BCO

British Council for Offices
November 2018

IMPROVING PRODUCTIVITY IN THE WORKPLACE

Lessons learnt and insights from the Whole Life Performance Plus project

OXFORD BROOKES UNIVERSITY

LCMB

CONSTRUCTING EXCELLENCE
delivered with bre

ABOUT THE BCO

The BCO is the UK's leading forum for the discussion and debate of issues affecting the office sector. Established in 1990, its membership base comprises organisations involved in creating, acquiring or occupying office space, including architects, lawyers, surveyors, financial institutions and public agencies.

The BCO recognises that offices don't just house companies, they hold people and so what goes on inside them is paramount to workplace wellbeing.

ABOUT CONSTRUCTING EXCELLENCE

Constructing Excellence is a cross-sector, cross-supply-chain, member-led organisation operating for the good of industry and stakeholders, and it aims to produce a better built environment.

It is a long-term advocate of a 'whole life value' rather than 'lowest capex' or, worse, 'lowest tender price' approach to construction, notwithstanding that budget constraints may apply. We hope this project will add weight to that.

ACKNOWLEDGEMENTS

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Engineering and Physical Sciences Research Council

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ABOUT THE AUTHORS

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Tom Cudmore is a senior consultant with LCMB. Tom has experience in both employee wellbeing and building operations, having delivered nationwide workplace health initiatives and building optimisation projects in a number of high-profile companies.

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FOREWORDS

In today's changing commercial environment and rapid globalisation, we see companies increasingly concerned with competitive edge, exceptional performance and sustainable profits. We believe this is very tough to achieve without healthy, engaged and productive staff.

BCO is exploring these themes through a series of initiatives on how health, wellbeing and productivity benefits the whole organisation. For instance, the recent BCO report *Wellness Matters: Health and Wellbeing in Offices and What to do About it* explains why health and wellbeing must be a primary ingredient throughout the design, construction and occupation stages of new-building delivery, or existing building refurbishment cycles.

We were therefore delighted to be given the opportunity to participate in this ground-breaking project, co-led by LCMB Building Performance Ltd and Oxford Brookes University, supported by Innovate UK and EPSRC, alongside a host of leading organisations.

> "The environment we create affects people physically, mentally and socially and hence the built asset value."

We all know that people's wellbeing and performance is affected by various environmental conditions, but we haven't known to what extent. The Whole Life Performance Plus project (WLP+) explores this in three very different buildings.

The project discovered that the internal environment was undermining productivity in all three buildings surveyed – this is particularly surprising, as these buildings house globally admired organisations. However, this is a fairly common finding in many buildings that are surveyed, which suggests we need to change our approach to ensure health and wellbeing are primary design objectives.

We also gained some valuable insights, such as how the low humidity levels we often experience in offices increase the risk of respiratory illnesses and hence work absenteeism.

At a practical level, the project found that intelligent building management systems are often limited and are unable to provide the granular data we need to measure building and human performance in offices.

This work marks an important step in deepening our understanding of how people and buildings interact. The project is important in another respect, as it shows how effective collaborative work between practice and academia can be.

It is now certain that the environment we create affects people physically, mentally and socially, which in turn has an impact on the built asset value.

This is an evolving field, and there is a need to continue this journey as our knowledge from the health and wellbeing disciplines increases. ■

Professor Derek Clements-Croome
BCO Research Committee

Constructing Excellence has been researching the impact of the built environment on organisational performance and value since its earliest days. Its aim is to ensure that the real estate delivered by the construction industry benefits society, organisations and the individual.

Its publications include *Be Valuable: A Guide To Creating Value in the Built Environment* (2005) and *Delivering Built Asset Operational Excellence* (2016), which summarise lessons learnt from clients and their supply chains across the retail, education, healthcare, industrial, infrastructure and commercial sectors.

The next logical step for the organisation was to research the impact of the indoor environment on workplace performance, productivity and wellbeing.

> "The most comprehensive study of the impact of the indoor environment on workplace performance in the real world and we are proud contributors."

I believe that WLP+, which is co-led by LCMB Building Performance Ltd and Oxford Brookes University, is the most comprehensive study of the impact of the indoor environment on workplace performance in the real world, and Constructing Excellence is a proud contributor.

This research proves that workplaces which are optimised for indoor environmental conditions enable workers to perform at higher levels.

It demonstrates a route for organisations to use their built assets and workplaces to enhance their performance and that of the UK.

I look forward to working with Constructing Excellence members and the construction industry to implement the findings of this work, and would like to thank all the consortium partners for their input to this important project. ■

Don Ward
Chief Executive, Constructing Excellence

EXECUTIVE SUMMARY

We all instinctively know that poor indoor environmental conditions lead to dissatisfied, unproductive and unwell building occupants. However, until now the relationship between indoor environmental conditions and productivity has not been measured, or even defined, outside the laboratory.

The main objective of the Whole Life Performance Plus (WLP+) project is to gain an empirical, evidence-based understanding of how to optimise working conditions and improve the building user experience, performance and productivity in the real world.

The WLP+ project was carried out between February 2016 and October 2018, undertaking monitoring of the indoor environments and workplace performance baseline and intervention evaluations in case study buildings.

This report summarises the end of project findings, with an interpretation of what the findings mean for improving workplace productivity.

Further findings will be released in due course through consortium partners and academic publications.

KEY PROJECT FINDINGS

The WLP+ project demonstrates and proves that optimising the indoor environment will allow workers to perform at increased cognitive capability, speed and accuracy of work and output.

Harnessed in the right way, businesses can convert this increased output into company-wide productivity, competitiveness, resource utilisation (both human and real-estate assets), return on investment and improved bottom lines.

This conclusion, combined with the fact that every building that was reviewed could be optimised, provides a strong investment case for organisations to review and improve the indoor environmental conditions in all existing buildings and for optimising the indoor environmental conditions in new, existing or refurbished workplaces.

The main findings of the project were:

- Workplace performance is both positively and negatively impacted by the indoor environmental conditions, particularly temperature and carbon dioxide (CO_2) levels. Optimising the indoor environment leads to improvements in staff cognitive capability, speed and accuracy of work and output. The conclusion is that optimising the indoor environment in both existing and new buildings will enhance workplace performance and productivity.
- Existing building management systems (BMS) and heating, ventilation and air-conditioning (HVAC) solutions are typically not sufficiently flexible or granular to optimise workplace indoor environmental performance.
- A more granular examination of the indoor environment will identify flaws and issues within the workplace. Using this approach, hidden performance issues were uncovered within the HVAC, BMS and mechanical and electrical infrastructure of the case study buildings.
- When people feel comfortable, they perform better. Perceived overall comfort has a positive correlation with perceived change in productivity, and an occupant's willingness to tolerate certain indoor environmental conditions appears to be influenced by their workplace experience and expectation.
- Occupants can also become more accepting of poor indoor environmental conditions, which are suboptimal for their performance, where people have grown used to suboptimal conditions over time. Analysing existing workplace indoor environments will help identify this untapped potential for performance improvement.
- Organisations struggle to define, measure and track productivity. However, those organisations that optimise their workplace indoor environments will create the potential to improve their staff performance and productivity.

PROJECT PARTICIPANTS

Building performance consultants LCMB co-led the project with academic lead partner Oxford Brookes University. The project team worked with a consortium of industry partners, including King's College London, EMCOR UK and Argent.

Oxford Brookes University led the research programme to empirically investigate the link between the indoor environment and productivity. Thanks to this empirical data it is now possible to calibrate and maintain building systems to deliver the most productive environments possible, which ultimately delivers greater return on investment for business owners and operators.

The project consortium members have developed an approach and methodology for optimising indoor environmental conditions and workplace performance. This methodology can now be used to support the business case for implementing improvements in existing and new buildings based on the learning from this project.

The project team hopes the project findings and the accompanying report will help organisations to improve new and existing workplace performance and productivity by drawing more attention to the impact that the design and optimisation of the indoor environment can have on performance and productivity. ■

Professor Rajat Gupta BArch MSc PhD FRSA

Professor of Sustainable Architecture and Climate Change, Director of the Oxford Institute for Sustainable Development (OISD), Oxford Brookes University

John O'Brien BSc (Hons), Dip. Eng., Dip. M., MBA, FLSi, FRSA

Founder and Managing Director, LCMB Building Performance Ltd

THE IMPACT OF WORKPLACE ON WORKER PERFORMANCE AND PRODUCTIVITY

THE UK'S PRODUCTIVITY PROBLEM

Worker productivity is fundamental for our economic health. Research by the Office for National Statistics (ONS)[1] has identified that productivity is an issue for the UK (Figure 1). In fact the UK is doing much worse than all but one of the G7 countries. The average UK worker is 36% less productive than a German worker and 30% less productive than a French worker on a GDP per hour worked. To put that into perspective, the average German worker could effectively take a third of their work days off and still produce more than their UK counterpart.

Workplace attendance is also low: UK companies lose 10% of working days a year to absenteeism[2] or presenteeism.[3] That's more than a month in which UK businesses are effectively closing their doors.

The salary cost of staff in office buildings can exceed energy and maintenance costs by 40 times and capital cost by almost 200 times annually. On this basis, the economic potential for performance improvement is enormous.

This productivity gap is one of the biggest roadblocks to the UK's prosperity, but efforts to close this gap have failed so far, with the UK struggling to keep up with productivity growth trends since the 2007 financial crisis. Low productivity is seen to be caused by both economic and individual factors. The common economic reasons given for the UK's low productivity are:

- companies have invested too little
- productivity is measured and tracked in the wrong way
- low growth and profitability rates are sustaining zombie companies
- businesses hold on to unproductive processes and workers.

Some human factors that have a bearing on productivity include:

- stress
- workplace politics
- management effectiveness
- remuneration
- health
- comfort.

Organisations launch countless initiatives to track and improve staff output, but sadly many of them are ineffective.

Naturally the UK wouldn't have a productivity gap if the problem were easy to solve. However, despite best efforts, there are no commonly recognised approaches or initiatives that measurably transform staff productivity in the long term.

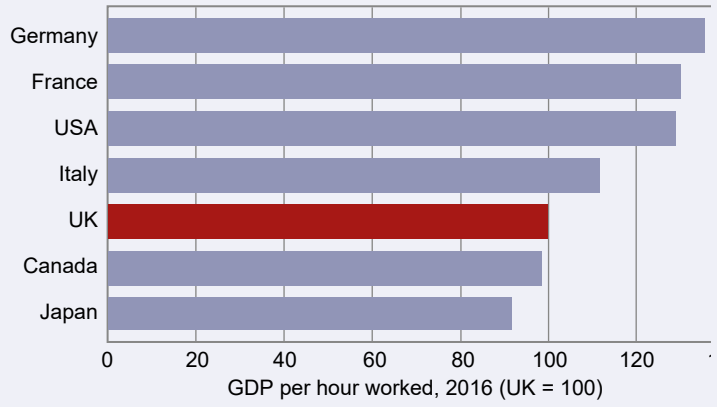


Figure 1
The UK's productivity is poor relative to most other G7 countries
ONS, 2016

PRODUCTIVITY AND BUILDINGS

Facilities managers know that the indoor environmental conditions are important for comfort and health, but workplaces struggle to provide the optimal conditions that allow for comfort, health *and* productivity. The World Green Building Council (WGBC) highlighted a lack of consideration for the indoor environmental quality in building design and operation, despite evidence of productivity improvements of 8–11% as a result of improved air quality alone.

The WLP+ project and consortium set out to solve the problem of productivity at its roots. The big question that was asked is:

> *Can the productivity problem be solved by improving the workplace environment?*

Over the course of three years, an abundance of laboratory data was found that demonstrates how the indoor environmental quality affects productivity. Temperature, humidity, light, space, noise, CO_2 and volatile organic compounds (VOCs)

1. International comparisons of UK productivity (ICP), final estimates: 2016, ONS.
2. Absenteeism is unplanned absences.
3. Presenteeism, or people coming into work when they are ill, can cause productivity loss, poor health, exhaustion and workplace health epidemics.

(among other factors) alter people's motivation, cognitive capability, productivity and wellbeing.

The data also show what the optimal levels are. When these metrics were applied to the real world, a profusion of workplace environments were found that fell well short of optimum levels for human performance.

The next stage of the project was to gain a deep understanding of the impact of the indoor environmental conditions on worker performance and productivity in representative samples of UK buildings, which included:

- an older building with aged and inflexible infrastructure
- a newer building with infrastructure representative of the bulk of UK workplaces
- an ultra-modern building occupied in the last 18 months, that was designed, built and certified to a BREEAM Outstanding rating.

The buildings also represented the typical UK model of ownership and operation:

- an owner-occupied building
- a tenanted building operated by a facilities management company
- a landlord tenant operated building – the shell and core services designed, delivered and maintained by the landlord, with the tenant taking responsibility for the workplace itself.

A two-phase approach was devised to learn how the indoor environmental conditions can impact people's performance and productivity.

1. a baseline indoor environment/performance level was created for each building in the study
2. a number of indoor environment interventions were tested to monitor how varying the indoor environmental conditions affect the building users.

A measure of the success of the project is that since October's project close, consortium members are extending the approach in order to improve performance in existing and new workplaces.

The purpose of this report is to:

- summarise and share project insights
- help organisations optimise the performance of their workplaces and buildings, as it was found that focusing on the indoor environment typically identifies building cost, energy and carbon savings
- help organisations to get the best out of their most expensive and costly assets – their people. ■

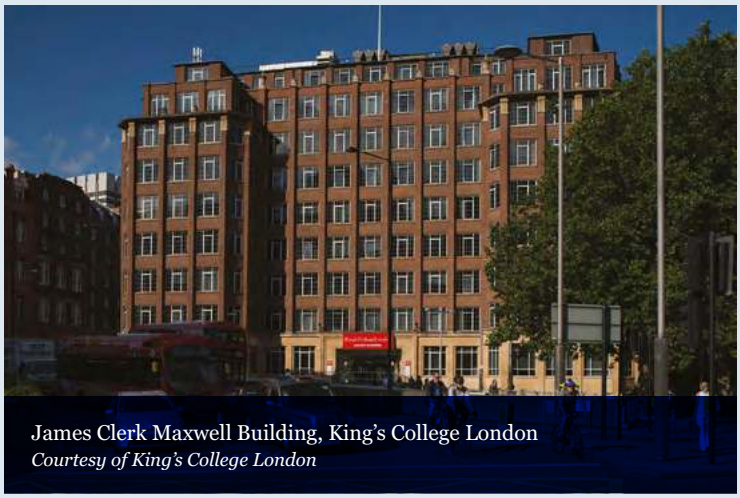
WORKPLACE PERFORMANCE AND PRODUCTIVITY IN THE REAL WORLD

Consortium partners King's College London, EMCOR UK and Argent each selected a building for investigation. In order to make the results as relevant as possible for the widest range of organisations, buildings selected were from a range of ages, sophistication and owner/operator models. The King's and EMCOR UK case study buildings were used to investigate indoor environmental conditions and workplace productivity, and the Argent building was used to investigate the value of implementing the insights gained from the King's and EMCOR UK case studies.

CASE STUDY

King's College London

The owner occupier case study



James Clerk Maxwell Building, King's College London
Courtesy of King's College London

Occupier:
King's College London

Size:
10,800 m²

Business:
Education

Occupants:
1,200

Location:
Waterloo, London

Ventilation:
Mixed mode

Constructed:
1938

Facilities management:
King's Estates

King's College London is one of the world's leading universities and has several campus locations across London. The research took place in the main administrative building, chosen because the level of occupancy is more consistent than in other parts of the estate. The environment is characteristic of a large proportion of UK office space, with high occupant density, and ageing heating, ventilation and air-conditioning systems.

APPROACH

As one of the core WLP+ research cases, an intervention and a control area were required. Monitoring was set up in two segregated spaces on floor 7 of the building. A six-month baseline period was completed first, which included indoor environment monitoring, Building Use Studies (BUS) employee occupant satisfaction evaluation surveys and performance tests of staff. These were undertaken in both the test and control spaces. Following the baseline, two interventions were completed, the first controlling the amount of fresh air on the floor, the second adjusting the temperature.

RESULTS

Results from the intervention study are summarised on page 12. In addition, there were several outcomes that provide important lessons. Some examples include the following:

- Occupants' willingness to tolerate certain indoor environmental conditions appears to be influenced by experience and expectation. Workers at King's were frequently exposed to high temperatures (>26°C) and a wide variation in room temperature between seasons. However, this was generally accepted. In other organisations, where tight control of temperature was normal, a variation of just 1°C from baseline was not tolerated by staff.
- People do not easily perceive changes in CO_2 level, but their performance is very sensitive to such changes. This means that if CO_2 levels are not measured it may never be possible to discover that workplace indoor environmental conditions are undermining performance and productivity. At King's, the building central air-handling system has insufficient capacity, with the building now accommodating 2–3 times more occupants than it was originally designed for. As the system can't provide sufficient fresh air, the CO_2 in the space is directly related to the number of windows that are opened, which in turn is influenced by the air temperature. This means that, in colder weather, the occupants have a choice of either cold draughts or poor air quality, and as people are more sensitive to draughts, the windows are shut and CO_2 regularly reaches in excess of 2,000 ppm. Most current standards recommend targets of 800–1,200 ppm for CO_2 in modern workplaces.
- In older buildings with limited BMS capability, upgrades to systems are expensive, making it difficult to build an investment case. There needs to be alternative cost-effective solutions to these issues. In the case study, it was demonstrated that simple monitoring of the indoor environment linked to supplementary ventilation can cost-effectively lower CO_2 from >2000 ppm to <1,000 ppm. Reducing CO_2 from these high to moderate levels leads to a significant improvement in staff performance. This demonstrates that the addition of supplementary systems can be more effective and less costly than upgrades to an existing system.

CASE STUDY

EMCOR UK and NATS

The facilities management case study

The NATS Corporate and Technical Centre
Courtesy of NATS

Occupier:
NATS

Size:
25,000 m²

Business:
Air traffic control

Occupants:
1,300

Location:
Fareham, Hampshire

Ventilation:
Mechanical

Constructed:
2004

Facilities management:
EMCOR UK

EMCOR UK has been providing a total facilities management solution for NATS since 2003. NATS provides air traffic control services across the UK and beyond, with its stated purpose to 'keep the skies safe'. Its performance-focused approach extends to everything it does, and involvement in the WLP+ project was a natural fit for its interest in improving human performance. The project builds on previous work with EMCOR UK to continuously improve its service and to ensure that NATS continues to be recognised as a leader in its industry.

APPROACH

The research methodology developed for King's was replicated at this second test site. The study took place in the administrative areas of the building, which are mechanically ventilated and controlled using a BMS set-up that is typical for a building of this type and specification. The plan was to use BMS logs to examine historical indoor environmental conditions, and use the BMS to monitor and control the interventions. On examination, restrictions typical of these systems meant the BMS was of limited value for the trial, and so remote internet-of-things (IoT) monitoring was installed. As with the King's study, data was collected from occupants through surveys and questionnaires in the baseline and intervention phases.

RESULTS

Some valuable and practical lessons were learnt from this unique site with mission-critical aims, including:

- Traditional BMS systems are poorly designed for recording and analysing data. They also typically don't monitor air quality at a sufficient level of granularity to deal with fluctuations across a floor area. In all the trials, significant variations were observed in CO_2 concentrations across floor areas. However, in all instances the BMS was taking aggregated CO_2 readings from the combined extract air, which are of limited value when trying to monitor localised CO_2 concentrations and evaluate their potential effect on users.
- People are less tolerant of temperature variations if they get a high standard of indoor environmental conditions. Building users at NATS are used to having conditions well controlled, and even small changes of 0.5–1°C to the temperature setpoint were picked up in helpdesk reports and staff feedback.
- Typically, there are energy-saving opportunities from optimising and examining indoor environmental control. By way of an example, during the intervention at NATS, a 50% decrease in fan speed resulted in only a very small, and acceptable, increase in CO_2 concentration. This is one illustration of the opportunities for energy reduction that can be realised when the indoor environmental conditions are examined in detail. We found opportunities for low-cost interventions to reduce energy use and/or improve environmental conditions in all the NATS workplaces that were reviewed.

CASE STUDY

Argent and Havas

The landlord/tenant case study

HKS Building, 3 Pancras Square, London
Courtesy of John Sturrock

Occupier:
Havas

Occupants:
1,700

Business:
Media and advertising

Landlord:
Argent LLP

Location:
King's Cross, London

Ventilation:
Mechanical

Constructed:
2016

Facilities management:
In-house

Size:
15,000 m^2

Certified BREEAM rating:
Outstanding

ARGENT

Since 1981, Argent has delivered some of the best mixed-use developments in the UK, including the regeneration of King's Cross, London, Brindley Place, Birmingham, and Piccadilly Place, Manchester. It is involved in the full development and asset management process – from identifying and assembling sites, developing designs and obtaining planning permission through to financing, project management of the construction process, letting, asset management and selling. Argent recognised the WLP+ project as an opportunity to better understand how to deliver the most productive workplace for its tenants and to differentiate its buildings in the market.

hkx

Havas SA is a French multinational advertising and public relations company, headquartered in Paris, France. It operates in more than 100 countries and is one of the largest global advertising and communications groups in the world. Havas consists of three main operational divisions: Havas Creative Group, Havas Media Group, Havas Health & You.

Argent introduced one of its King's Cross tenants, Havas, to the project, to review and optimise its new London headquarters, following a consolidation of 14 offices and 1,660 staff into one building in 2017. This part of the study was designed to examine how viable it is to implement indoor-environment-centric solutions in modern offices, based on the learning from the other two case studies. In addition, it was of interest to hear from Havas and its staff on what benefits the approach can bring to the business.

Havas wants its headquarters to be a source of competitive advantage, by designing a workspace to attract, retain and get the best from its talent. It recognised the WLP+ project as an exciting opportunity to understand how to get the most from the building. Havas used the WLP+ project as the basis of its post-occupancy evaluation.

APPROACH

Indoor environment data was collected using IoT devices across an area covering three floors and 500 workstations. Occupant feedback was collected via interviews with team managers, and a staff survey. A review of the building plant and operations was also conducted. Data was collected over a six-month period spanning three seasons (winter, spring and summer).

RESULTS

The indoor environmental data from the building showed a well-controlled environment with consistent temperatures across the building and minimal seasonal variation. However, relative humidity (RH) showed greater seasonal variation, and the CO_2 level showed more location variability across the workspaces. Based on what we know about indoor environmental conditions, productivity and wellbeing, several opportunities were identified for further optimisation, including:

- RH was below levels recommended by the Chartered Institution of Building Services Engineers (CIBSE) (>40%) and the International WELL Building Institute (IWBI) WELL Standard (>30%) for significant periods of time. Previous research[4] has shown that low RH causes skin dryness and is linked with an increased risk of colds and flu, which in turn leads to associated increases in staff absenteeism.
- CO_2 was always within CIBSE guidelines and rarely exceeded 1,200 ppm, comfortably meeting the design specification. For a significant period of time the CO_2 level was 1,000–1,200 ppm in areas with a high occupant density. The research suggests that in these spaces productivity gains could be achieved by keeping CO_2 below 1,000 ppm through better zonal control.
- As with many open plan office environments, noise can be an issue. Data collected from surveys and interviews showed this to be the case for some staff. Although noise data can be collected via decibel ratings, it is not possible to distinguish between noise type or detect the noise differences that very small changes to a location can make. Staff feedback was useful in helping to identify a suitable solution.
- The review of the indoor environment data identified several potential changes to the BMS and control of the plant and equipment that will reduce energy use and operational costs.

4. M. Sato, S. Fukayo and E. Yano (2003) Adverse environmental health effects of ultra-low relative humidity indoor air. *Journal of Occupational Health* 45(2): 133–136.

WHOLE LIFE PERFORMANCE PLUS (WLP+): PROJECT OVERVIEW

EVIDENCE TO DATE FROM A REVIEW OF THE LITERATURE

The European standard EN 15251 (BSI, 2007) acknowledges that the indoor environment affects occupant productivity, health and comfort. Recommended limits are therefore set for optimum performance. Negative factors in relation to productivity are often more obvious than positive factors: an environment that is too hot, too cold or too noisy can be uncomfortable or distracting to work in, but finding the optimal level of indoor environment parameters where productivity begins to increase is more challenging (Gupta and Howard, 2018a). Recent studies have sought to develop an understanding of the relationship between indoor environment and workplace productivity, although most are conducted in climate chambers that create artificial environments.

The effect of temperature on health and comfort has been widely researched, and temperature is broadly recognised to be an important indoor environment factor. In a survey conducted by the BCO (2018), one in six respondents perceived that their workplace had a negative impact on their health and wellbeing. For naturally ventilated buildings, comfortable indoor temperature is dependent on outdoor temperature. It is found that indoor temperature significantly influences workers' productivity in the recommended ventilation rate range (Tham, 2004). Fang et al. (2004) identified a link between temperature, RH and performance at different ventilation rates. Lan et al. (2011) found that performance on all tasks (with the exception of text typing) decreased in warmer conditions. The results from this study imply that optimum thermal comfort and optimum productivity may not occur at the same temperatures. Seppänen et al.'s (2006) meta-analysis suggested that the temperature range for optimum performance is close to the optimum range for comfort, particularly for mechanically ventilated buildings in winter. In free-running buildings there was a bigger difference between optimal temperatures for comfort and performance. A 2% decrease in productivity for going 1°C beyond the optimal range will have significant cost implications for the organisation (Gupta and Howard, 2018b).

A peak indoor CO_2 concentration of 1,500 ppm is specified for office spaces in order to maintain comfort air quality. In studies by Allen et al. (2015), Satish et al. (2012) and Kajtar et al. (2003), performance was found to decrease as CO_2 concentration increased. These studies indicate that everyday CO_2 levels within the current recommended standards could have significant negative impacts on worker performance (Gupta and Howard, 2018c).

More recently, Innovate UK's national research programme on building performance evaluation undertook case study investigations of 50 low-energy non-domestic buildings located across the UK, measuring the performance of building fabric, energy consumption, environmental conditions and occupant satisfaction. Meta-analysis of the surveys showed that occupant surveys in 12 out of the 21 workspaces reported an increase in perceived productivity due to the environmental conditions perceived by the occupants (Gupta et al., 2016).

The meta-study found that when occupants were satisfied with the indoor temperature, noise, lighting and building-related features, perceived productivity increased. Conversely, when indoor air was perceived as stuffy and smelly, perceived productivity decreased (Gupta et al., 2018).

It is evident that there is growing recognition of some kind of a link between indoor environment and perceived productivity in workplaces. The WLP+ project sought to empirically quantify this link between indoor environment, thermal comfort, and perceived and measured productivity.

METHODOLOGY

The two case-study buildings selected for the project interventions were the James Clarke Maxwell Building (JCMB) at King's College London and the Whitely offices of NATS.

The methodology adopted in the study had a predominantly three-pronged approach:

- physical monitoring of the indoor and outdoor environment, using data loggers
- occupants' perception of their indoor environment and productivity, through transverse and longitudinal surveys
- measured productivity, using performance tasks as a proxy.

Additional business output metrics (calls made, emails sent) and human resources data (absenteeism) were also collected. Figure 2 illustrates the methodological approach adopted in the project.

Continuous physical monitoring was implemented over a period of approximately 19 months, from March 2017 to September 2018. Indoor environmental parameters

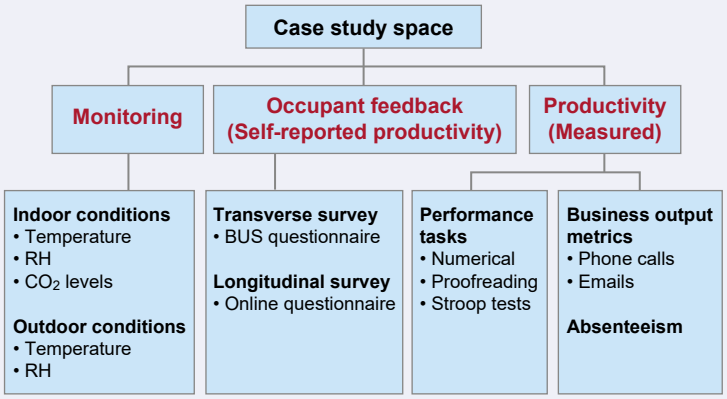


Figure 2
Methodology

(temperature, RH and CO_2 level) and outdoor environmental parameters (temperature and RH) were recorded at different locations around the case study offices (6 zones in JCMB, 20 zones in NATS), allowing localised conditions to be monitored and cross-related to individual occupants.

The Building Use Studies (BUS) survey provided an overview of occupants' perception of their working environment (BUS Methodology, 2018). A total of 99 surveys were received from JCMB (a response rate of approximately 80%) and 109 were received from NATS (a response rate of approximately 40%).

An online survey was used to record longitudinal feedback from occupants. The surveys were sent via email three times a day (morning, early afternoon and late afternoon). In total, 3,082 surveys (20% response rate) were completed by occupants at JCMB and 2680 surveys (10% response rate) were completed by occupants at NATS.

Simulated performance tasks provided a proxy measure of productivity. The tasks were designed to represent typical office tasks and consisted of:

- numerical tests – to solve simple mathematical questions
- proofreading – to identify spelling errors in a paragraph of text
- Stroop test – an interference test, differentiating between the colour of the text and the word.

Both the test score and time taken to complete the task were recorded. Tasks were sent via email twice-daily (morning and afternoon). In total, 1,179 tasks (16% response rate) were completed by occupants at JCMB and 1,186 tasks (8% response rate) were completed by occupants at NATS. The distribution of test responses for the two case study buildings is shown in Figure 3.

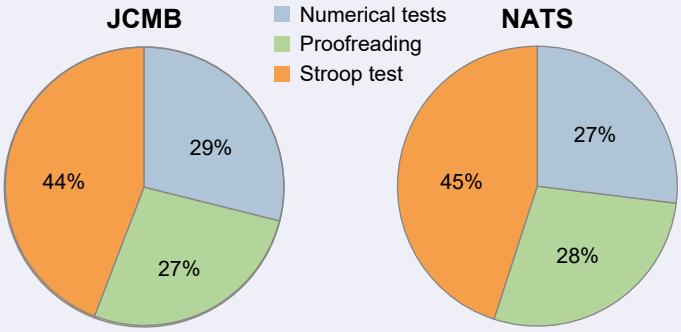


Figure 3
Distribution of tasks by type

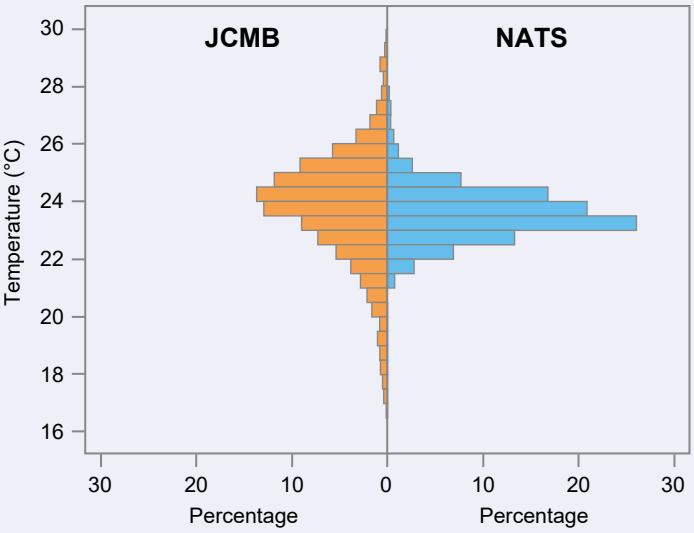


Figure 4
Violin graph showing distribution of indoor temperatures during working hours

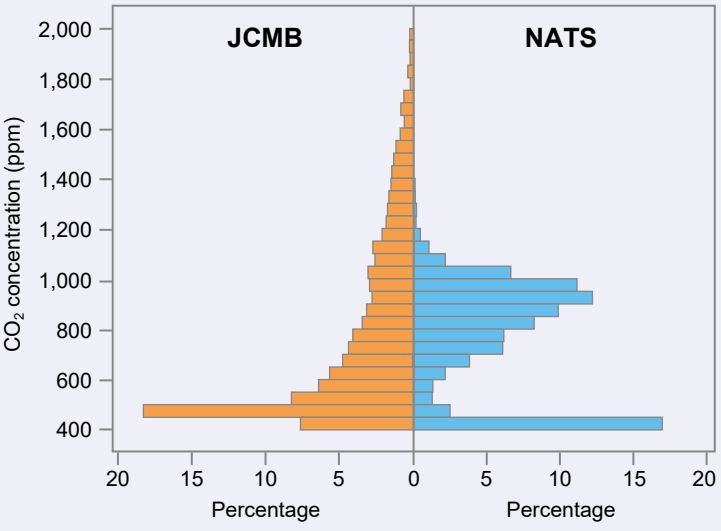


Figure 5
Violin graph showing distribution of indoor CO_2 concentrations during working hours

KEY FINDINGS

INDOOR ENVIRONMENT

The range of temperatures (daily, monthly or seasonally) was significantly greater in JCMB than in NATS. In JCMB, during the heating seasons the indoor temperatures were above the recommended 23°C for 58% of working hours, and during the non-heating seasons the indoor temperatures were above the recommended 24°C for 62% of working hours.

In contrast, in NATS, during the heating seasons the indoor temperatures were above 23°C for 58% of working hours, and during the non-heating seasons the indoor temperatures were above 24°C for 39% of working hours. Although both JCMB and NATS had the same proportion of working hours above 23°C in the heating seasons, the temperatures in JCMB exceeded this threshold much further than they did in NATS (Figure 4).

There was little seasonal variation in CO_2 concentrations in the mechanically ventilated NATS building. In JCMB, almost 20% of working hours were spent at CO_2 concentrations over 1,400 ppm during the heating seasons. However, in the non-heating seasons, when windows in JCMB were often open, the CO_2 concentrations dropped below the comparable levels in the NATS building, and less than 3% of working hours in JCMB were spent at CO_2 concentrations over 1,400 ppm (Figure 5).

PERCEIVED PRODUCTIVITY – SURVEYS

The strongest correlations with perceived change in productivity was found to be occupants' overall comfort rating (Figure 6). When occupants rated their comfort from 5 to 7, they perceived their productivity to be slightly increased. An overall comfort score of 4 or lower corresponded to occupants perceiving their productivity to be decreased (JCMB, n = 3,082; NATS, n = 2,680).

Occupants were asked to rate their thermal sensation (on a scale of 1–7) and their thermal preference (on a scale of 1–5). The results were plotted against occupants' perceived change in productivity (Figure 7). Again, the two case studies produced very similar results: when occupants felt cool (1–2 on the response scale) or warm (6–7 on the response scale), they perceived their productivity to be negatively affected (JCMB, n = 3,082; NATS, n = 2,680). Similarly, when occupants expressed a desire to be warmer or cooler than their current condition, they also perceived their productivity to be negatively affected (JCMB, n = 3,082; NATS, n = 2,680).

Comparing occupants' perception of the air quality (on a scale from 1 (fresh) to 7 (stuffy)) with their perceived change in productivity indicated that when occupants perceived the air to be fresher, they perceived their productivity to be increased, and when they perceived the air to be stuffier, they perceived their productivity to be decreased.

Although these trends were similar in the two case studies, it is worth noting that the occupants did have different tolerances to the actual temperatures within their workplace. Plotting thermal sensation votes against measured indoor temperatures showed a wide spread of results, indicating that thermal sensation and preference is subjective: at the same temperature, one person may feel too hot, another too cold, and another just right. The mean thermal comfort vote of 4 (comfortable) corresponded to a higher temperature in JCMB than in NATS, suggesting a role of adaptation.

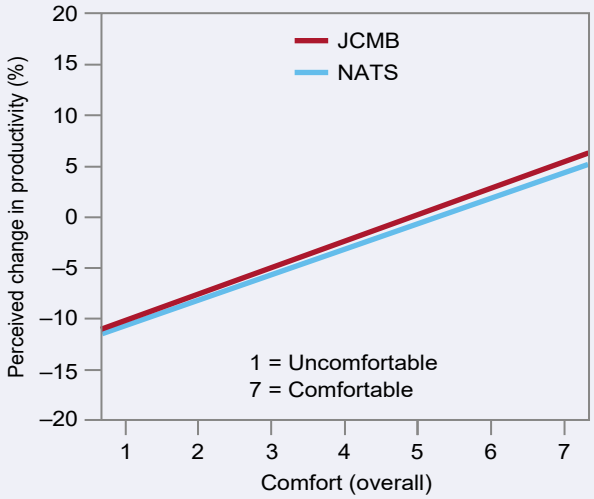


Figure 6
Relationship between occupants' perception of comfort overall and their perceived change in productivity

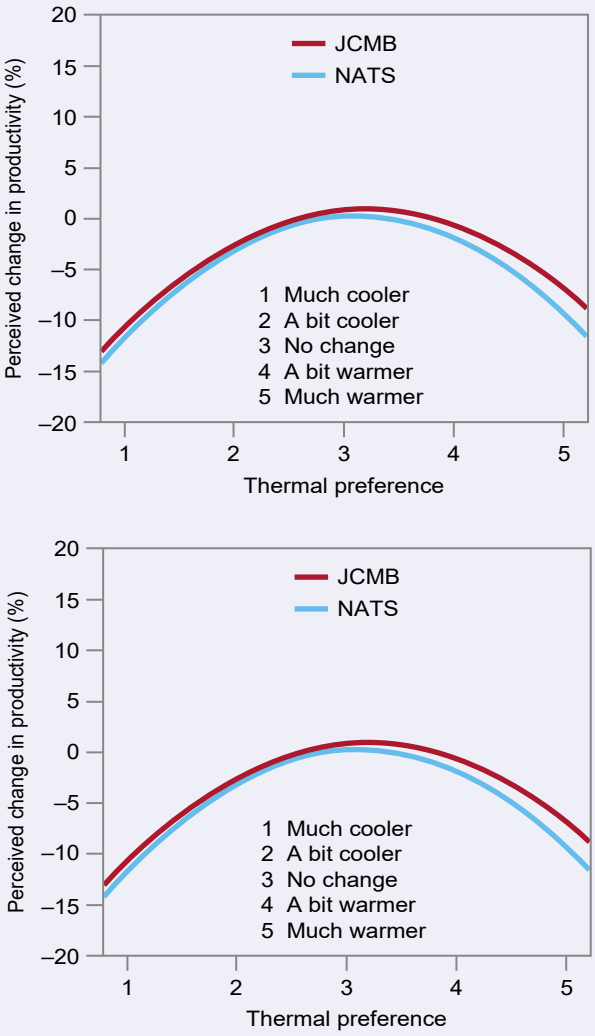


Figure 7
Perceived change in productivity plotted against occupant thermal sensation and thermal preference

MEASURED PRODUCTIVITY: TASK PERFORMANCE

In JCMB, during the CO_2 intervention (conducted from February to April 2018), the distribution of test scores was significantly different when CO_2 concentrations exceeded 1,400 ppm (Figure 8).[5] The median score when CO_2 concentrations were below 1,400 ppm was 96% (n = 308), compared with 90% when CO_2 concentrations were above 1,400 ppm (n = 34). A subset of this group, the proofreading tasks, had median scores of 79% when CO_2 concentrations were below 1,400 ppm (n = 77) and 67% when CO_2 concentrations were above 1,400 ppm (n = 16).

Proofreading tasks were also seen to be correlated with the CO_2 concentration in the validation period in JCMB (Figure 9). Test scores decreased as CO_2 concentrations increased (n = 14), and test durations increased as CO_2 concentrations increased (n = 14).

In the temperature intervention (October to November 2017) in NATS, numerical test scores and test durations showed significant differences when CO_2 concentrations were above or below 1,000 ppm (Figure 10). Below 1,000 ppm the median score was 92% (n = 25), compared with 80% (n = 8) when CO_2 concentrations were above 1,000 ppm. Below 1,000 ppm, the tests took a mean of 8.2 minutes to complete, compared with 13.3 minutes when CO_2 concentrations were above 1,000 ppm.

This CO_2 concentration threshold was significantly lower in NATS than in JCMB, again evidence of the role of adaptation in the occupants' perception and experience of their environment. Occupants in JCMB experienced much higher levels of CO_2, particularly during the heating seasons, and the detrimental effects of high CO_2 concentrations were not seen until levels exceeded 1,400 ppm. In contrast, NATS occupants were used to much lower CO_2 concentrations, so levels only had to exceed 1,000 ppm for negative effects to become evident.

High temperatures were also found to have a detrimental effect on performance, leading to lower proofreading scores in the first intervention in JCMB and lower numerical and proofreading scores in the second intervention in JCMB, which was conducted during the heatwave of July 2018 and

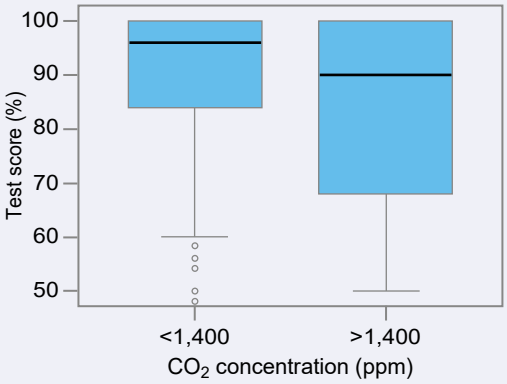


Figure 8
Box plots showing distribution of test scores when concurrent CO_2 concentrations were below and above 1,400 ppm, for all tests in JCMB during the CO_2 intervention

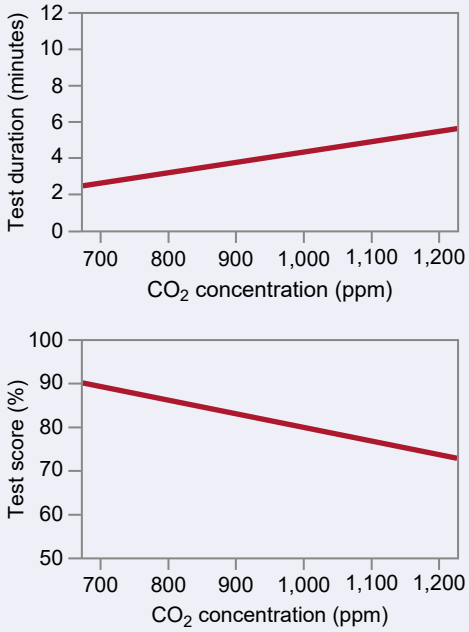


Figure 9
Correlations of test score and test duration with concurrent CO_2 concentrations for proofreading tasks completed during the validation period in JCMB

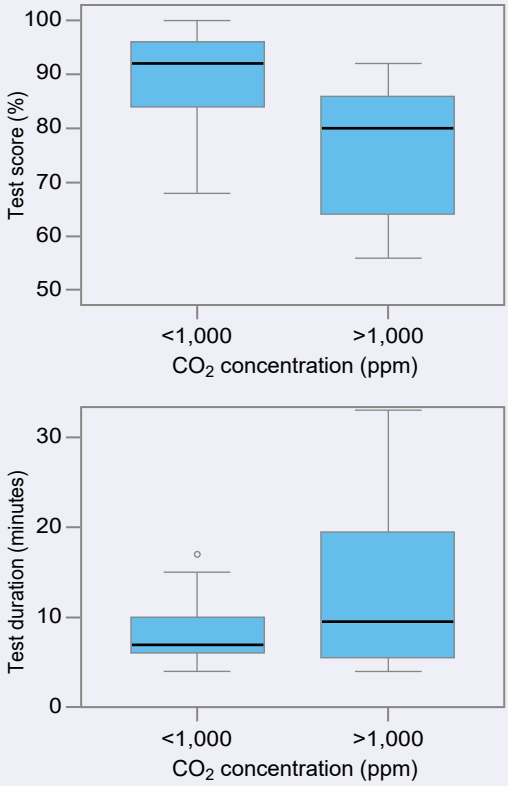


Figure 10
Box plots showing the distribution of test scores and test durations when concurrent CO_2 concentrations were below and above 1,000 ppm, for numerical tests in NATS during the temperature intervention

5. The 'box' of the boxplot encompasses the lower and upper quartiles, the horizontal line within the box shows the median, and the lines (whiskers) above and below the boxes show the extent of results above and below the middle 50% that are not considered outliers.

saw indoor temperatures exceed 29°C during working hours. Numerical test durations also increased with temperature during the second intervention and validation periods in JCMB.

The business output metrics that were available for JCMB (the number of emails sent in a day and the number of phone calls made in a week) did not provide any useful findings. Temperatures, RH levels and CO_2 concentrations varied so much over the course of a day and a week that the resolution of these data sets was not high enough to detect any meaningful correlations.

CONCLUSIONS

Occupants' perception of their environment matters for improving productivity

- There is a clear link between occupants' perception of their environment and their perceived productivity. When they felt too warm or too cold, they perceived their productivity to be negatively affected. When they perceived the air to be stuffy, they also perceived their productivity to be negatively affected.
- The relationship between perceived productivity and indoor environment was prevalent in both case studies, despite the differences in the ages of the buildings and the types of ventilation system (natural or mechanical).

Task performance is affected by indoor environmental conditions such as temperature, relative humidity and and CO_2 concentration

- Task performance can be considered as a proxy measurement for productivity. Performance was found to be negatively affected by high temperatures (particularly over 26°C during the non-heating season). low RH (particularly below 40%) and high CO_2 concentration (particularly above 1000 ppm).
- The design of the tasks was challenging. The most popular task was the Stroop test, perhaps because it took much less time to complete than the others and respondents could also score much higher. However, this meant that there was a very narrow distribution of test durations and test scores, and no meaningful cross-relations could be found. The numerical and proofreading tasks gave a spread of results closer to a normal distribution, but the tasks were less popular with respondents.

For business output metrics to be usable as a measure of productivity, the data sets need to have higher resolution spatially and temporally

- Business output metrics and absenteeism data proved difficult to obtain. Organisations may be reluctant to share information that may be considered sensitive for evaluating workplace productivity.
- The data need to have better spatial and temporal resolutions. Indoor environment is dynamic and varied greatly over the case study workspaces and over the days and weeks when the business outputs and absentee data were measured.

Perceived productivity and task performance offer complementary approaches in defining the link between the indoor environment and workplace productivity

- Measurement of perceived indoor environment and productivity helped to identify if there was a link between them, and task performance helped to define the threshold beyond which worker performance deceased.
- Statistical links between perceived productivity and perceptions of the indoor environment provided by the surveys were stronger than links between measured productivity (using task scores and task durations as a proxy) and measured indoor environment. Response rates for the surveys were also greater than for the tasks. However, both data sets are necessary to provide a complete understanding of the link between indoor environment and workplace productivity. ■

LESSONS LEARNT AND INSIGHTS

LESSONS LEARNT

Previous research, typically carried out in climate chambers, demonstrates how indoor environmental quality significantly impacts people's productivity. The research proves that variables such as temperature, CO_2, VOCs, noise and light have an impact on worker performance, productivity and wellbeing. The findings are powerful, but, because the results were generated within controlled environments, it was difficult to prove that the findings applied equally to the real world.

The WLP+ project took the insights gained in controlled environments and tested them in the real working world. The result is that we now know that indoor environmental conditions do indeed have an impact in the real workplace. The project shows that worker performance declines in indoor environments with higher levels of CO_2 and temperatures that are too warm or too cool for workers.

We also found that workplaces designed to achieve a standard setpoint will typically have greater variability around these setpoints across their floors and zones due to the limited number of sensors and controls. This is due to differences between the changing demands of the workplace (movement of people, internal and external gains, etc.) and the ability of the heating, ventilation, air-conditioning and control systems to respond. Interestingly, it was found that the level of variability depended on the age, condition and sophistication of the building's HVAC and control systems.

The following key lessons learnt were identified in the WLP+ project (Figure 11):

- By optimising the indoor environment, workers will perform at a higher level in terms of their cognitive capability and their speed and accuracy of work and output.
- Organisations struggle to define, measure and track productivity. Nevertheless, it was found that improving the working environment goes hand in hand with finding ways to measure productivity in a meaningful way. In other words, organisations that improve workplace environments, also find ways to measure productivity. The end result is that these organisations find empirically improved worker engagement and productivity.
- Existing BMS and HVAC solutions are typically not sufficiently flexible or granular to optimise workplace indoor environmental performance.
- Current IoT technology offers a cost-effective, accurate and granular way to monitor and control workplaces, on a temporary or a permanent basis.
- Examining indoor environmental conditions at a more granular level than the standard building zoning will identify indoor environment issues within the workplace. It will also uncover hidden performance issues within the HVAC, BMS and mechanical and electrical infrastructure.

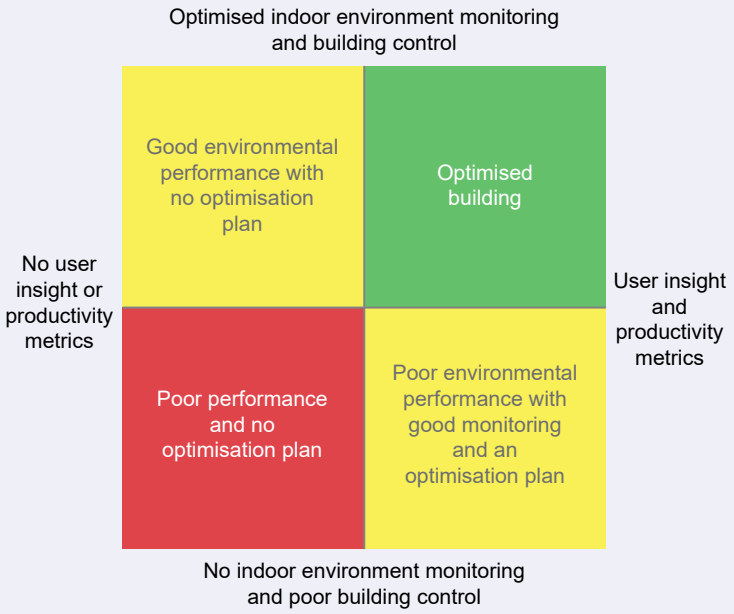


Figure 11
Lessons learnt in the WLP+ project

- Staff can perceive the impact of some indoor environmental variables, such as temperature, on their comfort, performance and productivity, but are much less aware of others, such as the level of CO_2. Levels of CO_2 have a significant impact on worker performance but, despite being relatively straightforward to reset to acceptable levels, they are seldom reviewed on an ongoing basis.
- Every workplace examined in the study had an indoor environment that compromised worker performance and productivity.

The project consortium has concluded, based on the WLP+ project, that there are steps to take in the design and post-occupancy evaluation of new workplaces, to optimise worker performance and productivity.

The consortium has also developed a methodology for measuring and improving the indoor environmental conditions and worker performance and productivity in existing buildings. The methodology identifies, measures and verifies workplace interventions. In addition, it provides business cases based on improved worker performance and productivity.

APPLYING THE INSIGHTS TO IMPROVE WORKPLACE PERFORMANCE AND PRODUCTIVITY

The WLP+ project demonstrates and proves that optimising the indoor environment will allow workers to perform at increased cognitive capability, speed and accuracy of work and output.

Harnessed in the right way, it is up to businesses to convert this increased output into company-wide productivity, competitiveness, resource utilisation (both human and real-estate assets), return on investment and improved bottom lines.

Combine this conclusion with the fact that every building reviewed in the study could be optimised, there is a strong investment case for organisations to review and improve the indoor environmental conditions in all existing buildings and for optimising them in new or refurbished workplaces.

Another consideration is that wearable technology can increasingly be used to measure environmental quality. The rise in popularity of these devices presents some interesting challenges for Chief Operating Officers (COOs) and directors of real estate. It is recommended that COOs should understand the workplace indoor environmental quality before their staff do. This will help avoid the situation of being blindsided by staff querying senior management about data from their wearables. This is a separate complementary area of research for the BCO (see the BCO report *Wearables in the Workplace* (BCO, 2016)).

CREATING A BUSINESS CASE FOR EXISTING BUILDINGS

We recommend using three factors to build a business case:

- the current performance of the workplace indoor environmental conditions
- the potential impact of improved indoor environmental conditions on staff performance and productivity
- the annual cost of staff.

The first source of information on which to build a business case is the existing building management data, if this is available at the right level of detail and frequency. If this doesn't provide sufficient information, it is recommended that indoor environment benchmarking is undertaken using standard instruments or IoT monitoring. The advantage of IoT technology is that it gives near real-time, granular, focused and detailed insight into workplace performance, and can be redeployed quickly based on initial results to offer faster discovery and insight into areas for improvement.

Once it has been evaluated where and how often indoor environmental conditions drift from the optimum, the investment case for interventions can be built based on costs and the value of the improved performance and productivity of staff.

CREATING A BUSINESS CASE FOR NEW BUILDINGS

For new buildings the business case will depend on the marginal cost of granular control, so that HVAC and BMS systems can respond to changing load, in order to maintain ideal indoor environmental conditions.

The marginal cost can be calculated by modelling the performance of the workplace under different scenarios. Then, the net present value of the additional investment can be determined based on the enhanced workplace performance and productivity.

The WLP+ project research and findings also suggest there is value in incorporating indoor environment studies in post-occupancy evaluations of new or refurbished buildings and workplaces. This approach will highlight improvement opportunities, as well as hidden problems, in building systems and infrastructure.

GAUGING PRODUCTIVITY

Gauging productivity is difficult for organisations and will vary depending on the business. As it's so difficult, most organisations do not track and measure productivity, but instead rely on lagging indicators of productivity such as sales, profitability and customer satisfaction.

The project has found that it is up to each organisation to define the measurable output, or the productivity that they require from each category of worker in the workplace. Once collected, productivity data should be overlaid on workplace indoor environment data. This will give organisations a means of establishing a baseline for both the indoor environment and productivity. This baseline can then be used as the yardstick to measure and establish the investment case for workplace changes, by measuring the impact of proposed changes on a sample area before scaling across whole buildings, estates or organisations.

A key takeaway from WLP+ is that the impact on performance and productivity is an important consideration when planning changes to a building or business infrastructure. If the conditions or layout change, then productivity could drop, so a fresh review should be undertaken to ensure that productivity remains close to its full potential.

Real-world studies have shown that a good indoor environment can be the catalyst for businesses to go the extra mile. It was found in this study that problems with humidity, temperature, air quality and noise are the key root causes in instances where a building fails to meet the requirements of its staff.

EVOLVING THE ROLE OF FACILITIES MANAGEMENT

Awareness and education will go a long way to help building managers understand the importance of workplace indoor environmental conditions. The WLP+ research suggests there is an opportunity for human resources and facilities management to work together more closely to understand how their workplaces impact worker performance and productivity, and then create the best working environment for everyone within the business. This is a potential route for facilities management, as a discipline, to deliver more value for organisations, and to raise their status and profile with the c-suite.

POTENTIAL IMPACT FOR ORGANISATIONS

Productivity and comfort go hand in hand. A company seeking to improve the environment of its building for productivity's sake will also create a better more comfortable workplace for its staff. The expected outcomes include:

- lower absenteeism and presenteeism
- better output levels
- increased performance throughout the workplace
- better staff retention rates
- a more cognitively capable and creative workforce.

HIGH POTENTIAL OPPORTUNITIES

Companies can positively influence their output and performance by investing in improving indoor environmental conditions where they have any of the following circumstances:

- High-value staff – staff are expensive to employ, staff retention and recruitment is an issue, staff cognitive capability or creativity is highly important for success.
- Staff output is high risk – staff performance is mission critical or mistakes are very costly.
- Staff must adapt working practices due to limitations of the building and/or environment –staff work around the building or workplace, rather than the workplace working for them. By simply collecting and analysing staff feedback it is possible to pinpoint some of the major factors that may be undermining or blocking staff performance.
- Facilities are expensive to rent or operate – marginal improvements in workplace output will help improve the return on investment from real estate.

If you are interested in learning more about the WLP+ project outcomes and methodologies developed by the consortium, and you would like to implement some of the lessons learnt and insights gained, you can contact the consortium members directly via the information given at the end of the report. ■

CONCLUSION

People are a business' biggest cost, and yet most workplaces aren't optimised to get the best from them.

The Whole Life Performance Plus (WLP+) project has demonstrated that workplace performance is impacted both positively and negatively by indoor environmental conditions.

The project has discovered that by optimising the indoor environmental conditions workers will perform at a higher level, in terms of their cognitive capability, speed and accuracy of work and output.

We believe, based on this project, that there is a compelling business case for optimising the indoor environmental quality in new and existing buildings. ■

APPENDIX
WLP+ OVERVIEW

The WLP+ project is made up of a consortium of leading industry and academic partners.

> "This study brings together social, economic and environmental aspects of building delivery and occupation, and will serve to identify the key components to deliver optimum buildings for employee wellbeing and productivity."
>
> *Argent UK*

The project is supported by Innovate UK and the Engineering and Physical Sciences Research Council (ESPRC).

CONSORTIUM PARTNERS

LCMB Building Performance Ltd
Co-lead of WLP+

LCMB is a building performance and productivity consultancy, making workplaces, buildings and estates support and deliver organisations' aims and strategy, by improving performance and reducing cost.

LCMB co-led the WLP+ project to better understand how the indoor environment can improve workplace performance, productivity and wellbeing.

Thanks to the WLP+ findings, LCMB has developed a workplace performance and productivity measurement and improvement methodology to help organisations improve their resource utilisation and return on investment.

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Oxford Brookes University
Co-lead of WLP+

The Low Carbon Building Research (LCBR) Group at Oxford Brookes University has world-leading expertise in building performance evaluation and post-occupancy feedback. As part of the WLP+ project, the LCBR group has developed innovative methods to measure worker performance and productivity. The group has published a number of research papers on the WLP+ project, that have been presented at national and international conferences such as Indoor Air 2018, Sustainable Ecological Engineering Design for Society 2016, Passive and Low Energy Architecture (PLEA) 2018, Windsor Thermal Comfort 2018, UK Indoor Environment Group (UKIEG) annual conferences 2017 and 2018, and CIBSE-ASHRAE Technical Symposium 2018.

The academic lead of WLP+, Professor Rajat Gupta, holds a senior professorial chair in sustainable architecture, and leads the multi-disciplinary Oxford Institute for Sustainable Development (OISD) at Oxford Brookes University. As principal investigator he has won over £10 million in research grants from EPSRC, ESRC, EU and Innovate UK in the areas of building performance evaluation, local energy mapping and scaling up energy retrofits.

Alastair Howard is a research associate in the LCBR Group. He holds a bachelor's degree in physics and a master's degree in Sustainable Buildings: Performance and Design, and has 15 years' experience of working in education. Alastair has been undertaking surveys and monitoring as part of the WLP+ project.

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Argent
Case study partner

Since 1981, Argent has delivered some of the UK's best mixed-use regeneration schemes, which include major commercial, residential, education, cultural and community developments in the UK's largest cities.

Argent is involved in the full development process – from identifying and assembling sites, constructing them, to letting and maintaining the finished properties.

Argent's interest in WLP+ originated from its ambition to deliver spaces that provide tenants with the best possible working environments.

Argent's key learnings

> "WLP+ has helped Argent identify the best internal environment for enhancing people's productivity and delivering those indoor conditions at the lowest energy consumption.
>
> This reflects Argent's continued commitment to creating sustainable places and being a responsible landlord. Argent hopes this exciting and relevant research will enable traction gain

within the industry, as it captures the value created through designing and managing buildings that work for people.

Argent will use the outcomes of the study to better understand the correlation between a building's internal environment and occupiers' wellbeing and productivity.

This will inform Argent of the most effective approaches to improving its assets, with the maximum benefit to tenants, and enable Argent to communicate the benefits of an optimised, well-managed office environment."

Steven Kellett
Sustainability Manager
Argent UK

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EMCOR UK
Case study partner

As one of the UK's leading integrated facilities management providers, EMCOR UK is responsible for some of the most demanding and technically challenging property estates in the world.

By monitoring and measuring environmental conditions alongside how people perform, EMCOR UK is able to put in place steps to improve the performance of building environments and the productivity and wellbeing of the people who work in them.

How EMCOR UK improves productivity

EMCOR UK will use its new knowledge, technology and experience to create optimised building environments and workplaces for occupants to perform to the best of their ability.

"The WLP+ project has strengthened EMCOR UK's understanding of the impact of indoor air quality, including CO_2, on the wellbeing and performance of people in their different working environments.

Knowledge gained has helped shape a range of new technology and data led advisory and intervention solutions."

Keith Chanter, CEO, EMCOR UK

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King's College London
Case study partner

King's is renowned for its world-leading education and research, as it has been throughout its 200-year history. The Estates & Facilities team contributes to this by striving to provide world-class services and facilities that enable students and staff to continue making the societal contributions and advances in research that make King's what it is.

How King's plans to implement the WLP+ findings

The WLP+ project has allowed King's to better understand how a building's performance can impact the wellbeing and productivity of its occupants, and in doing so has given the insight needed to make the most impactful changes to buildings management.

King's plans to review its estate to identify where improvements to the indoor environmental conditions will have the biggest impact across the wider King's community.

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British Council for Offices (BCO)
Dissemination partner

The BCO is the UK's leading member organisation representing the interests of all those who occupy, design, build, own or manage offices in the UK. It aims to stimulate new thinking on the design, development and occupation of offices across the UK. The BCO recognises that offices don't just house companies, they hold people, and so what goes on inside them is paramount to workplace wellbeing.

Since its inception in 1990, the BCO has become the leading provider of thought leadership, and debate around creating and using office space, which includes:

- communicating best practice through the BCO's *Guide to Specification*
- analysing industry issues such as the recent office-to-residential conversion legislation
- an extensive research programme
- annual awards, conference and regular events to recognise the most innovative workplaces in the UK and bring together the people behind them.

The BCO will include the WLP+ findings in its thought leadership, member support and research.

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Constructing Excellence

Dissemination partner

Constructing Excellence is a cross-sector, cross-supply-chain, member-led organisation operating for the good of industry and stakeholders, and it aims to produce a better built environment.

It is a long-term advocate of a 'whole life value' rather than 'lowest capex' or, worse, 'lowest tender price' approach to construction, notwithstanding that budget constraints may apply. We hope this project will add weight to that.

Constructing Excellence will use the WLP+ findings to help its supply-side members create more value for their clients, and help its client-side members to make smarter investment decisions based on outcomes.

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Innovate UK

Project funding support partner

Innovate UK is the UK's innovation agency and part of UK Research and Innovation (UKRI), a non-departmental public body funded by a grant in-aid from the UK government.

Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base.

Innovate UK has supported the funding of the WLP+ project.

Engineering and Physical Sciences Research Council (EPSRC)

Academic funding support partner

The EPSRC, also part of UKRI, is the main funding body for engineering and physical sciences research in the UK. By investing in research and postgraduate training, EPSRC is building the knowledge and skills base needed to address the scientific and technological challenges facing the nation.

EPSRC has supported the academic funding of the WLP+ project.

PROJECT SUPPORTERS

With special thanks to the following organisations for their input to and support of the WLP+ project and case studies:

NATS

NATS has been a driving force in the aviation industry since starting as National Air Traffic Control Services (NATCS) in 1962. NATS provides safe and efficient air traffic control in over 30 countries, including the UK, and plans to become the acknowledged global leader in innovative air traffic solutions and airport performance. In an organisation where optimising human performance is critical, the WLP+ research has revealed opportunities to improve the workplace and create an environment that helps NATS staff perform at their best.

Havas KX

Havas is a global media and communications company with a mission to be the world's best company at creating meaningful connections between people and brands, using creativity, media and innovation.

Their King's Cross office is an ultra-modern facility offering a creative environment for staff to thrive and produce high-end products.

Argent, Havas KX's landlord, hand-picked Havas to help show that its recent move to a state-of-the-art facility has had a positive impact on its staff, as well as helping improve staff satisfaction for all staff at Havas.

Havas will use the WLP+ findings to provide an improved environment for its talented staff to work in innovative ways to create meaningful connections between people and brands.

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