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THE QUALITY OF THE INDOOR ENVIRONMENT – A FOCUS ON THE ASSESSING METHODS

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ABSTRACT

The objective of the present study was to define the problems met by the members of a project (designers, architects, building owners) in term of global comfort. The question of global comfort concerns the different stages of building design and on the building exploitation. To assess the indoor environment quality, different criteria have to be taken in consideration according to the building knowledge stage:

- Satisfaction of an indoor environment projected compared to the technical specifications;
- Definition of the indoor environment quality by selection within a set of pre-defined classes;
- Comparison of several indoor environments.

In order to help the members of a project to solve their problems, it will be defined the technical specifications of a decision support system.

1. INTRODUCTION

During recent years, concern among scientists, health professionals and regulators have been growing about indoor air quality. It is well established that a number of pollutants occur indoors at levels that exceed those outside [2,3] and most people spend the majority of their time in the indoor environment. A recent survey found that individuals spend approximately 87 % of their time indoors, 7 % in or near a vehicle and just 6 % outside [4].

Despite the occupants requirements related to a comfortable life and workplace, designers and builders do not attach sufficiently importance to the environmental comfort during building design and construction. This is probably due to an inadequate understanding of the subject by designers and builders and a lack of information concerning the available design methods. Therefore, it seems opportune to assess the indoor environment quality defined according to the following five themes: thermal, visual, acoustic and olfactory comfort and air quality [1]. The criteria to be taken in consideration to characterize each component were

listed, as well as the principal application field of indoor environment quality in the buildings. In first time, it will be presented the study context through the building design and exploitation, then the various types of encountered problems and lastly, the technical specifications of the data processing tool to solve each multicriterion problem.

2. BUILDING DESIGN

The building is a complex object whose life cycle (design, realization, exploitation, and demolition) mobilizes the activity of many members having each one their specialities and their techniques. The question of global comfort arises on the various levels of building design; that it is for the technology option, pre-dimentioning or detailed study [5]. The following diagram shows the design process modelling of the building. To pass from a design level to another, we carry out cycles until obtaining stability of the solutions and to do not return to a lower level. These cycles include a proposal –assessment – analysis – and modification stage.

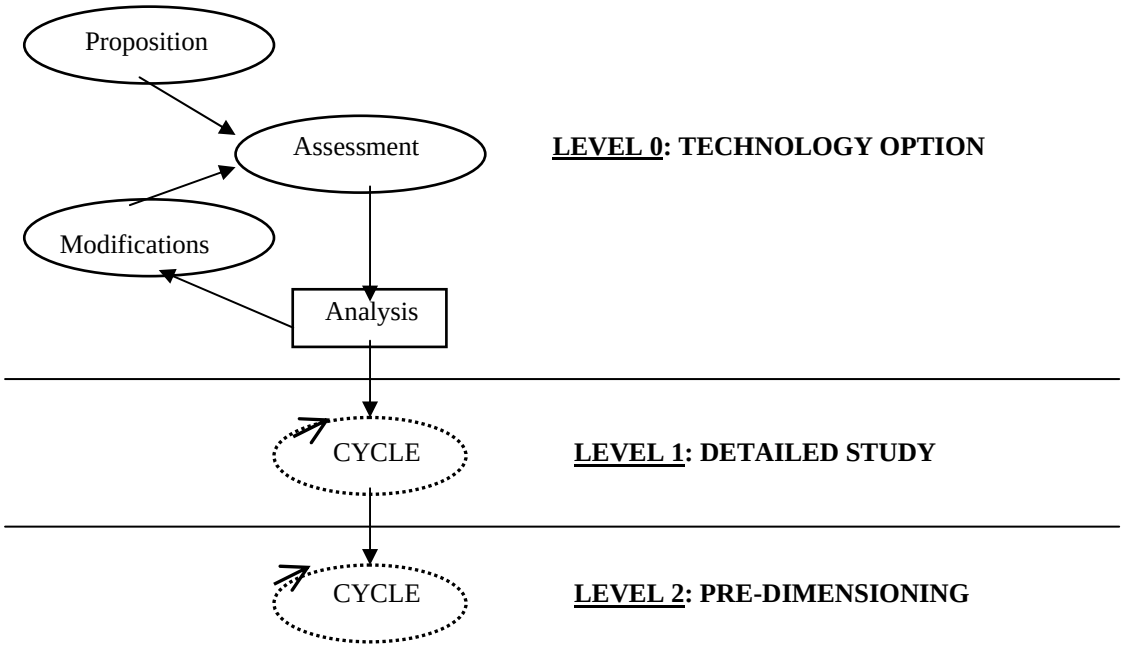


FIGURE 1. DESIGN PROCESS MODELLING

It will be intervened as well in stage of assessment as in the stage of analysis. In stage of evaluation, the performances of projected indoor environment will be determined. Of share this dynamic aspect of the design, the building object is not seen in the same way on level 0 as on level 2. The question of global comfort also arises in building exploitation, which covers in particular, the replacement of the equipment or the building refurbishing. The problem of global comfort is multicriterion by nature [1]. The criteria to be taken in consideration to define global comfort are indeed different according the levels. Thus, to want to have a single criterion, even on each level, would be illusory. The use of a synthesis single criterion, obtained by aggregation, would leave the decision-maker dissatisfied, because it tends to realize the average of the differences. The various types of problems will be defined in term of global comfort, met by the members of a project.

3. THE DIFFERENT TYPE OF COMFORT PROBLEMS

Exposure to different pollutants in the indoor air can be related to various perceptions, comfort and health effects. A common problem when elucidating health problems with a possible relation to indoor air is that the symptoms often are diffuse and their occurrence is widespread in the population. Even if the symptoms are observed more often when the indoor air quality is poor, it is rare to find a clear casual relationship with the indoor environment. Even our knowledge in the field of indoor air often is incomplete, it is important to underline the impact of good indoor air quality in a health and comfort related perspective [4,5].
The situations in which it is necessary to assess the global comfort are presented here. The stage is very important because it permits to establish, according to the situations, various strategies of reasoning to solve the problem. After discussion with professionals of the building, it seems that people are confronted at least with the three following problems:
- Satisfaction of an indoor environment projected compared to the technical specifications;
- Definition of the indoor environment quality by selection within a set of pre-defined classes;
- Comparison of several indoor environments.

For the members of a project, one of the problems most frequently is to know if projected indoor environments answers or not to the technical specifications given. The technical specifications being defined by a list of a criteria set and performances associated. To solve these questions, two steps must be adopted:

3.1. Satisfaction analysis

In this case, it will be considered that the projected indoor environment is accepted if all the criteria answer of the technical specifications. If at least one of the criteria is not satisfied, indoor environment is then refused.
Using formal examples, we illustrate three methods to determine the indoor environment performance and the technical specifications:

- Single average value

On the figure 2, the indoor environment quality is defined by four criterions. In Y-axis is represented the preference. Thus more the preference is large, better is the performance. So that an indoor environment is satisfactory, it will be necessary that its profile be strictly with the top of the technical specifications. On the figure 2 the indoor environment will be refused because the performance of I_B criterion is lower than that imposed.
A weak failure of a criterion can generate the refusal of indoor environment. The use of an interval to define the technical specification performances seems more adapted.

- Interval on the technical specifications

In this situation the indoor environment will be accepted if its performance value, for all the criteria is included in the interval defined by technical specifications. For the example, given to the figure 3, the indoor environment will be refused.

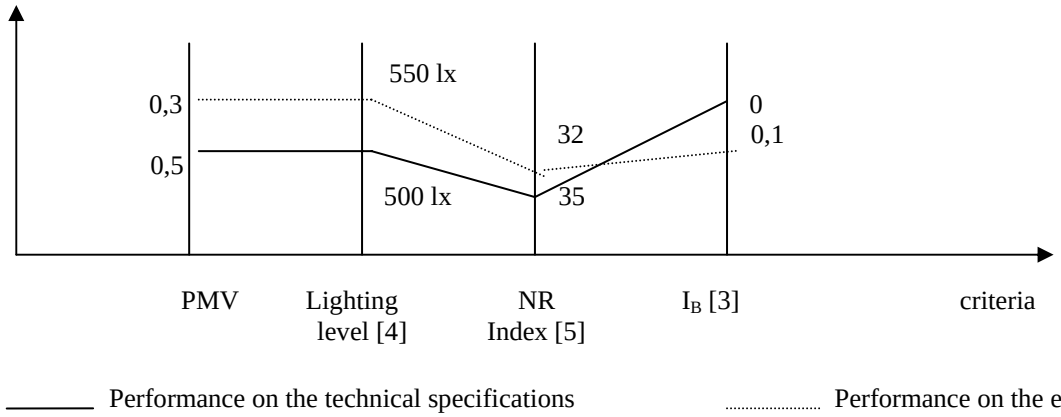


FIGURE 2. SINGLE AVERAGE VALUE FOR THE PERFORMANCES

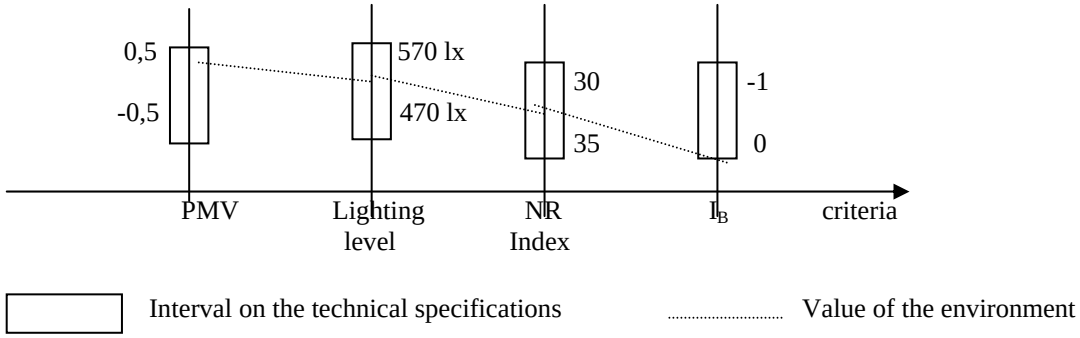


FIGURE 3. PERFORMANCES REPRENTED BY AN INTERVAL FOR THE TECHNICAL SPECIFICATIONS ONLY

- <u>Interval on the technical specifications and on the indoor environment</u>

It can be finally defined an interval for the indoor environment assessment to take in consideration the calculation uncertainties, for example: we accept the indoor environment if for all the criteria, the intervals are encased. We accept to that they straddle (NR index). In the case of disjoined intervals (I_B), we refuse the indoor environment.

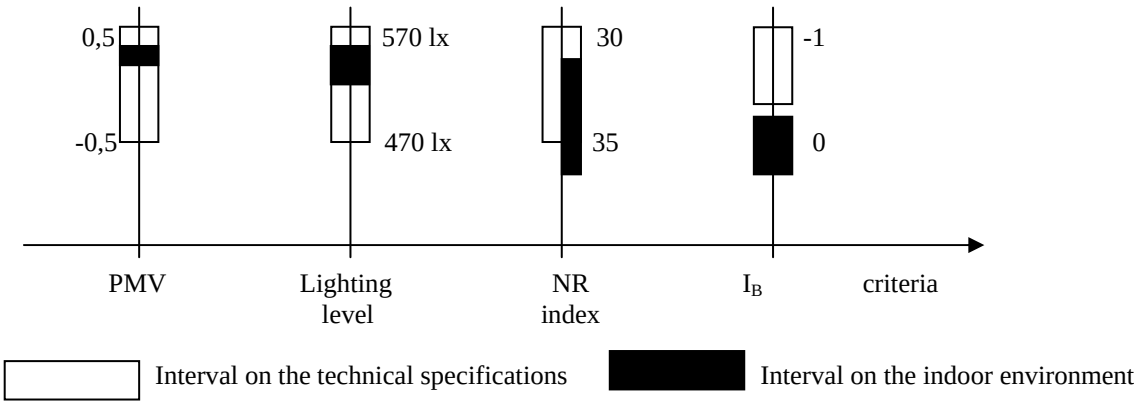


FIGURE 4. PERFORMANCES REPRESENTED BY AN INTERVAL IN BOTH CASES

This approach, by satisfaction analysis, does not leave action liberty and does not authorize any gap on any criterion; it is thus a very strict procedure. One-second way of tackling the problem can be considered.

3.2. Development of an assignment procedure

Compared to the previous situation, we envisage here to accept the indoor environment even if the performance of one or more criteria is not satisfactory. The indoor environment will be accepted if the difference with the technical specifications are not significant. We will refuse it in the contrary case. It were defined two classes (figure 5) and the problem is to assign indoor environment to the one of the two classes.

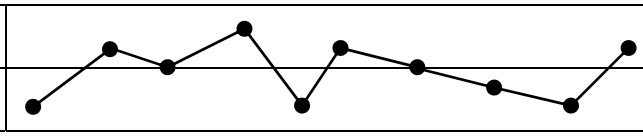
Class 1: The environment satisfate to the specification document	
Class 2 : The environment do not satisfate to the specification document	

FIGURE 5. CLASSES OF SATISFACTORY INDOOR ENVIRONMENT OR NOT

In multicriterion analysis, some authors [6,7] define this problem as sorting problems, which consists in assigning an indoor environment to one of the two categories. To solve this dual problem should be used the method by which is defined a reference indoor environment corresponding to the border between the two classes. By the means of a calculation of concordance or discordance index, are established then outclassing relations between the projected indoor environment and the reference indoor environment. Then, a class can be assigned.

4. TECHNICAL SPECIFICATIONS OF DATA PROCESSING TOOL

As it was just shown, the problems met by the members of a project are numerous. Faced with these multicriterion problems, the experts do not agree necessarily as for the criteria and resolution methods to be taken into consideration. We propose the use of a tool named Decision Support System (DSS), which is composed of two modules:

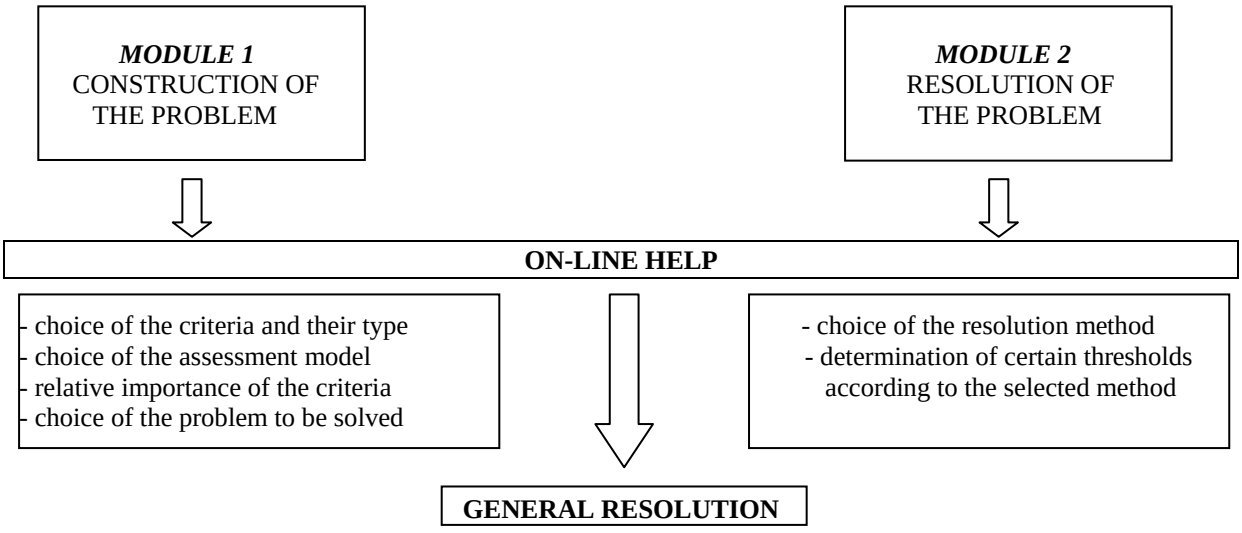


FIGURE 6. TECHNICAL SPECIFICATIONS OF A DSS

In a first, the user will must to establish the “decision matrix” through stages indicated on figure 6. The decision matrix is a table which gather the performances reached by the different indicators of each indoor environment. For each one of them, an on-line help will be offered to the user.
In a second module, the user will determine thresholds of concordance, discordance, and preference or of indifference according to the selected resolution methods. An on line help will be still proposed to the user.

5. CONCLUSION

The designers do not approach some essential points of the formulation of global comfort problems. This is probably due to an inadequate understanding of the subject and a lack of information concerning the available design methods. Most of the work consists to solve these problems arising from designers. For that, are implemented various reasoning strategies and adapted methodological tools. Lastly, in the definition of an indoor environment is it necessary to work on the local scale, that of a room for example, or must we consider building set from the start. We will try to propose methods to pass from the global comfort of a room to that of the building scale.

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