

## Considering users' factors in sustainable building refurbishment projects

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**Abstract:** Research shows that, as a result of poor energy efficiency, a significant amount of the UK's total energy expenditure is wasted. Changing building occupants' behaviour could help to prevent this energy loss and considerably cut carbon emissions per year. This paper presents an overview of the impact of occupants' behaviour on the energy performance of non-domestic buildings. It further introduces Halcrow's current research project on how to improve the energy performance of their recently refurbished and occupied Headquarters in London, while increasing the satisfaction and well-being of their employees. An employee benchmark survey was conducted at the pre-occupancy stage. The purpose of this survey was to identify the employees' level of satisfaction with their current workplace and, also, to indicate employees' motivation and energy awareness level. The mean score of 2.98 indicates that the majority of the respondents are neither satisfied nor dissatisfied with their current workplace. The results of this survey also show that employees who work in cellular offices on their own are less satisfied than those who work in open-plan offices. Regarding employees' sustainability awareness, most of the respondents said that they were not fully aware of Halcrow's sustainability targets. This paper provides the results of this survey in detail.

**Keywords:** Energy Awareness, Non-domestic Building, Sustainability, Refurbishment, and Carbon Reduction

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### 1. Introduction

About one fourth (25%) of carbon emissions in the UK, which is about 100 million tonnes of CO<sub>2</sub> per year, are generated by non-domestic buildings [1]. Considering the fact that 60% of the total non-domestic buildings in 2050 exist today [2], sustainable building refurbishment can significantly contribute to meeting the UK government's target. Every day about £7 million, which is about 21% of the UK's total energy costs, is wasted in UK industry due to poor energy efficiency [3]. In comparison, it is estimated that changing buildings users' behaviour could save this money for the companies and cut carbon emissions by 22 million tonnes per year [4].

It is argued that green technologies such as efficient lighting and advanced ventilating systems will enhance interior environmental quality and therefore be beneficial to human well being and productivity.[5]. Technologies which are designed to improve the energy efficiency of a building must engage with the users, or the building will underperform and energy savings will be limited [6]. Organizational scientists pay little attention to the physical environment, despite its impact on social behaviour [7]. Working space affects the user's performance [8], and productivity is also believed to be associated with the provision of high quality interior environments [9]. However, there is little understanding of how such benefits might be achieved by a satisfactory work environment.

Halcrow Group Ltd has recently refurbished a leased 1930's, 5-storey office building in Hammersmith, London. This building is now occupied by about 450 people who have moved from Halcrow's previous offices (Vineyard House (VH) and Shortlands) adjacent to the site. As staff satisfaction has a central place in social sustainability, Halcrow wishes to investigate innovative interventions currently available to reduce their energy consumption in their new HQ, while increasing their employee's satisfaction and well-being. To do this, a survey was carried out at the pre-occupancy stage to understand employees' needs and expectations

regarding their work environment. The findings from this questionnaire were considered at the design stage of the new building and also used as a benchmark for evaluating the new building's performance. This paper demonstrates some of the findings from the questionnaire.

## 2. Methodology

An employee survey was conducted to collect data regarding employee satisfaction, needs and expectations. This benchmark survey was used as a tool to enable the employees to confidentially express how they felt about their work environment. The first part of the questionnaire included items concerning demographic factors such as age, sex and employment status. Also, in this part, employees were asked to specify their modes of transportation to work and their willingness to work at home. In the second part, employees were asked to indicate their levels of satisfaction with their workplace physical environment, use of interior space, indoor facilities and current policies. For these questions, 5-point response scales were used, where: 1= Strongly Agree, 2= Agree, 3= Neither Agree nor Disagree, 4=Disagree and 5 = Strongly Disagree. In the latter part, employees were asked to state whether they were aware of Halcrow's sustainability targets and whether they felt personally responsible for contributing to Halcrow's sustainability objectives. This survey was sent via internet to all employees in Vineyard House (VH) and Shortlands buildings and stayed open for two weeks. Initially, 197 completed surveys were returned, (representing 34% response rate). Having excluded data from ineligible participants and questionnaires with missing data on more than 70% of items on "satisfaction with workplace" questions, the final sample consisted of 189, 162 from VH and 27 from Shortlands.

## 3. Results

This part of the paper illustrates the findings from the pre-occupancy employee survey, for VH employees only.

### 3.1. Demographic Questions

Over two-thirds of the 162 VH respondents were male, 32.7% (53) were female. Most respondents, 41% (66), were between 26 and 35 years old, 5.6% (9) were 25 years old and under, 23.6% (38) were between 36 and 45, 16% (26) were 46 and 55 and 13.7% (22) were over 55 years old. In terms of employment status, the majority of the respondents, 95.1% (154), were full-time. More than 70% respondents (115) indicated that they were based in VH 75%-100% of the time.

### 3.2. Mode(s) of Transport

About 98% (159) respondents answered this question. Their responses are shown in Table 1.

Table 1: Mode(s) of transport you normally use to commute to your office

	Frequency	Percent
Bus/Train/Underground/Foot/Bicycle	64	40
Car (in combination with other modes)	27	17
Bicycle (in combination with other modes)	32	20
Foot (in combination with other modes)	79	49
Bicycle (only)	5	3
Foot (only)	11	7
Car (only)	7	4

### 3.3. Working from Home

Of 154 respondents, 47.4% (73) indicated that they already worked occasionally from home; while 39% (60) said that they would consider working from home given the opportunity. Among the latter, 7 respondents reported driving to work for part, or the whole of their journey, with a total mileage of 9701.379 km per year.

### 3.4. Working in the Office after Office Working Hours

The majority of respondents, 57.1% (92), specified that they rarely worked after 7.00pm (0-1 evenings/ month). However, a good number - 40% (65), indicated that they needed to work in their office for 2-10 evenings/month. Only 2.5% (4) needed to work for more than 10 evenings/ month.

### 3.5. Using the Canteen in VH

About half the respondents (81) specified that they rarely used the canteen facilities in VH.

### 3.6. Office Set Up: 'Where You Sit in the Office'

The majority of the respondents, 76.4% (123) worked in an open plan office with more than 5 people, 17.4% (28) worked in a multi-occupant cellular office (5 people or less), 5.6% (9) had their own single cellular office and only 0.6% (1) of the respondents hot-desked in an open plan office.

### 3.7. Employees' Satisfaction with Their Workplace

#### Physical Environment

Approximately 86% (139) of participants answered all the questions (8) in this category; the results are illustrated in Figure 1.

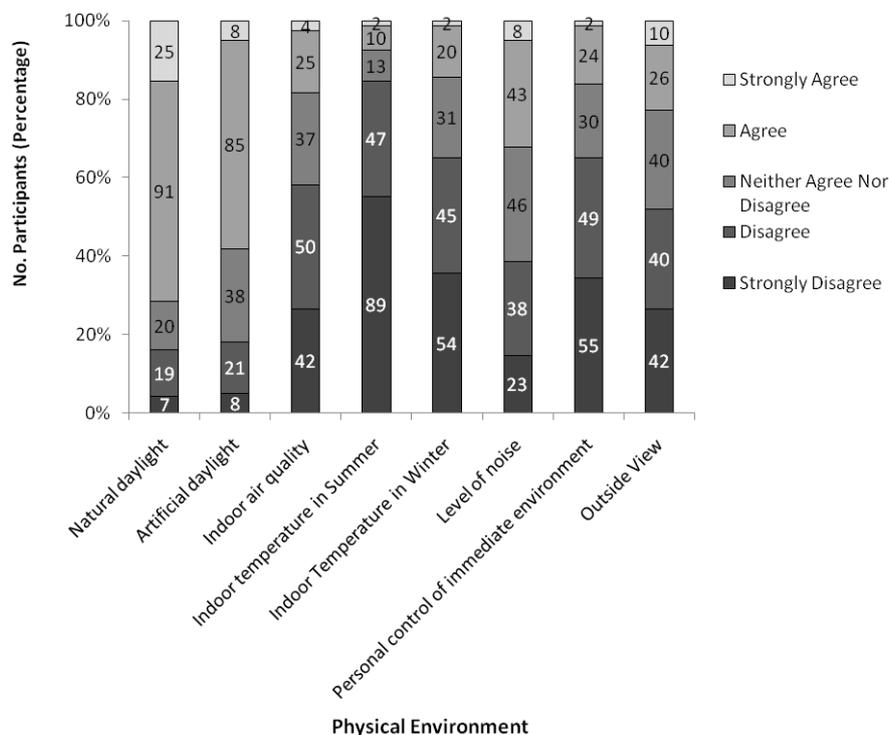


Figure 1: I feel satisfied with the physical environment of my workplace

### Use of Interior Space

Approximately 84% (136) of the participants answered all the questions (13) in this category; the results are illustrated in Figure 2.

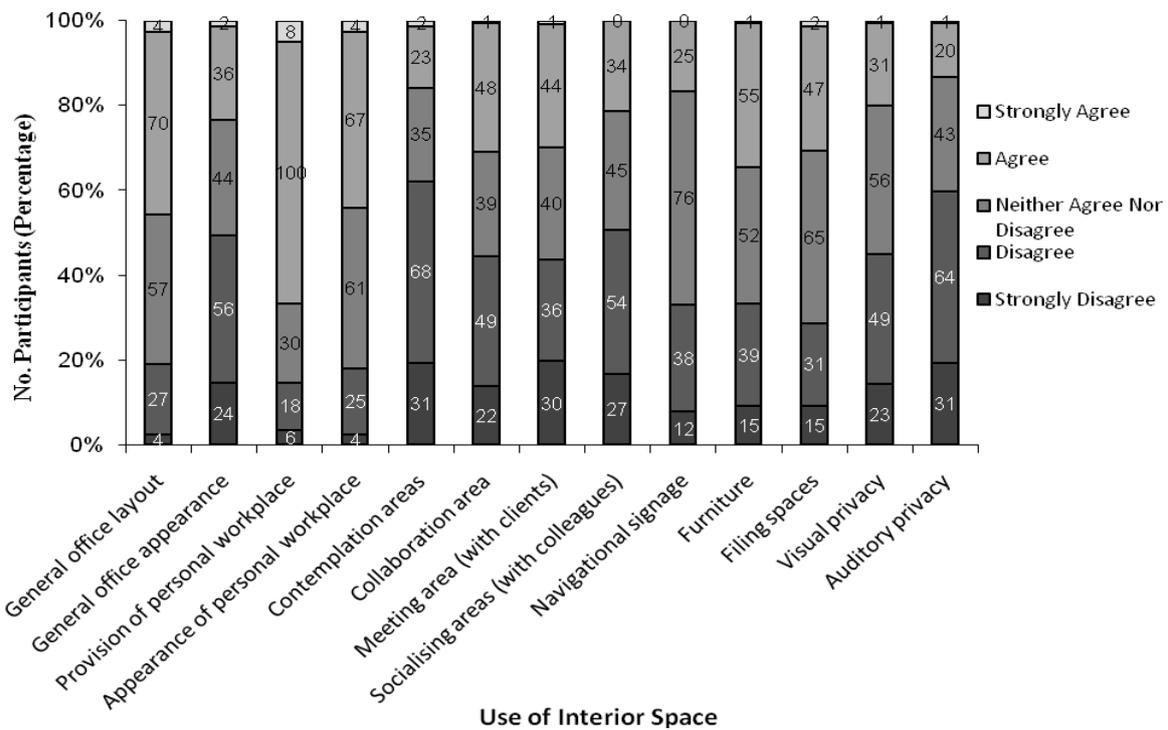


Figure 2: I feel satisfied with the use of interior space in my workplace

### Indoor Facilities

Approximately 92% (149) of the participants answered all the questions (5) in this category; the results are shown in Figure 3.

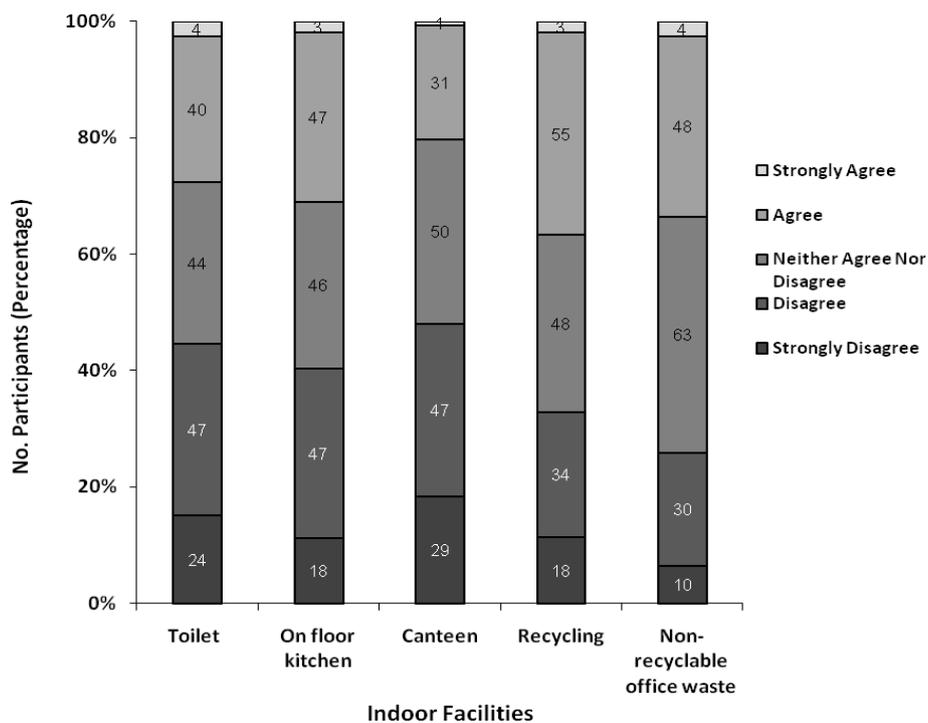


Figure 3: I feel satisfied about the indoor facilities in my workplace

**The Policies**

Approximately 98% of participants (159) answered this question; the results are shown in Figure 4.

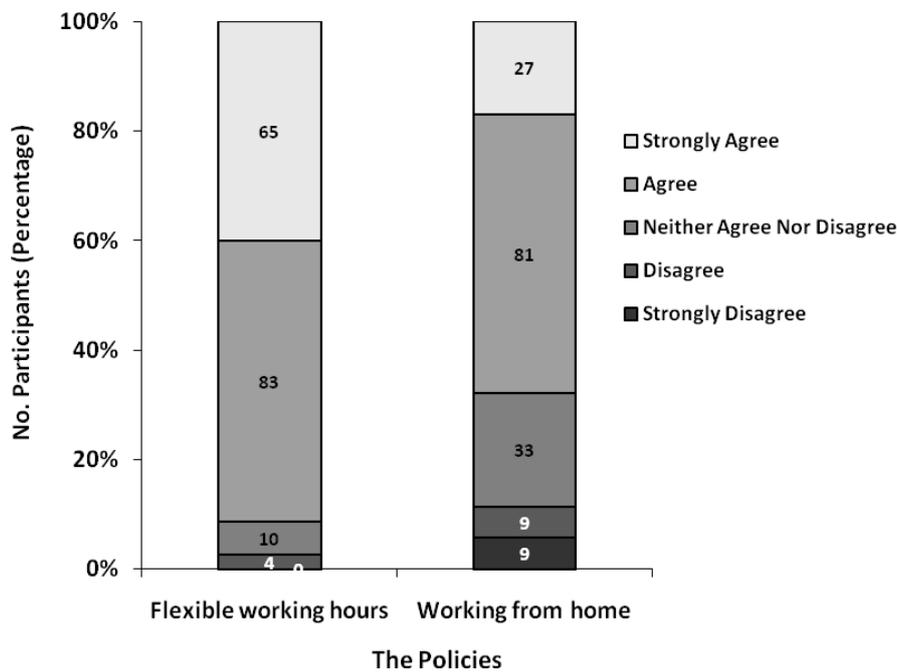


Figure 4: I feel satisfied with the policies available at my workplace

Table 2 shows the mean employees’ satisfaction level in each category. The 4 items together showed a satisfactory level of reliability (Cronbach’s alpha = 0.89), so overall satisfaction scores could be derived; overall satisfaction mean scores are also shown in Table 2.

Table 2: Mean Scores for Employee's Satisfaction

	Physical Environment	Use of Interior Space	Indoor Facilities	The Policies	Overall Employees’ Satisfaction Level at VH
Frequency	139	136	149	159	111
Mean	3.45	3.18	3.20	2.02	<b>2.98</b>

Analysis was conducted to assess whether overall satisfaction differed between office set-ups (e.g. open plan, cellular offices, etc) (see Figure 5 overleaf). Overall satisfaction of respondents in single cellular offices (Mean=2.61, Std. Error of Mean=0.14) was higher than that of those in open-plan offices (Mean= 2.98, Std. Error of Mean=0.047). This difference was significant,  $t(92) = -2.104, p=0.038$ .

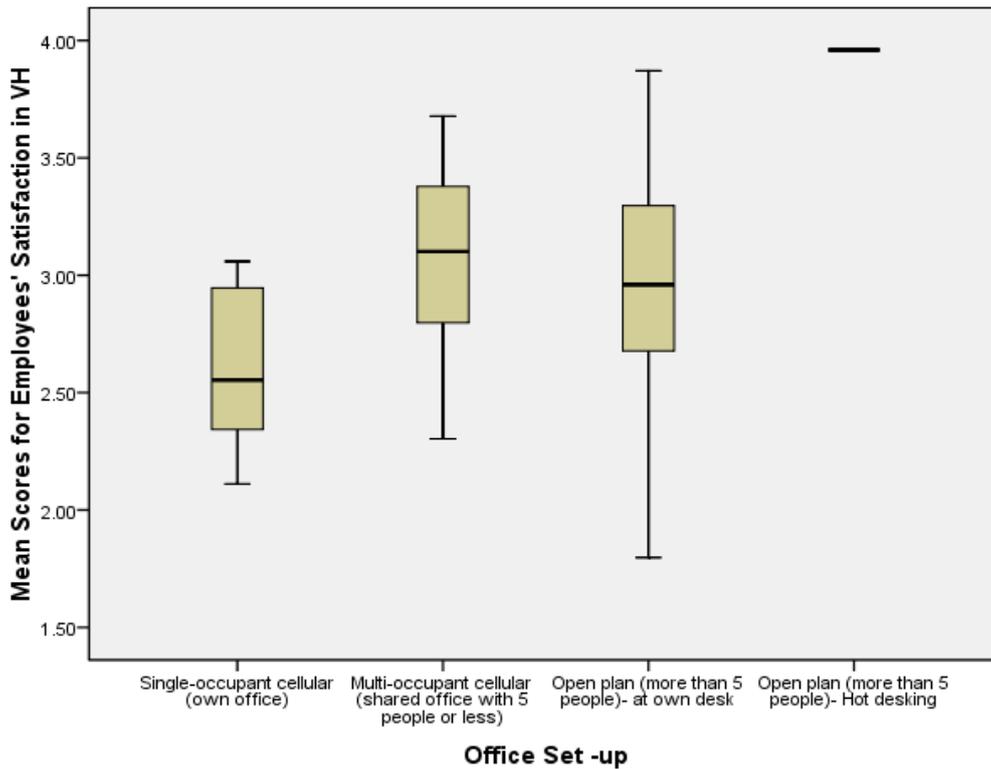


Figure 5: VH Employees' Satisfaction in different office set-ups.

### 3.8. The Positive Effect of Office Environment on Employees' Productivity, Well-being and Enjoyment

Figure 6 indicates the degree to which respondents felt that their current workplace had a positive effect on their productivity, well-being and enjoyment at work. The overall mean score (Cronbach's alpha = 0.902) was 3.07.

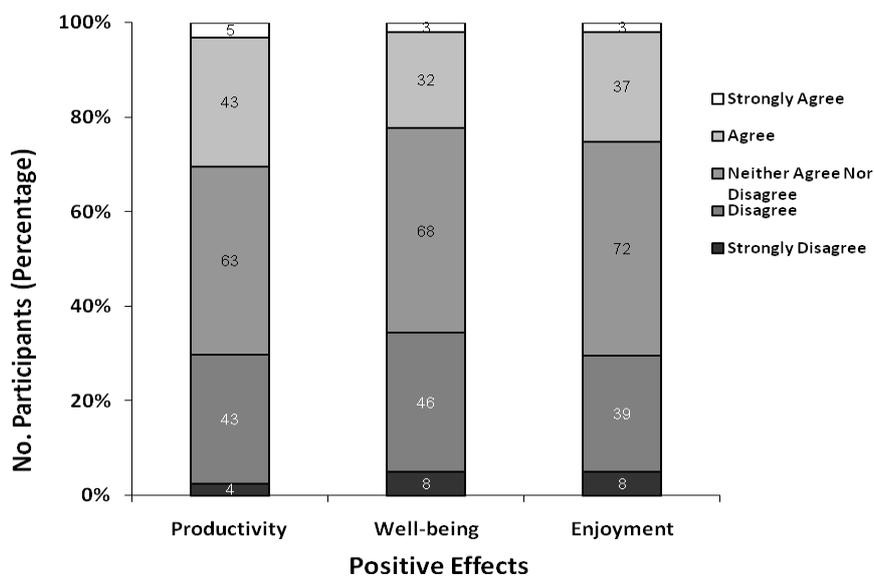


Figure 6: The Positive Effect of VH Environment on Employees' Productivity, Well-being and Enjoyment

An analysis was performed to assess the correlation between employees' overall satisfaction in VH and the positive effect of VH environment they perceived. A significant positive correlation ( $r = 0.602$ ,  $p < 0.001$ ) was found, indicating that satisfaction was positively associated with perceived positive effect

### 3.9. Employees' Awareness of, and Attitudes towards, Halcrow's Sustainability Targets

Figure 7 shows the level of employees' awareness of Halcrow's sustainability targets and whether they felt personally responsible for contributing to these targets.

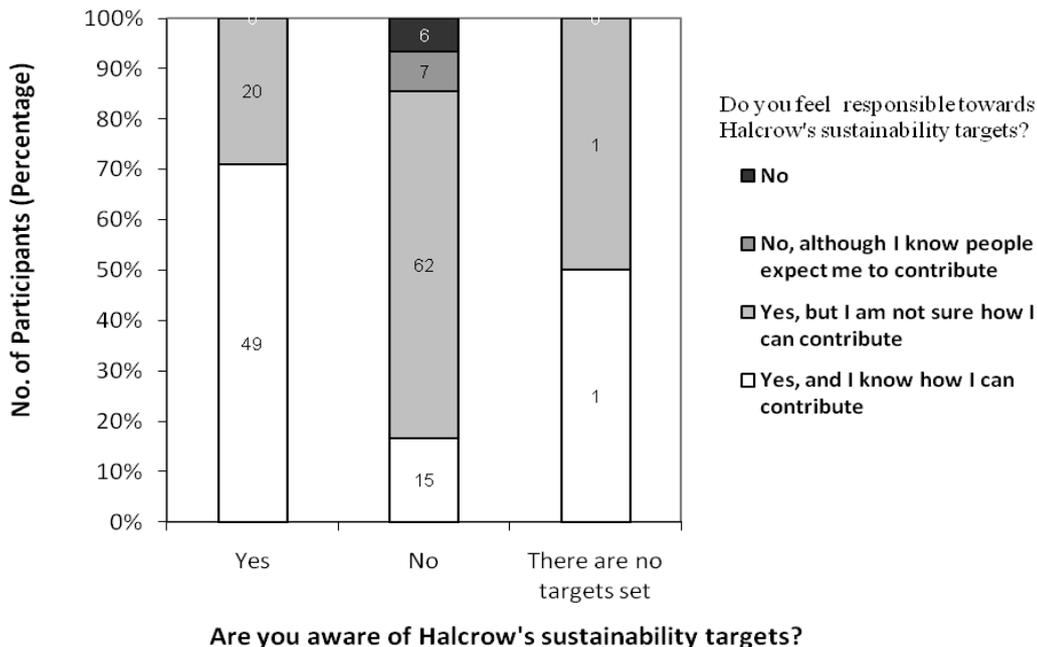


Figure 7: Employees' Awareness of and Attitudes towards Halcrow's Sustainability Targets

## 4. Discussion and Conclusions

A sustainable workplace is no longer just about technical fixes. Now, it is felt that behavioural intervention is perhaps going to be the key and that physical work environment might help drive certain behaviours. In this study, an employee survey was used as a tool to improve workplace sustainability by engaging the building's occupants.

The sample of respondents was broadly representative of the employees at VH, as indicated by responses to the demographic questions and the question regarding office set-up.

The overall employees' satisfaction score indicated that the respondents, on average, were neither satisfied nor dissatisfied with their workplace. Considering the four categories of employees' satisfaction separately, the respondents, (as was expected due to the poor air conditioning system in VH), were not satisfied with their workplace indoor temperature, indoor air quality and opportunity for personal control of the immediate environment. Inappropriate thermal conditions affect dexterity and increase physiological stress [10]; therefore, it was important to consider these issues in the building's refurbishment. Regarding the use of interior space, most of the respondents were not satisfied with the availability of contemplation areas and also with the auditory privacy of the individual workspace. Providing spaces for different work-styles, in the new building, was considered at the design stage.

The data presented in Table 1 (Modes of transport) indicate that the majority of the employees used sustainable modes of transport to commute to work. Giving the home-working opportunity to those who drive to work could save about 20.6 tCO<sub>2</sub>/year.

About half the respondents indicated that they rarely used the canteen facilities in VH. This was expected, as the canteen was too small to accommodate the number of the employees in VH and was not a welcoming place for the employees to socialize during their lunch breaks.

As is shown in Figure 5, and as confirmed by t-test, respondents who worked in single cellular offices were more satisfied than those who worked in open plan offices. However, it should be borne in mind that the sample size for single cellular offices was small compared to that for the open plan offices. Figure 7 indicated that the majority of the respondents did not know about Halcrow's sustainability targets and most reported that they did not know how to contribute towards Halcrow's sustainability objectives. This could be because the channels of communication were ineffective

This survey and the post-occupancy survey will indicate whether the refurbishment is meeting expectations that the new building is more sustainable than the old HQ building, and guide thinking on the need for new technical, behavioural and policy changes that are necessary to maximise sustainability performance within the budget and other practical constraints that have been identified.

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