

# An examination of the distribution of user perception scores in a world-wide set of sustainable buildings

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**ABSTRACT:** The authors have surveyed and analysed the users' perceptions of a world-wide set of sustainable commercial and institutional buildings located in a range of climatic zones. Their overall aim, based on a detailed questionnaire survey of the users of thirty-one buildings in eleven countries, was to determine how well these buildings were performing from the point of view of the occupants. The users' responses to forty-five aspects of building performance were sought. The 2035 respondents were asked to rate each aspect on a 7-point Likert scale. Following a brief introduction describing the nature of the buildings involved, the design of the questionnaire, and the methodology adopted for its administration and analysis, the paper describes in detail the distributions of the perception scores for each one of the forty-five aspects on which responses were sought during the surveys. These distributions support the view that users are well able to assess variations in a wide range of aspects of the premises they occupy and that more systematic use should be made of their perceptions in building design and evaluation.

Conference theme: Sustainability Issues

Keywords: Sustainable Buildings; Post Occupancy Evaluation; Users' Perceptions

## 1. INTRODUCTION

Over the last decade or so building designers and developers have been producing sustainable buildings for their more environmentally conscious clients. Many of these buildings have been highly rated in terms of relevant Building Sustainability Rating Tools (BSRTs) or have received awards for their low energy design. In the main, these ratings and awards are based on the building design and its potential for low energy and sustainable operation, and their focus tends to be on technical aspects of building design which are specifiable and measurable (Cole, 2005). Our interest has been in how these buildings are performing from the point of view of the building users.

With the notable exceptions of the work emanating from the Center for the Built Environment at the University of California Berkeley (Huizenga et al, 2006), the Indoor Environment Research Programme at the National Research Council of Canada (Birt and Newsham, 2009) and Building Use Studies (2011) in the UK, very few studies have undertaken and reported the results of user surveys of large numbers of buildings. Fewer still have reported the range of values obtained in these surveys and the characteristics of their distributions. The Probe Studies (BRI 2001) and more recent work by Leaman and Bordass (2007) being the main exceptions.

The performance in practice of a set of 31 commercial and institutional buildings in 11 countries worldwide has been investigated by the principal author and his collaborators to ascertain the users' perception of a range of factors: operational, environmental (including thermal, acoustic and lighting aspects), personal control, and satisfaction. This paper is part of a series describing different aspects of the findings of that research programme. It focuses on the distribution of the user perception scores in order to illustrate the range of values found in practice for each factor

The 31 buildings were located in the following countries (numbers in brackets); Australia (7), Canada (4), Germany (1), India (2), Ireland (1), Japan (2), Malaysia (2), New Zealand (3), Singapore (1), the UK (6), and the USA (2). These were selected on the basis of their sustainability 'credentials'. Virtually all were recipients of national awards for sustainable or low energy design or highly rated in terms of their respective countries building sustainability rating tool or in some way pioneered green architecture; and were willing to be surveyed. Space does not permit the detailed description of the design features of the individual buildings – these can be found in Baird (2010).

## 2. THE QUESTIONNAIRE SURVEY

The questionnaire used was the standard two-page office version developed by Building Use Studies for use in the Probe investigations. The sixty or so questions cover a range of issues. Fifteen of these elicit background information on matters such as the age and sex of the respondent, how long they normally spend in the building, and whether or not they see personal control of their environmental conditions as important. The remaining forty-five, asked the respondent to score some aspect of the building on a seven-point scale; typically from 'unsatisfactory' to 'satisfactory', where a '7' would be the best score (though in several instances a '4' or a '1' would be best).

The following six broad categories were covered: Operational; Environmental - Temperature and Air in both Summer and Winter; Environmental – Lighting; Environmental – Noise; Personal Control; and Satisfaction. 2,035 staff (approx 43% female, 57% male; 33% under 30, 67% over 30) 75% of whom had worked in the building for over a year,

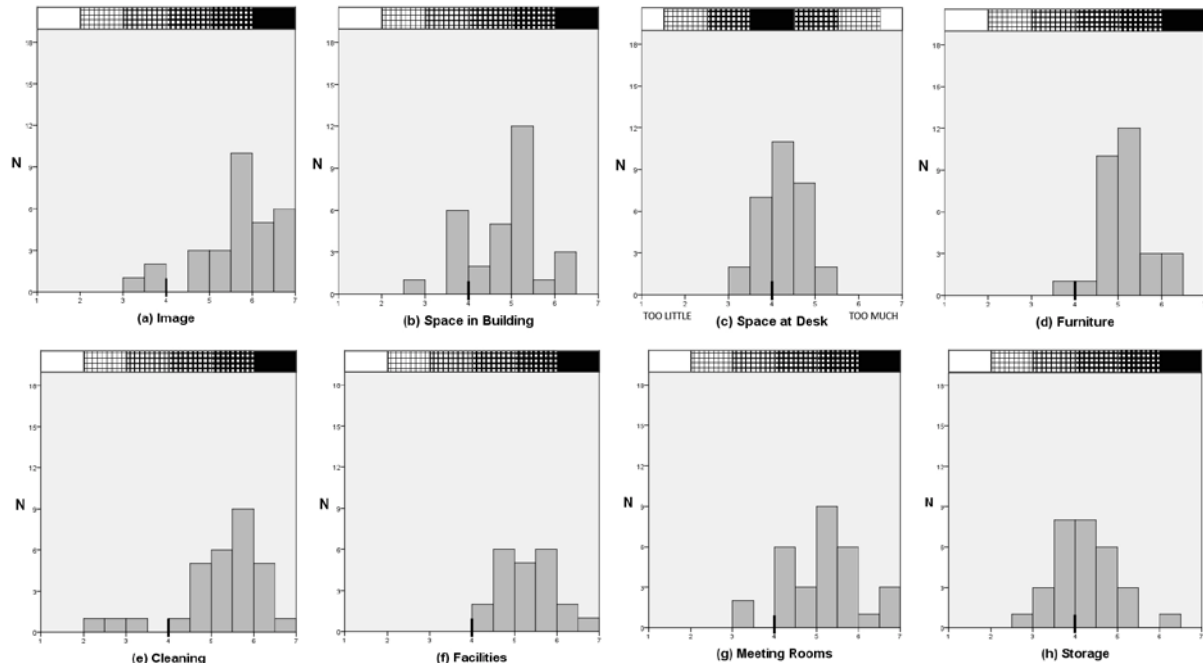
responded to the questionnaire, the vast majority scoring every question. Analysis of the responses yielded a mean value and standard deviation for each variable, and the distributions that are detailed in the following section.

### 3. DISTRIBUTION OF PERCEPTION SCORES BY CATEGORY

This section details each question, notes the mean scores and standard deviations, and describes their distribution.

#### 3.1. Operational Factors Category (see Fig 1)

This category includes Image, Space in building, Space at workstation, Furniture, Cleaning, Meeting Rooms, Storage, and Facilities. Histograms of the distributions of all eight of these factors are presented in Fig 1.



**Figure 1: Operational Factors**

*Image (Mean-5.6, s.d-0.95) – Fig 1(a).* The question posed under this heading was “How do you rate the image that the building as a whole presents to visitors...?” on a scale ranging from ‘Poor’ to ‘Good’. In most cases the respondents rate their buildings very highly. All but three have average scores well within the upper half of the 7-point scale. No less than eleven of the buildings score between 6 and 7, while thirteen score between 5 and 6. Clearly the majority of respondents took considerable pride in the image their building presented to visitors.

*Space in Building (Mean-4.8, s.d-0.83) – Fig 1(b).* The question posed here was “In the building as a whole, [how] do you think that space is used ...?” on a scale ranging from ‘Ineffectively overall’ to ‘Effectively overall’. In this case, twenty-three buildings score within the upper half of the scale while one building scores in the 2.5 to 3 range, and some sixteen are greater than 5.

*Space at Desk (Mean-4.3, s.d-0.53) – Fig 1(c).* The question posed this time was “Do you have enough space at your desk or normal work area ...?” on a 7-point scale ranging from 1 (too little) to 7 (too much). In this instance, the ideal would have been 4. What is interesting to see is that while over half of buildings (eighteen) had average scores between 3.5 and 4.5, nine of them averaged over 4.5 indicating that they had too much space, while only two, an office building and a college, were less than 3.5.

*Furniture (Mean-5.1, s.d-0.52) – Fig 1(d).* In the case of this aspect, the question posed was “How do you rate the usability of the furniture provided at your desk or normal work area ...?” The 7- point scale here ranged from ‘Very poor’ to ‘Very good’. As can be seen, all but one building scored greater than 4, the mid-point of this scale, and eighteen were greater than 5. Three of the cases scored over 6, with a further three between 5.5 and 6.

*Cleaning (Mean-5.2, s.d-1.00) – Fig 1(e).* The question posed to respondents was “How do you rate the cleaning ...?” with a scale ranging from ‘Unsatisfactory’ to ‘Satisfactory’. Most of the buildings were rated well into the ‘Satisfactory’ range for this aspect, with twenty-one of them scoring greater than 5. In two cases the scores were particularly low – the reason appeared to relate to the state of the toilets.

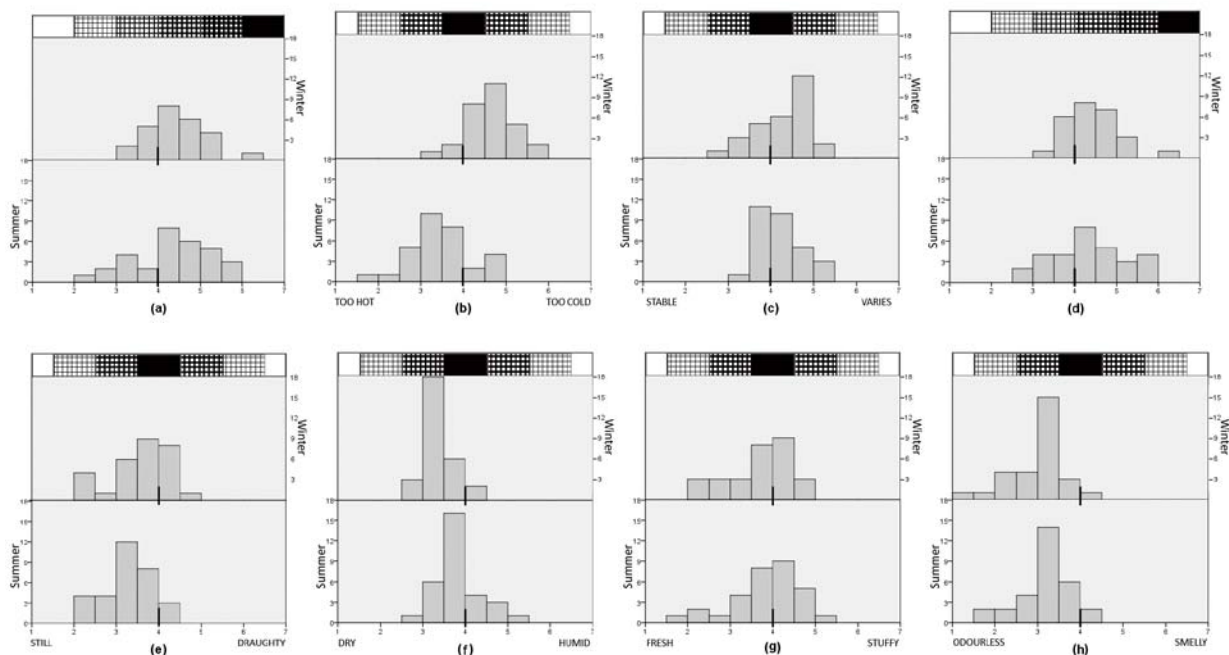
*Meeting Rooms (Mean-5.1, s.d-0.85) – Fig 1(f).* The question asked whether the “Availability of meeting rooms” was ‘Satisfactory’ or ‘Unsatisfactory’. Here, all but two buildings were above the mid-point of the scale, and nineteen were greater than 5. Four were greater than 6, while a further six lay between 5.5 and 6.

*Storage (Mean-4.2, s.d-0.73) – Fig 1(g).* Here, respondents were asked to score the “Suitability of storage arrangements” in their building on an ‘Unsatisfactory’ to ‘Satisfactory’ scale, and could also make a brief comment if they so wished. It can be seen that eighteen of the buildings scored greater than 4 and twelve scored less. Clearly storage arrangements were an issue for the users of many of these buildings, with three scoring under 3.5.

*Facilities (Mean-5.3, s.d-0.63) – Fig 1(h).* The question posed here was “In the building as a whole, do the facilities meet your work requirements?” with a scale ranging from ‘Unsatisfactory’ to ‘Satisfactory’. This question was added part way through the survey so that not all buildings were included. All twenty-two of those included scored greater than the mid-point of 4. Two were greater than 6, and six were in the 5.5 to 6 range.

### 3.2. Environmental Factors Category – Temperature and Air in Summer and Winter (see Fig 2)

This category included three questions related to temperature, four questions related to air, and a final question about conditions overall, in both Summer and Winter. The overarching question relating to all eight factors was “How would you describe typical working conditions in your normal work area in SUMMER and WINTER?” The following subsections describe the distribution of responses to each of the 16 questions.



**Figure 2: Environmental Factors – Temperature and Air**

#### *Temperature – Uncomfortable to Comfortable – Fig 2(a)*

*Summer (Mean-4.3, s.d-0.96)* – The mean score of 4.32 indicates that on average the buildings were on the comfortable side of this scale. Twenty-two of them scored above the mid-point, while nine dropped below, with three of the latter scoring less than 3. None of the buildings scored greater than 6, but eight were in the 5-6 band. Three of these had also rated highly in Winter. At the other end of the scale, four buildings scored 3 or less.

*Winter (Mean-4.4, s.d-0.68)* – The mean score indicates that on average the buildings were comfortable. As can be seen, nineteen of them scored above the mid-point, while seven dropped below, but even then none went below a score of 3. One building achieved a score of over 6, while four buildings were in the 5 to 5.5 band.

#### *Temperature – Too hot to Too Cold – Fig 2(b)*

*Summer (Mean-3.4, s.d-0.70)* – Once again noting that here a score of 4 would represent the ideal, the mean value indicates that on average the occupants of these buildings find it too hot in summer. This is borne out by the distribution which indicates that all but five of the buildings scored below the mid-point of the scale. Ten buildings were in the 3.5 to 4.5 band. Of the five that scored in the 4-5 range three were in hot-humid climates, two were in climates with relatively hot summers, and all five had air-conditioning systems. Seven buildings scored less than 3.

*Winter (Mean-4.6, s.d-0.56)* – Noting that here a score of 4 would represent the ideal, the mean indicates that on average the occupants of these buildings find it too cold in winter. This is borne out by the distribution which indicates that all but three of the buildings scored above the mid-point of the scale. Nine buildings were in the 3.5 to 4.5 band, while four were very close (within 0.2) of the mid-point score.

#### *Temperature – Stable to Varies during the day – Fig 2(c)*

*Summer (Mean-4.2, s.d-0.48)* – In the case of this factor, the mean value is the same as for winter conditions, but the shape of the distribution is almost its mirror image. However, the majority of the buildings (some twenty in this instance) are still on the variable side of the mid-point.

*Winter (Mean-4.2, s.d-0.62)* – Here, the average obscures the rather skewed distribution. The majority of the buildings (some twenty) are on the variable side of the mid-point.

*Air – Unsatisfactory Overall to Satisfactory Overall – Fig 2(d)*

*Summer (Mean-4.3, s.d-0.85)* – With a mean of 4.33 in a factor for which a 7 would be the ideal the overall trend here is towards the satisfactory end of the scale. Twenty of the buildings scored over 4, while ten scored under that figure. Two buildings scored less than 3.

*Winter (Mean-4.4, s.d-0.61)* – With a mean of 4.44 in a factor for which a 7 would be the ideal the overall trend here is towards the satisfactory end of the scale. 19 of the buildings scored over 4, while 7 scored under that figure. Four buildings had scores greater than 5: no building scored less than 3.

*Air – Still to Draughty – Fig 2(e)*

*Summer (Mean-3.2, s.d-0.54)* – Here it can be seen that twenty-eight of these buildings score on the 'still' side of the mid-point, and only three on the 'draughty' side. Eleven lie within the 3.5 - 4.5 band and six of these lie within the even narrower 3.75 - 4.25 band the last three having achieved a similar score in Winter. With scores between 2 and 3 eight buildings were perceived to be relatively still. None of these buildings was particularly draughty.

*Winter (Mean-3.5, s.d-0.65)* – Here it can be seen that twenty or around two-thirds of these buildings score on the 'still' side of the mid-point, and nine on the 'draughty' side. However, well over half of them (some seventeen) lie within the 3.5 - 4.5 band and no less than nine lie within the even narrower 3.75 - 4.25 band. With scores less than 3, five buildings were perceived to be the stillest, while none was particularly draughty.

*Air – Dry to Humid – Fig 2(f)*

*Summer (Mean-3.8, s.d-0.50)* – The average score for these buildings was close to the ideal of 4. Twenty of the buildings were within the 3.5-4.5 band (by comparison with eight in Winter) with a further seven on the dry side and four on the humid side of the scale.

*Winter (Mean-3.3, s.d-0.34)* – All but two of these buildings reported average scores on the dry side of the mid-point of this scale. While no less than 8 of them were within the 3.5-4.5 band, all of the rest fell under and on the dry side.

*Air – Fresh to Stuffy – Fig 2(g)*

*Summer (Mean-3.8, s.d-0.79)* – Similarly to wintertime (noting that a score of 1 would be the ideal) around half the buildings scored less than the mid-point of the scale. The four buildings that scored less than 3 also did so in Winter.

*Winter (Mean-3.7, s.d-0.72)* – For this factor a score of 1 would be the ideal and while seventeen of the buildings scored less than the mid-point of the scale, only six were under 3. None scored greater than 5.

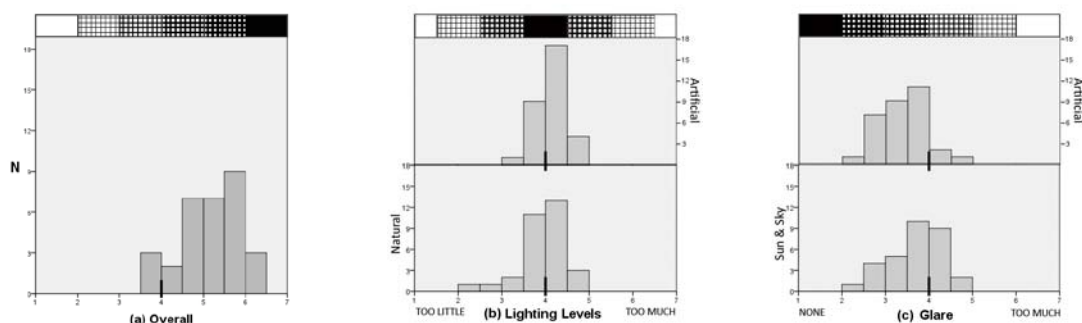
*Air – Odourless to Smelly – Fig 2(h)*

*Summer (Mean-3.1, s.d-0.63)* – The same two buildings that had scored less than 2 in Winter performed similarly in Summer. A further six scored between 2 and 3, and as in Winter none scored greater than 4.5.

*Winter (Mean-3.0, s.d-0.65)* – A score of 1 would be the ideal for this factor too. As can be seen, two buildings had scores less than 2, closely followed by a further eight in the 2-3 band. None scored greater than 4.5.

**3.3. Environmental Factors Category – Lighting (see Fig 3)**

The overarching request to respondents relating to this category was "How would you describe the quality of the lighting in your normal work area? *This question refers to conditions all year round*". Responses to five questions were sought - first a question related to Lighting Overall and whether it was satisfactory, followed by two questions related to the amount of natural light and whether there was any glare from sun and sky, and finally two further questions related to the amount of artificial light and whether there was any glare from that source.



**Figure 3: Lighting Factors**

*Lighting Overall (Mean-5.1, s.d-0.73) – Unsatisfactory to Satisfactory – Fig 3(a).* Twenty-eight of the thirty-one buildings scoring greater than 4, the mid-point of the scale, it is clear that most of the buildings are performing well in terms of this aspect. Three of the buildings have average scores above 6 and a further sixteen buildings are in the 5-6 band

*Lighting Levels – Too Little to Too Much – Fig 3(b).*

*Natural (Mean-3.9, s.d-0.48)* – With a mean score very close to the ideal and a relatively low Standard Deviation, it is evident that most of these buildings are performing well for this aspect. Twenty-six out of the thirty-one are in the 3.5-4.5 band. Only two buildings scored less than 3.

*Artificial (Mean-4.1, s.d-0.32)* – With a mean score very close to the ideal and a relatively low s.d., it is evident, in a similar way to natural light, that most buildings are performing well for this aspect. Twenty-six out of the thirty-one are in the 3.5-4.5 band. Four score between 4.5 and 5, but none of the buildings scores greater than 5 or less than 3.

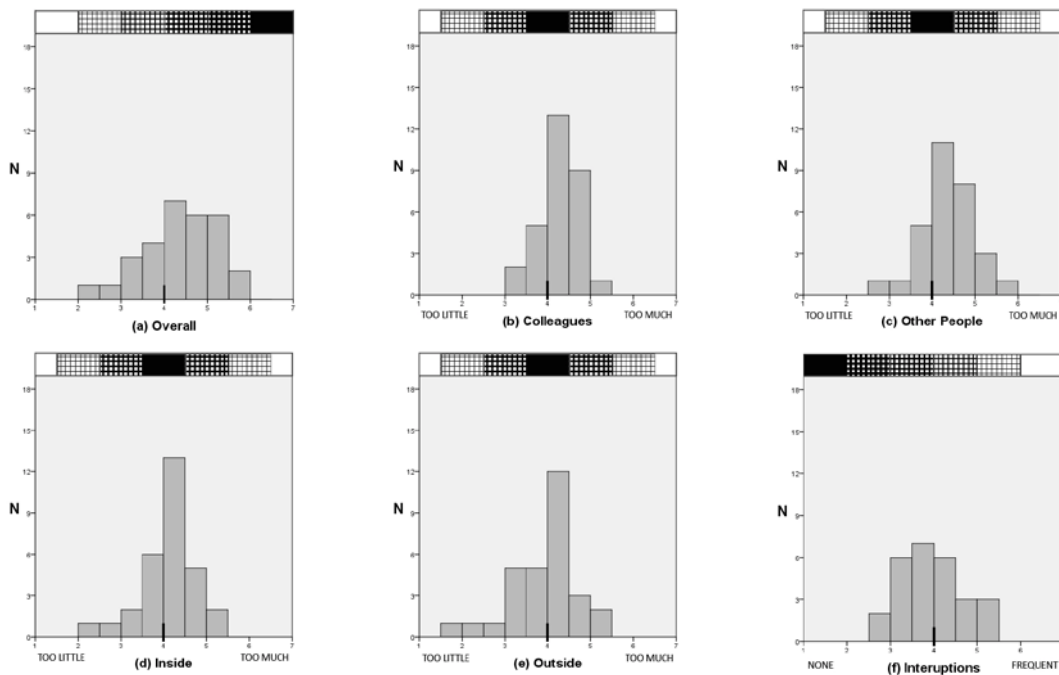
*Glare – None to Too Much – Fig 3(c)*

*Sun & Sky (Mean-3.7, s.d-0.61)* – The scale here ranges from ‘none’ to ‘too much’ with the ideal score a ‘1’. While twenty buildings get below a score of 4, only five make it under 3 and none achieve the 1-2 band.

*Artificial (Mean-3.3, s.d-0.52)* – As with glare from sun and sky, the scale here ranges from ‘none’ to ‘too much’ with the ideal score a ‘1’. However, twenty-eight buildings got below a score of 4, compared to twenty in the case of sun and sky glare. Eight buildings scored less than 3 – an all together different group from the five buildings that achieved this for sun and sky glare.

**3.4. Environmental Factors Category – Noise (see Fig 4)**

The overarching request here was “How would you describe noise in your normal work area? *This question refers to conditions all year round*”. Responses to six questions were sought under this heading - first a question related to Noise Overall and whether it was satisfactory, followed by four questions concerned with the sources of any noise – from colleagues, from other people, from inside, and from outside – and whether there was ‘Too little’ or ‘Too much’. A final question asked respondents to “Please estimate how you are affected by unwanted interruptions”.



**Figure 4: Noise Factors**

*Noise Overall (Mean-4.4, s.d-0.82) – Unsatisfactory to Satisfactory – Fig 4(a).* While the spread of scores is relatively wide (from 2.47 to 5.85) for this factor, some twenty-one of the thirty-one buildings are above the mid-point of the scale. Eight of these were in the 5-6 band; two were less than 3.

*Noise from Colleagues (Mean-4.3, s.d-0.44) – Too Little to Too Much – Fig 4(b).* Bearing in mind that a score of 4 would be the ideal, it can be seen that eighteen of the buildings fall within the 3.5-4.5 band. However, most (twenty-three) score greater than 4 indicating the users’ overall perception that there is too much noise from colleagues.

*Noise from Other People (Mean-4.3, s.d-0.58) – Too Little to Too Much – Fig 4(c).* Other people could range from members of nearby working groups to visitors, students, cleaners and maintenance personnel. A similar pattern is evident for this source as from colleagues, again indicating too much noise, with twenty-three buildings scoring above the ideal of 4. Still, around sixteen had average scores between 3.5 and 4.5.

*Noise from Inside (Mean-4.0, s.d-0.62) – Too Little to Too Much – Fig 4(d).* These sources could include nearby photocopiers and printers, kitchen areas, footfalls on hard surfaces, door operation, and the like. A similar pattern emerges here too, with twenty buildings averaging greater than 4, but nineteen within the 3.5-4.5 band. Overall there appears to be a perception of too much noise from inside sources.

*Noise from Outside (Mean-3.8, s.d-0.74) – Too Little to Too Much – Fig 4(e).* Here the concern is with sources such as nearby traffic routes, open-air performances, industrial and agricultural activities, and the like. Once again a substantial number of buildings (seventeen) have average scores in the 3.5-4.5 band. Only two scores were above 5 and three less than 3. Interestingly, the users of the thirteen buildings with average scores less than 4 are indicating they felt there was too little noise from outside.

### Unwanted Interruptions (Mean-3.9, s.d-0.70) – None to Frequent – Fig 4(f)

The ideal score for this question would be 1. While fifteen buildings do score under the mid-point of the scale, only two score less than 3. Three buildings have average scores greater than 5.

### 3.5. Personal Control (see Fig 5)

The 'Personal Control' question on the survey form was couched in the following terms – “How much control do you personally have over the following aspects of your working environment?” Separate responses were sought concerning heating, cooling, ventilation, lighting, and noise. The occupants were asked to score their response on a seven-point scale ranging from 1 for 'No control' to 7 for 'Full control'.

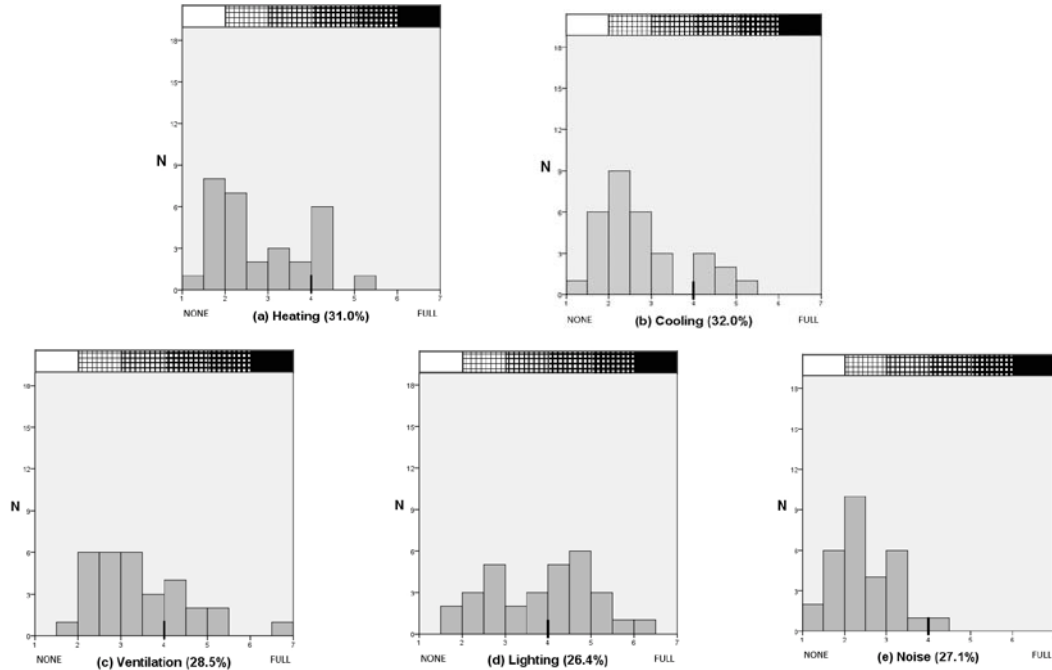


Figure 5: Personal Control Factors

*Heating (Mean-2.8, s.d-1.13) – No control to Full control – Fig 5(a).* Twenty-three of the buildings scoring less than 4, the mid-point of the scale, it is evident that the occupants of these buildings perceive themselves as having a relatively low amount of control of heating, on average. On average, some 31 per cent of respondents thought personal control of heating was important.

*Cooling (Mean-2.8, s.d-1.00) – No control to Full control – Fig 5(b).* The scores here parallel those for heating, with a mean of 2.81 and twenty-five buildings scoring less than 4. On average, some 32 per cent of respondents thought personal control of cooling was important.

*Ventilation (Mean-3.4, s.d-1.09) – No control to Full control – Fig 5(c).* On average, some 28.5 per cent of respondents thought personal control of cooling was important.

*Lighting (Mean-3.8, s.d-1.21) – No control to Full control – Fig 5(d).* This aspect achieved the highest mean score of the five, but still fell short of the mid-point of the scale. On average, some 26.4 per cent of respondents thought personal control of lighting was important.

*Noise (Mean-2.4, s.d-0.75) – No control to Full control – Fig 5(e).* This aspect achieved the lowest mean score of the five and had the lowest s.d. value. Only one building scored greater than 4 while no less than eight had mean scores less than 2. On average, some 27.1 per cent of respondents thought personal control of cooling was important.

### 3.6. Satisfaction Category (see Fig 6)

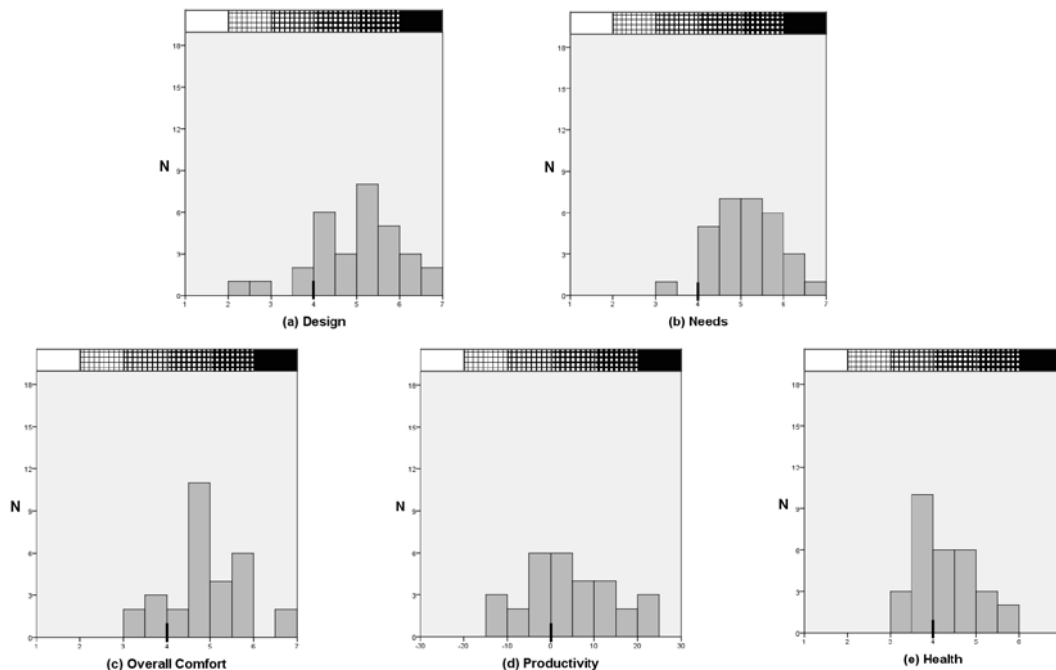
The following five factors are included under this category: Design, Needs, Comfort Overall, Productivity, and Health. All except Productivity are on 7-point rating scales where a '7' represents the ideal. In the case of productivity a percentage scale has been employed (see later).

*Design (Mean-4.9, s.d-1.07) – Fig 6(a).* Under this heading the question posed was “All things considered, how do you rate the building design overall?” the 7-point scale ranging from 'Unsatisfactory' to 'Satisfactory'. With a mean value close to 5, most of the buildings scored on the satisfactory side of the scale mid-point, with eighteen scoring 5 or over and five scoring over 6. The two buildings with mean scores under 3 were both located in hot humid climates.

*Needs (Mean-5.1, s.d-0.77) – Fig 6(b).* Here, the question posed was “Specifically, for the work that you carry out, how well do the facilities meet your needs ...?” with a scale ranging from 'very poorly' to 'very well'. All but one of the

buildings scored above the mid-point of the scale in this case, with four cases between 6 and 7. One building was rated at the lower end of this scale, in the 3.0-3.5 band.

*Comfort Overall (Mean-4.9, s.d-0.83) – Fig 6(c).* The question posed was “All things considered, how do you rate the overall comfort of the building environment?” – with responses sought on a 7-point scale ranging from ‘unsatisfactory’ to ‘satisfactory’. Two buildings had outstanding mean scores (6.56 and 6.50 respectively). A further six buildings were in the 5.5-6.0 band, and four between 5.0 and 5.5; only four buildings were below the mid-point of the scale.



**Figure 6: Satisfaction Factors**

*Productivity (Mean +4.07%, s.d 10.02%) – Fig 6(d).* The question posed in relation to this aspect was “Please estimate how you think your productivity at work is decreased or increased by the environmental conditions in the building?” together with the rider “Please try to evaluate this building with respect to your experience of using buildings in general”. In this particular instance a 9-point scale ranging from ‘-40% or less’ to ‘+40% or more’ in steps of 10% was used. While the spread of average responses is fairly wide in this case (with an SD of 10%) the mean is +4.07. Considering the scale mid-point value of 0% to be the ‘break-even’ point, this result indicates that on average the occupants of most of these buildings perceive themselves to be more productive. In fact, nineteen building had a positive score ranging up to 23%, with nine of them averaging greater than 10%. At the other end of the scale, of the eleven buildings with negative scores most were in the 0 to -10% band, though three fell into the -10 to -15% band.

*Health (Mean-4.2, s.d-0.71) – Less Healthy to More healthy – Fig 6(e).* This final question read “Do you feel less or more healthy when you are in the building?” with the added guidance note “Please try to evaluate this building with respect to your experience of using buildings in general.” In relation to the scale mid-point of 4, the occupants of these buildings perceive themselves to be more health on average when they are in the building. Strictly speaking this would apply to the seventeen buildings with mean scores greater than 4. Of these, five scored greater than 5. Of the thirteen buildings that scored below the scale mid-point, ten were in the 3.5-4 band and none scored less than 3.

#### 4. SUMMARY and CONCLUSIONS

It should be noted that individual respondents made full use of the entire range of the 7-point scales available to them. This of course is not shown in Figs 1 to 6 which are based on the averages of each building. However, even these can show a wide spread of scores, reinforcing the notion that people really are “the best measuring instrument” and that it is most important to get a high response rate (Leaman, Stevenson and Bordass, 2010).

In terms of the Operational Factors category (see Fig 1) there was quite a wide spread of scores. Only a very few buildings scored less than 3 on average (in the case of Cleaning and Storage), indicating a very good performance overall.

In the case of the Environmental Factors category, Temperature Overall in Winter had a much ‘tighter’ distribution than that in Summer (see Fig 2a) with SDs of 0.68 and 0.96 respectively. Markedly different distributions (Fig 2b) and means (4.6 and 3.4) make it very clear that most of the buildings were perceived as being too cold in winter and too

hot in summer. The spread and distribution of scores for summer and winter are similar for the other factors in the temperature and air sub-category.

Lighting Overall (Fig 3a) with a mean score of 5.1 is the best of the Environmental Factors category. The amounts of natural and artificial lighting are close to the ideal (Fig 3b) and tightly distributed with SDs of 0.48 and 0.32 for natural and artificial lighting respectively. The distribution of the scores for glare are similar in both cases, but few buildings get close to the ideal of 1 (see Fig 3c) on average.

Noise Overall is one of the less satisfactory aspects with an average of 4.4 and a relatively wide spread (an SD of 0.82). One of the surprising findings here was the spread of scores into the 'too little' range (i.e., less than 4 in this case). This was particularly noticeable in the case of 'outside noise'. One could speculate that many people feel the need to have some awareness of what is happening in the outside world – more than just a visual connection.

On a scale of none to full control, all five aspects of personal control had relatively wide distributions (with SDs from 0.75 to 1.21). Most were skewed to the low end of the scale, but lighting exhibited a 'bi-modal' distribution indicating at least two types of lighting control. Less than one-third of respondents felt personal control was important.

The Satisfaction category factors also exhibited a relatively wide distribution, with SDs ranging from 0.71 to 1.07 and relatively high mean values close to 5 (on a scale where 7 would be ideal) in the case of Design, Needs, and Overall Comfort. While the mean score for Health was lower at 4.2, all the buildings were in the 3 to 6 band. While on a different scale to the other aspects, respondents seemed well able to assess the impact of the building on their perceived productivity - with values ranging from – 15% to + 25%, an average of +4.07% and a SD of 10.02%.

A separate study (still to be reported) comparing this set of sustainable buildings with a larger set of more conventional building has indicated that the former are achieving significantly better scores for the Operational, Temperature, Air, Lighting and Satisfaction categories, while Noise and Personal Control are much the same.

All of the above serves to reinforce the notion, well expressed by Loftness et al (2009) that "Field measurements and surveys make it very clear that the smartest 'sensors' for ensuring comfort in the face of environmental variations are the occupants themselves, suggesting that building occupants should be integrated as sensors and controllers in the next generation of buildings".

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