Participatory Evaluation of Performance in Public Buildings. The Case of Historic Buildings of the Ministry of Public Works, Chile.

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Abstract
Sustainability in public buildings not only means appropriate design aimed at reduced energy demand and low environmental impact. It is most important to provide a safe and satisfactory environment for diverse users under real working conditions. With this in mind, an evaluation method was devised to allow users to assess their working environment and to keep a positive attitude towards improvement. Management decisions are usually made in a top-down approach oriented towards energy savings and the fulfillment of compulsory standards, but a close view of details, diversity of requirements, personal preferences is rarely considered in the audits, raising doubts on the value of results. In order to close the gap, a bottom-up approach was applied to a large complex building of the Ministry of Public Works, involving over 2,000 workers. The method included workshops, surveys, interviews, walk through, measurements and recordings. Variables and metrics were discussed and chosen with the users as well as their acceptability thresholds. A labeling method was also devised in order to identify deficiencies and to facilitate following-up. The response from nearly 500 employees was recorded and processed. Experts also visited the premises and produced independent reports. Information from both sources was then crossed and mapped. Those areas revealing contradictions were objectively evaluated by monitoring relevant variables. The results were presented to users, a priority was stated and a course of action was defined including deadlines and responsibilities. Wide participation and enthusiastic commitment was achieved thus helping to establish permanent self-management procedures.

Case study, Chile, POE, survey, field assessment, usability (key words)

Introduction

The need for this study was the concern of both employees and principals of the Ministry of Public Works about the performance of an old building that cannot be modified and, at the same time, will not comply for much longer the current environmental, energy efficiency and safety standards. The requisition asked for a diagnostics as well as a management program, but emphasized the need of a participatory approach, under the framework of the Ministry Modernization Program [1]. A conventional approach to face an obsolete building will most likely lead to a centralized automatic management system, which would not fulfill the participatory objective, so a purposely approach should be proposed and approved. The study was carried out by a multi-disciplinary group, including specialists in passive systems, active systems, power systems, comfort, field measurements, energy management and health and safety.

The Buildings

The headquarters of the Ministry of Public Works are located facing the Presidential Palace in the historic center of Santiago de Chile. Its eleven stories structure consists of 5 blocks built between 1937 and 1960, all of them especially heavyweight, quake-proof reinforced concrete. Current built area is around 39,000 sq. m. and occupancy is over 2,000 people. The massive structure has inner lightweight partitions which design has responded to many independent refurbishment projects, ending in a diversity of fabric and finishing. Most areas are occupied by offices, but also there are specific space uses like health care, cafeteria, auditorium, maintenance workshop and others.

The facades have no thermal insulation, in common with the current standard construction practice in Santiago. Central heating is provided by several boilers through radiators, but only a fraction of them are still in operation. Air conditioning has been added locally in some premises and there is no chilled water system. Ventilation is provided by opening windows. No ducts are built in, except restrooms and cafeteria, where mechanical extraction is provided. Lighting is mostly fluorescent with T8 tubes and conventional ballasts.

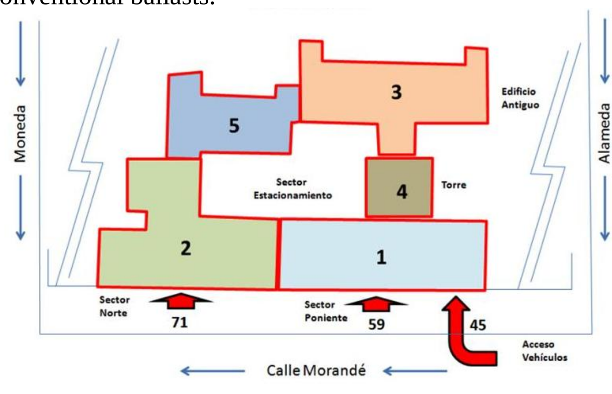

Fig. 1 Schematic plan of the five stages that were developed for the Ministry of Public Works since 1937.

Methods and Optimization

According to the nature of the study, both objective and subjective methods were applied. However, given the extent of the building, not all methods were applied to all situations, for which a screening stage was necessary and a careful selection of the criteria to be applied.

Taking the second floor (out of 11 stories) as a pilot, the methods for getting data were tested and analyzed in order to optimize significance and to reduce redundancy. At first, an informal meeting allowed the team to introduce themselves, to present the aims of the study, to ease doubts and to gain confidence among the employees.

Next step was the distribution of a pilot survey with questions and ratings on the environmental conditions. The team took a round throughout the second floor to verify the validity of terms used in the survey, to examine the range of conditions to be found and to measure times to complete the information. From these results, a dataset of significant variables was selected in agreement with the community and reduced to those in following tables.

The results were the forms for recording data and their way of processing. In most cases a 7 point scale was used since it is the method of evaluation used by schools, therefore was easily understood by users with no further explanation.

The aspects of risks were particularly significant in the perception of the building users, leading to a number of complaints that were reflected by including a number of variables related to material quality and safety in the final survey design.

Other questions involved type of clothing or other attitudes that show indirectly the comfort perception.

Table 1. Building environmental performance variables

ENVIRONMENTAL QUALITY			
	Air quality		Acoustics
	Lighting quality		Thermal perception

Note: Humidity was not included as not considered a significant issue.

Table 2. Building material and safety variables

MATERIAL QUALITY		SAFETY	
	Building shortcomings		Tripping hazard
	Maintenance faults		Falling objects

	Uncontrolled openings		Spills
	Emergency exits		Electricity hazard
	Ergonomics		Fire risk

The main survey was distributed to 542 users achieving a reply rate of 67%. The high rate of participation reveals the interest that rose during previous activities.

The survey was organized in coordination with physical visits dedicating a full week to each story. Users were requested to guide the team and produce information that was not apparent at the time of visit.

The walk through survey included at least 3 experts recording in detail all signs of right or inadequate working conditions, as well as risk situations. Pictures were taken thoroughly and every point worth reporting was marked in situ with a label identifying the problem. Same symbols were attached to floor-plan schematics. All signs of user alterations were also discussed and reported.

Figure 2: Example of a label for signalling a visual deficiency

At the same time, interviews were carried out with key users and individuals in charge of either operation or maintenance of the buildings. Records of complaints were examined and the paths of the actions taken. A number of pending jobs were identified.

An inventory of electric appliances was also conducted, as well as a check of the working loads in the power distribution boards. A number of undocumented circuits made more difficult the assessment of compliance.

Environmental measurements were only performed after information was collected and specific conflicts were identified. In particular the less evident problems or disagreement between users were considered as most appropriate for measurements. There were taken as evidence to confirm the cause of dissatisfaction or a non-fulfilled standard.

In short, at all stages the study was guided by the occupants' experiences collected. Behind them were the expert’s judgments and the instrumental observations.

Survey Results

Most frequent problems were areas particularly cold or warm, even some were not occupied which clearly showed dissatisfaction. Also complaints of glare and lack of adequate ventilation were frequent. Problems of noise and lack of privacy were rare. Few odor or mold problems were found. A surprisingly and unpleasant frequent problem was static electricity from wooden laminated floors.

Figure 3: Example of recording visual and cold problems.

Figure 4: Example of recording noise and ergonomic problems.

As expected, most conflicts were located near the West facade, which is exposed to excess solar radiation, even the rather small glazed area. The use of solar control devices is not currently allowed because of historic conservation rules. However, many problems could be mitigated by using external blinds.

Physical distribution of problems was analyzed jointly with users by means of symbols displayed in plan layout drawings. Users were particularly sensitive to being represented in their appreciations. After discussion they were fairly conscious of the symptoms and causes that were worth keeping in mind.

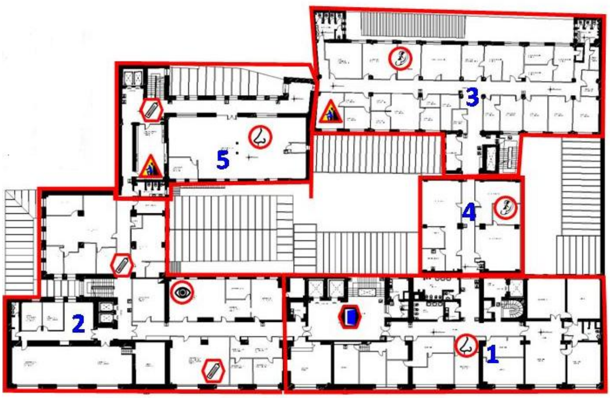

Figure 5: Example of symbols location in a floor-plan.

Tables were also made to analyze statistically the occurrence of dissatisfaction and/or risks reports. A comparison between the user's judgements and the expert's judgements was made. Disagreement was frequent and focused discussion. From this discussion a priority criterion was agreed for qualifying each problem and make decisions about the due actions. The priority level was given through a matrix stating the frequency of occurrence vs. the severity of the problem. High priority calls for immediate action, medium priority calls for a specialized technician visit in a short term and low priority means the problem should be paid attention during next routine maintenance.

Table 3. Matrix of priorities for reporting problems

	Frequent	Likely	Occasional	Infrequent	Unlikely
Severe					
High					
Moderate					
Low					

The priority level is stated in the label placed at site and in the report send to the management by users. Every user can follow-up the history of the reported issue by an intranet channel.

As a part of the consultancy, a user manual was prepared and presented to the community. It gives instructions for assessing and reporting any observation related to environmental, energy, ergonomics or safety issues. It also explains the way of following-up the course of action after a report. Committees were formed in some section with those users more interested in learning and assuming a leading role in their group. Many users showed their interest and commitment with the participatory approach and join these committees voluntarily.

Measurements

Two kinds of measurements were conducted: continuous monitoring and short samples. The first typo was used for temperature, humidity and noise, acquiring data during 24 hr periods at selected workplaces. The second included CO_2, illuminance, radiant temperature, air velocity and thermal imaging.

Figure 6: Example of illuminance and CO2 sampling at desk level

Cold spots and thermal bridges were looked for with infrared thermometers. Facades were also checked for unusual temperatures, thermal bridges and air infiltration.

Figure 7: Example of radiant temperature measurement.

Verification of minimum standards fulfilment was also done, relative to health regulations [3]. At all places where deficiencies were reported, measurements allowed to state the actual condition. Tables with these results were discussed with users.

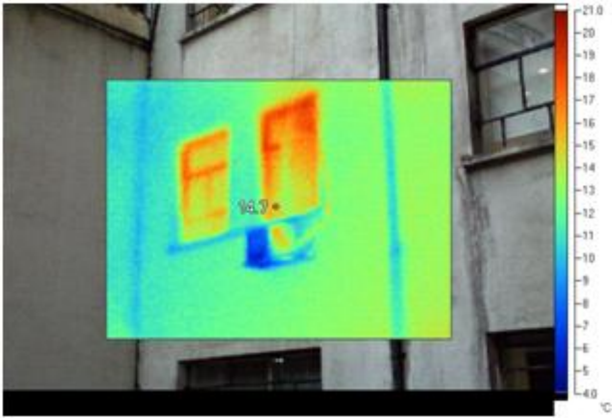

Figure 8: Example of thermal image of uncontrolled heated air leaking through windows.

Measurements of air velocity were made with hot wire anemometer where complaints were reported. Also CO2 measurements showed low values and little correlation to complaints about air quality. This results were surprising low for a building without mechanical ventilation and numerous partitions dividing deep plan offices.

Table 4: Example of verification of CO2 concentration in the second floor. Three out of 16 places that reported discomfort are out of range.

Punto	Sector	Recinto	CO2 [ppm]
1	2	Pasillo Sector Administración	325
2	2	Oficina 238: Subdepartamento Conservación por Administración	863
3	2	Unidad de Administración y Control de Gestión	619
5	2	Pasillo Interior	560
6	5	Oficina 246: Archivo General Oficina de Partes, Vialidad	590
8	5	Servicio Bienestar - Finanzas	1500
9	3	Sector Cerrado por puertas de vidrio Acceso Norte	950
10	3	Sector Cerrado por puertas de vidrio Acceso Norte	826
11	4	Oficina 208: Departamento Secretaría Técnica	1127
12	4	Oficina 213: Subdepartamento de Sistemas	1414
15	1	Oficina cerrada, sin ventilación	867
16	1	Oficina Secretaria, sin ventilación	980

Data from temperature and humidity measurements were also graphed in Givoni diagrams [4]. in order to better describe the comfort ranges to users. Most places showed conditions within comfort range, which remarkable for a building having poor HVAC systems and relies mostly on a large thermal mass, very effective in the climate of Santiago de Chile. Only a few places showed overheating.

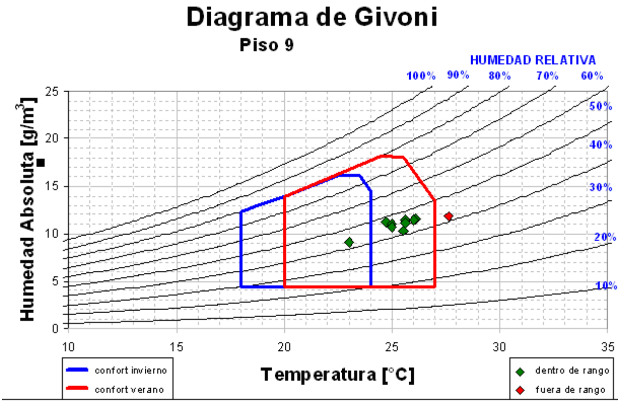

Figure 9: Example of Givoni diagram for 10 samples taken at 10 workstations on the 9th floor.

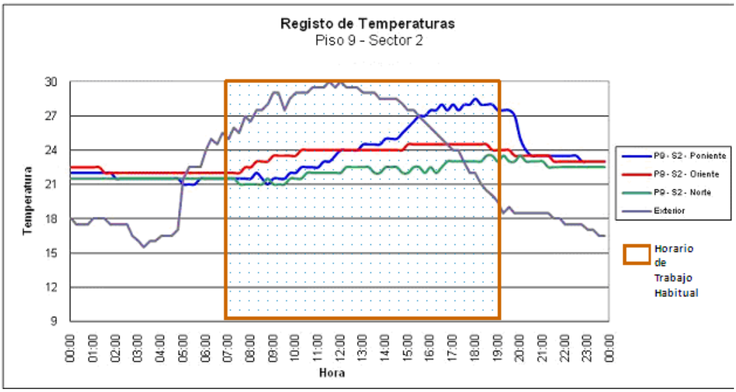

Figure 10: Recording of temperatures at several positions in 9th floor (Summer).

In this way the measurements are used to verify if there is coincidence between subjective judgements about comfort and physical conditions. Where a problem is confirmed, such as overheating during late afternoon, measurements are a useful tool for sizing and designing solutions.

Benchmarking

The method was also applied by Pacheco [5] to a recently refurbished building, verifying that the scales used are compatible with the BUS occupancy survey method [6]. In this way the results could be standardized for benchmarking purposes.

Even though there are no enough data in Chile for statistical analysis of public buildings, it is long needed to establish a recognized method for rating their performance under a common set of variables and scales. The approach proved to be robust and widely accepted by the users.

The key steps to get useful information with the help of high participation were:

a) Interviews and focus groups to identify most sensitive subjects
b) Standard survey to obtain wide coverage data
c) Guided walk-through by experts, eye checks and inventory
d) Cross-check and mapping of identified problems
e) Measurements at relevant workplaces
f) Delivery of results and self-managed tools to the community

The extensive use of these methods could be a significant contribution to the usability of public buildings, the effectiveness of management and the productivity of occupants.

Conclusion

This study confirmed the validity of relying on user's judgments as a main source of quality assessment regarding comfort and safety at work.

Participatory activities are time consuming and difficult to initiate, but produce rewarding results. In particular permanent commitment with energy efficiency programs, better understanding of the building dynamics and a system for making priority oriented decisions are among the most relevant results.

Another conclusion is that a building conceived with little concern about energy efficiency can provide satisfactory working environments provided it is operated keeping its limitations in mind.

The thermal performance of the building in a climate like Santiago, with temperature daily ranges over 15 K is largely dependent on its huge thermal mass, a decision made in this case on institutional grounds instead of energy strategy, but with a remarkable success given the local climate.

The reported combination of interviews, survey, walk-through and measurements proved a robust tool for assessing performance as well as user satisfaction.

8. References

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