Questionnaire's Elaboration and application to the contribution at knowledge of certificate LEED's application at Brazil with based on case studies.

Clélia Mendonça de Moraes[1,*]

[1]PMA Prefeitura Municipal de Araraquara, Brasil

Abstract. The sustainable building with LEED Certification search the better thermal comfort adaptation to their users. This research has analysed the impact of LEED certification at first Brazilian enterprises, which receives the seal of sustainable building. It is understandable that, initially, there was restrictions about the use in another reality of the American buildings. The questionnaire developed was distributed in XX national case studies. Note that the labour market must be prepared to the certification; otherwise, it will be difficult to achieve the final goal, which is being a sustainable building. The results obtained to confirm that LEED certification need to move forward in the indoor environment studies to buildings located in regions with tropical altitude climate with abrupt changes of temperature. The final results of questionnaire allows to obtain an evaluation of standard measures of an ideal temperature to the buildings, establishing the limit among comfort zones of human metabolism, proposing comfort model adaptive to a country with a wide latitudinal variation, as in Brazil.

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1 Introduction

This study is an experimental approach of human thermal comfort sensation and real thermal behaviour of the building with complementary evaluation based on thermal comfort methods of questionnaire and Fanger-ISO, Givoni, Humphrey-Nicol and Moraes.

In 2007 several buildings were certified Leed, Moraes, C.M. 2010. It is noteworthy the progress in seeking sustainable certification methodology. However, the sustainability parameters were defined from American concepts whose climatic characteristics and building materials are different from the Brazilian climate. Aware of these aspects, the LEED certification was made, emphasizing that the same buildings should be re-evaluated later because they would present divergences of construction concepts. Later in 2015, researchers from this public body met with researchers from the "Green Building Consul Brasil (GBC Brasil), located in the city of São Paulo, Brazil, with the purpose of carrying out an evaluation of these buildings certified after 2007. Based on the methodology presented by Moraes (2004) to the Congress Plea 2004, which evaluated the real thermal behavior in the classroom with the survey of climatological variables of the external and internal environment of the building located in two different universities in the state of São Paulo in order to contribute to the wellness and productivity. By means of thermal comfort methods (Givoni, 1969) of wrapping environments and their correlation with human thermal sensation (Fanger, 1970) with student participation. To establish thermal comfort limit conditions in the classroom, by verifying abrupt temperature changes in tropical altitude. Objective and subjective physical measurements were adopted. T (° C), RH (%), Var (m / s) and P (atm) were monitored; with the recording of internal data by means of "datalogger" and sensors; by the Meteorological Station, and the thermal perception of the student was evaluated with questionnaires. Therefore, this research presents the results of the questionnaires that were reassessed in 2015 and applied to the buildings which received LEEd certification to evaluate the Brazilian enterprises located in a tropical climate of altitude and to understand the restrictions of use in a reality different from the original reference (North American). Note that the questionnaires presented were answered by the users of buildings with LEED certification, that is, a real environment and reports present a spontaneous language according to the individual understands about the edification, so the comments are spontaneous sentences without rigor. The results presented by these individuals allow us to verify how the construction of the local urban climate influences the thermal behavior of the property and the individual.

2 Thermal comfort methods

A brief description of thermal comfort methods applicability is necessary for people have a good understanding about the profile of the research in development. In the same way, some researcher's models to deal with human comfort sensations are described below:

Fanger - Establishes the thermal heat flux between the person the physical environment through the clothes. Predicted mean votes (PMV) and Predicted Percentage of dissatisfied (PPD), sets a satisfaction degree.

Givoni – Demonstrates how the environmental conditions like: DBT, UBT, RU%, atmospheric pressure and air velocity change the thermal comfort conditions. This study focuses the effects of the environment conditions.

Humprey & Nicol – Demonstrates how factors such as corporeal mass, ethical body characteristics as high-mass, acclimatization factors and origin affect the result on thermal human comfort evaluations. This model also adopts blood flux and corporeal area for modelling the human thermal response. This method is important because shows the adequacy of adopting the local applicability of the thermal satisfaction response.

Moraes - The method of delimiting the rules of thermal comfort of the connection of its system is human and its correction with an idea of edification, being verified like changes of temperature. Adopting objective and subjective measures. Monitoring the climatological variables; with internal data logging for the heat control means and sensors; External for Meteorological Station and the thermal barrier of users of edification was evaluated with questionnaires.

.1 Experimental setting for the building

The experimental scenario chosen for the study was the first buildings to receive LEED certification in Brazil.

3 Building users' thermal comfort

Equations should be centred and should be numbered with the number on the right-hand side.

Use italics for variables (*u*) and bold (**u**) for vectors. The order for brackets should be {[()]}, except where brackets have special significance.

Q1 Gender

	Company 3	Company 4	Company 5
Male	58,14%	37%	31,03%
Female	41,86%	63%	68,97%

Q2 Age

	Company 3	Company 4	Company 5

Questionnaires were distributed to all employees of commercial buildings, considering the layout of each building and measurements of internal and external climatological variables. Read the article Plea 2004; Moraes, C. M.; et al.

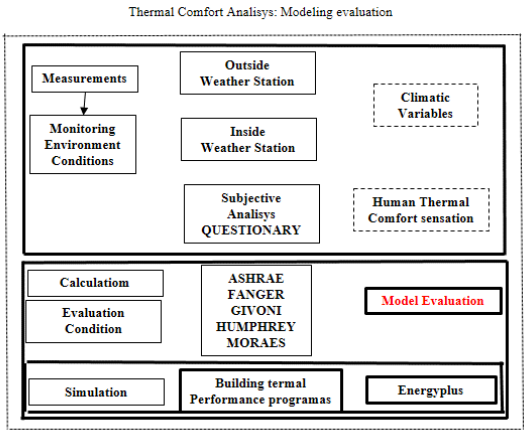

Figura 1: Experimental settings

Q3 Position or Activity

	Company3	Company 4	Company5
Direction	13,95% - 6	4% - 4	0,87% - 1
Manager, Coordinator	32,56% - 14	46% - 46	27,83% - 32
Operational	37,21% - 16	25% - 25	49,57% - 57
Other	16,28% - 7	25% - 25	21,74% - 25

Under 25 years old	13,95% -6	25% - 25	6,9% - 8
25 to 35 years old	41,86% -18	50% - 50	49,14% -57
35 to 45 years old	30,28% - 13	19% - 19	24,14% - 28
45 to 55 years old	11,63% - 5	5% - 5	14,66% - 17
55 to 65 years	2,33% - 1	1% - 1	5,17% - 6
Over 65 years old	0,00% - 0	0% - 0	0,00% - 0
Total	23	100	116

Q4 Location of your workstation. Only answer if you have a fixed work location. You can select more than one option

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	Company3	Company 4	Company5
Next to window (until 2 meters)	60,47% - 26	60% - 6	59,65% -68
Near the wall (until 2 meters)	20,93% - 9	19% - 19	11,40% -13
Near the door (until 2 meters)	13,95% - 6	6% - 6	2,63% - 3
Center in the environment	20,93% - 9	29% - 29	21,05% - 24
Next to restroom (until 2 meters)	0,00% - 0	19% - 19	2,63% - 3
Near to corridor (until 2 meters)	18,60% - 8	19% - 19	24,56% - 28
Near to coffee (until 2 meters)	4,65% - 2	5% - 5	5,26% - 6
Near to printers (until 2 meters)	25,58% - 11	14% - 14	13,16% - 15
Other (specify)	2.33% - 1	0% - 0	2,63% - 3
Interviews	43	100	114

Q5 The role of sustainability Specify your impression of this theme. If any question does not apply to you, do not respond.

Company 3

	Never	Sometimes	Many times	Always	Total
I am interested in sustainability issues.	0,00% 0	23% 23	33% 33	44% 44	100
My employer is concerned about sustainability	1,03% 1	22,68% 22	51,55% 50	24,8% 24	97

Company 4

	Never	Sometimes	Many times	Always	Total
I am interested in sustainability issues.	4,2% 1	8,3% 2	45,8% 11	41,7% 10	24
My employer is concerned about sustainability	4,3% 1	21,7% 5	39,1% 9	34,8% 8	23

Company 5

	Never	Sometimes	Many times	Always	Total
I am interested in sustainability issues.	0,00% 0	28,45% 33	42,24% 49	29,31% 34	116
My employer is concerned about sustainability	0,88% 1	15,79% 18	31,84% 42	46,89%53	114

Q13 In your opinion, how important are the factors listed for health improvement / conservation in the workplace?

Company 3	not important	Little important	Important	Much important	Total
Air Quality and Ventilation	0,00% 0	2,44% 1	14,63% 6	82,93% 34	41
Thermal comfort	0,00% 0	4,88% 2	26,83% 11	68,29% 28	41
Lighting	0,00% 0	2,44% 1	26,83% 11	70,73% 29	41
Acoustic quality	0,00% 0	12,20% 5	34,15% 14	53,66% 22	41
Spaces and ergonomics	0,00% 0	7,32% 3	26,83% 11	65,85% 27	41
Green Areas	4,88% 2	12,20% 5	36,59% 15	46,34% 19	41
Textures and coatings	4,88% 2	48,78% 20	29,27% 12	17,07% 7	41
Transport	4,88% 2	7,32% 3	29,27% 12	58,54% 24	41

Facilities and Conveniences	2,44% 1	2,44% 1	48,78% 20	46,34% 19	41
Company 4	not important	Little important	Important	Much important	Total
Air Quality and Ventilation	0% 0	0% 0	14,9% 14	85,1% 80	94
Thermal comfort	0% 0	0% 0	17,9% 17	82,1% 78	95
Lighting	0% 0	0% 0	19,2% 18	80,9% 76	94
Acoustic quality	1,06% 1	2,13% 2	30,9% 29	65,9% 62	94
Spaces and ergonomics	0% 0	1,06% 1	23,4% 22	75,6% 71	94
Green Areas	0% 0	12,63% 12	49,5% 47	37,9% 36	95
Textures and coatings	5,32% 5	40,43% 38	40,5% 38	13,9% 13	94
Transport	0% 0	3,19% 3	35,1% 33	61,7% 58	94
Facilities and Conveniences	0% 0	5,26% 5	34,8% 33	60% 57	99

Company 5	not important	Little important	Important	Much important	Total
Air Quality and Ventilation	0,00% 0	0,88% 1	20,18% 23	78,95% 90	114
Thermal comfort	0,00% 0	0,88% 1	15,79% 18	83,33% 95	114
Lighting	0,00% 0	0,88% 1	20,18% 23	78,95% 90	114
Acoustic quality	0,00% 0	3,54% 4	30,97% 35	65,49% 74	113
Spaces and ergonomics	0,00% 0	1,79% 2	25,89% 29	72,32% 81	112
Green Areas	0,00% 0	11,71% 13	61,26% 68	27,03% 30	111
Textures and coatings	4,46% 5	39,29% 44	45,54% 51	10,71% 12	112
Transport	2,68% 3	5,36% 6	38,39% 43	53,57% 60	112
Facilities and Conveniences	0,88% 1	5,31% 6	43,36% 49	50,44% 57	113

Q14 In this space you can write about what can affect to improve or to worsen health in your workspace.

Company 3	
Air conditioning	Noise harmful to health

Company 9	
Thermal comfort	Natural lighting
General Ventilation	Artificial Lighting
Natural ventilation	Bank or ATM 24hrs
Air quality	Cleaning
Noise (sound pollution and air conditioning)	Safety
Check the air temperature of the air conditioner	Removing carpet due to respiratory allergies
Economy time	Include green areas
Ergonomics furniture (chair, desk, leptop position and meeting room)	Install Emergency System
Improve room layout according to the air-conditioning duct	Trash for organic waste

Company 5

Thermal comfort	Natural lighting
General Ventilation	Artificial Lighting
Natural ventilation	Removing carpet due to respiratory allergies
Air quality	Dust
Noise (sound pollution and air conditioning)	Adjusting the curtain
Check the air temperature of the air conditioner	Do not put anyone to sit facing the window.
Ergonomics furniture (chair, desk, leptop position and meeting room)	Water Quality Acoustic quality
Air conditioning and asepsis	Privacy
Breaks, such as work experience	Cleaning
Access to healthy food	Improve lifts with sensors
Bathroom door for people with disabilities is very heavy	Inefficiency of air distribution design by air conditioning
Central Air Conditioning directly affects health, because many of the hours of the daylight, the temperature is very cold and other time is very hot.	The air conditioning regulation system is individualized by room
Best temperature air conditioning in summer (air conditioning better controlled).	Install larger number of plugs
Open office desk does not work in Brazilian culture	

Q15 Air Quality and Ventilation. Specify your impression of this theme. If any question does not apply to you, do not respond.

Company3	Never	Sometimes	Many times	Always	Total
The office is well ventilated	7,7% 3	12,8% 5	35,9% 14	43,6% 17	39
The office air is very humid	81,9% 31	13,2% 5	2,6% 1	2,6% 1	38
The office air is very dry	47,4% 18	31,6% 12	18,4% 7	2,6% 1	38
I can control the ventilation of my workplace, either by opening or closing windows or by controlling forced ventilation	56,8% 21	18,9% 7	16,2% 6	8,1% 3	37
The velocity of air circulation impairs because it is too high	76,3% 29	21,1% 8	2,6% 1	0,0% 0	38
I feel discomfort due to air localization	61,6% 24	33,3% 13	0,0% 0	5,2% 2	39
I have the feeling of stale air ("stagnant air") in the environment	66,7% 26	23,1% 9	7,7% 3	2,7% 1	39
The office has a bad smell (unpleasant odors). If so, please describe odors unpleasant	84,7% 33	12,8% 5	2,6% 1	0,0% 0	39

Company 9	Never	Sometimes	Many times	Always	Total
The office air is very humid	5,56% 5	30,0% 27	51,1% 46	13,3% 12	90
The office air is very dry	64,7% 57	29,5% 26	5,68% 5	0,00% 0	88
I can control the ventilation of my workplace, either by opening or closing windows or by controlling forced ventilation	25,9% 23	41,8% 37	22,5% 20	10,2% 9	89
The velocity of air circulation impairs because it is too high	73,9% 65	15,9% 14	6,9% 6	3,5% 3	88
I feel discomfort due to air localization	62,1% 54	25,3% 22	8,1% 7	4,6% 4	87
I have the feeling of stale air ("stagnant air") in the environment	59,1% 52	26,5% 23	11,4% 10	3,5% 3	88
The office has a bad smell (unpleasant odors). If so, please describe odors unpleasant	34,9% 31	52,9% 47	8,9% 8	3,4% 3	89
The office air is very humid	58, 9% 53	28,9% 26	8,89% 8	3,33% 3	90

Company 5	Never	Sometimes	Many times	Always	Total
The office air is very humid	15,3% 17	27,0% 30	39,7% 44	18,0% 20	111
The office air is very dry	61,7% 66	30,9% 33	4,7% 5	2,8% 3	107
I can control the ventilation of my workplace, either by opening or closing windows or by controlling forced ventilation	19,7% 21	42,1% 45	27,1% 29	11,2% 12	107
The velocity of air circulation impairs because it is too high	94,6% 105	2,7% 3	0,90% 1	1,80% 2	111
I feel discomfort due to air localization	60,0% 66	29,1% 32	6,4% 7	4,5% 5	110

I have the feeling of stale air ("stagnant air") in the environment	52,8% 58	25,5% 28	12,8% 14	9,1% 10	110
The office has a bad smell (unpleasant nhodors). If so, please describe odors unpleasant	38,6% 42	44,1% 48	8,3% 9	9,2% 10	109
The office air is very humid	36,9% 41	41,5% 46	18,1% 20	3,6% 4	111

Company 3	
Bad odors	Natural ventilation
No ventilation in bathrooms	

Company 9	
Improve Air Conditioning System	General Ventilation
Bad odors	Natural ventilation
Mold	Open the windows
No ventilation in bathrooms	Noise (sound pollution and air conditioning)
Excess humidity in environments	Dust
Removing carpet due to respiratory allergies	Food court in common area
garbage	Sewer

Company 5	
Bad Odors	No ventilation in bathrooms
Sewer	No of ventilation in the garage and cafeteria
Mold	Removing carpet due to respiratory allergies
Improve Air Conditioning System	Excess humidity in environments
Ventilation in general	Improve layout and ventilation of meeting rooms
Natural ventilation	

Q19 Thermal sensation on the desktop Specify your impression of this theme. If any question does not apply to you, do not respond.

Company 3

	The thermal sensation in the summer is	The thermal sensation at 40 winter is
Very Cold	15% 6	10% 4
Cold	10% 4	15% 6
Slightly cold	20% 8	20% 8
Neither cold nor hot	37,5% 15	42,5% 17
Slightly hot	7,5% 3	7,5% 3
Hot	10% 4	5% 2
Very hot	0% 0	0% 0
Total	40	40

Company 9

	The thermal sensation in the summer is	The thermal sensation at 40 winter is
Very Cold	12,79% 11	2,44% 2
Cold	11,63% 10	12,2% 10
Slightly cold	16,28% 14	15,85% 13
Neither cold nor hot	32,56% 28	36,59% 30
Slightly hot	19,77% 17	14,63% 12
Hot	5,81% 5	10,98% 9
Very hot	1,16% 1	7,32% 6
Total	86	82

Company 5

	The thermal sensation in the summer is	The thermal sensation at 40 winter is
Very Cold	23,64% 26	7,41% 8
Cold	22,73% 25	24,07% 26
Slightly cold	20,00% 22	25,00% 27
Neither cold nor hot	22,73% 25	26,85% 29
Slightly hot	6,36% 7	11,11% 12
Hot	2,73% 3	3,70% 4
Very hot	1,82% 2	1,85% 2
Total	110	108

4 Results

3.1. Employees' thermal comfort

The effectiveness of the model of the methods used to verify the sensation of human thermal comfort and the real thermal behaviour of the building reached the objective obtaining the description of the 55 questions asked to the employees of the companies that received the LEED Certification. In this article we focus on the results of the questionnaires about the employee's profile, his workstation, thermal comfort and which aspects that most influence the quality of the building.

The growing number of LEED-certified buildings from 2007 to the present year has shown a strong tendency to opt for sustainable buildings, influencing builders and customers, and building employees are accepting sustainable building solutions that contribute to the environment and, in parallel, reduce building maintenance

costs compared to traditional buildings. Obtaining a LEED certification requires a technical rigor on the part of the construction entrepreneur, a series of documentation and proof of compliance with the requested requirements. Another point is the specialized workforce from the project prepared by architects and engineers to the execution of the project and the supply of construction materials by specialized companies for the execution of the service. The certified buildings have emerged from the initiative of private companies using North American concepts for the construction of sustainable buildings. However, the American parameters present climatic and constructive factors different from the Brazilian reality. Such facts are perceptible to the users of the buildings certified and verified through the questionnaires. It is fundamental to adapt the certification to the user of the building and the place where the building is implanted. In this way, the certification must respect the local climatic characteristics, verifying that Brazil is a country where the tropical climate of altitude predominates and a wide latitudinal variation. Introducing the use of natural ventilation as a way to reduce heat and reduce building odors. In this way, the use of passive technology taking advantage of nature's resources to the extreme and then opting for the use of passive technology for the days too much heat would provide thermal comfort to the user of the building. Thus, obtaining an ideal temperature for the buildings, establishing the limit between the zones of comfort of the human metabolism proposing an adaptive model of comfort for Brazil. However, it is not an easy task and requires a process of adaptation to the labor market, making it important to treat the results raised in these works and to evaluate them with scientific technical rigor by companies and universities with the intention of seeking sustainable buildings that receive the support labor market and tax incentives, rebates and leadership by the public sector.

Future work

Application of the questionnaires and the environmental variables of temperature, humidity, air velocity and atmospheric pressure raised in the place in the methods of evaluation of the sensation of the thermal comfort of the human being and the thermal control of the building.

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