

Better Places for People: Health and Wellbeing Measurement Methods in Workplaces

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ABSTRACT

Considering we spend about 90% of our time in built environments, it is crucial to understand how buildings have an enormous impact on the health and well-being of its occupants. Regarding the workplace, studies demonstrate that indoor air quality and ventilation, thermal comfort, noise and acoustics, daylighting and lighting, interior layout and active design, views and biophilia, look and feel, location and access to amenities, may have a significant influence on the employee's productivity. Such concerns, particularly in large business offices, have already led to considerable investments thus creating a new market with new business opportunities.

Although the scientific community is yet to agree upon consolidated wellbeing metrics and measuring methods, a few alternatives have presented themselves with promising results. Among them, the Green Building Council's Brazil (a nongovernmental organization founded in 2007) in partnership with IPT (Instituto de Pesquisas Tecnológicas – Technological Research Institute), indicates a path by applying the perceptual and physical metrics, based on the report about Health, Wellbeing and Productivity developed by the World Green Building Council (WGBC).

Throughout this session, the authors aim to present the results of the Survey conducted with the occupants of office buildings in Brazil. In order to obtain the perceptive metric, an online questionnaire was applied on LEED CI (commercial interiors) certified buildings, collecting about 300 answers anonymously, considering the topics: indoor air quality and ventilation, thermal comfort, acoustics, lighting, layout and ergonomics, biophilia and views, look and feel, location, transportation and access to amenities. Regarding the physical metrics, the survey demonstrates measurements of illuminance in the workplace, measurements of the acoustic quality of both internal and external noise, and temperature measurements of air, mean radiant, humidity and air velocity. From the gathered data, important evidence of the relationship between the subjective wellbeing and physical concepts are brought to light.

Keywords: *green building, wellbeing, acoustic*

1. INTRODUCTION

In 1987 during an United Nation Organization meeting, Brundtland commission has defined sustainable development as: 'Satisfy present needs, without compromising capacity for future generations to satisfy their own needs.' The green movement and assessment science has begun during the beginning of ninetys all over the world. (Marcovitch, 2012). ISO 14000 regulations were created from Agenda 21 decisions during the United Nations international congress for the environment and sustainable development, known as ECO 92. The concern about the sustainability in buildings and the built environment had an advance when the United States Green Building Council USGBC was founded in 1993. The Green Building Council Brasil, GBC Brasil, has been founded just in 2007.

The sustainability concept is based on the equilibrium of three spheres, or the triple bottom line: Planet, People and Profit, known as the 3 P! Basically, all assessment tools were created also based in three contents: Structure, Process and Results. Structure is related to the physical area, space, form, function, installations and maintenance. (Sommer, 1969) Process is consisted on an evaluation of all data, records, orders, protocols and indicators. Results can be assessed comparatively as financial results, costs per unit and productivity. Total quality management and continuous quality improvement are examples. LEAN and Six Sigma are also assessment methods focusing on reducing waste in all building sectors, from industrial to healthcare.

Nowadays there are many sustainable certification systems in Brazil, like: Leadership in Energy and Environmental Design LEED the American model, AQUA- HQE based on a French model, 'Procel Edifica', 'Selo Caixa Azul', both Brazilian systems; besides international systems: the American Living Building Challenge LBC, the German system DGNB, the British system BREEAM, the Japanese system called CASBEE and others. The tendency is that all these quality tools are going to be more challenging, not only to reduce the impact on the planet, but also to be restorative, like the Restorative Design.

It is inevitable to compare the 3P with the health, wellbeing and productivity. Health is inside the Planet and environment, wellbeing is part of the People, the social sphere and productivity is related to Profit. (Wolff, 2013) According to World GBC report, we spend about 90% of our life time in built environments. These built environments should be healthy and collaborate to increase our wellbeing. Handful of organizations and researchers are already using surveys to quantify a range of concepts which had previously been extremely difficult to measure, like The Gallup Workplace Audit, The Leesman Index, Building Use Studies (BUS) Methodology and CBE Berkeley.

Company owners and directors think that sustainable buildings just save water and energy that contribute to 10% of the business operating costs. Although staff costs, including salaries and benefits typically account for about 80 or 90% of business operating costs. It is the value equation, not cost savings, that has driven the business case for energy improvements and green building certification in many markets and there is every reason to think that may begin to happen with health, wellbeing and productivity as well. Green buildings should focus on people and human beings, because human resources are the most important assets.

It is difficult to measure health and wellbeing because is subjective and personal. That is the reason this research focus on Brazilian culture and the way their offices function. The study evaluated real cases, close to Brazilian people and their satisfaction with the workplaces. (Preiser and Vischer, 2008) The survey included physical and perceptual metrics and not financial metrics.

2. METHODOLOGY

The research was conducted for occupants of seven LEED (Leadership in Energy and Environmental Design) certified offices under the CI category (Commercial Interiors), located in São Paulo city, in Brazil. An online questionnaire was applied via web, accessed by independents links by building. The link was sent by to each company's manager, HR or facilities representative, who was responsible for distributing to the office's occupants. It took approximately 15 minutes to them to complete the survey.

The development of the questionnaire was based on research literature and discussions with professionals who conducted similar studies, including the reputed IPT (Institute for Technological Research), Skanska England (one of the world's largest construction groups), Los Andes University and GBC Colombia. ISO and ASHRAE standards were used for the preparation of the questions and qualitative Likert's scale were rather used for the answers choices.

The goal of the questionnaire was to collect anonymously occupant's importance and satisfaction regarding the built factors of the building and workplace, such as: indoor air quality and ventilation, thermal comfort, natural daylight and lighting, acoustics quality, interior layout and ergonomics, green areas and views, aspect and perception, location, transportation and access to amenities. Personal data such as gender, age, work regime, work shift, workstation location and time working for the company were also collected.

Regarding indoor air quality and ventilation, the following points were assessed: ventilation, humidity, individually controlled ventilation, air speed, discomfort due to localized air streams, stale air and unpleasant odours, as well as the occupant's satisfaction level.

The goal of assessing the thermal comfort was to verify: thermal sensation in summer and winter, which period of the day there is thermal discomfort, feeling cold or hot at any given time of day and level of satisfaction with the thermal conditions of the working environment.

As for natural daylight and lighting, the use of natural lighting, user's control of natural or artificial lighting, amount of lighting (little or excessive) and user's satisfaction were evaluated.

On acoustics quality, noise from internal equipment (printers, telephones, keyboards and computers), vibration (including air conditioning), colleagues, noise coming from the building's external environment and user's satisfaction with the level of noise were evaluated. (Barreto and Silva, 2010)

About interior layout and ergonomics, privacy at the workstation, density of people in the office, pain in hands, back, legs, neck, arms and malaise, the existence of areas to make private phone calls, rest, comfort and information about the chair, computer screen adjustment possibility, if the occupant spends most of the day sitting or standing, sufficiency of space activity implementation, and the level of the user's satisfaction. (Ulrich, 1991)

Regarding green areas and views, the research evaluated: occupant's feeling about the existence or lack of plants and flowers in the office; visibility of trees, green areas, gardens and sky through the window and user's satisfaction level in this regard. (Lohr et al., 1996)

Questions about the aspects and perceptions involved cleanliness and organization of space, the occupant's feeling about the shapes, colors and textures of the walls and floors of the office and the user's satisfaction level in relation to this category.

Transportation category evaluated the means of transport to get to work, the distance from user's residence to a public transport station, availability of complimentary transport provided by the employer, if the user has no other choice to commute to work, how long the commute takes, user's stress due to commute and level of the user's satisfaction with transportation.

Finally, the access to amenities category assessed the existence of car and bicycle parking in the workplace, bicycle storage, existence of a pantry or cafeteria in the office, if there are restaurants, day care centers, parks or plazas nearby the workplace and the occupant satisfaction level regarding the category.

For the analysis of this research, only companies that registered over twenty respondents were considered, in order to avoid biased samples. Participating companies received a full report with diagnosis of their results, which can be used as a basis for the implementation of improvements.

The evaluation of perceptual method results enabled to identify, in company number 5 (see the matrix importance x satisfaction), that acoustic quality was the greatest dissatisfaction factor to occupants. With this finding, the IPT conducted measurements of sound inside two participating companies. Measurements were carried out during a typical work day, approximately, from 9 am until 3 pm, using two meters of the sound pressure. One equipment was kept fixed at one point considered critical in terms of exposure to noise generated internally, others piece of equipment were allocated in various office points, including meeting spaces areas and collective rooms, with five minutes duration measurements.

3. RESULTS

Questionnaire sent to participating companies considered nine factors of interest in literature: air quality and ventilation (1), thermal comfort (2), daylighting and lighting (3), acoustics quality (4), internal layout and ergonomics (5) green area and views (6), aspects and perceptions (7), transportation (8) and access to amenities (9). Besides questions related to each subject factor, there was also questions about the importance the respondent attributed to each factor, and how pleased he was. With data collected from these responses a matrix of importance and satisfaction was prepared for each company, which can be seen in Figure 1. (Slack, 1994) Each survey were answered only by occupants office staff per company, a total of four buildings were surveyed.

These nine factors represent the structure and workplace physical conditions that most interfere in occupants comfort and wellbeing. Seven factors are related directly to the built environment of the green building and two factors are regarding building location and surroundings.

Likert's qualitative scales were used to measure the answers thus the data analysis was necessary to make a numerical association replacing degrees of importance "Worthless", "Not very important", "Important" and "Very important" by the values 1, 2, 3 and 4 respectively; and replacing the satisfaction levels "Totally dissatisfied," "Dissatisfied" "Satisfied" and "Totally satisfied" also by 1, 2, 3 and 4 respectively.

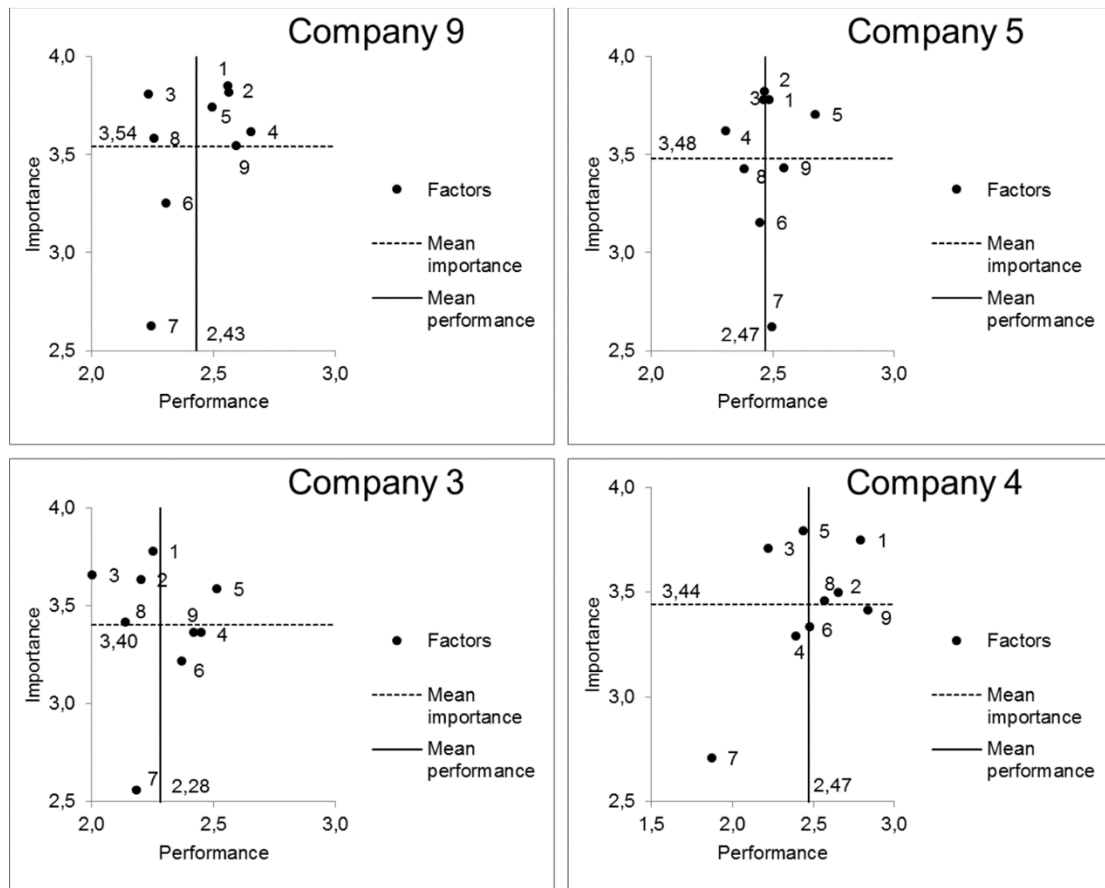


Figure 1: Matrix importance/performance of seven factors separated by company

Matrix was constructed by placing on abscissa axis the average satisfaction of all respondents for each factor and on ordinate axis the average of importance. (Martilla and James, 1977) Also plotted are the points of satisfaction and importance regarding all nine factors so factors comparisons can be done. (Pavot and Diener, 1993)

Regarding Company 3, the factors 1, 2, 3, 5 and 8 were considered more important than the factors 4, 6, 7, and 9; and respondents are more satisfied with the factors 4, 5, 6 and 9 than with the factors 1, 2, 3, 7 and 8. Highlighting the factor aspects and perceptions (7) that was considered least important in all four companies.

Regarding Company 5, the factors (1, 2, 3, 4 and 5) were considered more important, except for the factor 4 (acoustic quality) that was considered below average in terms of satisfaction, although three of them (1, 2 and 3) were situated close to the limit.

Regarding factor 4 (acoustic quality) of the office, 23 of the 116 respondents complained of noise with comments like "Coworkers talk very loudly on the phone", "People should respect the open space," "During the night, when turn off the air conditioning is noticeable the noise it makes and in the morning when they turn it on.

During the day, I think he got used to it.," Open space contribute to inconvenient noise, requiring a higher concentration at work and increased stress at the end of the shift "and even more damning phrases like" I just cannot work when two people are on the phone next to me "or" noise is one of the factors that affects me more than any other factor. Often I have to go to the quiet zone ". This company has a soundproof room called "quiet zone" where people can go at any time and stay as long as they want, when they feel disturbed by office noise.

Specific questions showing users perceptions can be seen in Table 1.

	Never (%)	Sometimes (%)	Many times (%)	Always (%)
I feel distracted/ annoyed by noise from phones, printers, computers, keyboards, and other equipment.	12,96	42,59	24,07	20,37
If windows are opened, there is too much street noise.	61,54	12,09	10,99	15,38
I feel distracted/ annoyed by machine noise from outside.	78,79	17,17	3,03	1,01
I can hear vibration noise	64,42	28,85	2,88	3,85
I feel distracted/ annoyed by speaking people noise at office.	8,41	29,91	28,97	32,71
I feel distracted/ annoyed by air conditioning vibration noise.	56,19	34,29	6,67	2,86

Table 1: Noise level perceptions at workplace

It was also asked about people's satisfaction regarding noise level, and the answers were: 7.41% were totally satisfied, 50% satisfied, 30.56% dissatisfied and 12.04% completely dissatisfied.

To improve the analysis of company acoustic quality, a physical measurement of sound pressure in the workplace was made. All respondents work in a single floor of a LEED CI certified building, and seventeen points were chosen to be measuring points. One point, considered the noisiest, was monitored during all working day, from 9:13 am until 14:53 pm, and others sixteen points were measured for 5 minutes each. At the noisiest point were measured 65 dBA and it is acceptable within offices limit, according to ABNT NBR 10152, Brazilian acoustic code standard. Sound pressure levels can be seen in Figure 2.

Measurement every half second was conducted amounting a total of 7200 measurements per hour. To better understand the sound pressure levels, measurements during lunch time are represented by the solid line, and one hour later is represented by the dotted line, were organized by frequency and sound pressure level. As an example, the average sound pressure levels were calculated of 20 Hz frequency which resulted in 44.54 dBA for lunch hours and 53.07 dBA outside this time (Figure 3). It appears that during lunch break all measured points were below the audible line, except for the frequency point of 125 Hz and sound pressure 58.28 dBA both during lunch time and outside it can be perceived. During working hours, all measured points above 200 Hz are capable of hearing.

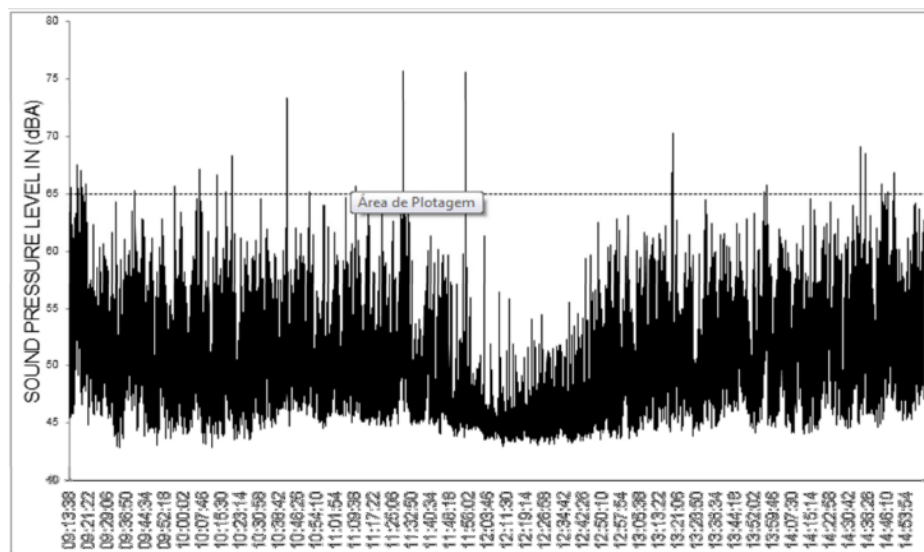


Figure2: Sound pressure level in dbA

At Figure 3 can be seen the frequency band normally used by spoken voice that goes from 500 to 2,000 Hz and the noise perception limit of air-conditioning equipment noise depending on the frequency and sound pressure provided by the equipment manufacturers.

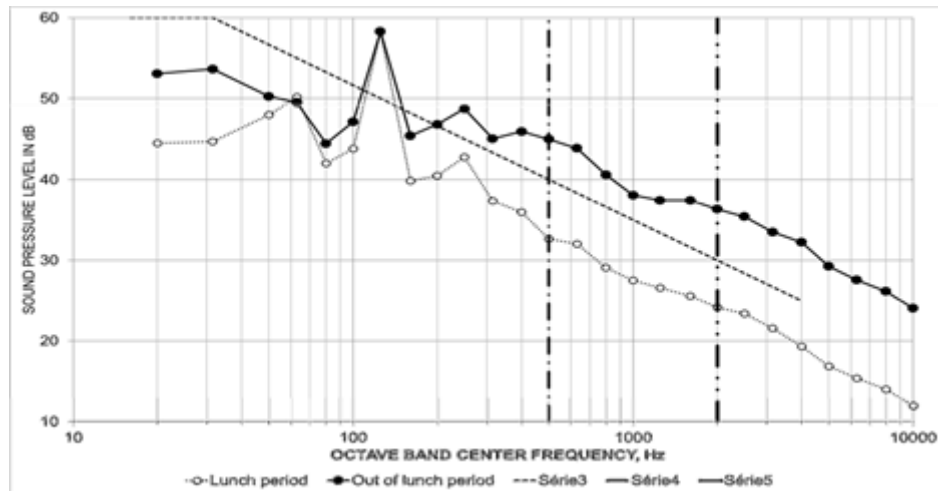


Figure 3: Sound pressure level by frequency during one hour

4. CONCLUSION

As shown on results, offices' acoustics affect people wellbeing in the workplace. Brazilians workers are loud even for LEED CI certified offices. The participant offices have been planned considering acoustics protection, for common offices the results would be really worse. Brazilian culture with the latin root is talkative, passionate, friendly and loudly sometimes! That is why not only the built environment but also the behavioral habits need to be aligned. This research aims to collaborate with the sustainable community of green buildings focusing on people. Training and sustainable courses can help to reduce the disturbance in Brazilian offices, consequently improving workers health and wellbeing and also their productivity. Brazilian sustainable facility managers really need to integrate with human resources managers to benefit all, planet, people and profit.

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