Whitepaper

How does Indoor Air Quality (IAQ) impact fit for purpose environments?

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Is indoor air quality holding you back?

Every building has a purpose. It also has a set of factors that affect whether it meets that purpose. For example, a school that is fit for purpose encourages mental alertness in students and teachers. A hospital needs to be clean and comfortable. A data centre requires stable temperature and humidity levels.

Across all buildings, one of the most vital factors often overlooked is Indoor Air Quality. IAQ has a significant impact on indoor environments, impacting on occupant wellbeing and how well the building delivers on its purpose.

The impact of poor IAQ on wellbeing?

Let's look first at occupant wellbeing. Between home, work or study, and other shared environments such as supermarkets and cafes, people typically spend 70-90% of their time indoors. It can be even higher for infants, the elderly and the chronically ill. That means IAQ affects us all daily.

If IAQ is poor, it can impact people on varying levels. Nuisance and discomfort complaints are the more obvious signs, typically triggered from being too hot or too cold or from sitting in a draft. These typically result in calls to service companies to make adjustments to temperatures or airflows to remedy the issues – with varying degrees of success...

However, some issues are less obvious, with significant but more subtle impacts, such as complaints of stuffiness. Complaints of this nature usually indicate a lack of fresh (outdoor) air required for ventilation purposes and will impact a person's cognitive abilities.

When we're in an indoor environment designed for work or study, we rely on our cognitive abilities to think, focus, be creative and mentally process information. But all of our cognitive skills suffer if indoor air quality is poor due to a lack of ventilation. Our attention span is reduced, our memory function is reduced and our ability to use logic and reasoning are impaired. Poor IAQ can even reduce our ability to process the information we hear or read, reducing comprehension, as well as reducing our creativity levels so valued by many organisations.

If indoor air quality is allowed to fall even further, it can impact on health, triggering headaches, dizziness, fatigue, skin or eye irritations and respiratory difficulties. In more extreme situations it can even lead to Sick Building Syndrome, where poor IAQ triggers these kinds of symptoms in a significant number of occupants whenever they spend time in the building.

Often the source of these building related illnesses is hard to pinpoint. It could be a specific indoor air contaminant or pollutant. But because it usually can't be seen, it will often be left unremedied.

Of course, the potential build-up and spread of biological contaminants such as viruses and bacteria have been of particular concern over the past couple of years.

The real costs of poor IAQ?

While the impact of IAQ is felt directly by occupants, it has a flow on effect on the building's purpose. Over a building's life cycle, the impact of poor IAQ becomes a significant and very real cost.

Research from the American Society of Heating, Refrigerating and Air-Conditioning Engineers has estimated that it can cause a 2-16% decrease in productivity and increased absenteeism in commercial buildings. In schools, it can lower test performance by 20% and in hospitals, it can delay discharges, which has wide ranging impacts on the efficiency and cost of healthcare.

This shows that occupant wellbeing is not just a 'nice to have' — it's essential to a productive environment and a healthy, fully-functioning building.

The current standards for workplace IAQ

Current applicable standards for New Zealand workplaces (as for most placed around the world) prescribe minimum rates of outside air ventilation to provide acceptable levels of indoor air quality. The underlying assumption is that by delivering the prescribed rate of outside air into a building, based on full occupancy, everything will be fine. But this is rarely verified in the real world and does not take into account variability of use.

Occupancy levels can impact on both building operational costs and IAQ. When occupancy is low, buildings will typically be over-ventilated – good for occupants health, but adding unnecessarily to the building running costs. When occupancy rates are high, buildings may be under-ventilated, reducing the IAQ below required standards and effectively lowering the overall productivity levels of the occupants. The traditional 'set and hope' approach to air quality simply ends up being costly and counterproductive.

A better approach, but by no means perfect, is Demand Controlled Ventilation. This is where CO_2 levels are measured in one or more locations throughout the building and outdoor air ventilation rates are increased or reduced to maintain CO_2 levels under an acceptable level. As it is difficult and expensive to measure oxygen levels directly, CO_2 is used as a surrogate measure for a corresponding reduction in oxygen levels, which is what our bodies are really reacting to.

However, the trick is to get the oxygen rich outdoor air to the right places — typically meeting rooms, breakout rooms or function spaces have disproportionately higher occupancy rates compared to standard office spaces, so this is where we see the most significant impact of low oxygen levels – depicted by reporting high CO_2 levels.

An interesting phenomenon is the apparent ability of the body to rapidly adjust or readily accept poor indoor air quality. Have you ever walked into a crowded meeting room or function that has been running for some time and have been taken aback by the stale smell within the room? While the lack of ventilation is patently obvious to someone moving from a fresh environment into a stale environment, it is much less obvious to those within the room. This means that IAQ has a somewhat stealth characteristic, sneaking up on people over time. This is a fundamental reason why we need sensors and controls to continuously monitor and adjust systems to maintain acceptable indoor air quality.

The new conversation we need

As our understanding of IAQ issues increases, and the impact it has on occupant wellbeing and building lifecycle costs becomes more apparent, we need to shift the conversation on from minimum standards and instead aim for something better. Great IAQ should be the new benchmark.

That prompts more questions. What does ‘great’ look like, and how can we know it has been achieved? How do we reassure building occupants that their environment is as safe and healthy as possible? Through measurement, adjustment and demonstration.

Measuring what matters

The most influential parameters we can measure are those that relate to comfort and health.

The basic measures of comfort are Dry Bulb Temperature (air temperature) and relative humidity. In a typical air conditioned building, temperature measurements are only ever correct at the point of measurement, and relative humidity is invariably low and uncontrolled. Drafts and air movement also impact comfort and are almost never measured.

More useful to measure is Mean Radiant Temperature, which takes into account the surface temperatures of our surroundings, such as cold glass or floors warmed by direct sunlight. This is what our bodies really feel, and has a more significant impact on comfort. Daylighting is also important — natural light is important for our general feelings of wellbeing and meets our biophilic drive to be connected to nature.

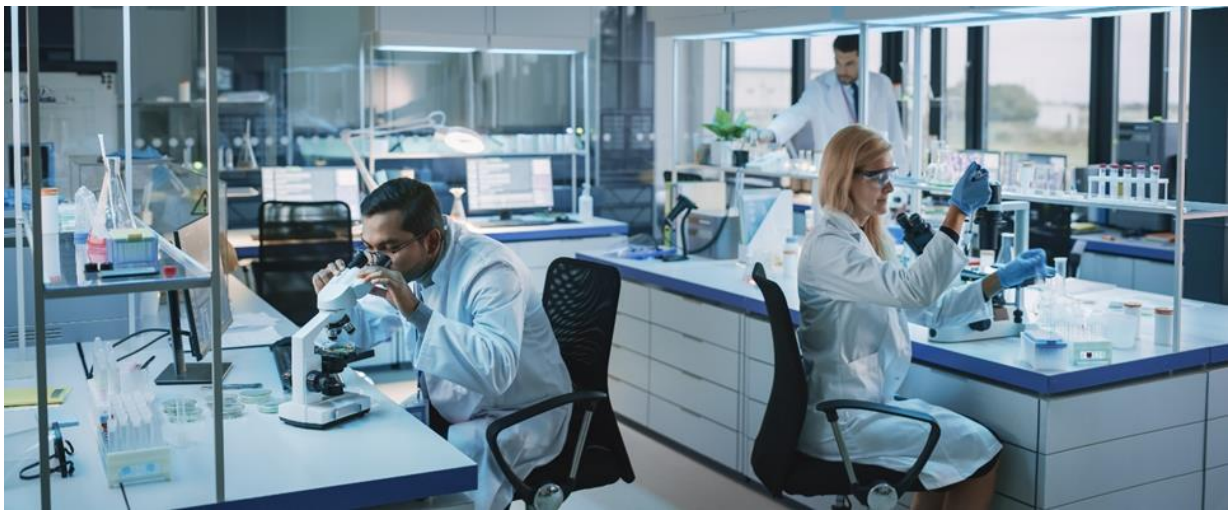
Out of these measures, Dry Bulb Temperature is the only one consistently measured and regulated. Relative humidity is usually only measured when specific needs demand it, such as in a data centre. Drafts and Mean Radiant Temperature are almost never measured in the field, and daylighting is rarely measured unless intelligent lighting controls are installed. To truly measure comfort, we need to take all of these indicators into account.

When it comes to measuring health, monitoring CO_2 levels is an easy way to improve IAQ. By aiming for a target maximum of around 800 PPM (depending on the situational ambient CO_2 levels), it's possible to minimise the impairments to productivity and learning ability in workplaces and schools.

There are other, less obvious measurements that should also be considered. Total Volatile Organic Compounds (TVOC) are emitted as gases from common building products and, at increased levels, can have a negative impact on occupant health. If a building has interior car parking, carbon monoxide levels should also be monitored as high levels can cause fatigue, headaches, confusion, and dizziness.

Natural occurring particles such as pollen, droplets, mould spores and pathogens can cause health issues and can be tested for with air and surface swabbing. An unusual but increasingly recognised risk in some counties is radon, a radioactive gas that is a major cause of lung cancer. It results from the breakdown of naturally occurring traces of uranium in the ground and can accumulate in basements in particular. Fortunately, New Zealand does not have this issue.

Of all of these, only carbon monoxide measuring is mandated. CO_2 is now commonly measured in most new buildings, but monitoring is rarely retrofitted into existing buildings. TVOC's are sometimes monitored instead of CO_2 but it's rare for both to be monitored together. And monitoring of natural particulates, or air and surface swabbing are almost unheard of in New Zealand.



How to make use of the data

A lack of measurements and reporting is contributing to poor results in terms of comfort, health and wellbeing within our buildings. But if the goal is great IAQ, so we can have healthier buildings and occupants, measurement alone is not enough. There needs to be real-time system adjustments or operational procedural changes in response to the data that has been gathered. To get meaningful engagement from stakeholders, changes need visibility. For example, a dashboard that tracks monitored results and shows progress towards a building's ideal targets gives everyone usable information and motivation to make positive changes.

The opposing forces of energy and health

There is one significant complication for building owners and managers when it comes to actively improving IAQ to improve health and comfort. It usually requires an increase in energy consumption. This has an economic impact and is at odds with attempts to lower carbon emissions and improve sustainability.

The tension exists because low energy consumption relies, among other things, on minimising outside air when it is not suitable. For example, the temperature of outside air in mid-winter or mid-summer needs more energy to regulate it. On the flip side, building health benefits from maximising the use of outside air for ventilation purposes. Modern heating, air conditioning and ventilation systems could for instance be programmed for either an 'Energy Bias' or a 'Health Bias' depending on the prevailing environment. The challenge is finding a happy medium that balances health and energy consumption imperatives and delivers great IAQ results.

Changing the way we think

To improve IAQ in a scalable way, and allow our buildings to meet their purpose well, requires a shift in mindset. It is relatively simple; but it takes a commitment to making changes and sticking with them.

The steps are simple. First we need to measure what we are trying to manage. Then we need to automate responses to that data, in real time, so action happens quickly and effectively. This can be achieved most easily via a Building Management System.

The next step is to record and publicly share the results, ideally using a recognised measurement and certification system. This helps to create an environment of accountability and compliance, where IAQ is valued by building owners, managers and occupants.

Ultimately, it comes down to priorities. Over the past decade, Green building standards have made significant progress. However in many countries, including New Zealand, strategies to enhance human health in buildings have not advanced at the same pace. If organisations are serious about making their people their first priority, improving IAQ needs to be on their radar, and they need to understand its importance within a business-focused framework — it's about achieving the balance between productivity, wellbeing and energy consumption.

Education is needed to improve awareness and understanding of IAQ. The Environmental Protection Department in Hong Kong introduced their voluntary IAQ Certification Scheme in 2000., updating the scheme in 2019. Their approach is inclusive and is aiming to educate from an early age with an interactive, kid friendly version available. It's a smart, sustainable and long sighted approach.

Certifications also help embed awareness and compliance. There are various building health and wellbeing certification programmes who have made their platforms available internationally.

The COVID-19 pandemic has put a spotlight on worker wellbeing in shared environments. For facility managers, IAQ is no longer a niche conversation — it's central to creating fit-for-purpose buildings. Air quality shouldn't hold back your efforts to do better for business, for people and for the planet.

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