IMPROVING INDOOR ENVIRONMENTS TO INCREASE PRODUCTIVITY BY 15%
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HOW TO ACHIEVE A 15% INCREASE IN PRODUCTIVITY BY IMPROVING YOUR INDOOR ENVIRONMENT?

Fewer issues with the air conditioning units, fewer complaints regarding the indoor environment, and increased productivity among staff. Optimization of the overall indoor environment can effect a 15% increase in productivity. How can this be accomplished?

Improving the indoor environment and increasing productivity are things you can achieve by managing sources of air pollution and heat, controlling the HVAC systems properly, dealing with complaints effectively, and being sure to include HVAC units in any structural alterations.

Research conclusively shows that a temperature that is a fraction below a comfortable level will result in optimum productivity. In addition to temperature, the indoor environment is influenced by air quality, with cleaner air resulting in increased productivity. Furthermore, the indoor environment has a considerable effect on satisfaction and therefore on productivity too. As facilities manager you can contribute to this by way of your services.

How great would it be if the people in your office were to come to work smiling, with a corresponding reduction in absence due to illness? Where working conditions are in good order, employees are happy, healthy and productive, as a result of which they perform their work better and more swiftly. The upshot of this is increased returns for the organization. Within an office organization, the employees are the means of production, and at the same time the greatest expense. At least 80% of costs comprise staffing costs, whereas expenses associated with business premises make up only 10% of total outgoings. Increased returns on staffing costs therefore result in a higher profit margin!

This publication will not only provide you with insight into the effects of your facilities management services on the productivity of your employees, but will also offer guidelines for influencing these effects. How does the indoor environment influence productivity and what is the extent of this influence? What elements make up the indoor environment and what indoor environment values are optimal? We present you with a practical manual on how you can achieve these optimal values.

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HOW DOES THE INDOOR ENVIRONMENT AFFECT PRODUCTIVITY?

The indoor environment influences productivity by way of direct processes, such as tiredness and irritations, and indirect processes, such as health problems.

Employees’ productivity is influenced by a great many factors:
- the organization (e.g. its culture or remuneration structure);
- the people themselves (e.g. due to their knowledge and skills);
- the working environment.

One important aspect of the working environment is the indoor environment. The indoor environment is an aggregate of air quality, the thermal climate (temperature), light and view, and the acoustics.

The indoor environment affects productivity through a variety of processes. First and foremost there is a direct influence. In a good indoor environment people feel more comfortable, and this in itself makes them more productive. If the indoor environment is less optimal, staff feel troubled by such things as draughts and noise, which can cause them to tire and become less productive. These complaints can also engender dissatisfaction, again affecting productivity. Nigh on half of office workers complain of overheating in the summer, and stale, musty indoor air.

An inadequate indoor environment also has an indirect influence on productivity through health problems and illnesses. Air quality constitutes an interplay of pollutants arising from people (odours and CO2) and substances released from the office environment such as emissions from interior/construction materials and dust. Irritating substances in the air can trigger allergies, infections can occur, and toxic substances released from materials can even lead to serious diseases such as cancer. Unfortunately it is the case that health problems are common in practice. Around 20% of office staff experience headaches, sore eyes or an irritated nose or throat on a daily or weekly basis.

MAJOR AND MINOR EFFECTS

The fall in productivity is more pronounced in the event of an increase in temperature than it is in the event of a decrease in temperature. Overheating in the summer therefore has a greater effect on productivity than complaints with the cold during winter. So invest in extra cooling!

The capacity of plants to cleanse the air is sometimes overestimated. A meaningful effect is only brought about once 10-20 plants per person are present. Which in many offices is simply not feasible!

Increasing the ventilation will only bolster productivity if the filter is not saturated and worn out. If it is, then the negative effect of the resultant pollution will override the positive effect of the increased ventilation. Consequently, increased ventilation only makes sense when well-maintained equipment is being used!
The maximum gain in terms of productivity is 15% where the indoor environment is optimized. With optimal values for temperature this is 6%, for air quality 7%, for light 3%, and for noise 9%. These individual percentages total over 15% because separately the aspects have a different effect than they do when measured as a whole.

Theoretically, an indoor environment that is fully in order (in terms of temperature, air quality, light and noise) can produce a 10-15% increase in productivity in comparison with an indoor environment that is in poor order. Results in laboratory situations (climate chambers) and in actual working situations differ considerably because the effects are often complex. What are the most important effects of the separate aspects of the indoor environment on productivity?

### Temperature

A realistic increase in productivity is 6% where the indoor temperature in the summer is reduced from 28 °C to 25 °C. After all, if the air temperature falls below 20 °C or exceeds 25 °C then productivity decreases by 2% per degree.

### Air quality

Improving air quality can result in a 2-7% increase in productivity. By removing sources of pollution such as dirty carpets, dirty air conditioning units and dirty equipment, a 7% increase in productivity can be effected. If the fresh air supply is increased (e.g. from 30 m³ per hour per member of staff to 40 m³) then a 2% increase in productivity can be effected.

### Light

If improvements are made to lighting then a 2-3% increase in productivity is possible. These improvements can consist of higher intensity lighting, less contrast in a workspace and preventing glare.

### Noise

Noise nuisance from colleagues in particular has a detrimental effect on productivity. Depending on the original source of the noise nuisance, acoustic improvements will enable a 3-9% increase in productivity.

The extent to which gains in productivity can be achieved in your office will depend on such things as the present situation. If a great deal of attention has already been devoted to fostering a healthy indoor environment in the building, then the benefits of measures implemented will be less. In other words, the more inadequate the situation at the present time, the greater the effect will be of the measures you take.
A comfortable temperature is subjective and specific to the moment, but it is better to keep it within the 20-25 °C range. Clean indoor air is ensured by minimizing sources of pollution by supplying 40 m$^3$ of fresh air per hour per member of staff.

The thermal climate and the air quality can be influenced by maintaining air conditioning units and by cleaning. The day-to-day responsibilities of a facilities manager.

**Thermal climate**

Productivity is at its highest around or slightly under the temperature perceived to be comfortable. The temperature perceived to be comfortable will be different for everyone. Differences in individual physiology (being someone who feels the cold or suffers in the heat) mean that different people will perceive the same circumstances differently. Consequently, the highest level of comfort for buildings is described in the literature as a level at which 5% of staff are still not completely satisfied.

Comfort is also specific to the moment; the circumstances in which an individual feels comfortable can change rapidly. Due to a change in activity, for instance, or the time of day or season. Even the outside temperature has an effect. During the summer people are less warmly dressed and the indoor temperature will need to be higher than it is in the winter in order to be comfortable.

However, it is possible to offer threshold values, within which the chances of an employee experiencing discomfort or health problems are small. The majority of people will feel comfortable within an (air) temperature range of around 23-25 °C in the summer and 20-22 °C in the winter. In addition to a comfortable air temperature, a comfortable indoor climate should neither be gaining nor losing heat (e.g. through cold window panes), there should be no significant difference between temperature at head height and at floor level, and there should be no unwanted air flow (draught).

There are some indications that in some cases the most comfortable temperature is not the most productive one. In an experiment carried out in a climate chamber it emerged that productivity was highest at a temperature of 20 °C, even though this was perceived to be uncomfortable by the participants. Other studies also confirm that productivity is optimal at a temperature slightly lower than is comfortable.

Due to the fact that comfort is subjective and specific to the moment, there is only one way of keeping everyone happy: give each employee individual control, allowing them to adjust the conditions to their needs or to their liking at that particular point in time. The possibility of exerting one's own influence on the indoor environment also plays a significant role in satisfaction with the indoor environment, and it has a direct effect on productivity. Such a possibility (e.g. by means of a window that can be opened or a radiator button) will effect a 2-4% increase in productivity.
Air quality

The best indoor air is clean air. Nonetheless, the quality of indoor air is nearly always inferior to that of outside air. This is due to the fact that multiple sources of pollution are present in an office building. These sources give off dust and particulate matter, which remain in the air until they settle or are removed.

Dust that is inhaled can cause irritation and problems with the respiratory tract. Chemical and biological substances can also trigger all manner of allergic reactions and irritations, and even cause diseases. Though a great deal of research is being done, for many substances it is as yet unclear at what concentration they become harmful and what exactly their effect is on human health. Furthermore, chemical substances react with one another, creating new compounds. And to make the whole process even more complicated, all these substances collectively have a different effect than each substance individually. Consequently, it is often ill-advised to measure specific concentrations in the indoor air. However, reducing sources of pollution is regarded as a solution.

For CO2, a ceiling value of 1,000 or 1,200 ppm (the quantity of CO2 molecules per million molecules in the air) is often given. CO2 is particularly a good gauge of air quality in spaces such as a meeting room, where the majority of air pollution is being caused by the people present. Above the indicated ceiling value, the other substances given off by people will result in odour nuisance and irritation of mucous membranes. Nonetheless, a direct effect of CO2 on health does not occur until extremely high concentrations occur, i.e. 30,000+ ppm (these do not occur in buildings). Achieving an acceptable level of CO2 requires a minimum supply of fresh air of 40m³ per hour per member of staff.

indications from users

Office workers describe their problems in line with the way in which they perceive these. The terms that they employ in this regard do not always tie in with the technical causes. As facilities manager, it is down to you to put yourself in the shoes of the member of staff and interpret the complaint correctly. A couple of much heard examples:

Lack of fresh air
Fresh air is associated with temperature (hence the expression ‘fresh’ air). Warm, humid air is more readily perceived as stale and musty than cool, dry air is, irrespective of how clean the air actually is! As such, complaints regarding fresh air are not necessarily related to air quality, but can often be attributed to warm, humid indoor air.

Dry air
A common complaint in the winter is dry air. Nonetheless, measurements of humidity in offices have not revealed any correlation between this complaint and humidity. This complaint is often caused by an excessive air temperature or by irritating substances in the air. Only in cases of extremely low relative humidity (<15%) does this factor start to play a role.

Lack of oxygen
We all know what lack of oxygen means: stale, musty air that feels oppressive. Yet this does not mean that there is too little oxygen in the air. Fresh outside air contains around 21% oxygen, with around 17% oxygen remaining in exhaled air. Enough for us to be able to satisfy our oxygen requirements. The cause of this oppressive feeling is often - as with the other complaints cited above - a combination of excessively warm and polluted air.
The sun, people and equipment will heat up a room. Dust can play host to micro-organisms, and inhaling these can lead to health problems. Although it is better to tackle heat and air pollution at source, equipment in good working order will be capable of extracting heat and air pollution effectively.

The thermal climate is influenced by sources of heat (the rays of the sun, heated air in the air supply, radiators, equipment and people) and heat removal (by opening windows, extraction of ventilation air, and cooling units). In over 70% of buildings in the Netherlands the air conditioning system does not work in line with the design, thereby causing problems in the indoor environment. There is a high probability that this is an issue in your building as well. In these cases it turns out that more than two thirds of the problems are being caused by failure to adapt equipment to a changed layout or level of staffing, or by broken or faulty parts.

Sources of air pollution include construction materials, interior materials, air conditioning units, the activities and work processes being performed in the building, the ground and the outside air. If cleaning is insufficient, then a proportion of these sources will be amplified. Dust will be wafted up into the air, and if it remains settled then it provides a suitable environment for micro-organisms.

Cleaning the working environment and properly managing air conditioning units will enable the supply and removal of pollutants and heat to be controlled. Tackling things at source rather than combating the effects often has a considerable and robust impact and prevents all manner of side effects. The extraction of harmful substances uses energy and the flow of air can result in complaints of draughts. But heat that cannot get in does not have to be removed either.

THE MOST SIGNIFICANT CAUSES OF PROBLEMS IN PRACTICE

- Saturated and worn-out filters in the air handling units due to maintenance being performed with insufficient frequency.
- Top cooling (cooling of max. 3°C of outside air instead of fully fledged air conditioning) without proper heat insulation (exterior sunblind).
- A structural change of layout without adapting the equipment resulting in air inlets and outlets being outside the room or positioned, of all places, right underneath or above a workplace. This often occurs where cellular offices are converted into open-plan office space.
- A higher level of staffing than provided for in the design, as a result of which the equipment is no longer up to the job. This sometimes occurs within the compass of flexible and home working schemes (known in Dutch as ‘Het Nieuwe Werken’).
- Less efficiency on the part of units due to them approaching the end of their lifespan. This increases when efforts are made to save on replacement costs by stretching the lifespan of buildings and equipment.
By controlling sources of air pollution and heat, properly managing air conditioning units, dealing with complaints effectively and including systems in any structural alterations, you will be able to contribute towards creating a productive working environment.

The following points for attention and measures will help you to contribute towards creating a productive working environment.

**Control sources of air pollution**

- Ensure layout is conducive to thorough cleaning.
- Ensure compliance with the Healthy Cleaning rules of thumb. A healthy effect only lasts 1-2 days. So clean every other day as a minimum!
- Ensure that cleaners have proper access to all nooks and crannies and that they do not feel (or get) impeded by staff present during day-to-day cleaning activities.
- Get cleaners to flag things up: both the preconditions for problems like damp and incipient symptoms such as moulds.
- Ensure compliance with the clean desk policy.
- Have staff do their own bit towards creating a healthy working environment for themselves by getting them to keep things clean and tidy.
- Occasionally it may be necessary to relocate certain activities or equipment. For example, printers could be moved to areas where no employees are sat, or staff could be spread throughout the building to ensure better heat distribution.
- Have a visual inspection of the units carried out on a regular basis so as to detect microbiological growth in AHU filters, ducts and grilles early on.

**Control source of heat**

- See to it that the sunblind works properly, particularly on façades facing south or south-west in the case of limited cooling.
- In the case of rooms adjacent to a façade that faces south or south-west, be prepared for excessive heat in the summer, particularly if the building was constructed before 1980 and there is no exterior sunblind. The worldwide energy crisis during the 1970s resulted in increased attention being paid to the energy efficiency of buildings. Prior to the 1980s the building envelope barely had any insulation value.
- Be prepared for issues related to the cold in spaces bordering a façade that faces north-east during the winter, again particularly if your building was constructed before 1980.
- Ensure that you know the extent of your internal heat load (caused by both people and equipment).
- Consider redistributing people and equipment over rooms so as to improve the way in which the heat load is spread and to control air pollution.
Control your equipment

- See to it that you know what you can expect from your equipment.
- Make sure that the information from the Building Management System (BMS) reflects the actual situation as well. Faults are found surprisingly often in the connection between the equipment and the BMS, resulting in inaccurate information being presented. You would therefore be well advised to avoid steering blindly on the basis of results from the BMS, instead assessing the situation in situ.
- Ensure that revisions are included.
- Compare the original construction and equipment plan with the current situation vis-à-vis structure and equipment. Have walls be moved? Have ventilation inlets and outlets been modified accordingly? Have the temperature controls been modified accordingly?
- Compare the current heat load (level of staffing and number of computers) with the original heat load calculation. Does the current capacity still suffice?

Deal with complaints effectively

- There is an important difference between central complaints (it is cold throughout the building) and local ones (there is a draught in one room). In the case of a central complaint, the cause is often readily identifiable (a faulty boiler or air handling unit) and the solution is often quick to become clear too. In the case of local complaints it is often much trickier to identify the cause, and psychosocial factors sometimes play a role as well. Implementing the solution entails risks to the central indoor environment. If local arrangements are tinkered with, there is a chance that problems will arise elsewhere. Be cautious in this respect.
- In practice, structural solutions frequently end up being shelved due to the requisite levels of investment. The alternatives opted for are ‘pampering’ the employees making the complaints and makeshift solutions at local level. Experience shows that this provides some relief in the short term. It is true that paying attention to complaints ameliorates people's experience of the issues at hand and can temporarily bolster productivity. However, this should not be used as an excuse not to strive towards a genuine solution. It is sometimes the case that a decent solution will not be cheap.
When engaging in alterations to layout or structure, include equipment and services from the outset

- See Adjust the frequency of cleaning where staffing levels rise.
- When altering the layout (e.g. switching from cellular offices to an open-plan office space), get a specialist to recalculate the design and requisite capacity for the equipment. In this regard pay sufficient attention to:
  - The capacity in relation to the new level of staffing;
  - The positioning of inlet and outlet openings and controls.
DO YOU NEED TO UNDERSTAND EVERYTHING?

As facilities manager, you are not expected to know all the ins and outs of air conditioning systems. At the end of the day this is a specialized field, and even the specialists themselves sometimes have trouble identifying the cause of problems and subsequently resolving them.

Nonetheless, it is crucial that you have a broad understanding of the way in which the equipment works to ensure that you are able to engage in discussions on it. However, the most important thing is that you know when you need to ask for help, be this in the spirit of prevention or once you are already faced with a problem!

DO THE PRODUCTIVITY SCAN!

A comfortable and healthy indoor environment can boost productivity by as much as 15%. This publication has provided you with insight into how you can do so. If you would like to be given an indication of how much your productivity can be boosted within your building, please feel free to do the productivity scan at www.sodexo.nl (in Dutch only). This will quickly give you an idea as to the maximum gain in productivity you could achieve within your own office.
REFERENCES

About Sodexo

Sodexo, world leader in Quality of Life Services

Founded in 1966 by Pierre Bellon, Sodexo is the global leader in services that improve Quality of Life, an essential factor in individual and organizational performance. Operating in 80 countries, Sodexo serves 75 million consumers each day through its unique combination of On-site Services, Benefits and Rewards Services and Personal and Home Services. Through its more than 100 services, Sodexo provides clients an integrated offering developed over more than 45 years of experience: from reception, maintenance and cleaning, to foodservices and facilities and equipment management; from Meal Pass, Gift Pass and Mobility Pass benefits for employees to in-home assistance and concierge services. Sodexo’s success and performance are founded on its independence, its sustainable business model and its ability to continuously develop and engage its 428,000 employees throughout the world.

Sodexo Nederland supplies a wide array of ‘On-site Services’ to business clients, government agencies, hospitals, care and educational institutions. These services encompass landscaping, buildings management, reception services, security, workwear management and distribution, vehicle fleet management, catering supplies and numerous other facilities management services, ensuring its clients are able to focus their attention solely on their own business activities. For further information please see: www.sodexo.nl