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Evaluation of Occupant Comfort in Office Buildings in Ghana

Morkporkpor Delight Sedzro[1, 2, *], Daniel Vindex Kwabla Domeh[1], Augustus Addy-Lamptey[1]

[1]Marine Engineering Department, Faculty of Engineering, Regional Maritime University, Tema, Ghana
[2]Brew Hammond Energy Centre, KNUST, Ghana

Email address:
delight.sedzro@rmu.edu.gh (M. D. Sedzro)
[*]Corresponding author

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Abstract: Occupant comfort, ranging from acoustic to thermal has been shown to affect health and work productivity in office buildings. Thus, the need to understand the link between these factors and work productivity considering Ghana's recent growth in office infrastructure triggered by development in its economy cannot be overlooked. In this study, the office buildings of two institutions are evaluated based on eight categories of institution, age, gender, thermal, acoustic and visual comfort and other parameters such as smell and indoor aesthetics. Overall, 115 occupants responded to the survey questionnaire. The results show the female occupants more unsatisfied with certain parameters such as thermal comfort and lighting, compared to the males. Occupants above the age of 50 towards the retirement age of 60 were also satisfied with the acoustic and internal aesthetic of their workspace. The results serve as a guide to remodeling of any office space in line with improvements of the office building.

Keywords: User Satisfaction, Indoor Environmental Quality, Thermal Comfort, Visual Comfort, Acoustic Comfort, Internal Layout and Aesthetics, Smell, Ghana

1. Introduction

Buildings are designed and constructed to meet certain requirements; but most buildings do not perform as anticipated implicitly affecting running cost, occupants' performance, health, safety and in most cases comfort. To this end, the evaluation of buildings, post commissioning, remain an extremely cost-effective measure; improving workplace productivity when carried out and implemented [1]. The availability and functionability of control systems aimed at regulating occupant comfort are key to indoor environmental quality with tacit implications on the overall performance and energy consumption of any building. Whether in residential or commercial buildings, available literature has shown comfort and satisfaction are not often attainable, largely due to the complex nature of the buildings and their control systems [2]. One of the efforts at addressing this over the years has essentially been through Post Occupancy Evaluation (POE), which provides useful information on the performance of the building, as well as feedback on the satisfaction or comfort of its occupant. Such information, according to Lawrence & Keime [3], can be used markedly to improve the process and design of future construction through pointing out areas for future designs improvement. Across the globe, particularly the developed world, buildings have evolved, moving away from the traditional function of shelter to their effect on the environment and the minimization of energy consumption [4]. The foregoing effect is thus a burden on architects and engineers to change the way they design and construct buildings. Consequently, these technocrats are not only expected to comply with common standards and codes, but also new regulations based on requirements that are set by organizations such as the Leadership in Energy and Environmental Design (LEED) etc. [5]

Historically, POE in buildings originated in the United Kingdom and has been in practice in one form or the other since the 1960's [6] [7]. Its usage has seen marked improvement partly due to the fact that discernable disparities exist between the expected and actual energy consumption of any building. And this, is, often not because predictive techniques are wrong, but because the assumptions often used are not well informed by what really happens in practice [8]. Without the utilization of POE, most Architectural Engineering and Construction (AEC) experts today rarely monitor the performance of their building post construction and there is very little attention to actual satisfaction of the user. On the other hand, growth in population, increasing demand for building services and comfort levels, together with an increase in the time spent in buildings, assure the upward trend in energy end use [4]. The focus of most conventional literature and extant studies however, remain more tied to energy consumption as opposed to occupant satisfaction ignoring the fact that, human behavior in avoiding discomfort can be knotted directly to end use energy [9]–[12]

Also, evolving design of modern offices and working environments must continue to expect high levels of spatial and technological change through the provision of suitable Indoor Environmental Quality (IEQ) in support of intensive computer laden or paper work [13]. While the aforementioned has implicitly shaped changes in building design and the control of the indoor working environment, the need to determine occupant perception and comfort remains overriding with a keen focus on its implication on energy use. Post Occupancy Evaluation is one such tool at achieving this objective. POE is described in general terms as a broad range of activities aimed at understanding how buildings perform once they are built [14]. In other literature, it is also defined as a process in which a building has to be evaluated in a systematic and accurate manner after it has been built and occupied for some time [15], [16]. Extant studies such as [38], have also defined it as any and all activities that originate out of an interest in learning how a building performs once it is built, including if and how well it has met expectations [6]. Essentially, the value of systematic learning from POE is primarily in twofold. One identifies additional benefits that can be obtained per the evaluation of the building; allowing for minor tuning to enhance its performance for the users [17]. Such cases, involve a typical scope to achieve enhancements at a nil or low cost. And this, can involve measures such as, incorporating energy efficient elements into the fit-out or a change in the building management including user protocols. The second benefit, takes the form of a guidance on follow up procurement [17]. Thus, this ensures that successful aspects that the users endorse are incorporated in future projects along with the aspects of the building that warrant improvement to occupant comfort.

In Africa, particularly the west, POE has evolved at a slow pace in the built environment. As with other technologies and tools, its growth is also shaped by an initial high cost, ease of social acceptance and ignorance of its long-term benefits, as is the case in the implementation of certain technologies e.g. renewable energy. Nonetheless, since its first implementation and documentation elsewhere, POE has been used extensively in office buildings. In the California-based Centre for the Built Environment, a web based survey and accompanying online reporting tool was developed to assess the performance of the workspace aimed at identifying areas of improvement. The study also provided useful feedback to designers and operators about specific aspects of building design features and operation strategies from the occupants' perspective through the evaluation of indoor environmental quality such as office furnishing, thermal comfort, air quality, lighting, acoustics, building cleanliness and maintenance. In *Wagner et al.*, [18] the workplace occupant satisfaction across 16 office buildings in Germany was studied. The results highlighted occupants' control of indoor climate, and the perceived effect of their intervention on satisfaction with their thermal indoor conditions. Observations in Wagner *et al.,* [18]'s study were synonymous with that of Barlow & Fiala [19] which also laid emphasis on the occupants' ability to control the indoor climate predominantly thermal comfort.

Contrary to such positive observations, a study by Mahdavi *et al.,* [20] in office buildings in Austria demonstrated considerable levels of dissatisfaction with certain aspects of the indoor climate and environmental control systems. The occupants interviewed in this study admitted to a knowledge gap of their offices' environmental systems and welcomed clarification on the use of building systems in place. Such observation of dissatisfaction were consistent with [21] in which the negative effect of indoor environmental quality were reported e.g. effects such as fatigue and sick building syndrome. In Kamarulzaman *et al.,* [22] and Wolkoff [23], the effect of Indoor Environmental Quality (IEQ) on occupants' health and work performance was underscored including the identification of a gap in the information about occupants' own assessments of the IEQ parameters measured. On buildings designed to measure environmental impact, it was found that, buildings designed for lower environmental impact were better than conventional buildings from the occupants' point of view [24]. Leaman & Bordass' [24] study compared user experiences through surveys in 177 conventional buildings, with mixed modes or air conditioning and green buildings. Their study also concluded that green buildings scored better on: ventilation/ air, health, design, image, lighting, overall comfort, and perceived work productivity compared to the latter. In a POE of 20-office building across the United States, Statistical analyses of over 400 workstations linked characteristics and environmental qualities to occupants' satisfaction. The results obtained also disputed the validity of current IEQ standards and guidelines [13].

In the Ghana, the phenomena of occupant perception and POE are not new. Albeit the challenges with achieving energy security, occupant perception, post construction, remains an area rarely explored. Very little literature exist on the assessment of the performance of buildings with rather scanty documentation on POE except for the notable works of [2] [25] [26] amongst others. Interestingly, Ghana's commercial and residential buildings account for over 50% of the country's total energy consumption [27], imperceptibly driven by ignored factors such as occupant behavior or the desire to reduce discomfort. Considering the fact that Ghana has experienced economic growth over the last decades, the need to prioritize POE is noteworthy, primarily, as infrastructure project for office buildings and white colour jobs is conspicuously on the rise. Moreover, with an increasing interest in building services globally, and the support of studies such as [21] [28] which demonstrate, health and productivity can be tied to indoor environmental comfort, the concept of POE must become paramount for any government.

Particularly on building construction, Ghana has had its fair share of improvement, gradually moving away from typical vernacular architecture to westernized style of architecture. In terms of thermal comfort requirement, Ghana's climate can best be classified as hot and humid with much of its climatic conditions predominantly outside the human comfort zone [29]. Accordingly, a greater part of the country requires cooling for a notable part of the year. In terms of visual comfort or lighting, daylight was the primary source of lighting in building with other forms of artificial light apart from electric lighting used complimentarily. Most windows were made of wood and louver blades, which facilitated lighting and ventilation. Thus, the advantage to the foregoing was a deviation from the strong need for electric fans and air conditioning systems; implicitly facilitating energy efficiency compared what pertains today. Recently however, there has been a movement towards universal building design approaches with extensive use of glazing that is poorly adapted to the local climatic conditions. Such designs, which are sometimes poorly done, permit high penetration of solar radiation leading to high cooling loads and energy consumption. A significant majority of the buildings in Ghana are also constructed of sandcrete blocks with low thermal mass and the low night outdoor air temperature. Viz-a-viz security consideration, most of the windows presently incorporated in most design are kept closed, subliminally creating the need for forced ventilation in line with thermal comfort.

On conventional literature with regards to POE in Ghana, studies such as Simons *et al.,* [26] showed that windows/glazing were more for clear views to the outside than it was for ventilation in the AC buildings. As such, such buildings were either hardly opened or not operable at all. Interestingly, this observation was inconsistent with an earlier study on office buildings in Ghana which found that occupants in office buildings had a strong urge to operate windows, even in air-conditioned buildings [2]. In both studies nonetheless, it was found that satisfaction in office buildings correlated with the flexibility of the buildings control system. Training in the use of control facilities was underscored in both cases. Overall, occupant satisfaction cannot only be linked to IEQ but also other elements such as view, layout, amount of privacy, aesthetics etc. as documented elsewhere (see [30]–[34]). Quite unfortunately, a missing element with regards to the evaluation of occupant performance in Ghana is the assessment of their satisfaction of the working environment. Most evaluations are tied to the performance of the workers in terms of their assigned task. Thus there is a hypothesis that occupants are satisfied with their working environment so long as they do not complain about it. Against the foregoing, this study assesses occupant perception and comfort of the office building line with the benefits of POE highlighted herein. Feedback on occupant satisfaction of their indoor environmental quality is sought, highlighting prospects of modification, improvement to occupant comfort with an overall link to work productivity. Largely, the study is focuses on two maritime institutions in Ghana, namely, Ghana Ports and Harbour Authority of Tema (hereafter referred to as GPHA-T) and Regional Maritime University (hereafter referred to as RMU) and seeks to answer the questions, "Are staff of GPHA-T and RMU satisfied with their working environment? The effect of indoor environmental parameters such as thermal comfort, light, acoustic, colour, and smell on staff satisfaction and comfort are evaluated.

2. Materials and Methods

2.1. Buildings Used in the Study

The RMU and GPHA-T, were selected because of their pivotal role in the maritime development in the country. Again, because most studies within the Ghanaian maritime sector ignore studies related to the built environment, the study sought to highlight issues related to architecture and other building services within that domain. This study, thus, focused on the administration block of the GPHA-T and all office buildings within RMU. Compared to the administration block of GPHA-T which is fairly new, all the buildings at RMU used in this study are older than ten years with the exception of its lab complex which was commissioned some four years ago. Overall, data was collected through questionnaire surveys in relation to parameters such as occupant comfort e.g. temperature, lighting, acoustics and smell. Voluntary participation and confidentiality were upheld in this study with no occupant forcibly required to participate or declare his identity. The entire research was conducted in Accra, the capital of Ghana.

2.2. Questionnaire Surveys and the Measurement of Satisfaction

The use of questionnaires in POE study, is significant, particularly as it translates the satisfaction of occupants directly by fundamentally allowing the measurement of the performance gap of the building in terms of its intended purpose. Its use is also known to ease the assessment of building performance through the facilitation of communication between the users and the facilities manager of the given building [35] [36]. With regards to feedback, conventional literature shows, the use of questionnaires promote very positive results in terms of its role in shaping occupant satisfaction (See [37]–[39]. Other supplementary literature that showcase the use of questionnaires in POE for determining satisfaction are also available [8] [40].

For this study, a list of performance indicators was identified through literature review to develop a questionnaire. For each respondent, irrespective of the institution, the questionnaires were categorized into 8 groups based on satisfied, no response and unsatisfied. The terms unsatisfied and dissatisfied are considered synonymous in this study. The experience of the user is considered an important factor in the process of determining satisfaction [41]. Such experience, based on certain elements such as sense, feel, act, think and relate are often ignored in studies on the conceptualization of the user. Satisfaction therefore reflects a feeling resulting from a process of evaluating what is received against what is expected or the fulfillment of needs/wants [42]. Albeit the existence of earlier renowned theories such as the contrast and discrepancy theory [42]–[45] non of such models were explored in this study. The concept of satisfaction in this study was used to depict the level of comfort of the occupant with the listed factors of thermal, visual, acoustic, internal aesthetics and smell. Tacitly, the satisfaction of each of the occupant is based on their previous experience and the element of sense, feel, act, think and relate in line with their working environment. All occupants in the study were however involved in the same kind of sedentary activity.

Overall, the measure of satisfaction was in line with the following: place of work, gender, age, thermal comfort, visual comfort/lighting, acoustic and smell. Regrettably, Health and performance were not evaluated, as there was no medical professional involved to validate any related assertion. For he questionnaires, open-ended section was factored to solicit for detailed qualitative feedback. A sample size of 60 was adopted for RMU and 75 for GPHA-T. out of which 50 and 65 responses were obtained respectively representing 83% AND 86% respectively. To administer the questionnaire, four enumerators were tasked to explain the concept of comfort in terms of thermal, visual, acoustic and smell to each of the occupants. This was done to ensure all occupants had a fair understanding of these factors in line with their satisfaction. Responses were collected over a period of 3 months and analyzed accordingly.

2.3. Hypotheses Testing Procedure

As mentioned earlier in Section 1.0, it is perceived that staff in Ghanaian workplaces are satisfied with their working environment, since management do not receive complains in this regard. Therefore, the study sought to find out if this perception is true with GPHA-T and RMU, through hypothesis testing using the Statistical Package for Social Sciences (SPSS) software. Firstly, the null and alternative hypotheses were stated as, "employees of GPHA-T and RMU are satisfied with their working environment" and "employees of GPHA-T and RMU are dissatisfied with their working environment", respectively. The data collected from respondents was organized into eight categories as illustrated in Table 1. Then each category of data was tested for distribution type using the Shapiro-Wilk test for a one-tailed decision in which only 5% (0.05) error is allowed. A correlation test using Spearman's rho test statistic was also conducted to know if thermal comfort, light, acoustic, colour, and smell, have any bearing on the satisfaction experience expressed by staff of GPHA-T and RMU with regards to their working environment. Finally, the one sample Chi-Square test was conducted to decide whether to reject or accept the null hypothesis. It should be noted that, also for Spearman's rho and Chi-Square tests, a one-tailed decision using 5% (0.05) error margin was adopted.

Table 1. *Respondents data categorized into 8 groups.*

Group	Title	Survey Question
1	Gender	Are you male or female?
2	Place of work	Do you work at GPHA-T or RMU?
3	Thermal comfort	Are you satisfied with the thermal comfort experienced at your work place? Yes/No.
4	Light	Are you satisfied with the light brightness at your work place? Yes/No.
5	Acoustic	Are you satisfied with the level of sound/noise at your work place? Yes/No.
6	Colour	Are you satisfied with the for colour for structural painting and decoration works at your work place? Yes/No.
7	Smell	Are you satisfied with the smell at your work place? Yes/No.
8	Overall	In all, are you satisfied with the environment in which you work? Yes/No.

3. Results and Discussion

3.1. Analysis of Respective Indoor Environmental Parameters

3.1.1. Thermal Comfort

Defined as the "the state of mind that expresses satisfaction with the surrounding thermal environment" [46], [47]. Thermal comfort can be influenced by a host of factors including, personal factors such as activity level, thermal insulation of clothing and environmental factors such as air temperature, mean radiant temperature, velocity etc. From the questionnaire, it was inferred 60% of the occupant in RMU were unsatisfied with their thermal comfort, See Figure 1. The above observation was largely because most of the occupant were not secluded or shared a common office space. Most of the air conditioners were also being replaced as of the time of this study. At the GPHA–T, our data showed a higher percentage of satisfaction with the thermal environment compared to the latter institution (see Figure 2), this was due to the fact that new air conditioners had just been installed across all the offices. In terms of their gender, it was inferred females were more unsatisfied with the thermal environment within both institution, consistent with studies such as [48]. See figures 3 and 4.

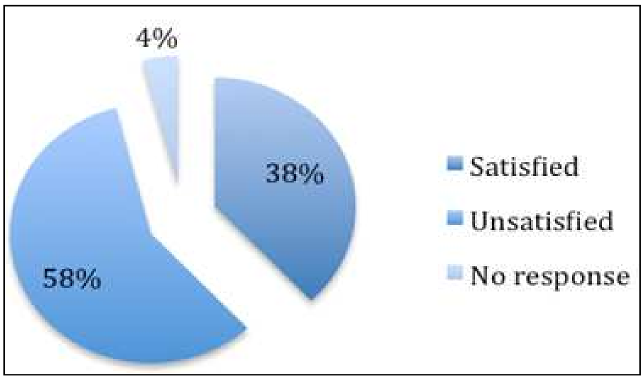

Figure 1. *Thermal Comfort RMU.*

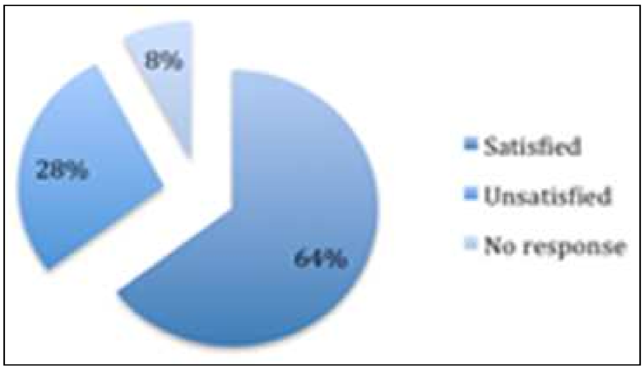

Figure 2. *Thermal comfort at GPHA-T.*

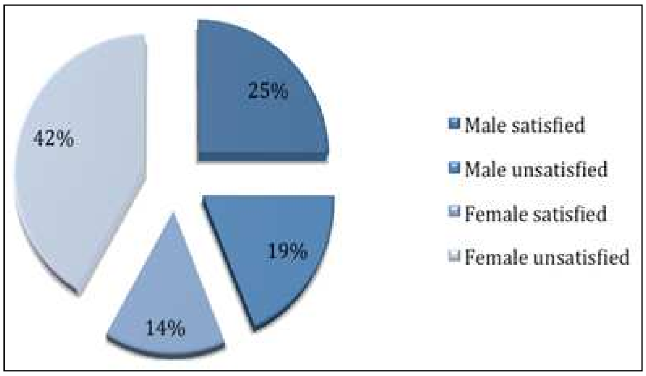

Figure 3. *Percentage of Male and female satisfaction with thermal environment at RMU.*

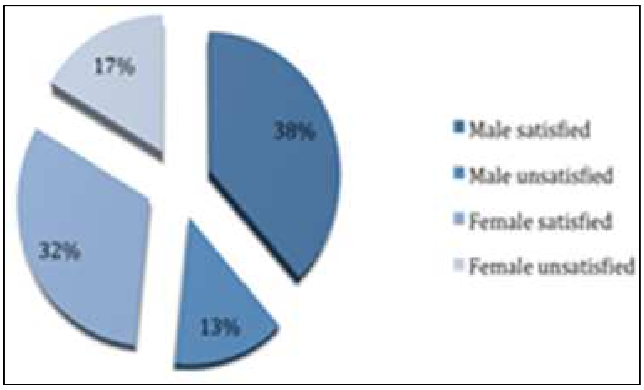

Figure 4. *Percentage of Male and female satisfaction with thermal environment at GPHA-T.*

3.1.2. Visual Comfort (Lighting)

Visual comfort is a very paramount parameter amongst the the indoor environement quality attributes of any given space. Particulary as visual comfort facilitates the working activity within a specified space, there is the need to look out for glare, contrast and lighting adequacy in line with the level of task or task requirement. Primarily, visual comfort can take the form of day lighting or electric lighting. Irrespective of the documented influence of daylighting and electric lighting on working activity (see [49]–[54]); visual comfort in this study was measured as one entity. Inferring from the data collected, occupants at the GPHA-T expressed better visual comfort compared to occupants at the RMU (see figures 5 and 6). Both males and females expressed a higher percentage of comfort in both instutition, see figures 7 and 8.

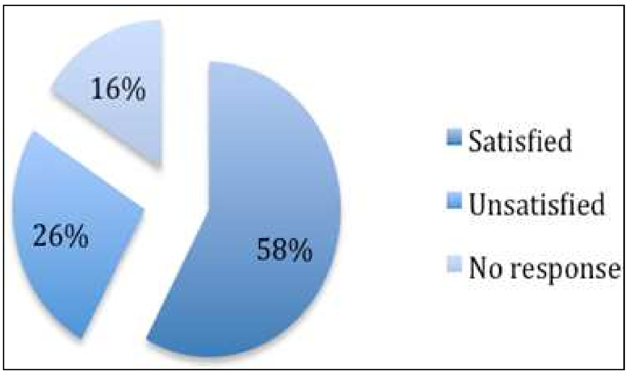

Figure 5. *Visual comfort at RMU.*

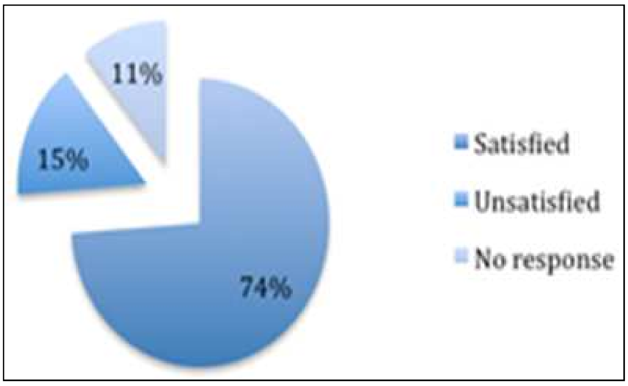

Figure 6. *Visual comfort at GPHA-T.*

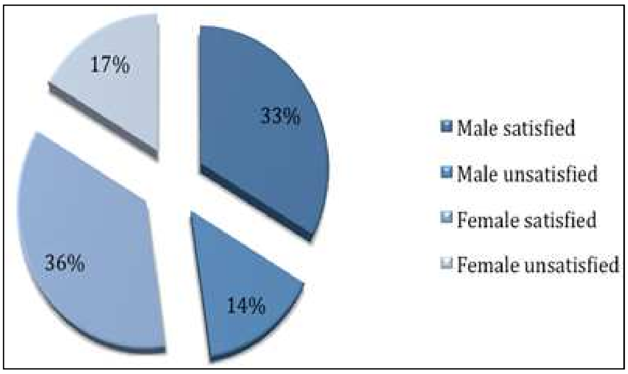

Figure 7. *Percentage of Male and female satisfaction with visual comfort RMU.*

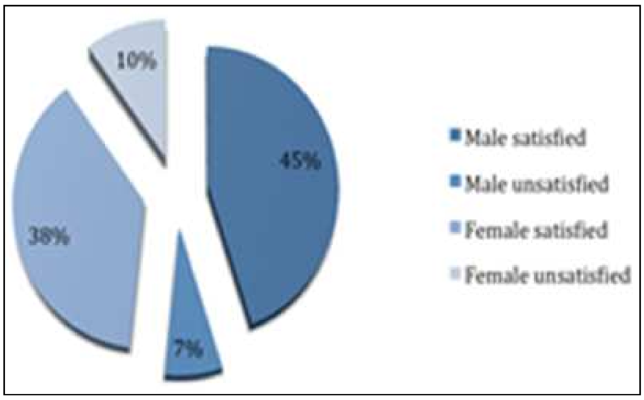

Figure 8. *Percentage of Male and female satisfaction with visual comfort at the GPHA-T.*

3.1.3. Acoustic Comfort

For most office working environments, the need to ensure accoustic comfort is weighty considering the fact that most task require some level of focus or detail to facilitate delivery. As shown in [55], accoustic comfort provides conditions that facilitate clear communication of speech between occupants. Other studies have also found that intelligible speech is attended to and is more distracting than unintelligible speech or sounds with no information content. Again, numerous non-physical characteristics of sound can be linked to subjective responses to noise and noise can in general terms be is defined as a psychological concept involving unwanted sound perceived by the listener as being unpleasant, bothersome, distracting or psychologically harmful [56]–[61]. So, whether occupants want to or not, their exposure to noise or other sound cannot be ignored within their working space. At the RMU, 56% of the occupants expressed dissatisfaction with the accoustics while 75% of the respondents at GPHA-T expressed the reverse (see figure 9 and 10). Of both instituitions however, higher percentage of both males and females expressed satisfaction with their accoustic environment at 71% and 81% respectively (see figures 11 and 12).

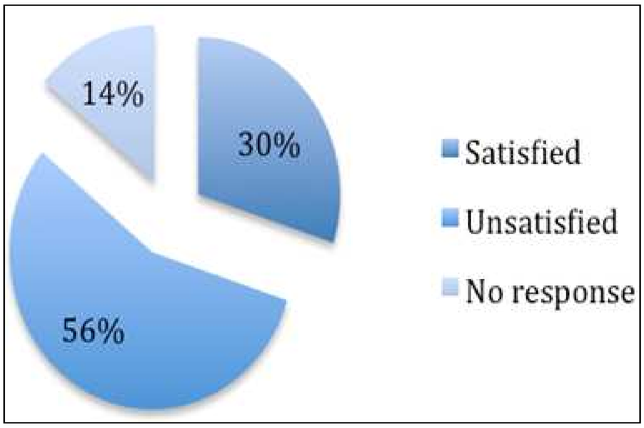

Figure 9. *Acoustic comfort at RMU.*

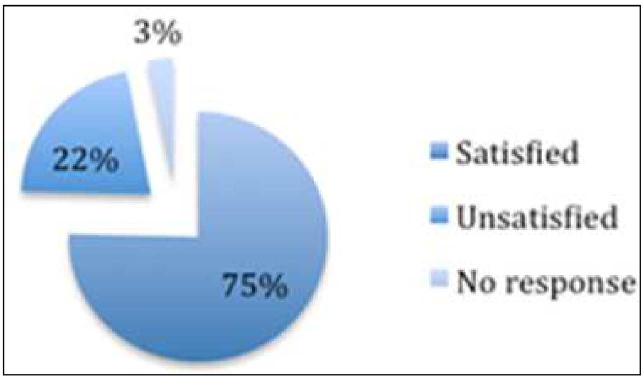

Figure 10. *Acoustic comfort at GPHA-T.*

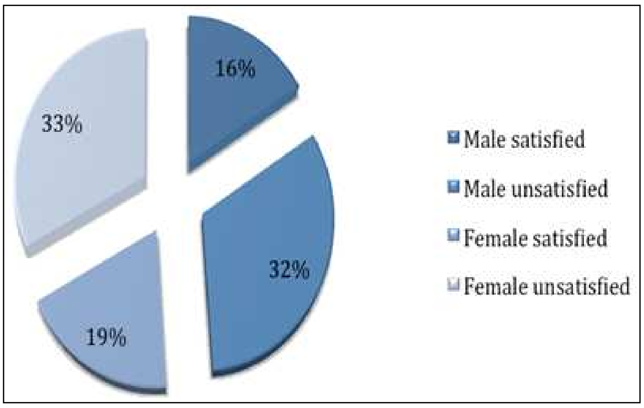

Figure 11. *Percentage of Male and female satisfaction with acoustic comfort at the RMU.*

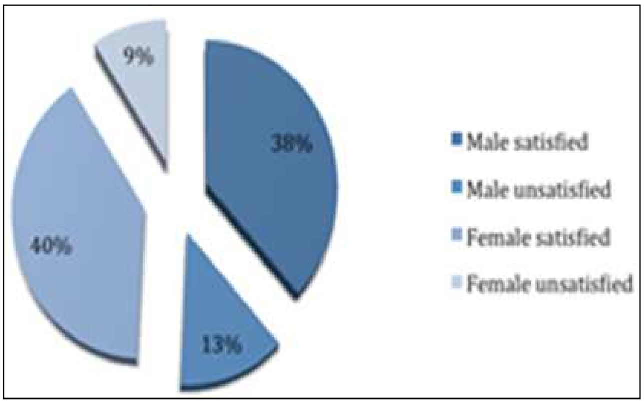

Figure 12. *Percentage of Male and female satisfaction with acoustic comfort at the GPHA-T.*

3.1.4. Other Factors

On other factors such such as the colour of painting and interior aethetics, 64% of the occupants at RMU were unsatisfied compared to 77% that expressed the contrary, see figures 13 and 14. Out of this percentage, 64% of the males and 75% of the females were unsatified at RMU while 85% of the males and 75% of the femaies at GPHA-T also expressed satifaction. See figures 15 and 16.

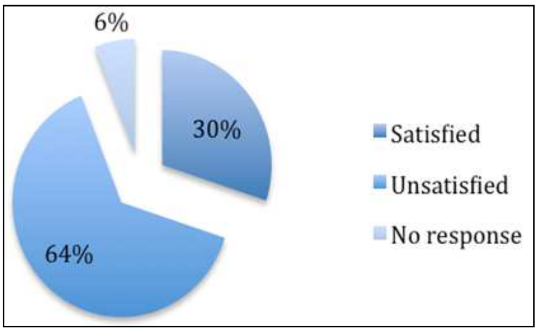

Figure 13. *Colour of painting and internal aesthetics at RMU.*

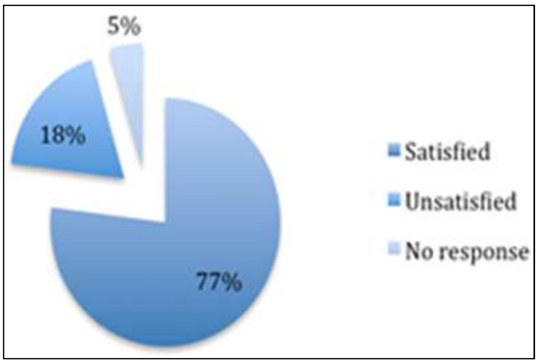

Figure 14. *Colour of painting and internal aesthetics at GPHA-T.*

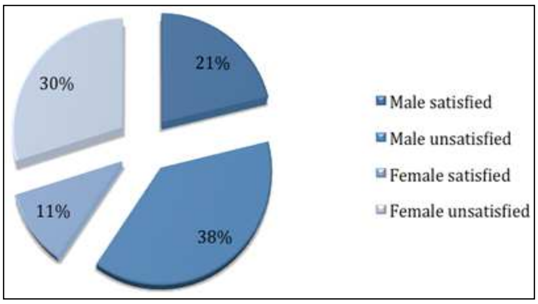

Figure 15. *Percentage of Male and female satisfaction with colour of painting internal aesthetics RMU.*

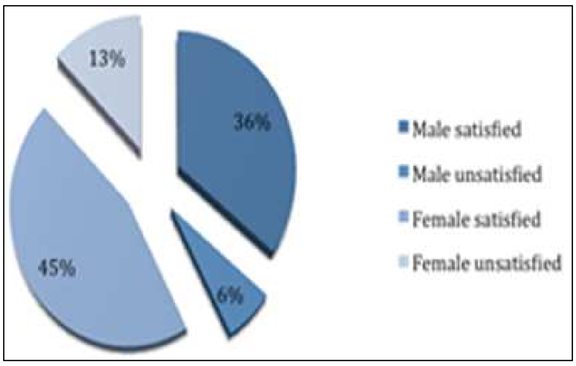

Figure 16. *Percentage of Male and female satisfaction with colour of painting internal aesthetics GPHA-T.*

On the sense smell, 64% of the occupants at RMU were satisfied with the smell of their work space while 66% of the occupants at GPHA-T were also satisfied. Out of the aforementioned percentages however, the males in both institutions were more satisfied compared to the females (42% and 42% respectively).

3.1.5. Age in Relation to Indoor Environmental Comfort

With regards to the role of age on the occupant indoor environemntal comfort, data collected showed most of the ocupants between the ages of 20 to 30 at the Regional Maritime University were satified with the thermal comfort compared to those between the ages of 50-60. For accoustics and colour perception of the indoor environment, our data showed those between the ages of 50 and 60 were more satisfied in terms accoustics compared to the younger occupants. The above observation could perhaps be linked to the widely accepted hypothesis that aging leads to age-related hearing loss as documented across other literature (see [62]–[66]).

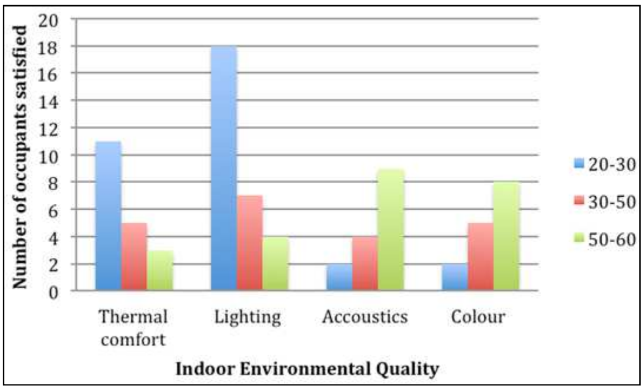

Figure 17. *Age in relation with indoor environmental quality at RMU.*

At the GPHA-T, a similar observation was made in terms of the role of age on the perception of indoor enevironmental quality. As in the case of the RMU, occupants between the ages of 20 to 30 were more satisfied with their thermal comfort compared to those above 50 years. The observation with regards to thermal comfort for both institutions were inconsistent with previous studies such as [67]–[69] that demonstrate that, there is no differences in the preferred temperature between younger and elderly subjects. On lighting, our data was consistent with studies such as Knez & Kers [70] which argue the fact that different age group share different conceptions about the indoor lighting.

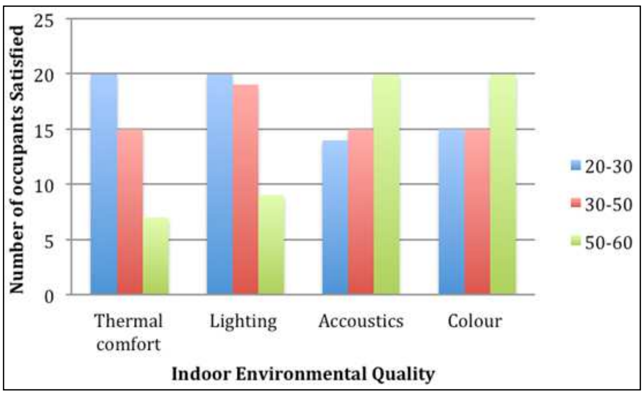

Figure 18. *Age in relation with indoor environmental quality at GPHA-T.*

3.2. Outcome of Hypotheses Testing

3.2.1. Data Distribution Type

The Shapiro-Wilk test produced significant values (p-value) of 0 for each data category as shown in Table 2. With the p-value being less than the 5% error margin stated in Section 2.3, there is a strong evidence against normality and hence each data category has a skewed distribution.

Table 2. *Results of normality test using Kolmogorov-Smirnov and Shapiro-Wilk statistics.*

Group Title	Kolmogorov-Smirnov Test	Shapiro-Wilk Test
	P-value	**P-value**
Gender	0	0
Place of work	0	0
Thermal comfort	0	0
Light	0	0
Acoustic	0	0
Colour	0	0
Smell	0	0
Overall	0	0

(Source: SPSS software)

3.2.2. Correlation Tests

The nonparametric correlation test using the Spearman's rho statistic result is shown in Table 3. A p-value of 0.000 was realized for each correlation test between data category 8 and those of categories 3 to 7. With the p-value less than the 5% error margin, there is a strong correlation between data category 8 and each of data categories 3 to 7. As such, it is seen from the table that the correlation coefficient values have been flagged with **; which means thermal comfort, lighting, acoustic, colour, and smell, influenced staff decision on satisfaction with their working environment.

Table 3. *Summary results of Spearman's rho test for correlations.*

Group Title	Spearman's rho Test	Gender	Place of work	Thermal comfort	Light	Acoustic	Colour	Smell	Overall
Gender	Correlation Coefficient	1.000	-0.032	0.192	0.039	0.047	0.028	0.000	-0.096
	P-value	0.000	0.367	0.020	0.339	0.308	0.384	0.499	0.154
	* Flaging			*					
Place of work	Correlation Coefficient	-0.032	1.000	-0.226	-0.160	-0.454	-0.443	-0.032	0.006
	P-value	0.367	0.000	0.008	0.043	0.000	0.000	0.367	0.476
	* Flaging			**	*	**	**		
Thermal comfort	Correlation Coefficient	0.192	-0.226	1.000	0.774	0.743	0.754	0.796	0.739
	P-value	0.020	0.008	0.000	0.000	0.000	0.000	0.000	0.000
	* Flaging	*	**		**	**	**	**	**
Light	Correlation Coefficient	0.039	-0.160	0.774	1.000	0.684	0.615	0.870	0.821
	P-value	0.339	0.043	0.000	0.000	0.000	0.000	0.000	0.000
	* Flaging		*	**		**	**	**	**
Acoustic	Correlation Coefficient	0.047	-0.454	0.743	0.684	1.000	0.789	0.608	0.610
	P-value	0.308	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	* Flaging		**	**	**		**	**	**
Colour	Correlation Coefficient	0.028	-0.443	0.754	0.615	0.789	1.000	0.520	0.602
	P-value	0.384	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	* Flaging		**	**	**	**		**	**
Smell	Correlation Coefficient	0.000	-0.032	0.796	0.870	0.608	0.520	1.000	0.795
	P-value	0.499	0.367	0.000	0.000	0.000	0.000	0.000	0.000
	* Flaging			**	**	**	**		**
Overall	Correlation Coefficient	-0.096	0.006	0.739	0.821	0.610	0.602	0.795	1.000
	P-value	0.154	0.476	0.000	0.000	0.000	0.000	0.000	0.000
	* Flaging			**	**	**	**	**	

(Source: SPSS software)

3.2.3. Hypotheses Test

To decide amongst the null and alternative hypotheses, which must be accepted, the one-sample Chi-Square test was conducted and the results is shown in Table 4. The significant values for data categories 3 to 8 are less than 0.05 (i.e. error margin), which is a strong evidence against the null hypothesis and hence rejected. Therefore, the alternative hypothesis is accepted; from statistical inference therefore, employees of GPHA-T and RMU are not satisfied with their working environment. Also the thermal comfort, lighting, acoustic, colour, and smell, enjoyed at their work premises influenced employees' decision.

Table 4. *Hypotheses test summary results.*

Group Title	Test Type	P-value	Hypothesis Decision
Thermal comfort	One-Sample Chi-Square Test	0.000	Reject the null hypothesis
Light	One-Sample Chi-Square Test	0.000	Reject the null hypothesis
Acoustic	One-Sample Chi-Square Test	0.000	Reject the null hypothesis
Colour	One-Sample Chi-Square Test	0.000	Reject the null hypothesis
Smell	One-Sample Chi-Square Test	0.000	Reject the null hypothesis
Overall	One-Sample Chi-Square Test	0.000	Reject the null hypothesis

(Source: SPSS software)

4. Conclusion

Very few studies have been carried out on POE in Ghana. Interestingly, majority of these existing studies focus on indoor air quality with very little on visual comfort, acoustics, indoor aesthetics and smell. Also noteworthy, the general notion across most institutions is that occupants are comfortable within their workspace so long as they report to work and carry out their assigned task. Such a notion is often held by management who do not consider it necessary to evaluate occupant perception and comfort post the commencement of work or occupancy of their respective office spaces. This study therefore measures the above hypothesis with keen consideration of some of the indoor environmental qualities overlooked in extant POE study in Ghana.

The study shows that occupant have mixed reaction in terms of satisfaction to different IEQ. On thermal comfort, occupants prefer segmented office spaces against the concept of open office spaces, which is gradually catching up in the country. The above is substantiated, through the qualitative feedback part of our survey questionnaire, which was an open ended section. In addition to the analysis on smell and internal aesthetic highlighted herein, the study showed, the choice of colour and sitting arrangement for any office space is paramount to the comfort of the occupants. Also inferred from the open-ended section of the survey questionnaire, occupants commented on the need for "calm paint colours" and natural fragrances synonymous to working outside their office space. All occupants were however comfortable with lighting except for disparities in line with them to gender and age as demonstrated in Section 3.1.5. On the other hand, it was observed, lighting for most of the office spaces were not in line with standard requirements as is the case in certain countries e.g. UK. Although a significant percentage of the occupants expressed satisfaction with visual comfort, most of the light bulbs installed in the office space had been installed just for the purpose of brightness, not specific to the task requirement. This observation is noteworthy for future studies with regards to the office space. Finally, on acoustic, the study concludes, occupant dissatisfied with their acoustic environment did not do so on the basis of an egress of sound or music into their office space but based on radio, music or chatting by colleague occupants of the same space.

In view of the foregoing, our study argues that office spaces should be designed with keen consideration of the requirement of its occupants and the nature of work assigned. As argued in other studies, evaluating IEQ is significant and should form part of organizational management procedures. Such frequent evaluation through POE will inform employers of the needs of their employees directly adding on to employee satisfaction and work productivity. Finally, this study focused on two institutions and should therefore not be used as a general yardstick for office design and occupant satisfaction. Whereas it highlights significant gaps in terms of POE in office buildings in the country, it must be understood that the work culture and architecture of all institutions vary significantly. A broader study on office buildings is recommended in other to arrive at far reaching conclusions on occupant satisfaction in office building across the country.

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