Users' Perceptions
– Experiences from Swedish and Danish Office Buildings

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Abstract

This paper reports on two studies of modern Scandinavian office buildings, one study of four Danish office buildings and one study of a Swedish one. The Danish study confirms that the floor plan layout is a very important parameter for the users perception of the indoor environment. Open plan offices generally have a lower perceived indoor environment than cellular ones. The users perceived needs to adjust the indoor climate parameter are highest and the perceived degree of control is lowest in open plan offices. The hypothesis was confirmed that the higher the ratio of the users perceived degree of control to the need of control, the more satisfied are the users with the indoor parameters. The forgiveness ratio is also lower for open plan offices, and the Danish buildings have generally a lower score than the British PROBE buildings for the same score of indoor climate in general. The study of the Swedish building shows that most important factors for the users' satisfaction were factors related to the work task and colleagues. Less important were a comfortable physical indoor climate/environment and aspects related to the workplace as such. The results indicate that it is only of minor importance that the users can control/change the indoor climate/environment.

Keywords

Office buildings, indoor environment, users perceptions, questionnaires, perceived control

1. Introduction

This paper reports on two studies of modern Scandinavian office buildings. Both studies are mainly based on questionnaires to the users in the buildings. The purpose of the first study was mainly to survey the users' perceptions of the indoor environment with emphasis on control of different building services systems. One important question was the user's perceived degree of control of important indoor parameters. The main purpose of the second study was to survey the users needs and perception of the indoor environment in general including the work environment. Another purpose was to find out the users' attitudes towards advanced technical solutions in new buildings.

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The first study was carried out at a postdoc research study at the Danish Building and Urban Research Institute (Jagemar, 2002), the second study was a thesis for the licentiate of engineering degree, at the Department of Building Services Engineering, Chalmers University of Technology (Bengtsson, 2003).

2. Four Danish Office Buildings

2.1 Purpose

The main purpose of this project was to identify human and technical barriers for the use of “advanced” energy technologies and “advanced” control systems in new and existing office buildings. A secondary purpose was to formulate requirements on the functions of the building services systems in order to make them meet the users’ needs. “Advanced” technologies and control systems were defined as systems with the purpose to reduce the use of energy, with maintained or increased indoor environmental quality. Examples are:

- Control (preferably individual) of the indoor temperature,
- Automatic control of the indoor air quality, e.g. by a maximum level of carbon dioxide concentration,
- Automatic control of the indoor lighting levels by presence control and/or by the indoor daylight levels,
- Control (preferably automatic) of solar shading devices to reduce glare and direct sunshine as well as veiling reflections on PC screens.

2.2 Method

Initial plans were to investigate six buildings, three new and three refurbished. Selection criteria were formulated mainly depending on:

- Floor plan,
- Type of HVAC system,
- Control of different indoor environmental parameters.

The buildings were inspected in advance and the operation personal interviewed to make sure that no known major malfunctions did exist in the buildings. The major tool for the following investigation was a three-page questionnaire to the users of the building. It was distributed to all users present in the morning and collected in the late afternoon. During the day, measurements of the indoor thermal environment were carried out, and in some buildings also the background noise levels. The indoor temperature was also measured in a few places in each building during a period of about two weeks generally following the day the questionnaire was distributed.
The investigation of each building was usually carried out during one winter and one summer period.

Table 1 shows the number of respondents at each questionnaire occasion as well as the mix of men and women, and the age. The buildings are described in the next section. As Table 1 shows only four buildings were finally investigated, as described in the next section, but two of them could provide five different zones (A1-A2, B1-B3).

Table 1. Respondents in each building and at each questionnaire occasion.

		Building						
Occasion	**Respondents**	**A1**	**A2**	**B1**	**B2**	**B3**	**C**	**D**
Winter	Number (responses %)	29 (83%)	30 (88%)	55 (96%)	28 (97%)	36 (88%)	89 (78%)	65 (68%)
	Male/Female	28%/72%	17%/83%	31%/69%	21%/79%	53%/47%	29%/71%	71%/29%
	Mean age (95% confidence)	40.2 (±4,1)	34.8 (±3.3)	28.9 (±3.0)	27.2 (±3.0)	29.7 (±3.7)	38.0 (±1.6)	38.0 (±2.2)
Summer	Number (responses)	-	-	45 (78%)	28 (90%)	32 (70%)	65 (61%)	-
	Male/Female			11%/89%	14%/86 %	34%/66%	34%/66%	
	Mean age (95% confidence)			27.5 (±1.8)	29.2 (±5.0)	22.3 (±1.2)	38.4 (±1.9)	

The significance of observed differences in mean values were analysed using t-tests. The 95% confidence intervals were also calculated for all observed mean values.

2.3 Selected office buildings

The original plans were to investigate six buildings. However, at a late point in time, two buildings hade to be dropped: one atrium building with a natural ventilation system because of commissioning problems with the indoor temperatures wintertime; one building with balanced mechanical ventilation because the company occupying the building was in a major organisational restructuring process, including dismissing people. The employees had more important things in their minds than the indoor environment of the building.

Even if only four buildings remained, two of these could be divided into different parts. In building A one floor had new building services systems, i.e. new lighting system and VAV-system, whereas another floor still had the original systems, i.e. the old lighting system and the old CAV-system. In building B three different open plan offices were studied separately.

Table 2 shows the main characteristics of the studied buildings. In all buildings radiators below the windows provided heating. In most building the radiators had manual thermostat valves.

Table 2 The main characteristics of the studied Danish office buildings.

Building	**A1**	**A2**	**B1-B3**	**C**	**D**
Floor plan	Open plan	Open plan	Open plan	Cellular 1 person	Cellular 1-3 persons
HVAC-system	AC-CAV	AC-VAV CO_2-control	AC-VAV CO_2-control	MV-CAV	AC-VAV
Lighting System	Standard florescent Partly manual control	High frequency Occupancy control Daylight control	High frequency Occupancy control Daylight control	Standard florescent Manual control	Standard florescent Manual control
Solar shading	External venetian blinds – semi-automatic	External venetian blinds – semi-automatic	Internal ventian blinds – manual	External solar screens - manual	External ventian blinds – automatic with manual override
Glass	Double	Double	Double – solar shading	Double	Double
Windows	Non-operable	Non-operable	Operable	Operable	Operable

The studied part of building A comprised of the two top floors of the northern half of a three-story building. In turn this buildings was a part of a major building complex for an insurance company. The building had rather low occupant density, furnished for about 12-13 m² per person. In addition all users are normally not present at the same time. To prevent draft, the supply air temperature in the old CAV system is about 20-22°C. Despite that the building is from the 1980s it has a rather high window to wall ratio, 65% towards the east and the west, and about 50% towards the north. If the next day is expected to be sunny, the ventian blinds are lowered by the automatic system. The users can override the automatic system, but each manual breaker controls a rather large window area, three breakers per the east wall and the west wall, respectively. The north facing windows also have manually controlled internal ventian blinds. These are needed to control early and late sun during the summer as well as reflections from the south facing windows in the higher building to the north.

Building B is an old tobacco manufacturing plant totally rebuilt into a modern office building for a mobile phone operator. The old building had one store with a high ceiling height and sawtooth roof with north-facing angled roof windows. As part of the rebuilding, new floors were built in certain areas of the building. Consequently, parts of the bottom floors have a rather low ceiling height and sidelighting only from windows in the wall. Some of these rooms have a depth of up to 18 metres from the windows. On the other hand, the ceiling height is also rather low on the new upper floor with a lot of daylight coming from the existing windows in the sawtooth roof. This short distance to the roof windows can cause problems with daylight glare as well as some cold draft in wintertime, despite that the windows are changed to modern ones.

The windows in the walls have generally internal ventian blinds and the few south facing windows also have external overhangs. Between the summer and the winter questionnaire internal venetian blinds were installed on the windows in the saw-tooth roof. The reason was to give the ceiling a more even brightness and reduce veiling reflections in computer screens.

In all rooms with sawtooth roof, beams in the ceiling could also cause draft problems if the inlet air devices in the ceiling were not correctly adjusted. Between the summer and winter questionnaire the inlet air devices were adjust to reduce drafts.

The studies part of the building B is three open plan office rooms: one large room on the ground floor with about 125 workstations and with full ceiling height; one smaller room on the ground floor with about 50 workstations and with a new floor above; and finally one room with 46 workstations on the new first floor. All workstations are not used at the same time. In the two rooms on the ground floor about 60% to 70% were used, but in the room on the first floor 90% to 100% were used. In the two smaller studied rooms the users can control the set-point of the room temperature on one thermostat on the wall, whereas in the larger room there are two thermostats.

Building C is a very typical new Danish office building with balanced mechanical ventilation, but without any cooling coil in the air-handling units. It has a narrow floor plan with a central corridor and cellular offices on each side. The building is Lshaped which means that there are about equal window area towards all four directions of the compass. The office rooms are almost exclusively one-person rooms.

Building D was selected mainly because it had an automatic system for solar shading on the south facing that had been working successfully for many years. The building is from the late 1980s and has a narrow floor plan with a central corridor with cellular offices on each side. The windows face south and north, respectively. The studied 1½ floor is floor 5 and 6 in the seven-story building. The rooms are more or less equally divided between one person and two persons rooms. A few rooms have three persons. The automatic external ventian blinds system is controlled by one light sensor on the south wall. The blinds are only moved about once every hour. In each room there is a manual override, which gives the occupant the possibility to fully control the solar shading. The control switch in a few rooms was hard to reach due to the furnishing.

2.4 Results

The floor plan of the buildings turned out to be a parameter of major importance, which is in accordance of earlier research, e.g. Leaman (1992). Consequently, the results are divided into buildings with cellular offices and open space, respectively. Results are shown only for two of the buildings and for one season. Then follows an analysis of the relationship between the perceived personal control and the perceived indoor climate. Finally the forgiveness ratios of the buildings are calculated.

2.4.1 Buildings with open plan offices

The example of results is for winter conditions in building A. Here two floors with old (1st floor) and new (2nd floor) building services systems can be compared.

Figure 1 shows that the general satisfaction with the indoor climate is quite low, 27% for the 1st floor and 43% for the 2nd floor. The difference in mean values between the floors is statistically significant ($p < 0.05$). The satisfaction is higher for the new systems regarding air movements ($p < 0.10$), indoor air quality ($p < 0.05$), and lighting ($p < 0.05$). There are no differences in the satisfaction regarding indoor temperature and small, statistically insignificant, differences regarding daylighting and noise. Despite that the new VAV system, on average, has a lower outdoor air flow rate than the old CAV system, particularly in winter time, the users are more satisfied with the indoor air quality with the new system.

An interesting result shown in Figure 1 is that the perceived need for personal control regarding lighting is lower ($p < 0.05$) for the new system on the 2nd floor. The perceived control possibilities of the lighting system do not have much foundation in reality since the users do not have any technical possibilities to control the lighting. The only difference between the two floors is that the lighting on the whole floor can be manually controlled in the old system, whereas occupant sensors control the new system. However, the perceived control is statistic significantly higher for the old lighting system ($p < 0.05$).

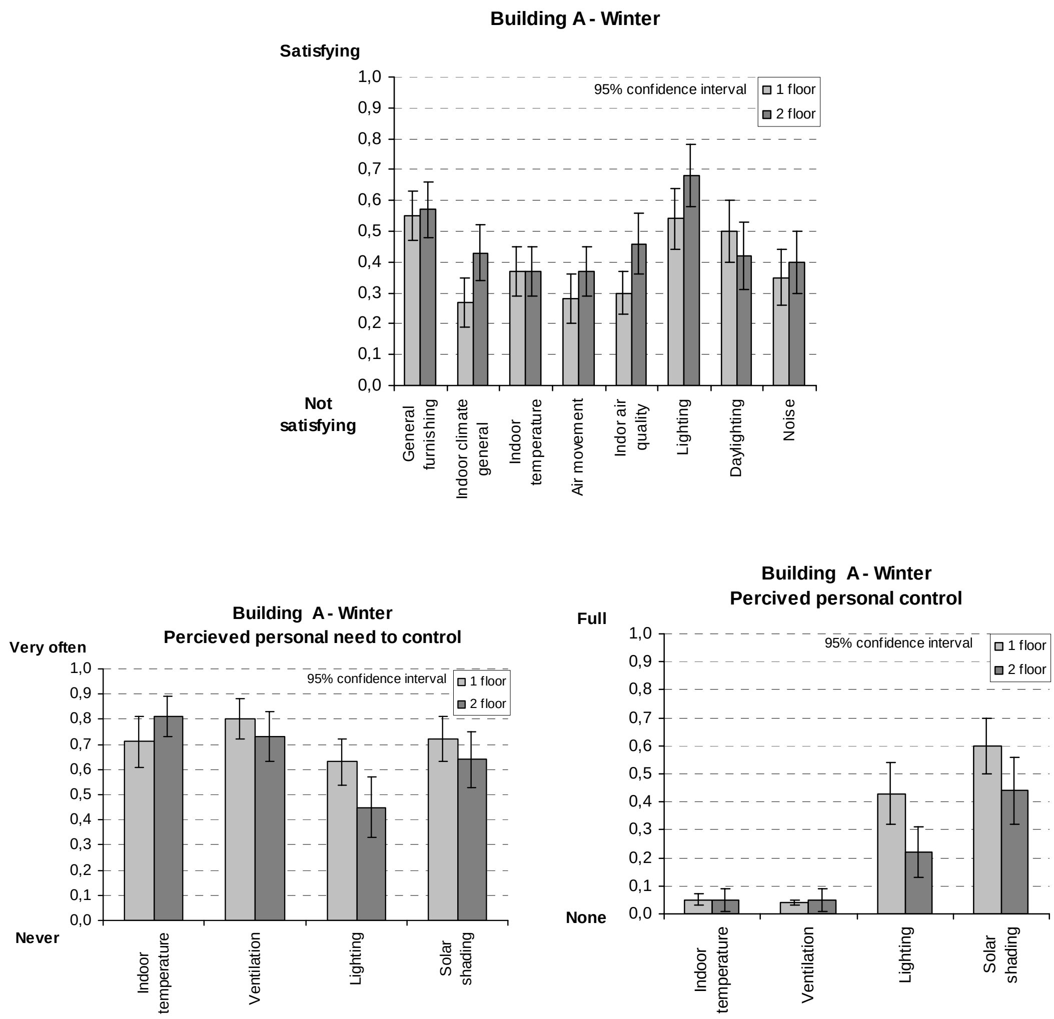


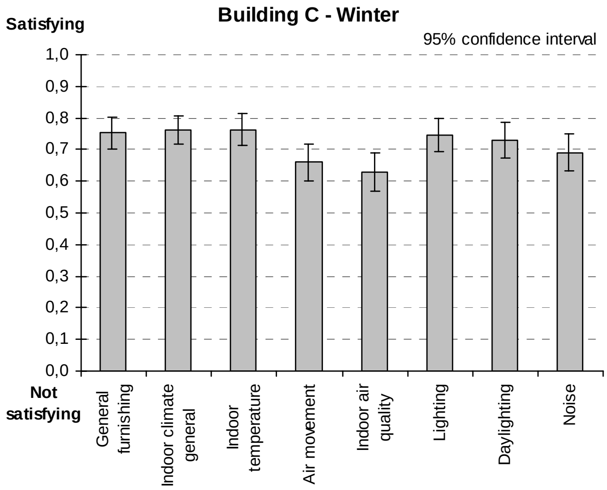
Figure 1. Results for the winter season for building A, where the 1st floor has old building services systems and the 2nd floor new ones.

2.4.2 Buildings with cellular offices

The example of results is for the winter season for building C. Figure 2 shows these results.

If Figure 2 is compared with Figure 1 it is clear that the satisfaction with all indoor parameters is much higher for almost all parameters in the building with cellular offices. Only the new lighting system in Figure 1 has a score that is closed to the one in Figure 2. What is really striking is the much higher perceived control in cellular offices, as well as the lower need of personal control.

For building C the difference between the winter and summer seasons is mainly expressed in the decreased satisfaction with the indoor temperature. This parameter decreases from 0.76 in the winter to 0.59 in the summer ($p< 0.01$). The explanation is that there is no cooling in the building. Despite this, the summer score is rather high.



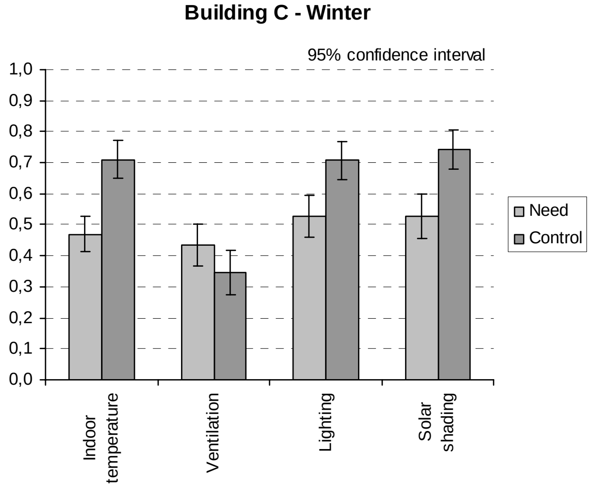


Figure 2. Results for the winter season for building C.

2.4.3 Relationship between perceived personal control and indoor climate

Based on initial analyses of the results, the following hypothesis was formulated regarding the users perceived personal control:
The higher the ratio is between "the users possibility to control" to "the users need of control" the more satisfied are the users. As a first approximation this relationship can be assumed to be linear.

This hypothesis could not be validated based on individual results, but on averages for whole buildings it turned out to be reasonable robust for all types of building services systems and all seasons. Figure 3 shows the users satisfaction with different indoor climate parameters as a function of the ratio between the users possibility to personal control and the need of personal control for all the studied buildings and the winter season.

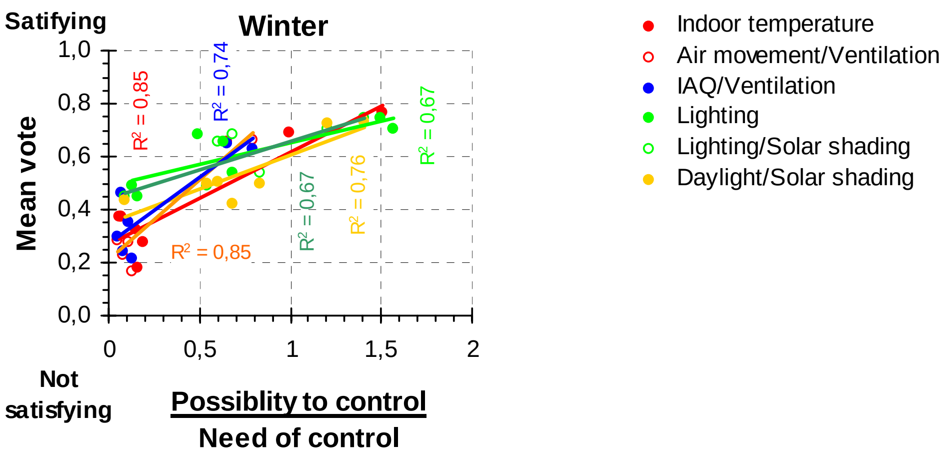


Figure 3. The users satisfaction with different indoor climate parameters as a function of the ratio between the users possibility to personal control and the need of personal control for all the studied buildings and the winter season.

As Figure 3 shows that the hypothesis is valid for all indoor climate parameters controlled by different building services systems. The highest coefficient of determination (R^2) for a linear equation is obtained for Indoor temperature and Air movement/Ventilation. Also for the other parameters the coefficient of determination is acceptably high.

One reason for this result may be that there is a large difference in the control ratio between buildings with open plan and cellular floor plans, respectively. The results for the open plan buildings are all located at the low ratios < 0.2 on the x-axis. However, the results are valid for all buildings individually with the exception of Daylighting/Solar shading for a couple of buildings.

2.4.3 Forgiveness ratio

The forgiveness ratio was used in the PROBE studies (Leaman et al, 1999) to sum up the behaviour of a building's indoor environment in relation to its users. The forgiveness ratio indicates:

1. How well the building and its technical systems in general can compensate the users for inadequateness in individual indoor environmental parameters,
2. The tolerance the users have for the building and its technical system in deficiency in one or more indoor environmental parameters.

The first indication presumes that users accept some deficiency in a single environmental parameter provided that the general indoor environment is perceived as satisfactory. The second indication implies that a forgiveness ratio greater than unity indicates that occupants tolerate faults in detailed performance.

In this case the forgiveness ratio is calculated for each building and for each season, which gives the definition:

$$Foregiveness\ \ factor = \frac{Satisfaction\ with\ Indoor\ Climate\ in\ General}{Average\ of\ \ satisfaction\ with\ Thermal\ Climate, Indoor\ \ Air\ Quality, Lighting,\ Noise}$$

Figure 4 shows the forgiveness ratio for the studied buildings as a function of the indoor climate in general. The first observation is that only the buildings with cellular floor plans make a score greater than 1. For two of the buildings with open plan floor plans the score is close to 1, but for the rest of this type of buildings the score are lower, in some cases as low as 0.65. The two buildings with open plan offices with a score close to 1 are both rooms in building C in the summer time. The coefficient of determination of the forgiveness ratio as a linear function of the indoor climate in general is high (R^2=0.84). In the next section a comparison is made with the British PROBE-buildings.

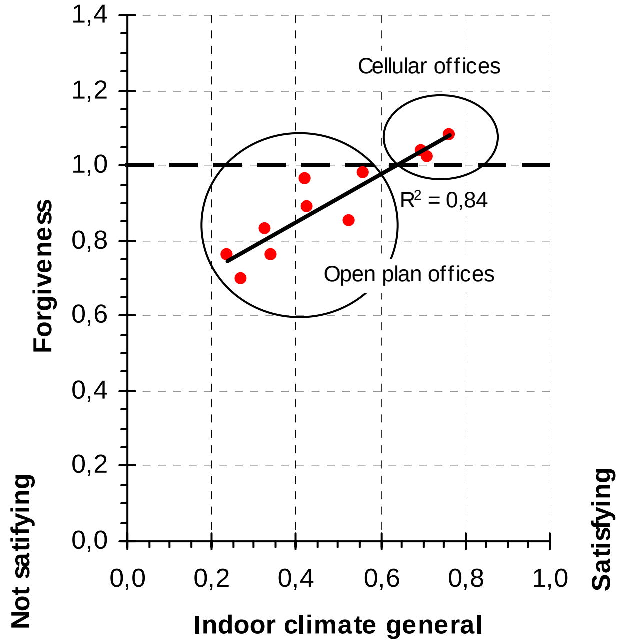


Figure 4. The forgiveness ratio as a function of the indoor climate in general for the studied Danish buildings.

2.5 Discussion

The well-known fact that buildings with open plan floor plans have more general problems with the indoor environment experienced by the users was again confirmed. These problems also lead to the fact the users experience a much large need for individual control of the indoor environmental parameters. The real control possibilities for the users are also much smaller in open plan offices than in buildings with individual offices. During the time this study was carried out the facility management personnel in building C decided, in order to get higher user satisfaction that the users in one room first must converse with each other and then phone the facility manager if they want to change the set-point for the room temperature. In most rooms there was one thermostat on the wall where the temperature set-point could be changed about +/- 5°C. As a result of the new policy this manual thermostat changed was disabled.

Glare and veiling reflections in computer screens, mainly caused by bright windows, was also a real problem. When the study was done flat screens were not used in any of the buildings. One special problem occurred in building C with the saw tooth windows used for daylight. The ceiling windows were generally much brighter than the rest of the ceiling, which resulted in veiling reflections on PC screens. The way to fix this problem was to install grey internal ventian blinds. However, this resulted in much less daylight than earlier and the daylight controls of the lighting system were not of much use any longer.

Background noise is also a well-known problem in open plan offices. The source of the noise is mainly people talking, both to each other and in telephones. The users seem to accept the "talking noise" from members of the same group, whereas "talking noises" from other groups were seen as more annoying. In building C two of the rooms were dominated by call centre activities, and the minority of users not involved in this activity were more annoyed by the background noise than the other user.

2.5.1 Comparison with PROBE Buildings

In the PROBE studies (Leaman et al., 1999) the forgiveness ratio was defined somewhat different than in this study, since one questionnaire dealt with both summer and winter conditions. This mean that the numerator had scores for temperatures and indoor air quality for both seasons. The numbers to average then became six instead of four. The PROBE score for Overall Thermal Comfort (= indoor climate in general) also hade to be recalculated from a 7 point scale to a 0 to 1 scale.

Figure 5 shows the forgiveness ratio for both the Danish office buildings and the PROBE buildings as a function of the indoor climate in general.

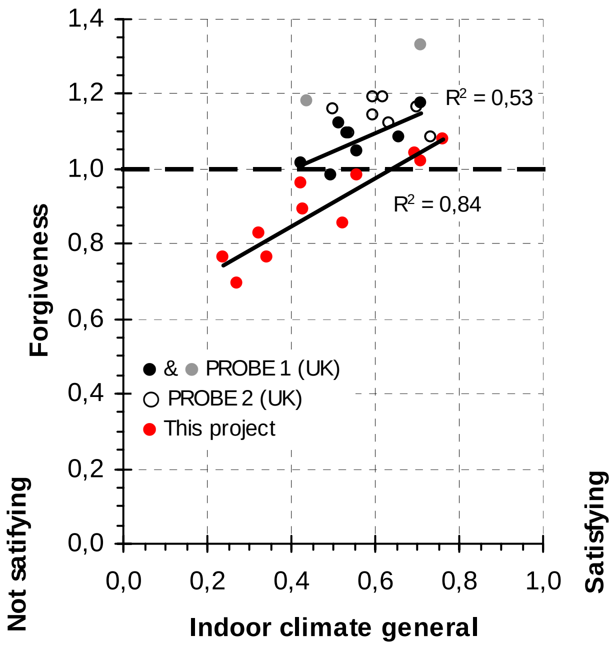


Figure 5. Forgiveness ratio for the PROBE buildings and the Danish office buildings as a function of the indoor climate in general

Figure 5 shows that only one of the PROBE buildings has a forgiveness ratio below unity. The indoor climate score in the PROBE-buildings is never as low as in some of the Danish buildings. The general comparison with the PROBE-buildings is that the

Danish buildings had a lower forgiveness ratio for the same score of the indoor climate in general. Not even Danish buildings with cellular offices did score as good as most PROBE buildings. This may be a result of the questions not be exactly the same as well as the different scales.

3. One Swedish Office Building

3.1 The studied building

The studied building is located just south of Gothenburg and was built as a new local corporate head quarter for a large international company. The users are from nineteen daughter companies that moved from almost as many office buildings in the greater Gothenburg area. The southern part of the triangular building is used as a repair shop for mainly electrical motors and was not studied. Between the repair shop and the office part of the building is a glassed street with a reception and a restaurant for the employees. The main conference areas are located on the bottom floor next to the reception. The floor area of the office part is about 9.500 m² divided on 4 floors. The office part of the building is located around a small atrium with north facing roof windows. The floor plan is a mix of open plan offices and cellular offices. During the project time rebuilding to more cellular offices were done. The building is air-conditioned with an HVAC-system based on active chilled beams, e.g. working as induction units with the supply air supplied through the beams and thereby inducing room air to be cooled. Heating is supplied via radiators below the window. A thermostat in the ceiling can control each chilled beam individually. However, to reach this thermostat the user has to stand on a chair. The radiators have thermostat valves where the user can select the set-point. The lighting system is a HF-system with personal control from each workplace and daylight control of the perimeter zones. Strings can also control each lamp in a luminary; two lamps for uplight and one lamp for downlight. In addition an occupancy sensor controls the luminary above each workstation.

3.2 Method

Following the tradition of Bedford (1936), the indoor environment in this modern office building was assessed by letting occupants rate their perception of that environment. We adopted a wide definition of indoor environment, letting respondents (occupants) rate both physical and social/psychological aspects. Simultaneously, a measurement of the indoor climate at the occupant's workplace was performed. Using self-assessed judgement of the indoor environment and comparing it with the actual environment parameters has been successfully employed in laboratory setting by Fanger (1970). In field studies the method has been successfully used in the EU-research project SCATS; see e.g. Stoops (2001).

3.2.1 Respondents

Data was collected during both summer (N = 83, 18 women and 65 men) and winter (N = 108, 24 women and 84 men), to enable a more thorough picture of the buildings' performance and the effects on its occupants. Respondents had a mean age of 43 years (range 22-62 years) in the summer study and a mean age of 43 years ranging between 21 and 75 years in the winter study. On average, respondents had worked 40 weeks at their current workroom.

3.3 Results

3.3.1 Physical parameters and perception of indoor climate

Participant judged their perception of temperature on a 7-point scale, ranging from 1 = very cool to 7 = very warm. The simultaneous measurement of temperature at the specific workroom included both air temperature and globe temperature. Both these measures were positively and significantly correlated with the perception on the cold - warm scale during winter (air temp. $r = .28$, $p < .01$ and globe temp. $r = .29$, $p < .01$) and in the summer study air temperature was significant ($r = .18$, $p < .05$) while globe temperature was not ($r = .13$, ns) but still positively related to the judgments on the cold – warm scale. The results thus indicate, that although the temperature in the different workrooms only vary between 19.6 $^{\circ}$C and 23.1 $^{\circ}$C (air temp.) and between 20.9 $^{\circ}$C and 23.8 $^{\circ}$C (globe temp.) people generally perceive it to be cooler when they work at a spot who indeed have a lower actual temperature relative to other places in the building. Another expected result in relation to temperature was that participants working in a colder workroom (both measured and perceived) generally judged the air quality to be better than participants working in warmer workrooms.

3.3.2 Satisfaction with work and workplace

As part of the questionnaire/interview, the respondents judged the importance of 22 different factors relating to satisfaction with their work and workplace. All factors were related to the work/indoor environment and the judgement was made on a 7-point scale ranging from 1 (not at all important) to 7 (very important). The results were highly similar for both studied seasons, and the three most important factors were in descending order: to feel productive (winter M = 6.6, summer M = 6.6), a perception of work tasks as stimulating (winter M = 6.4, summer M = 6.5) and to have a permanent workplace of one’s own (winter M = 6.4, summer M = 6.2). The least important factors were cooling air movements (winter M= 4.7, summer M= 4.4), privacy (winter M= 4.9, summer M= 5.0) and possibility to change/control the temperature (winter M= 4.9, summer M= 5.1). As can be seen even the three least important factors were judged to be of some importance, indicating that all 22 factors were relevantly related to the respondents’ view of what constitutes a satisfactory workplace.

In the questionnaire distributed during the summer period, we added a new task in relation to these factors. The respondents were now asked to rank the importance for a workplace to be satisfactory (1 = most important through to 4 = least important). 4 categories were constructed out of the original 22 factors. The categories were named climate (e.g., comfortable temperature, fresh air and good artificial lightning), workplace (e.g., clean office, privacy and own permanent workplace), control (e.g., possibility to change/control the temperature, lightning and air quality) and work (e.g., to feel productive, stimulating work tasks and to enjoy ones colleagues). Across the 77 respondents, the work category was ranked to be the by far most important category (M = 1.1) followed by quite a margin by the categories climate (M = 2.6) and workplace (M = 2.7). The category to be ranked least important of these four was control (M = 3.5).

An added question in the summer questionnaire made it possible to use hierarchical regression analysis to find the most important variables for judging the environment at the workplace as generally comfortable (dependent variable). The analysis revealed that social climate followed by a perception of work as stimulating and liking of work tasks were most influential in explaining the variance in the dependent variable. All relations were positive indicating that a good social climate, a view of work as highly stimulating and high liking of work tasks all contribute to a perception of the workplace as generally comfortable.

3.4 Conclusions

The empirical data suggests that the most important factors for creating a satisfactory workplace are related to work tasks and colleagues. That is, if you as an employee feels that you are productive, have stimulating working tasks and enjoy the company of your colleagues you will probably be highly satisfied with your work and workplace. Of lesser importance for satisfaction in this respect are that you have a comfortable physical indoor climate/environment (e.g., comfortable temperature, fresh air and good artificial lightning) and aspects related to your workplace (e.g., a clean office, privacy and a permanent workplace of your own). The results indicate that it is only of minor importance that you as an employee can control/change the indoor climate/environment (e.g., temperature, air quality). Dwelling on these results, one should take into account the fact that data was collected in a building where the majority of its occupants perceived the physical indoor climate/environment as satisfactory. It is possible to speculate that the judged importance of factors related to the physical indoor climate/environment would be higher in a less satisfactory building in that respect.

4. General Conclusions and Discussion

From the study of four Danish office buildings can be concluded the well-established fact that the floor plan has a large influence of the users perception of the indoor climate, both in general and on parameters where no big physical difference should exist between different floor plans. The users perceived degree of control is smaller in open plan offices than in cellular ones. The users perceived need to control the indoor climate parameters is also larger in open plan offices. These fact lead to a hypothesis that:
The higher the ratio is between "the users possibility to control" to "the users need of control" the more satisfied are the users. As a first approximation this relationship can be assumed to be linear.

This hypothesis proved valid for building averages for practically all indoor environment parameter that the users could control. However, the difference in the control ratio is large between open plan offices and cellular ones.

This relationship needs more research to be confirmed and expressed in a general equation form.

All Danish buildings with open plan offices scored below unity in the forgiveness ratio, only buildings with cellular offices scored slightly higher than unity. The Danish buildings scored significantly lower at the same perceived indoor climate in general as the British PROBE buildings. The best Danish buildings were more or less equal to the worst British ones. In Scandinavia the forgiveness ratio have not been used earlier and the general results need more studies to be confirmed.

In the study of a modern Swedish office building, the most important factors for creating a satisfactory workplace are related to work tasks and colleagues. That is, if the user feels productive, has stimulating working tasks and enjoys the company of the colleagues the user will probably be highly satisfied with your work and workplace. Of lesser importance for satisfaction in this respect is to have a comfortable physical indoor climate/environment and aspects related to your workplace. The results indicate that it is only of minor importance that you as an employee can control/change the indoor climate/environment. However, these results were obtained in a building were the user in general were satisfied with the indoor environment and consequently felt little need to change it.

To sum up, there is a need for future studies which, more clearly catches the users entire work situation as well as the users perceived degree and need of control of the indoor parameters. Hereby it would be clearer if the Scandinavian trend towards more individual control of the indoor environment is justified.

5. References

Bedford, T. (1936). "The Warmth Factor in Comfort at Work". *Rep. Industrial Health Research Bulletin, 76.*

Bengtsson, M (2003). *Brukarens uppfattning av inomhusmiljön – En fältundersökning i en modern kontorsbyggnad (The Users´ Experience of the Indoor Environment – A Field Study in a Modern Office Building).* Dokument D2003:1. Department of Building Services Engineering, Chalmers University Technology. Gothenburg, Sweden (In Swedish).

Fanger, P. O. (1970). *Thermal comfort – Analysis and Applications in Environmental Engineering.* Danish Technical Press. Copenhagen, Denmark

Jagemar, L. (2002). *Brugerundersøgelse af avanceret energiteknik i kontorbygninger (User Survey of Advanced Energy Technology in Office Buildings).* By og Byg Dokumentation 035. Danish Building and Urban Research Institute. Hørsholm, Denmark (In Swedish/Danish). http://www.by-og-byg.dk

Leaman, A. 1992 . "Open plan offices: kill or cure?" *Facilities*, May 1992. http://www.usablebuildings.co.uk

Leaman, A., B. Bordass, R. Cohen, M. Standeven (1999). *Probe Strategic Review 1999 - Report 3: Occupant Surveys.* Report from the PROBE team to the Dept. of Energy, Transport and the Regions, August 1999. http://www.usablebuildings.co.uk

Stoops, J. L. 2001. *The Physical Environment and Occupant Thermal Perceptions in Office Buildings – An Evaluation of Sampled Data from Five European Countries.* Document D56:2001, Dept. of Building Services Engineering, Chalmers University of Technology. Gothenburg, Sweden. (Chalmers Dissertations)