fully satisfied the project would be not considered suitable. The judgments obtained at the level of the 15 criteria contribute to the definition of each macroarea’s judgment (good, critical, insufficient) and to the final evaluation of the project analyzed (good, critical, insufficient). However, it is important to highlight that since the 15 criteria do not all have the same influence on the health status, they have been appropriately weighted. Specifically, to each criterion has been assigned a weight according to both health impact (low = 1, medium= 2; 3 = high) and to the number of components of the health status involved (physical well-being, social well-being, psychological well-being ). The weight of each criterion, understood as its impact on the individual health, is given by the product of the scores thus obtained, subsequently normalized with respect to the sum of the weights.

The score of each area of evaluation is given by the weighted average of the scores obtained by each criterion, while the total score of the project is obtained from the weighted average of the each assessment area’ score.

On the basis of the minimum and maximum scores 3 intervals of the rating scale, were identified which correspond to three different performance judgment: insufficient if the score is between 0 and 1; critical if it is between 1 and 2; good if it is between 2 and 3. In order to support the evaluation process and to facilitate the communication of the performance level of the projects evaluated, an Excel software was developed (METH_vers01).

It is important to note that the proposed methodology to be used in its entirety by evaluating each criterion through the sub criteria and their judgment and not merely attributed to the reading of the final numerical data. Starting from the application of the METH on 50 case studies, it was noticed that in some sporadic situations specific criteria could not be considered. Thus was introduced the possibility of excluding the criteria to be not regarded as applicable. In the case of the absence of one or more criteria, the criteria’s weights are automatically recalculated by the system.

The program also develops different graphs that can effectively communicate the outcome of the assessment, the strengths and the weaknesses of the projects evaluated: a radar diagram that shows the score obtained by each assessment area in the range between 0 and 3, a histogram showing the overall score, a histogram showing the distribution of scores for each area of assessment. The METH developed in collaboration with the ABC Department of the Politecnico di Milano and ASL Milano, has been tested on 50 projects related to buildings located in the city of Milan. The building projects on which it was decided to test the instrument were selected on a first sample of around 100 projects actually submitted to the ASL Milan for the mandatory hygiene opinion. The selection was based in order to include different building types, as hospitals, nursing homes and similar; schools (of different ages); homes, offices, buildings for the leisure and sports; retail. The application of the evaluation tool, carefully documented at every stage in order to have an adequate feedback, took about 6 months of work.

Each case study was analyzed by focusing on the description of the project, the location, the type of intervention (new construction, redevelopment total or partial), the qualitative judgment (15 criteria), the outcome of the analysis (matrix and graphics) and any comments found. The objectives of the trial were different: in the first place was important to verify the consistency of the assessments made by METH with the guiding principles of the experience. Consequently, for each case study carried out a comparison between the assessments made by METH and the hygiene opinion defined through the traditional assessment procedure ASL mostly based on to the subjectivity and the limited experience of technicians. Secondly, it was important to assess the applicability of the instrument, any critical and timing of use of the same.

Finally, the application of the tool has highlighted the current level of the quality and hygiene performances of construction projects. The evaluation tool it should also enhance the design healthier and more livable buildings
beyond the mere compliance with the law, often outdated, contradictory or inadequate to ensure high level of indoor air quality.

Results and discussion

From the application of the evaluation tool to the case studies, it has emerged that in all cases the assessments made by instrument have touched all the major issues able to influence directly and indirectly on comfort. The strengths and weaknesses highlighted by the METH were greater, more complete and consistent than the traditional system linked to the experience and subjectivity of ASL assessors.

However, it was found that in some rare cases of projects evaluated (8%) certain criteria were not evaluable. For example the criterion parking or green space criterion in the case of a redevelopment of a surgical unit in a health facility: the endowment of green spaces and car parks in fact depends on the entire building project – all the hospital and not only the redevelopment the individual department-block. For this reason, in order to make the tool broadly applicable, it has been introduced the possibility to exclude from the assessment system (on the basis of a specific motivation) those criteria that “cannot be evaluated”. The application has also highlighted the need to request some technical integration to designers, as the sub-criteria are often not deeply explicated as it emerges from the technical reports traditionally delivered to the ASL. Specifically, the 28% of cases were judged as insufficient for the presence of sub-criteria that were not assessed due to the lack of documentation (90%) and for the presence of criteria not applicable (10%). Only for the 40% of the cases, the documentation has been considered sufficient and comprehensive for the evaluation of METH, an aspect that highlights the lack of attention to some specific issues. In the above mentioned cases, the instrument has detected simple, effective and rapidly implementable.

By comparing the assessments developed by different technicians on the same projects it has been possible to verify the objectivity of the instrument. Regarding the results of the application, the analysis has showed that among the cases analyzed, the 84% had achieved an overall low judgment, the 12% a critical one and only the 4% has pursued a good judgment. In particular, as regards these latter cases, it is possible to observe that has been paid a great attention to the following thematic areas: the indoor air quality, waste and resources and quality of service, while the most overlooked topics seem to be outdoor quality and quality of the project. Furthermore, by considering the prevalence of judgment “insufficient”, it must be highlighted that it does not mean that the project is not consistent to the regulations but simply that it was achieved the minimum standard neglecting the concept of quality and prevention. In this sense the use of METH should gradually address to design healthier buildings and more livable beyond the mere compliance with the regulations. The use of an Excel software could be considered as very effective as it allows to clearly focus on the strengths and weaknesses of the projects under evaluation, enhancing the introduction of appropriate corrective actions (short-term strategies) and addressing interventions towards the achievement of higher levels of sustainability (long-term strategies).

Concluding remarks

The need to promote health starting from the quality of the built environment, has led to the definition of a multi-criteria evaluation system with the aim of supporting the preparation of the hygiene opinions the ASL are called to draw about construction projects.

As for the efficiency, rapidity and clarity of sanitary assessments, testing of the tool gave a positive outcome and the implemented version of the METH is currently being used by the ASL Milano. For this reason, it is hoped that the METH will soon be also adopted by other Italian ASL calls to the evaluation of projects.

Keywords: assessment, comfort, health, hygiene, projects

References