Evaluation of the indoor environmental quality in 10 office buildings in Greece using a post-occupant evaluation strategy based on the application of a web-based tool

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Abstract: The quality of indoor work environment is proved to have a direct effect on the employee's productivity, job satisfaction and health. However, the issue of indoor environmental quality in not often considered due to financial, administrative and technical reasons resulting in inappropriate working conditions. The aim of the present study is to provide a simple, yet efficient solution for the evaluation of buildings performance, considering the complexity of the indoor environment. To this end, an assessment tool, called "Comfortmeter" has been developed in order to identify critical situations and to provide a set of suggested improvements. The Comfortmeter is the result of a collaboration between international authorities and organizations involved in efficient, sustainable and high performance office buildings. The tool focuses on 6 subjects: lighting, acoustics, thermal comfort, office environment, air quality and individual control. The assessment has been performed in 10 office buildings in Greece with the following procedure: An online survey has been administrated among the employees and the responses are statistically analyzed guaranteed all confidentiality issues. The outcome is an analysis, a) presenting the current comfort conditions of the building, b) indicating issues of attention, c) suggesting measures of improvement d) providing financial indicators of productivity advantage and productivity improvement potential in €/year.

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1. INTRODUCTION

Over the last decades there has been a change in the global economy that thereinafter changed the working environments. More people are employed in offices and therefore the need to understand and assess their impact on the occupants is evident. Indoor environmental quality (IEQ) is a matter that is researched since the 1920s and is strongly connected with the occupants productivity (Al Horr et al., 2016). One study that was conducted in the UK for occupants in various sectors indicated that a good office environment may improve the productivity by up to 20% (Clements-Croome, 1999). Occupants can be affected by many different aspects in a working environment and in different ways. Issues like the thermal, acoustic, visual comfort and other like the indoor air quality are investigated in such terms.

Since the connection of the indoor office environment with the occupants' productivity has been established, new strategies and techniques were formed to pinpoint threats and investigate solutions. The wellbeing and behavior of employees has been the center of numerous studies and research and later the issue of post-occupant evaluation (POE) was been established. During the 1960s this type of evaluation was introduced as a remedy from significant problems in field of building performance. The definition of POE can be described as a "diagnostic tool and system which allows facility managers to identify and evaluate critical aspects of building performance systematically' (Preiser, 1995). The assessment of the occupants' behavior, demands and needs is a very complicated and dynamic procedure, since all of the above consist both objective and subjective components. Additionally, POE is a systematic evaluation of the building performance after construction and while some time has passed since it was occupied (Goçer, Hua, & Goçer, 2015). In these terms numerous techniques were introduced each different in approach to assess the office environment after the occupation of a building (Geng, Ji, Lin, & Zhu, 2017; Leaman & Bordass, 1999).

Mostly since 2000s the effort to perceive and form certain POE tools and campaigns as part of project deliveries was introduced. Earlier, the research and studies that were conducted were mostly for scientific purposes and experience shown that prospective clients would not directly be involved or care about POE techniques (Bordass & Leaman, 2005). In this term there were also other issues that shifted the interest of researchers and consultants as well.

Over the past decade the need for more efficient and green buildings was greatly increased. Research on near energy buildings and eco-friendly ones flourished and the decrease of CO^2 emissions while fighting phenomenon like the urban heat island and the climate change in general was put in the center of attention. While the design of new buildings or the refurbish of old ones with new materials and equipment met the demands of environmental sustainability, in most cases the human interaction with the building environment was not taken into account (Thatcher & Milner, 2016). Therein lies a great debate over possible investments for new and old buildings as well. Should these investments be focused over the direct turnover from a very efficient building design or over the users' demands and needs, therefore improving their productivity which is an indirect turnover? Research that is done until now provides sufficient proof that the majority of working environments can be best described as uncomfortable and inefficient. This mostly applies in old office spaces and other similar buildings that were not initially designed with a more user friendly approach. This applies to the building elements and components as well the controls and management of a building. Wilkinson, Reed, & Jailani, (2011) have investigated how the occupants satisfaction levels and productivity should be approached in sustainable office buildings.

Fortunately, as previously mentioned POE techniques are adapted after the construction of a building and after some time has passed since it was occupied, therefore they can be used with great success in already completed buildings (newly built or refurbished). The assessment of the IEQ may lead to various conclusions and provide solutions for improving the productivity of employees. For example, Tsushima, Tanabe, & Utsumi, (2015) indicated that workers with higher sustainability awareness were more content with their IEQ in energy-saving offices; raising the matter of better informing the public in these matters. Shen, Newsham, & Gunay, (2016) developed certain approaches for already existent data streams regarding the occupancy in order to assess and probe possible energy saving solutions. While the use of mobile/cloud and other IT infrastructure increases in quantity and quality the raw data streams that can be generated to a building is growing rapidly. These same services can be used for data mining information related to occupancy and can prove invaluable in the future analysis.

In Greece, although studies for the building environment have been thorough, little work has been done to assess the users perceptive. Nevertheless, the need of specifying the IEQ along with the individual occupants characteristics is great as it can lead to substantial changes for future design and realization of projects (Antoniadou, Kyriaki, Manoloudis, & Papadopoulos, 2017). That been said the work that is presented with this paper is to our knowledge the first in the matters of POE and IEQ and their correlation in Greece ever.

2. THE COMFORTMETER APPROACH AND METHODOLOGY

The growing need for more energy efficient buildings towards the NZEB design has introduced also the matter of more comfortable working environments. In order to specify problems and provide solutions a specific tool called "Comfortmeter" was developed for office buildings. It consists of one survey questionnaire, the statistical analysis of occupant's responses and the final report of the findings.

There are various ways and much flexibility to perform the survey either on-site or not, while the questionnaire can be distributed online via email and can be accessed from a standard web-browser. Physical contact with the clients is not necessary and the system is fully automated so it can provide scheduled reminders ensuring that more answers are generated increasing the response rate. The questionnaire includes 55 questions and covers the topics of thermal, visual and acoustic comfort, indoor air quality, individual controls and management of the office environment.

After the survey completion the data is gathered and checked for storage in a database. The statistical analysis of the stored data is carried out through an econometric model which ensures the user anonymity to represent the subjective comfort experience of occupants. After analysis the outcomes of the survey are presented in a final report that contains the information about the occupants' satisfaction levels, the areas of improvement and possible measures that can be applied. Additionally a quantitative estimation of the buildings' comfort levels on the occupants' productivity is generated, as well as a comparison of the performance between the buildings under examination against other similar previously analyzed office buildings. The finalized report provides compact and comprehensive results regarding the buildings comfort levels and the occupants' satisfaction rate.

As part of the QUANTUM project the University of Athens participated in the Comfortmeter survey engaging more than 30 possible clients. Until the time that this paper was written the analysis of 10 office buildings was completed regarding their overall comfort and the occupants' satisfaction levels. In general the buildings that were examined are located in the greater Athens area, specifically 5 out of 10 while the rest are located 2 in Peloponnesus, 1 in Crete, 1 in Salonika and 1 in Kozani.

Each of the examined cases presents different conditions in many regards. In order to generate the reports with enough credibility and minimize the error margin each client-company should have nearly as much as 20 or more employees. However this is a small number of occupants for a single building, therefore the survey may refer in whole buildings in some cases or in part/s of buildings in others. Specifically 3 clients/companies out from the sample of 10 that are reported occupy part of the building for their offices while the rest occupy the whole building area. Additionally, some companies may employ more than the 20 occupants that participated in the survey, therefore a representative sample regarding their location in the building was selected. For privacy reasons the buildings are referred with numbers (1-10). In Table 1 the basic characteristics of the reviewed buildings are presented.

Table 1 Characteristics of the reviewed buildings.

Building	Client business sector	Location	Type	Gross Floor (m²)	Occupants	Conditioned shared of space (%)
1	Maritime	Central Athens	Part of Building	345	13	100
2	Environmental Consultancy	Central Athens	Part of Building	450	21	91-100
3	Constructions	Kozani, Macedonia	Whole Building	200	10	91-100
4	Local authorities	Central Athens	Whole Building	2166	57	61-70
5	Local authorities	West Athens	Whole Building	10000	65	91-100
6	Environmental Consultancy	North Athens	Whole Building	1800	95	100
7	Technical services	Arcadia, Peloponnesus	Whole Building	450	21	91-100
8	Local authorities	Laconia, Peloponnesus	Whole Building	648	25	81-90
9	University	Chania, Crete	Part of Building	3160	100	61-70
10	Technical services	Central Salocika	Whole Building	939	25	91-100

As mentioned, after the collection of all the completed questionnaires and the analysis of the raw data a "Productivity advantage" and "Productivity improvement potential" in €/year can be calculated. The initial analysis provides information about the fields that need improvement in order to increase productivity in the working environment. Each different building is compared with the already formed database of investigated buildings that are used as reference, stating the best and worst practice in each field. The comparisons indicate if and where there are problematic behaviors depending on the scores that were achieved from the survey against the referenced buildings. In order to calculate the productivity advantage and the productivity improvement potential a certain algorithm has been developed. As inputs we use the variables that are shown in Table 2 and as output we receive a new variable called "Productivity effect" that will be used for the next calculations.

Table 2 Calculation of productivity effect of 1% increase of overall comfort (€/year).

Variable	Value	Calculation procedure
Self-reported productivity increase in case of 1% increase of overall comfort (%) (A)	Depending	Average value for X respondents, based on the statistical relation between self-reported effect of overall comfort on productivity
Turnover per employee (€/year per employee) (B)	99.076	Sum of salary cost, non-salary cost (ICT, facilities,) and normal profit margin for an average Belgian employee in the service sector
Employees per m² (employee/m²) (C)	0.0364	Assumes 27,46 m² conditioned floor surface per employee (average value for 29 surveyed office buildings)
Floor surface (m²) (D)	Varying	Conditioned floor surface
Productivity effect of 1% increase of overall comfort (€/year) (E)	Final value	**(E = A x B x C x D)**

As it is indicated the first input "Self-reported productivity increase" (variable A) is not a constant value and depends on the current average value of the respondents of the ongoing survey campaign. The other non-constant value that is inserted as input to the algorithm is the conditioned gross floor surface (variable D) of each building under investigation. The other two variables are calculated from reference as it is implied. Specifically the "Turnover per employee" (variable B) is calculated for an average Belgian employee in the service sector, so it may serve only as a varying indicator as in each country this average value would naturally differ. In this study we have used the turnover values per employee according to the Hellenic Statistical Authority (Hellenic Statistical Authority). The next variable "Employees per m^2" (variable C) assumes 27.46 m^2 conditioned floor space per employee and it is an average value for 29 referenced buildings. The final output is the "Productivity effect" with unit (€/year) and is next used to calculate the "Productivity Advantage" and the "Productivity improvement potential" values by multiplying it with the differences of the average score and the overall comfort improvement potential (%) respectively.

The two final aforementioned variables are in general used as indicators to identify the areas where one building excel or underperform compared to others. Evidently, that way the comfort aspects that need caution are acknowledged and the clients can proceed to rectify them.

3. RESULTS AND FINDINGS

As mentioned in the previous section the Comfortmeter tool was used for the evaluation of 10 buildings in Greece. Nevertheless, each of the buildings present great diversity comparing to the others in structural and technical elements and equipment. Additionally, as it is expected by the bibliography the anthropogenic data that are collected are very subjective for every case, therefore general results are limited. While the nature of the survey is user based there are additional information we have to gather for the investigated office buildings to better assess the working environment conditions. This information includes technical characteristics for the HVAC systems and the building elements and other information like the occupation schedule, etc. The combined knowledge of this information with the statistical analysis of the users' responses can lead to significant conclusions. In Table 3 we present the aforementioned information for the investigated buildings.

Table 3 Technical information of the investigated buildings.

Building	*Year of construction and renovation*	*Occupation schedule*	*HVAC*	*Thermostat*	*Mechanical ventilation*	*Insulation*	*Frames and Glazing*	*Shades and Lighting controls*
1	2011	Monday to Friday, 09:00-19:00	VRV	YES	YES	6 cm EPS	Triple glaze with thermal break and aluminum frames	Automated blinds with user control
2	1955, renovations 1999 and 2007	Monday to Friday, 08:30-18:30	Gas for heating, AC for heating-cooling	NO	NO	Typical	Double glaze with aluminium frames	Blinds
3	2007	Monday to Friday, 08:00-17:00	Oil for heating, AC for heating-cooling, fan coils for cooling	YES	NO	Typical	Double glaze with aluminium frames	None
4	1980	Monday to Friday, 08:00-17:00	Gass and portable heaters for heating, AC for heating-cooling, Ceiling fans for cooling	NO	NO	Typical	Double glaze with aluminium frames	Blinds
5	2006	Monday to Friday, 08:00-17:00	Gass for heating, AC for heating-cooling	NO	NO	Typical	Double glaze with thermal break and aluminium frames	Blinds
6	2000	Monday to Friday, 08:30-18:30	VRV	YES	YES	3cm EPS	Double glaze with aluminium frames	Blinds
7	1980, partly renovation 2014	Monday to Friday, 09:00-19:00	AC for heating-cooling	NO	NO	None	One glaze with aluminium frame	Shutters, Blinds, Awnings
8	1980	Monday to Friday, 08:00-17:00	AC for heating-cooling	NO	NO	Typical	Double glaze with aluminium frames	Blinds
9	2002	Monday to Friday, 09:00-19:00	VRV	YES	YES	5cm Mineral wood boards	Double glaze with aluminium frames	Blinds
10	1968, renovations 2002 and 2012	Monday to Friday, 08:00-17:00	Gass for heating, AC for heating-cooling	YES	NO	Typical	Double glaze with aluminium frames	Blinds

The majority of the buildings investigated present typical to none insulation and are equipped with simple double glazes with aluminium frames, which may affect greatly the users thermal comfort. Additionally, only 4 out of the 10 possess thermostat controls while only 3 are equipped with mechanical ventilation. For heating and especially for cooling purposes most buildings utilize AC units, which is a common practice in Greece in general.

The results of building 2 (client no2, referenced in Tables 2 and 3) are presented as an example of the methodology. The second client is located near the center of Athens and occupies the 1st and the 4th floor of a residential building that was built in 1955. Basic renovation works have been carried out for the 1st floor in 1999 and for the 4th floor in 2007. This type of building is common in the city of Athens where new structures are scarce. Specifically in the center of the city most buildings are built between 1950 and 1980 when no national directives were specified in terms of insulation and other construction elements standards. The renovations that took place in the offices mainly affected the non-opaque elements, where the simple one glaze windows were replaced by simple double glaze ones with aluminum frames. The heating system of the building is gas powered whereas for cooling needs air-condition units have been installed to the offices. Additionally the heating system is central and no user intervention is possible, while also there are no mechanical ventilation units.

All of the above characteristics affect the users' responses in the survey as we can see in the next figures (Figures 1-4). Figure 1 presents the comfort aspects in the building that generate the highest productivity advantage (the calculation method of the "Productivity advantage" and "Productivity improvement potential" was described in previous section). In this case we observe good scores in the aesthetic aspects in the working environment such as the office furniture quality, the office layout, the cleanliness and the individual adaptability clothing. The score of 94% compared to the average score of 67% for the "Office furniture" generate a productivity advantage of 5983 €/year. Good scores are also achieved in matters of adjustability for heating, cooling and lighting as well as for the natural ventilation via windows, scores that are justified by the individual control of AC units and the absence of mechanical ventilation.

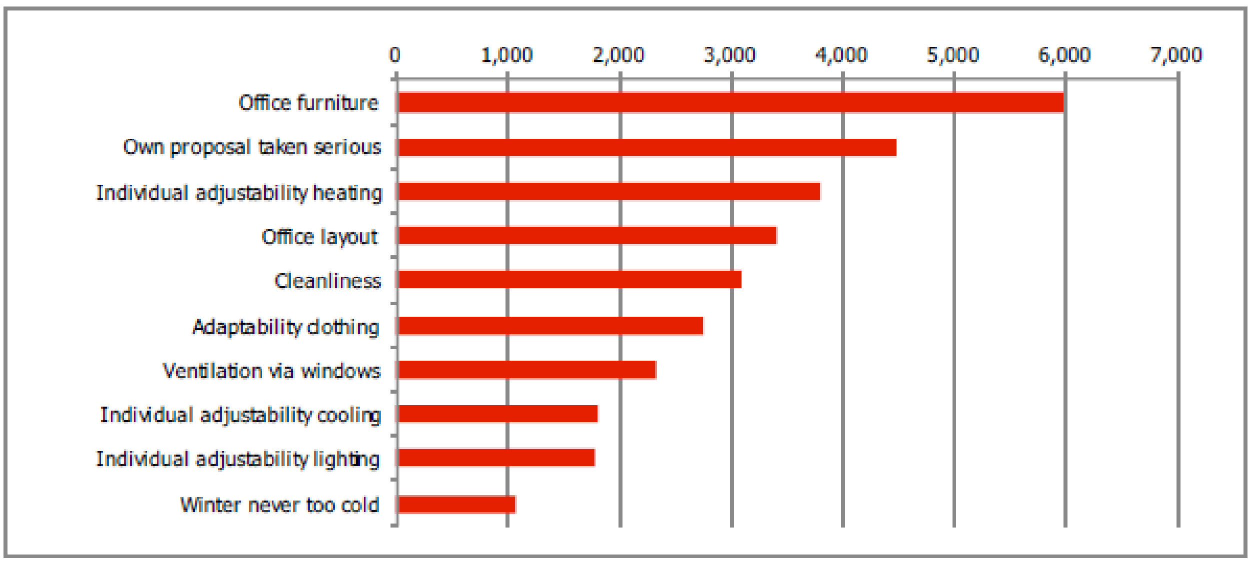

Figure 1: Productivity advantage of the best comfort aspects (€/year), rough estimate for the building no2.

In Figure 2 we present the comfort aspects with the highest productivity potential, while these aspects present the lowest scores. In general the fact that the building is old and located in a busy neighborhood with look-alike buildings affect these aspects. Improving the score for "View from window" would generate a productivity improvement of 15404 €/year.

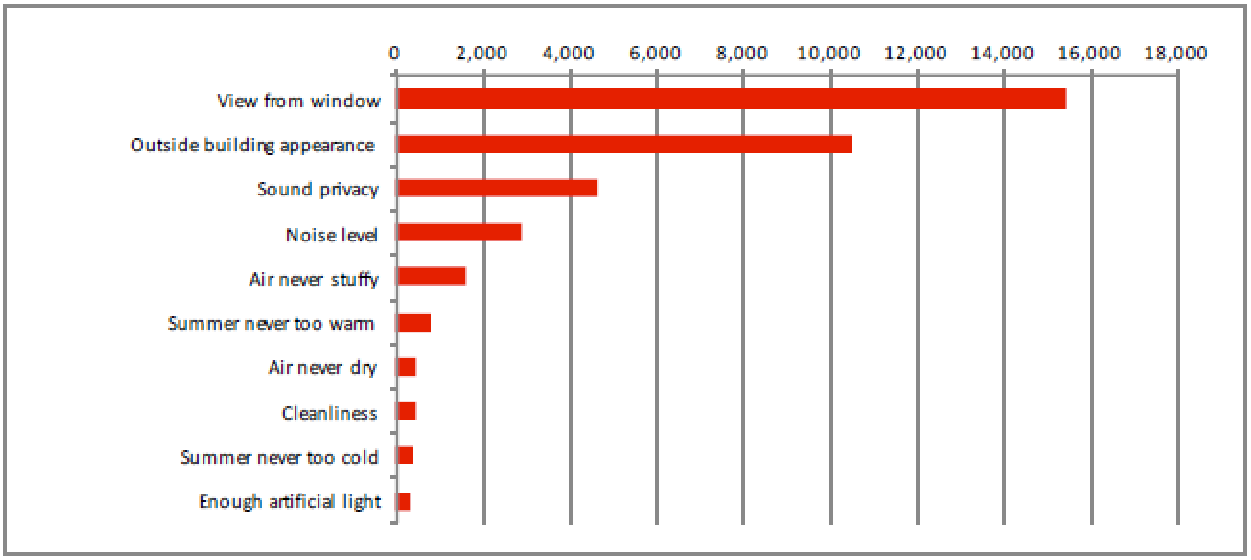

Figure 2: Productivity improvement potential of the worst aspects (€/year), rough estimate for the building no2.

In Figure 3 we present the detailed comfort aspects scores in the building (including error) compared with the worst, average and best practice values. The AC units' adjustability and the overall offices quality improve the overall score, while we pinpoint the problematic behavior of the sound and the air quality aspects.

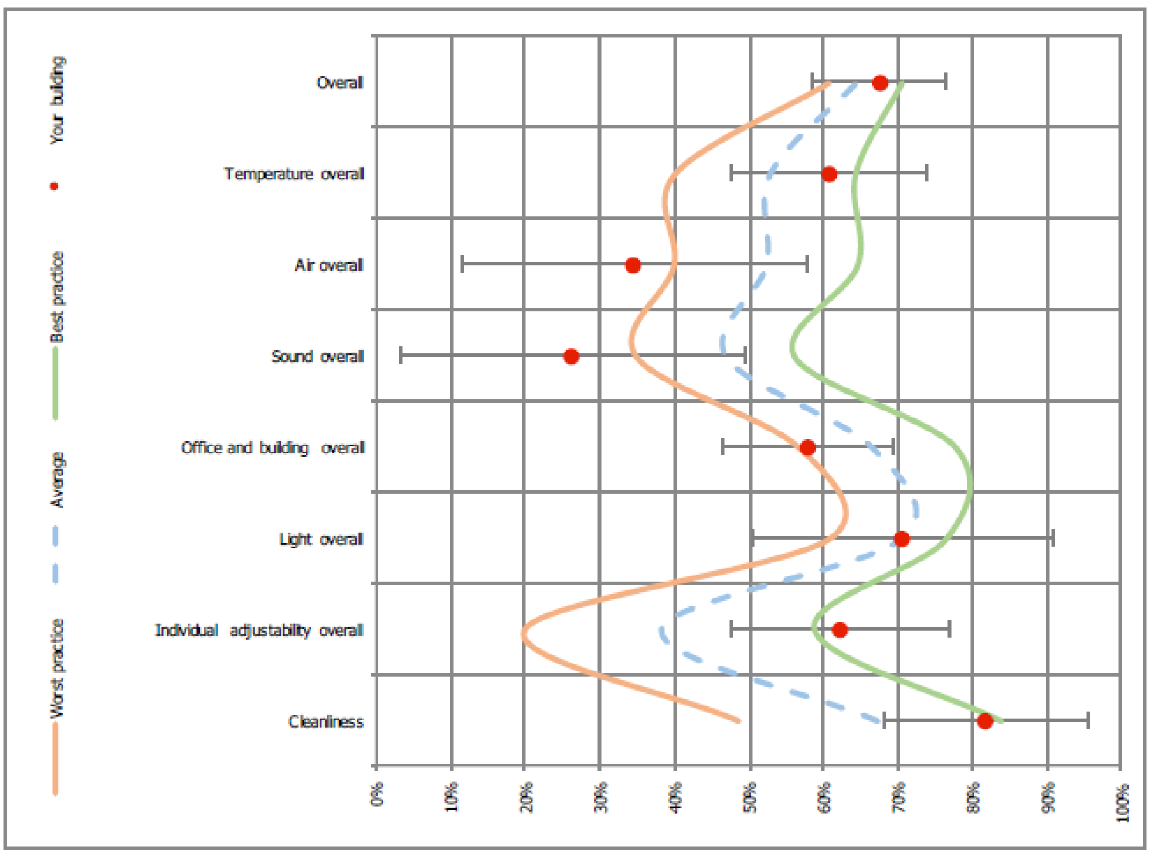

Figure 3: Scores of comfort aspects for the building no2 (0%=very dissatisfied, 100%=very satisfied).

The final result of the analysis is a table with all the summarized data compared to the best practice in each field. This way a final productivity improvement potential (€/year) is calculated for the comfort aspects of the building. The summarized data for all the investigated buildings are presented in Table 4.

Table 4 Productivity improvement potential of overall comfort via increase of comfort aspects.

Building	Comfort Apects	Overall	Temperature overall	Air overall	Sound overall	Office and building overall	Light overall	Individual adjustability overall	Cleanliness	Total
	Best practice	71%	64%	65%	56%	78%	77%	59%	84%	-
1	**Building score**	70%	66%	68%	48%	73%	71%	69%	75%	-
	PIP (€/year)	1584	-	-	2682	5030	700	-	2161	12157
2	**Building score**	67%	61%	34%	26%	58%	71%	62%	82%	-
	PIP (€/year)	6647	1036	4431	8569	17040	686	-	454	38863
3	**Building score**	81%	81%	82%	64%	83%	76%	67%	93%	-
	PIP (€/year)	-	-	-	-	-	-	-	-	0
4	**Building score**	40%	52%	36%	11%	40%	45%	26%	28%	-
	PIP (€/year)	309434	16952	19335	60776	151169	17120	39746	55547	670079
5	**Building score**	58%	57%	20%	22%	41%	60%	77%	75%	-
	PIP (€/year)	897315	65711	220650	325448	1054847	64959	-	64748	2693678
6	**Building score**	65%	64%	59%	50%	65%	77%	52%	67%	-
	PIP (€/year)	65215	-	5245	10798	66156	-	9950	21916	179280
7	**Building score**	41%	33%	40%	32%	29%	67%	54%	57%	-
	PIP (€/year)	88766	12757	5179	9904	59482	1523	1750	8092	187453
8	**Building score**	44%	56%	47%	32%	48%	48%	32%	59%	-
	PIP (€/year)	101026	4939	4547	14742	53571	4898	11127	14371	209221
9	**Building score**	55%	57%	63%	41%	56%	67%	61%	57%	-
	PIP (€/year)	74387	4931	675	9835	41122	2322	-	12866	146138
10	**Building score**	76%	72%	82%	44%	79%	93%	68%	86%	-
	PIP (€/year)	-	-	-	10348	-	-	-	-	10348

Table 4 can be used as a key indicator for assessing issues of discomfort in the working environment and come up with solutions. The overall estimation represents some general information extracted by the questionnaire, therefore it was deemed necessary to calculate the total amount of all overall comfort aspects. The comfort aspects with the lowest scores present the highest improvement potential. Specifically for the 2nd client, since the interference with the neighborhood in its entirety is not feasible we suggested that they deal with the air and sound problem by installing new highly efficient double glaze windows and frames with thermal break, in addition to changing the behavior of the employees with simple rules (close the windows during the hot days and using natural night ventilation). That way the exterior noise can be minimized and the indoor air quality would be improved in terms of air changes and temperature.

Evidently, we observe that there is an overall overestimation of the total productivity potential. In order to produce an estimation for the Greek buildings the turnover per employ value that is used in the calculations is adjusted to the Greek economics. Nonetheless, we observe that newest buildings that are equipped with energy efficient equipment perform very well based to the users' perception. In fact, building 3 in disregard with the low efficient structural components that is made of performs excellent. Buildings 4, 5, 7 and 8 present the lowest scores overall. Buildings 4, 7 and 8 are old with bad maintenance and poor equipment, therefore their performance is expected. Building 5 is a whole different case, while being a relative new construction its performance highlights the poor structural elements that were chosen in relation with the inadequate management.

In order to analyze the productivity improvement potential for all cases we replaced the "Turnover per employee" and the "Employees by m^2" values in the algorithm according to the Greek reality to improve the evaluation of the method (Hellenic Statistical Authority). The national records are categorized according to the building services and the number of employees in each company. The normalized data are reported in Table 5.

Table 5 Total Productivity improvement potential of overall comfort via increase of comfort aspects, corrected.

Building	Employees per m^2, normalized	Turnover per employee, normalized (€/year)	Total PIP (€/year)	Total PIP, normalized (€/year)
1	0,0377	63106	12157	8016
2	0,0467	94409	38863	47477
3	0,0500	94409	0	0
4	0,0263	67367	670079	329398
5	0,0065	67367	2693678	327067
6	0,0528	67367	179280	176751
7	0,0467	94409	187453	229003
8	0,0386	94409	209221	211306
9	0,0316	67367	146138	86388
10	0,0266	94409	10348	7212

In Figure 4 we present the corrected total productivity improvement potential for each building. Evidently, the corrected amounts are much more representative and this procedure should be followed in the future to solidify our results.

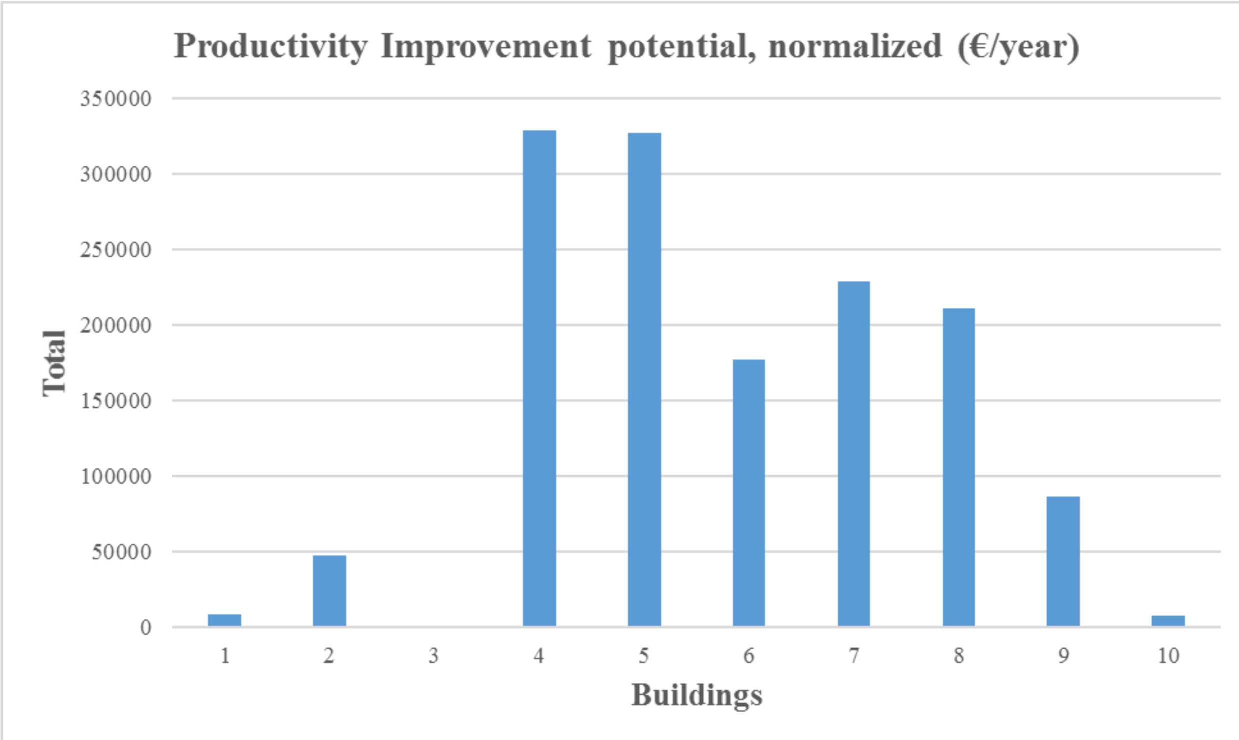

Figure 4: The corrected total productivity improvement potential for each building.

Finally in Table 6 we present for each building the comfort aspects with the lowest scores indicating where there are discomfort issues. Accordingly the productivity improvement potential for each of the major issues is stated in order to solidify the importance of these comfort aspects. Since the problems in every building have been diagnosed and evaluated the clients' building manager or the consulting agency that uses the Comfortmeter tool can process solutions.

Table 6 Productivity improvement potential of worst comfort aspects.

Building	Worst comfort aspects	Productivity improvement potential (€/year)	Productivity improvement potential, normalized (€/year)
1	View from window	8154	5376
	Sound privacy	2865	1889
2	View from window	15404	18818
	Outside building appearance	10519	12851
3	Office Layout	1626	2128
	Enough Daylight	1140	1492
4	Cleanliness	55547	27306
	Outside building appearance	44124	21690
	Office layout	41744	20521
5	View from window	663576	80572
	Outside building appearance	459012	55733
	Office layout	438254	53213

6	View from window	33750	33274
	Cleanliness	21916	21607
7	View from window	14988	18310
	Outside building appearance	14145	17280
8	View from window	18113	18294
	Office layout	15067	15217
9	View from window	21657	12802
	Cleanliness	12309	7276
10	Office furniture	11089	7729
	Sound privacy	6731	4691

Collectively we can observe that bigger buildings present highest productivity improvement potential than the smaller ones, as expected from the calculation method. At this point we must state once more that the generated amounts in €/year are only indicative. The presence of the gross floor surface in the calculations of the productivity improvement potential may lead to unrealistic estimations. For example building no 5 been the biggest one in our analysis with over 10000 gross floor surface presents potential over 1.5 million €/year which is clearly an overestimation.

The most common comfort aspects that generate low scores are the "View from window" (70%), "Outside building appearance" (40%), "Office layout" (40%) and "Cleanliness" (30%). The two first aspects cannot be addressed directly and in an effective way, while the latter are easily resolved. Despite the initial expectations for the realization of this survey, we observe that the more significant comfort aspects in the working environment like the thermal comfort or the air quality does not concern much the employees. For example, in old buildings with typical insulation and low efficiency glazes thermal comfort should be one of the lowest scoring comfort aspects which is not the case. In fact we observe that simple matters like the cleanliness and the office layout seem more important to workers. For our case the majority of the office buildings that were investigated are equipped with AC units (very common for buildings in Greece) that allow full control of the indoor temperature. In fact this particularity may affect the responses of the occupants on the matters of thermal comfort and indoor air quality. Nevertheless, as was confirmed by the analysis the first steps that should be taken in order to achieve highest efficiency and productivity in the working environment, are the improvement of the office layout and the cleanliness.

4. CONCLUSSION

A new assessment tool for the indoor work environment called Comfortmeter was created under the frame of the project QUANTUM. A survey campaign using the tool was designed and is still carried out in order to assess the indoor comfort aspects in buildings across several European countries. For the Greek case until now 10 buildings in total were investigated and analyzed.

The Comfortmeter tool consists of an online survey, an analysis protocol and the resulting report for each investigated building. The focus group for research are different types of office working environments. In our case we investigated buildings with much diversity proving that the tool is suitable for use in pretty much every case. Buildings were selected in Athens, Salonika, Peloponnesus, Macedonia and Crete, while operating in the sectors of "Energy Consultancy", "Technical services", "Local authorities" and other. A certain procedure was carried out prior to the tool use, involving the collection of all necessary technical information and constructing a building ID while also gathering any additional information and addressing the occupants. A mailing list of the employees is formed for input to the automated system of the survey and after the collection of responses (usually during a week's time period) we proceed to the analysis.

For every comfort aspect that is included in the survey, individual scores for each building are generated from the accumulative responses of the employees. These scores are used as indicators for excellent performance and problematic issues. The tool also allows the users to indicate certain problems that are present by completing comments. Using a certain algorithm two new indicators are formed the "Productivity advantage" of the best comfort aspects and the "Productivity improvement potential" of the worst ones. New buildings that are investigated through the survey campaign are inserted to the database of the tool and are used for comparisons with the best and worst practice in each comfort aspect.

Using the indicators the comfort aspects that need caution are pinpointed and solutions can be processed. In general the most common comfort aspects that generate low scores are not connected with the thermal comfort and the indoor air quality, rather than that of more aesthetic nature. Employees seem discontented with the view from their window, the outside building appearance, the office layout and cleanliness. This subject needs more investigation and the data collected from the Greek case should be compared with the accumulative European data within the project. Therein arises the question if there is a gap of misinformation among the employees about the proper thermal and air quality conditions within the working environment.

The overall analysis indicates that the Comfortmeter tool is an efficient and cost effective way to assess the indoor working environment. Different comfort aspects can be examined and the tool can be applied in various building types and clients. That been said the calculations method of the two indicators that were mentioned earlier seems problematic to adjust in every building type and may lead to overestimations. In order to provide more indicative results the algorithm that is used was modified as per the values of "Employees per m^2" and the "Turnover per employee" according to the national records of the Hellenic Statistical Authority. By applying the normalization methodology we resulted to the estimation that if we improve the worst common aspects in each case there can be a margin of productivity improvement potential of 7212 to 329398 €/year.

While the campaign of the surveys continues more buildings will be investigated across Europe enriching the already formed database providing useful insights on the employees' behavior and the indoor working environment. Finally, the Comfortmeter tool can be used for research for individual cases of buildings (with the implementation of the personalized information for each of them) and for the total as well (with the statistical analysis of the collective data of similar types of buildings).

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