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A Case Study to evaluate the indoor global quality

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Abstract. This paper proposes two complementary procedures for assessing the global quality comfort: the first one, prevalently objective, is based on the acquisition of microclimate measured data and computed subjective values; the second one, that is purely subjective, uses a questionnaire drawn from the ISO/DP 10551 Recommendation. An application to some lecture-halls and laboratories of the school is here showed.

Introduction

Comfort and health protection within the work areas requires environmental conditions in accordance with standard values and/or sanitary limits of some descriptors linked to physical phenomena like heat, light, sound, odor, color and so on.

Scientific papers and rules, however, separately consider the impact produced by the single parameters. Some researchers, recognizing that people experience effects of various and combined factors, have begun compared surveys of the discomfort from heat, noise and vibration, color and noise, indoor air pollution, heat and noise [1,2], etc. The aim of this work is to find a relationship among two different methodology of analyzing.

Two complementary procedures are here proposed: the first one, prevalently objective, is based on the acquisition of measured data and computed subjective values while the second one, that is purely subjective, uses a questionnaire drawn from the ISO/DP 10551 Recommendation [3] in order to assess the personal discomfort vote so to the single aspects and global exposition.

Case Study.

Present study was applied to lecture-halls and laboratories distributed along two buildings (central and branch), five and three stored respectively, showing different urban and climate features. The examined indoor spaces have been 30 (21 lecture-halls and 13 laboratories) with 663 (382 and 281) interviewed young people (15-18 years old). Experimental data refer to different environmental conditions and a set of fixed operative conditions: shut doors and windows in the presence of a near constant number of students, with the lights on or out and open shutters, working heating system.[4-5] Measurement station located in the more sensible zones according precise visual and thermal criteria.

In the Table 1 and Table 2 we report the values measured in lecture halls (LH) and laboratories (L) of Central and Branch Building. The measures are: dry bulb temperature t_d, wet bulb temperature, relative humidity j, globe thermometer temperature t_g , air speed v_a and visual parameters daylight D and artificial lighting AL (expressed like horizontal illuminating in lux).[6-7]

Table 1. Microclimatic and visual parameters of Central Building

ZONE	t_d(°C)	t_w (°C)	j	t_g(°C)	v_a(m/s)	D (lux)	AL (lux)
LH 310	22.21 22.48 22.39	16.06 17.16 16.34	49.8 52.0 50.9	22.31 22.81 22.61	0.02 0.16 0.06	480 534 507	612 658 635
L 303-304	23.47 23.85 23.68	17.47 18.83 17.93	52.3 54.6 53.4	24.14 24.27 24.19	0.01 0.20 0.09	510 585 549	773 825 800
LH 314	21.98 22.36 22.19	15.99 17.28 16.32	49.7 53.1 51.5	23.15 23.23 23.20	0.00 0.22 0.08	502 560 528	715 740 728
L 315-316	21.49 21.68 21.57	16.02 19.97 17.22	54.0 56.2 55.0	22.32 22.72 22.49	0.01 0.16 0.09	422 498 458	618 660 638
L 301-302	23.05 23.28 23.16	16.90 18.49 17.34	50.8 54.2 52.0	24.14 24.45 24.23	0.01 0.17 0.06	670 695 680	890 915 900

Table 2. Microclimatic and visual parameters of Branch Building

ZONE	t_d (°C)	t_w (°C)	j	t_g (°C)	v_a (m/s)	D (lux)	AL (lux)
LH 904	19.55 22.59 21.75	16.59 17.81 16.94	54.7 64.0 61.1	20.74 22.21 21.61	0.01 0.17 0.04	155 220 205	360 390 375
LH 928	20.62 20.88 20.76	15.00 15.76 15.21	52.1 58.8 53.7	21.46 22.00 21.75	0.01 0.10 0.04	260 315 280	450 485 460
L 914-915	20.34 20.72 20.63	15.21 16.71 16.37	55.4 61.3 57.0	20.51 21.09 20.84	0.01 0.16 0.03	310 345 320	505 540 515
LH 919	19.90 20.62 20.28	15.23 16.64 15.39	55.9 62.9 58.3	19.89 20.44 20.20	0.00 0.14 0.03	280 305 290	532 589 558

On the basis of the measured microclimatic parameters for the studied spaces, belonging to the class of moderate thermally spaces, the values of the comfort descriptors PMV and PPD have been computed. In Tables 3 an 4 we report the relative results for the sample zones.

Table 3. Comfort indices PMV, PPD and correlated parameters of Central Building

ZONE	t_a(°C)	t_{mr} (°C)	j (%)	t_{cl}(°C)	p_v (kPa)	p_a (kPa)	PMV	PPD (%)
LH 310	22.39	22.61	50.1	26.08	2.70	1363.3	0.48	9.9
L 303-304	23.68	24.19	53.4	27.37	2.92	1562.7	0.60	12.7
LH 314	22.19	23.20	51.5	25.88	2.67	1377.0	0.70	15.4
L 315-316	21.57	22.49	55.0	25.26	2.57	1415.9	0.69	15.0
L 301-302	23.16	24.23	52.0	26.85	2.83	1474.7	0.74	16.5

Table 4. Comfort indices PMV, PPD and correlated parameters of Branch Building

ZONE	t_a(°C)	t_{mr} (°C)	j (%)	t_{cl}(°C)	p_v (kPa)	p_a (kPa)	PMV	PPD (%)
LH 904	21.75	21.61	61.1	25.44	2.60	1590.4	0.44	9.2
LH 928	20.76	21.75	53.7	24.45	2.45	1315.4	0.68	15.0
L 914-915	20.63	20.84	57.0	24.32	2.43	1385.1	0.49	10.2
L 919	20.28	20.20	58.3	23.97	2.37	1386.4	0.42	8.7

The second assessment methodology is subjective type and uses as a basis the questionnaire provided by the rule ISO/DP 10551 [5]. This procedure has been applied for estimating the effects of various environmental factors upon the hygrothermal comfort conditions. The primary structure of the aforesaid questionnaire contains a big set of questions about the considered single aspects (11, 5 and 8 respectively for the hygrothermal, acoustical and visual sections) and 2 for expressing the personal global judgment. A detailed analysis of the formulation allows reducing the interview contents to 13 questions with unique standardized replays attributing to each one a numerical codex (vote).[8-9]

These scales do not homogeneous each other: some list 7 judgment degrees, some 4. We note also that the scale of thermal sensation is straight forth in relation with the scale of PMV.
The tables 5 and 6 report the results of the subjective methodology.

Table 5. Complete distribution of the replays referring to the sample of the interviewed students of the whole central building.

	VOT								
SCALE	-3	-2	-1	0	+1	+2	+3	Mean	d
1	22	35	121	147	53	4	0	-0.52	1.05
2				153	167	37	25	0.82	0.85
3	0	1	25	124	157	55	20	0.78	0.96
4				193	140	33	16	0.66	0.81
5				85	197	75	25	1.10	0.82
6				99	184	77	22	1.05	0.83
7				91	153	89	49	1.25	0.96
8				131	198	49	4	0.81	0.69
9	5	19	26	179	69	61	23	0.46	1.24
10				198	150	29	5	0.58	0.70
11	2	6	48	172	105	36	13	0.39	1.02
12				240	122	15	5	0.44	0.64
13				182	168	28	4	0.62	0.67

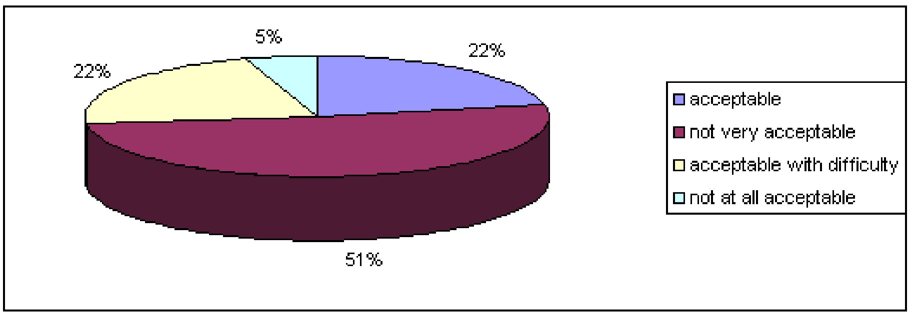

Figure 1 Distribution of the global comfort (Central Building)

Table 6. Complete distribution of the replays referring to the sample of the interviewed students of the whole branch building

	VOTE								
SCALE	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**Mean**	**d**
1	43	61	109	53	15	0	0	-1.23	1.89
2				49	143	63	26	+1.25	0.85
3	0	2	14	45	133	67	20	+1.12	0.98
4				58	152	58	13	+1.09	0.77
5				64	177	32	8	+0.95	0.68
6				78	161	35	7	+0.90	0.70
7				73	150	43	15	+1.00	0.79
8				95	155	26	5	+0.79	0.68
9	12	54	108	83	15	9	0	-0.77	1.06
10				81	130	55	15	+1.01	0.84
11	2	3	5	71	109	67	26	+1.10	1.01
12				86	138	46	11	+0.94	0.79
13				63	142	63	13	+1.09	0.79

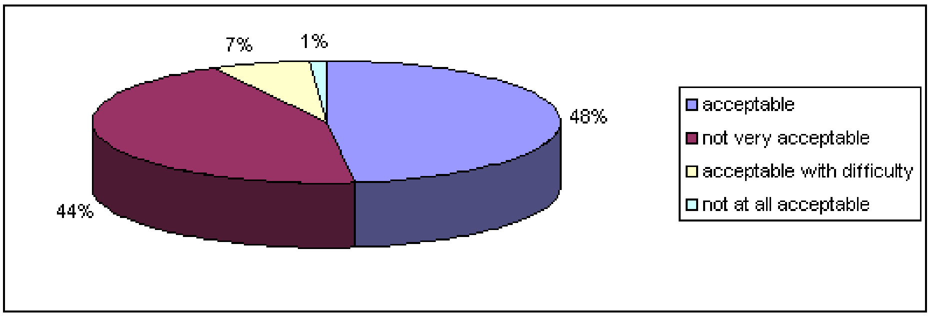

Figure 2 Distribution of the global comfort (Branch Building)

Conclusion.

From the analysis of the physical data comes out a situation fully in agreement with the results of the subjective survey, putting in evidence in particular a clear difference between the two buildings[10]. If we consider for instance the thermal comfort in the central building we find a mean value of PMV= 0.61 and a percentage of dissatisfied people PPD = 13.4% where the mean thermal sensation(question 1) is -0.52 corresponding to a situation of neutrality and slightly cool and the percentage of pupils judging the environment acceptable a little is 37%. In the branch building we find: PMV =0.48, PPD = 10.4%, -1.23 and 53%. Moreover the branch building avails of a lower illuminating (about 100÷150 lux) than the central one.

The proposed target is to know statistically which aspect (thermal, acoustic, lighting, air quality etc) should be a priority action in any recovery global environmental, and find reliable answers in the made analyses.

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References

[1] Clausen, G., Carrick, L., Fanger P.O., Kim, Sun Woo, Poulsen, T., A comparative study of discomfort caused by indoor air pollution, thermal load and noise. Indoor Air 1994, 4, 255-262.

[2] Barbaro,S.; Bonanno,A.;Patti, B.; Mazzola, S.; Franzitta; V.; Grippaldi, V. Acoustical aspects of the environmental control. An effective tool for a sustainable urban planning., Proceedings of the the 2nd European Conference REBUILD, Florence, Italy, April 1998.

[3] D. Milone, S. Pitruzzella, V. Franzitta, A.Viola, M. Trapanese. Energy savings through integration of the illumination natural and artificial, using a system of automatic dimming: Case. Applied Mechanics and Materials, Vol. 372 (2013) pp 253-258

[4] V. Franzitta, A. Milone, D. Milone, M. Trapanese, A. Viola. A case study to the Evaluation of Global Environmental Quality, concerning thermal, acoustic and atmospheric conditions of urban areas. Advanced Materials Research Vol. 726 (2013) pp 1068-1072.

[5] V. Franzitta, A.Viola, M. Trapanese, Daniele Milone. A procedure to evaluate the indoor global quality by a sub objective-objective procedure. Advanced Materials Research Vols. 734-737 (2013) pp 3065-3070,.

[6] V. Franzitta, D. Milone, M. Trapanese, A. Viola, V. Di Dio, S. Pitruzzella. Energy and Economic Comparison of different conditioning system among traditional and eco-sustainable building. Applied Mechanics and Materials, Vol. 394 (2013), pp 289-295

[7] M. Trapanese, V. Franzitta, , A Viola. The Jiles Atherton Model for Description Of Hysteresis in Lithium Battery. Conference Proceedings - IEEE Applied Power Electronics Conference and Exposition - APEC 2013- Long Beach,(CA), March 2013-978-1-4673-4355-8, pp 2773-2775

[8] V. Franzitta, , M. Trapanese, A. Viola,S. Costanzo. Assessment of the Trend of Albedo: A Case Study of Palermo. Advanced Materials Research Vols. 734 (2013),pp 1865-1869

[9] M. Trapanese, V. Franzitta, G. Ciulla, V. Lo Brano, A Viola. An Approach to Rank Noise Pollution in Workplaces. Advanced Materials Research Vols. 726 (2013), pp 3132-3136.

[10] M. Trapanese, V. Franzitta, A Viola. Design and Performance of a High Temperature Superconducting Axial Flux Generator. IEEE Transactions on Magnetics, Vol. 49, issue 7, pp 4113-4115.

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