Sick Building Syndrome, Productivity and Control

Gary J Raw and Michael S Roys, Building Research Establishment, Adrian Leaman, Building Use Studies Ltd.

This paper shows how staff productivity can be reduced by sick building syndrome (SBS) and by limiting individual control over the office environment.

Introduction

Sick building syndrome is a phenomenon whereby people experience a range of symptoms when in specific buildings. The symptoms are irritation of the eyes, nose, throat and skin, together with headache, lethargy, irritability and lack of concentration. Although present generally in the population, these symptoms are more prevalent in some buildings than in others, and become reduced over hours or days when the afflicted person leaves the building concerned. The cause (or causes) are at present not clearly identified, but the syndrome can be discriminated from other building-related problems such as physical discomfort, infections and long-term cumulative hazards such as asbestos and radon.

Gary Raw has summarised elsewhere [1] the evidence concerning the causes of SBS, and possible solutions. The same report includes evidence concerning the economic impact of SBS. The total economic impact of SBS would include staff absence and turnover and time spent complaining and dealing with complaints. Extreme cases of "dealing with complaints" may include major building modification or even demolition, but even regular management-union meetings can work up a considerable bill. There may also be costs which are more difficult to identify, relating for example to the introduction of new technology and energy conservation measures: if staff come to identify these (probably in error) as causing SBS, then efficiency improvements may be more difficult to implement. This paper is concerned specifically with the cost of reduced productivity while staff are nominally engaged in productive work.

While it may be seen as obvious that people experiencing ill health will perform at less than their peak, it has proved difficult to confirm or to quantify this. The research problem is essentially one of measurement; how can productivity be measured? There are, of course, measures which companies use at the corporate level (units produced, annual turnover etc) but these combine many factors and they do not permit an examination of any specific effect of SBS on staff productivity. In the case of some types of work (e.g. data entry) an objective measure of individual productivity could relatively easily be obtained. Even here, some formula would have to be applied to represent the balance of speed and accuracy. Where the worker's output is more complex, objective measures are even more difficult to obtain. There are no doubt possibilities for making objective measurements, but the fact is that it has not been done in studies of SBS.

The data presented in this paper are therefore based on productivity reported by the staff themselves in the Office Environment Survey [2]. This survey was the most comprehensive UK study of sick building syndrome. It included a questionnaire survey of 4373 workers in 46 United Kingdom office buildings of varied age, type and quality, with a range of ventilation systems. The occupants of the buildings were staff of local and central Government and private sector companies.

The questionnaire included questions on the following: background information about individual workers; their experience of building-related symptoms (dry eyes, itching or watering eyes, dry throat, lethargy, headache, blocked or stuffy nose, runny nose, flu-like illness, difficulty breathing, chest tightness); and ratings of productivity, stress, environmental conditions in the office and personal control over those conditions. Since only a very limited analysis of effects on productivity was originally reported, we have carried out a more thorough analysis, which is the subject of this paper.

Measurement of Productivity

Productivity was assessed by subjective ratings in response to the instruction "Please rate how much you think the physical conditions at work influence your productivity" (*Table 1*). For the purposes of analysis, responses were coded from 1 (the most positive effect on productivity) to 9 (the most negative effect), with 5 being 'neutral' - no effect on productivity. The percentage of respondents who reported each level of effect is also shown in *Table 1*. These ratings are referred to in this paper as "WEP" - Worker Evaluation of Productivity.

WEP can be regarded in two ways. First, it can be seen as a measure of what the respondent believes, regardless of whether that belief is correct. If workers believe the office environment affects their productivity, that is important in itself, i.e. the belief itself may effect productivity, or the worker may leave for a job which offers a better perceived environment. The belief is also likely to affect other aspects of working life.

Second, WEP may reflect actual productivity. While the scale has

Table 1. Productivity ratings and overall percentage of staff who gave each rating

	Productivity increased by				No effect				Productivity decreased by
Response	40% or more	30%	20%	10%	0	10%	20%	30%	40% or more
Code	1	2	3	4	5	6	7	8	9
% Staff	4.0	4.7	7.0	6.6	24.5	27.1	17.1	6.5	2.4

apparent validity in this respect, we have no means of establishing its actual validity since actual productivity was not assessed. The safest assumption is that WEP is valid as a relative scale, but the actual percentages reported may be subject to error. This would imply that the most valid point on the scale is the neutral point (zero effect on productivity) and this is the point at which conclusions about absolute level of productivity can most safely be drawn.

The Relationship Between Productivity and SBS

Workers reported whether they had suffered any of a list of symptoms (*see introduction*) on two or more occasions during the past 12 months. For each symptom reported they were asked if this got better on days away from the office. People who responded "yes" were said to have a building-related symptom. A simple index of symptoms was calculated by summing the building-related symptoms reported [2].

The number of symptoms was highly correlated with WEP (*Figure 1*) and individuals who reported more than 2 symptoms also reported a mean decrease in productivity (i.e. WEP greater than 5). This result provides a valuable benchmark: more than two symptoms means a negative effect on productivity. In this survey, 55% of all staff and all the air-conditioned buildings (based on the average staff response) fitted this criterion. The mean number of symptoms per person was 3.11, with a range of building means from 1.25 to 5.25. The best buildings (none of them air conditioned) did have fewer than 2 symptoms per worker on average, the best air conditioned buildings had between 2 and 3 symptoms [2].

WEP combines variation due to the building with variation due to the individual person; it is also not normally distributed. The results were therefore checked using a new score. "ResWEP" - Residual Productivity - the difference between each person's WEP score and the mean WEP for his/her building. A positive ResWEP score means a positive effect on productivity. The distribution of ResWEP is close to normal, and it eliminates building variation in productivity. It is therefore a better measure of personal productivity for evaluation in relation to other individual characteristics.

ResWEP was found to be highly correlated with symptoms. A number of other findings have been reported in detail [3], including correlations between productivity and a range of subjective evaluations of environmental conditions in the office. The remainder of the results presented in this paper are concerned specifically with the role of individual control over the environment.

Productivity and Control

There were significant effects of several variables related to control: the number of people sharing an office, job category (managerial/professional/clerical or secretarial/other) and the extent to which the individual worker could control environmental conditions in the office (temperature, lighting and ventilation).

The effect of job type was in fact completely accounted for by the number of people sharing an office (e.g. managers report high productivity because they tend to work in rooms of only 1-4 people). The effect of number in the room can, in turn, be attributed (theoretically) to a number of factors, including control over lighting, ventilation, temperature and noise. Privacy can also be considered as control; control over seeing, hearing, and interacting with other people. *Figure 2* shows the decreasing level of individual control as the number of people sharing a room increases.

It was therefore necessary to examine the relative importance of control as such, and the number of people sharing a space, in relation to productivity. Only in the case of control over temperature was the size of the overall effect sufficient to carry out this

Figure 1. WEP by number of SBS symptoms.

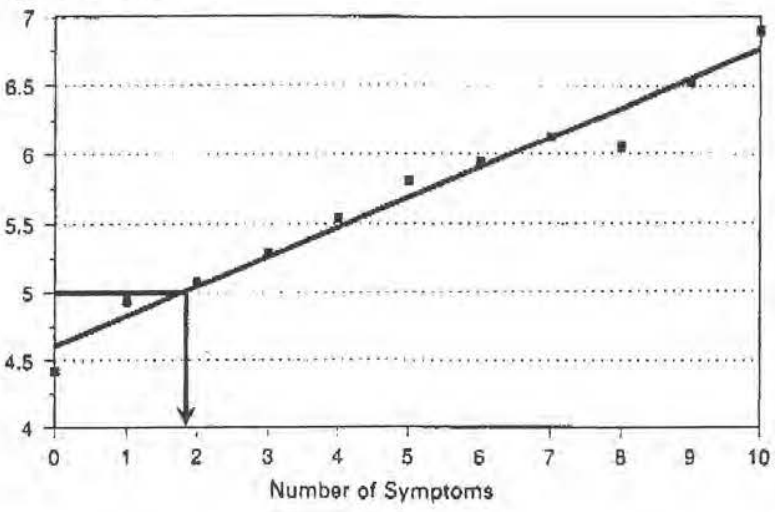
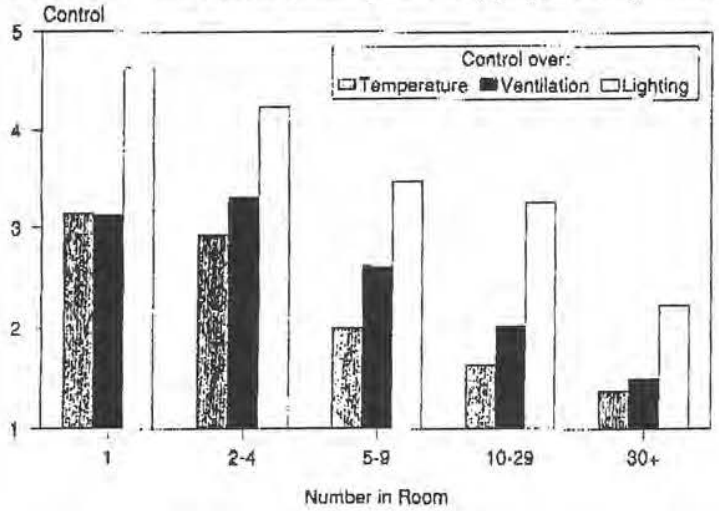


Figure 2. Environmental control by number of people sharing a room



analysis. The results are shown in *Figure 3*. Overall, productivity increases with level of control whatever the number of people (the largest difference is between medium and high control). Where the degree of control is low or intermediate there is little effect of the number of people in the room, although rooms of fewer than five people have some advantage. Once a high level of environmental control has been achieved, the number of people in the room becomes important in its own right, and an intermediate number of people is associated with the highest productivity.

In the debate about the relative merits of cellular and open plan offices, this result strikes a satisfying note of compromise, the first target is personal control (which is more easily achieve in offices for fewer people), then the size of the offices can be designed for the work to be carried out (and in general it seems that offices of 5-9 people are preferred).

Conclusions

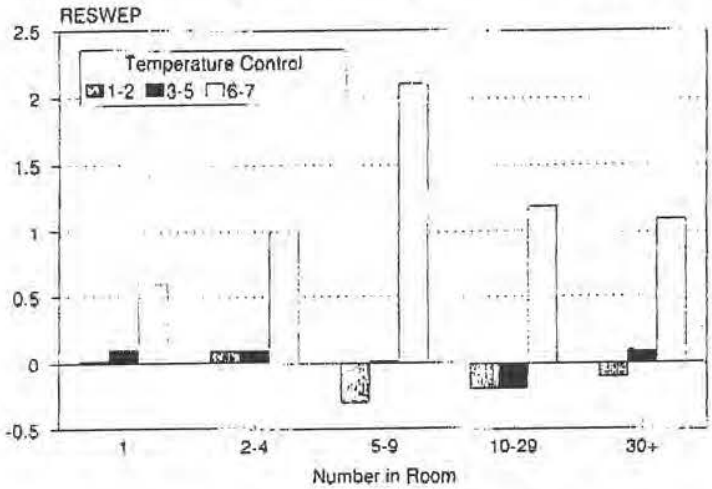
Productivity is a direct determinant of the success of an organisation, and hence any measures which could improve productivity should be considered useful to employers. The results of our analysis indicate areas in which improvements could be made.

- improve the indoor environment so as to reduce building-related symptoms to fewer than 3 (ways of doing this are described elsewhere [1], but one action suggested directly by the analysis is avoidance of passive smoking [3];
- improve personal control over the environment by, for example, local control over lighting, opening windows and local temperature control (within the limits imposed by requirements for overall control of the indoor environment);
- aim for five or fewer sharing a room unless there is a high degree of personal control over the indoor environment.

The number of people accommodated in a room would of course also depend on the necessary arrangement of working groups, and changes may not be feasible in some existing buildings, but the costs should be evaluated in view of possible productivity improvements.

This study was based on statistical analysis of a number of buildings, not individual cases, and its findings cannot necessarily be applied directly to a specific building without considering conditions in that particular building. They do however give an indication as to how productivity can be improved or, alternatively, the cost in lost productivity of not carrying out improvements.

Figure 3. ResWEP by control over temperature and number in room



References

1. Raw, G J (1992). Sick Building Syndrome: a Review of the Evidence on Causes and Solutions. HSE Contract Research Report 42/1992. London: HMSO.

2. Wilson, S and Hedge, A (1986). The Office Environment Survey, a Study of Building Sickness. London: Building Use Studies Ltd.

3. Raw, G J, Roys, S M and Leaman, A (1990). Further findings from the office environment survey: productivity. Proceedings of 'Indoor Air 90', Volume 1. 231-236. Ottawa: Canada Mortgage & Housing Corporation.

Further information is available from: Building Research Establishment, Garston, Watford, WD2 7JR. Telephone: 0923 894040 Fax: 0923 664010