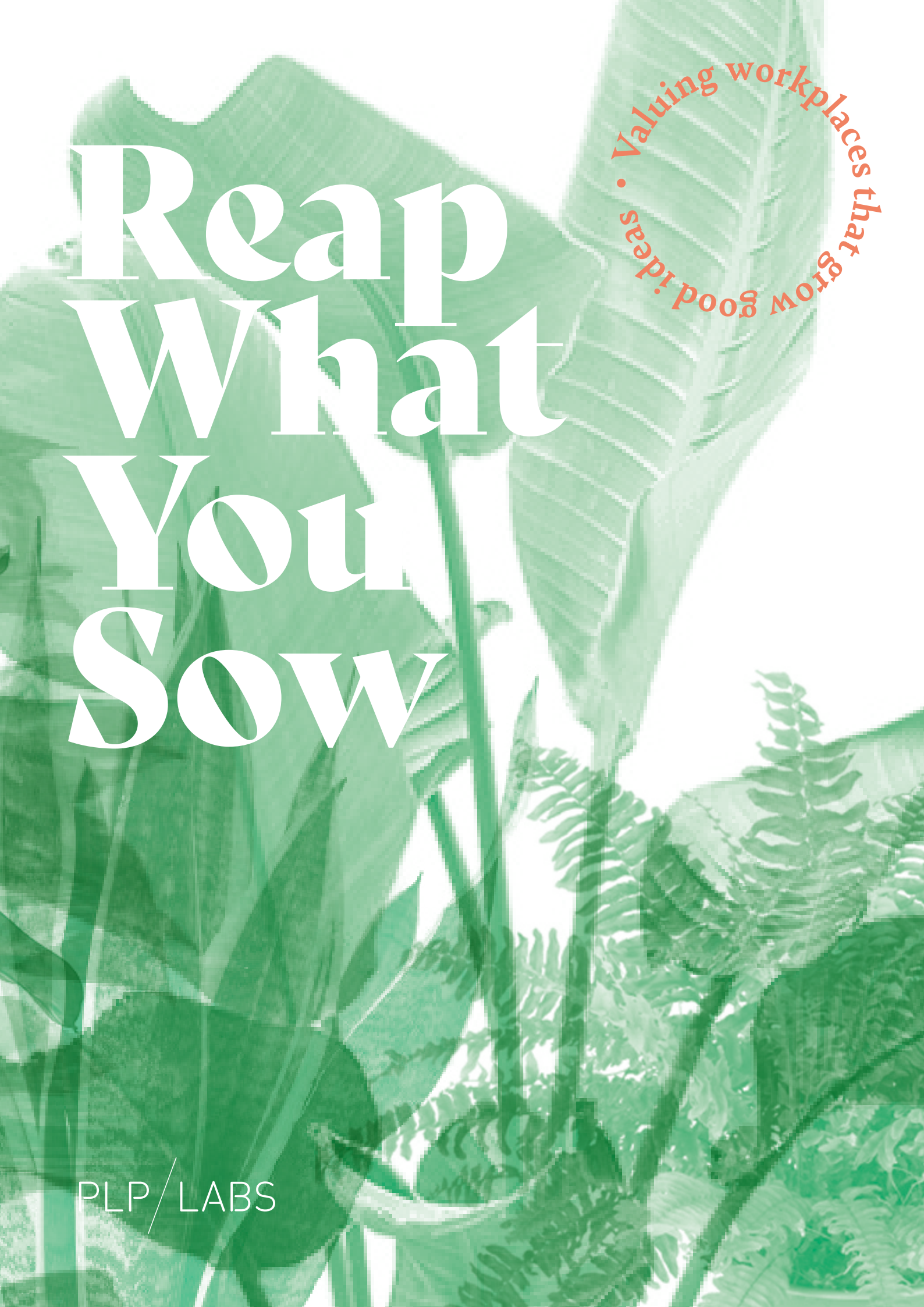

Reap What You Sow
Valuing workplaces that grow good ideas •
PLP/LABS

Authors
Joyce Chan-Schoof
Main author, PhD Research Scholar at Loughborough University
Professor Derek Clements-Croome
Contributing author, University of Reading
Savannah Willits
Editor, PLP Labs Team Lead

Abstract
Biophilic workplace design has a higher monetary value in terms of wellbeing and environmental quality than non-biophilic workplace design.

PLP Labs engaged in a research project with the authors to measure and monetise the well-being value of biophilic design. This was done using a new approach to POE which used qualitative and quantitative measurements collected at our studio. Next, a financial proxy for well-being was applied to the data. In the end, a business case, with the resulting monetary value based on enhanced wellbeing, was crafted for designers to advocate for biophilic design.

Acknowledgements
Collaborator and indoor plants sponsor: Adrian Byne (Benholm Group).

Loughborough University, Dr. Vicky Lofthouse & Dr. Robert Schmidt III (PhD supervisors of the Lead Investigator), School of Design and Creative Arts & School of Architecture, Building and Civil Engineering. Loughborough University.

British Council for Offices (BCO) financed an earlier pilot study on the use of wearables to collect meaningful data from office workers. This previous research informed the study on the measurement and value of biophilic design.

Biophilic Design, Alex Bond contributed to the early phase of design.

* The research project is part of a doctoral research of Joyce Chan-Schoof at Loughborough University, she is the Main Investigator of this case study.

Contents

βιο + φιλία

life *love of*

Biophilia

noun (n.)

1. Love of life

Humans have an innate desire to connect with nature & other forms of life.

Green Value?

Biophilia describes an innate need to connect to nature. In practice, biophilic design can take the form of green roofs or green walls, skylights, houseplants, water features, or wood furniture.

We know that a connection with nature is good for us, but what are the tangible benefits and how can we communicate these economic outcomes to decision-makers who create our working environments?

Can biophilic design add value to the workplace; not only through improving air quality and aesthetics, but also by having a tangible impact on employee health, well-being, creativity, productivity, satisfaction, engagements, and up-skilling?

Given employees are the largest cost for a business, to what extent can biophilic design save companies money by ensuring that staff are healthier and happier at work?

We explore these questions by delving into the value of biophilic design. This brochure lays out the economic value of connecting with nature in the workplace using an in-house pilot study conducted at PLP Architecture. By doing so, we make a business case for spatial designers to use and advocate for biophilic design.

Eureka Epiphany Envision

What Environments Produce Great Ideas?

Great ideas arise in unusual places.

From shower thoughts, visions in dreams, reflective long walks to inspiring conversations: our best thinking can be unpredictable and elusive.

But what do each of these things have in common?

We do our best thinking in restorative and stimulating environments commonly and abundantly found in nature.

We do our best thinking in restorative and stimulating environments commonly and abundantly found in nature.

The natural environment massively impacts our bodies, minds, and emotions.

For instance, daylight helps regulate circadian rhythm, which is linked to sleep quality, fatigue, mood, productivity, and overall health.

Controlled lab experiments link the natural environment to improvements in attention, vigilance, memory, creativity, comprehension, and motivation, as well as stress reduction (1).

1. Allen et al., 2015; Ayuso Sanchez et al., 2018; Kalantari & Shepley, 2020.

The environment and cognitive functioning are inherently linked.

We experience an increase in perceived attention, creativity, productivity, and stress reduction in the presence of nature.

In the same vein, our brain needs micro breaks to function. Continual focus for hours on end can tire the brain and drain our energy due to the build-up of glutamates, a type of neurotransmitter linked to learning and memory. Access to nature helps our neural networks recover from mental fatigue caused by focused attention over longer periods of time. One study suggested that working near a window that overlooked a forest offered a 4 percent reduction in stress (2).

Each of these positive benefits are vital for thinking and productive environments, like the workplace.

2. Shin, 2006.

Experts suggest that we prefer natural environments because our brains evolved in nature.

Attention Restoration Theory
We can concentrate better after spending time in or looking at nature (3).

Habitat Theory
Aesthetic pleasure in landscape derives from the observer experiencing an environment that is favourable to deep-seeded biological needs (Orians & Heerwagen, 1992).

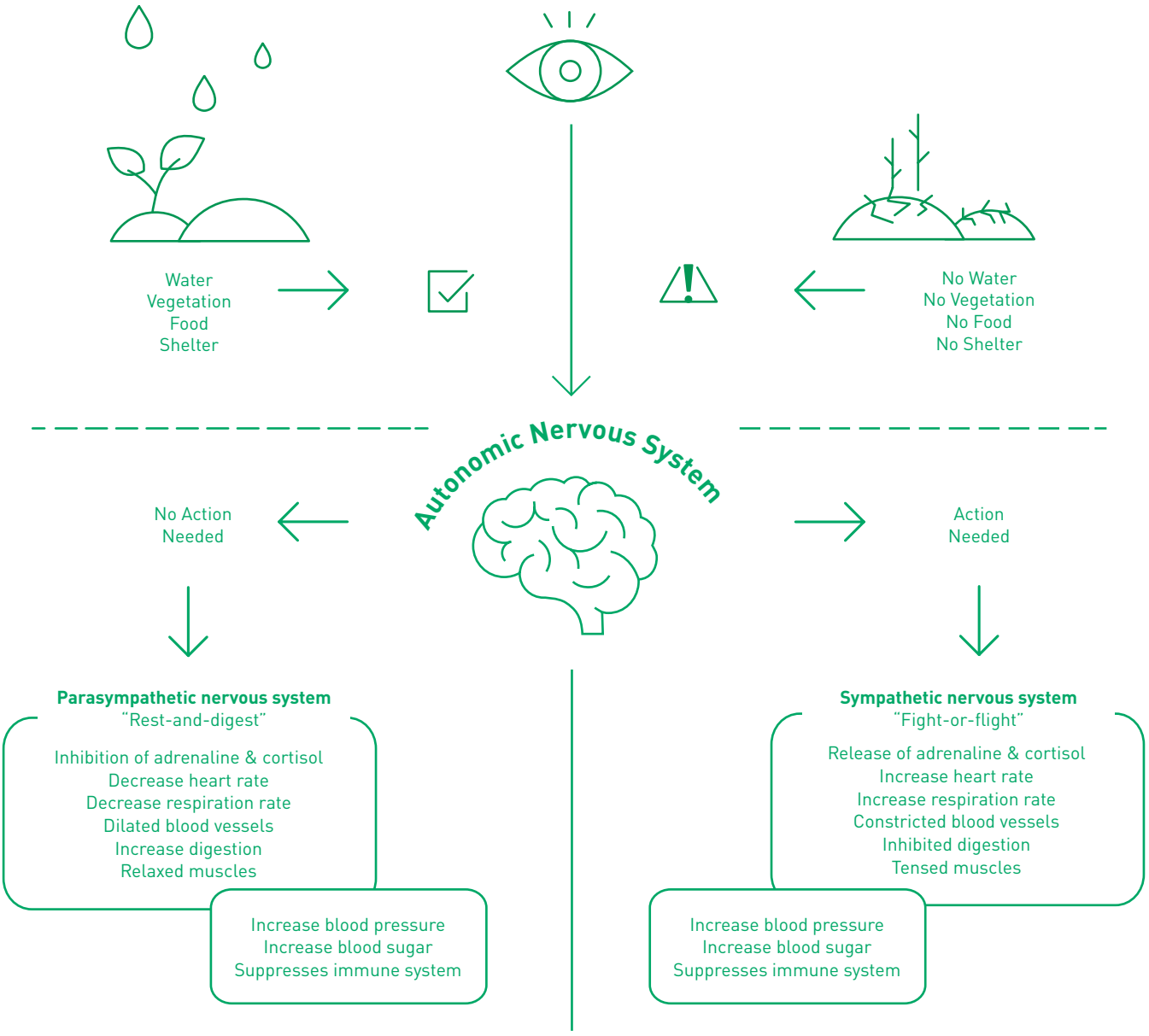
Prospect-Refuge Theory
Environments that provide people with the capacity to observe (prospect) without being seen (refuge) feel secure (4).

The Savanna Hypothesis
We retain genetically based preferences for features of high-quality African Savannas where our ancestors lived when their brains and bodies evolved into their modern forms (5).

Stress Recovery Theory
Natural environments promote recovery from stress, while urban environments tend to hinder the same process and needs (6).

Our minds are hardwired to respond positively to environments that offer water, daylight, plants, and shelter. The Attention Restoration Theory, Habitat Theory, Prospect-Refuge Theory, Savanna Hypothesis, and Stress Recovery Theory all document and point to this phenomenon.

3. Kaplan, 1989; 1995.
4. Appleton, 1996.
5. Balling & Falk, 1982; 2010.
6. Orians & Heerwagen, 1992; Ulrich et al., 1991.



Source: Naava

The study of neuroscience, such as the study of glutamates, also affirms nature's importance to cognitive functioning. Access to nature relaxes our limbic system that is responsible for memory and emotions, as well as links the intellectual cerebral cortex to our survival and unconscious brain. Therefore, we experience an increase in perceived attention, creativity, productivity, and stress reduction through the presence of nature.

Appraisal

Even more elusive than a clever idea, how do we value thought-provoking and productive places?

Nature has a profound impact on our physical, mental, and emotional stasis, but how do we account for this impact?

In corporate real estate, the environment impacts the bottom line.

Due to the brain's positive reaction to nature, biophilic design is positively correlated to well-being, as well as productivity, happiness, and life satisfaction. Therefore, biophilia impacts the corporate bottom line.

By introducing nature into the office environment, businesses may increase the value of their staff and workplace at a fraction of the cost of other interventions, like team retreats or office renovations. Therefore, the dramatic spike of interest in biophilic workplace design in recent years comes at no surprise.

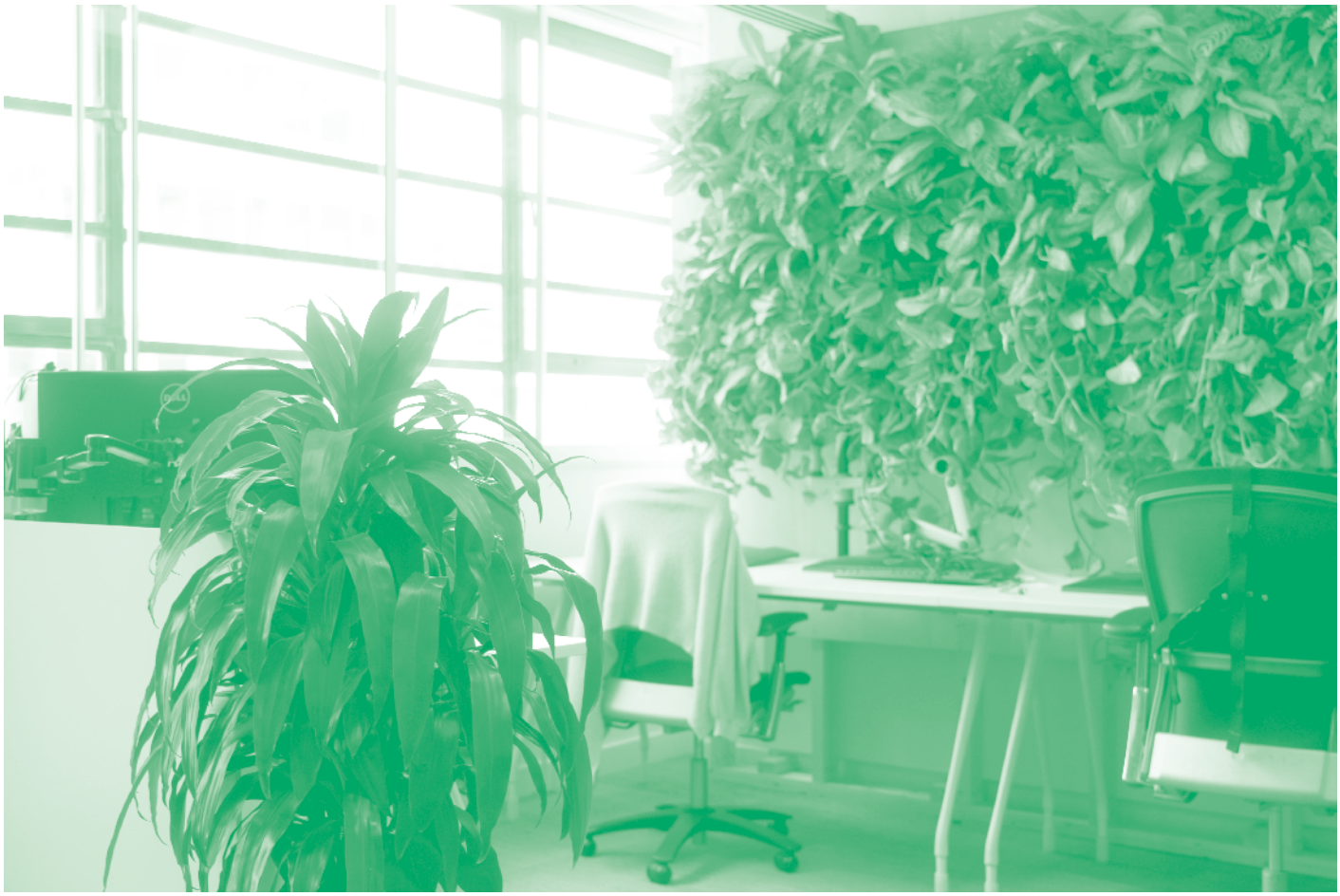
However, biophilic design is still seen as an expenditure rather than an investment. We challenged this misgiving by investigating the tangible financial benefits of high quality spatial and environmental design. When attached to a £ sign, biophilic design has the potential to drive commercial decision-making.

The monetary representation of biophilia, and by extension its associated benefits, provides investors with a more holistic and representative understanding of the value of design during the briefing and budget planning stage.

To test this idea that biophilia drives more positive feelings in the workplace, we conducted an in-house pilot study. A group of designers and architects conducted their daily work in a meeting room at PLP Architecture's HQ. Over the course of 8 weeks the environment inside changed from an average office space to a multi-sensory experience by providing rich, natural stimuli.

The study complemented previous research on biophilic workplaces that show biophilia improves health and well-being of occupants (7). More importantly though, a valuation analysis was applied to the well-being data collected during the study. This exercise demonstrated that by applying a robust methodology it is possible to link well-being to financial savings in a way that commercial decision-makers more easily digest. Our preliminary insights can help designers to make a stronger business case for biophilic design.

7. Refer to BCO Report, Use of Wearables in the Office - A Review and Examples in Practice

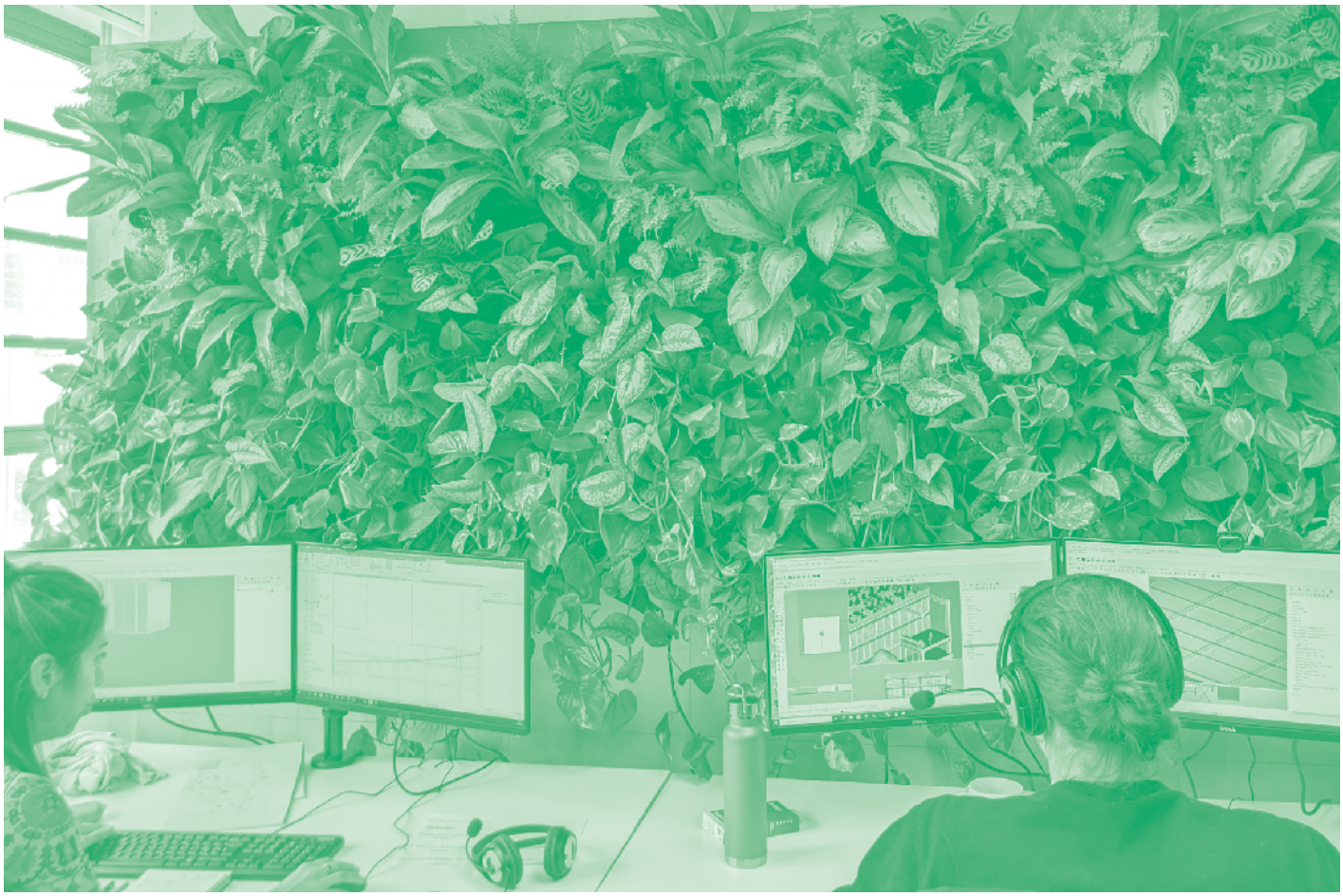


The pilot study also adopted the Flourish Framework to a gain deeper understanding of the multi-sensory experience, please refer to pg23 for more information. The framework evaluates how the subjective and objective parameters of a design (top two quadrants) may impact people in terms of feelings, cognitive functions, and economic outcomes (bottom two quadrants).

The objective and subjective environmental facts impact feelings and economics, so that if one undervalues the environment then there is a detrimental impact on feelings and economics (8).

The Flourish Framework can be used as an early design and POE assessment tool.

8. Clements-Croome, 2020.



Biophilia may lead to large financial rewards given its positive influence on the workforce and the bottom line. Yet, the discounting of biophilic design persists given a lack of standard practice of weighing the cost and benefits or applying an economic valuation geared towards investors.

The barriers to assess the 'true' economic value of designing for well-being are readily apparent. This difficulty is not due to a lack of evidence of the benefits of biophilic design but narrowing down and justifying economic figures. Asserting an economic valuation is troublesome given the complex relationship between people and place, which requires nuanced financial proxies and modification.

Nevertheless, there are ways to quantify people-centric benefits. For instance, the new economic paradigm – the Well-being Economy aims to create a virtuous circle in which people's well-being drives economic prosperity, stability and resilience (9). Instead of merely relying upon a single metric of economic growth like Gross Domestic Product (GDP), there are more holistic approaches to determine a country's well-being.

9. OECD, 2019.

When attached to a £ sign, biophilic design has the potential to drive commercial decision-making.

In the context of the built environment, impact assessments of social and sustainability issues predominantly focus on procurement and construction activities. Therefore, capturing the comprehensive impact of design is less developed.

When making financial judgments on people-centric outcomes, a Post-Occupancy Evaluation (POE) is a favoured method as it collects subjective and objective measurements of people and places. However, this evaluation method is still not standard practice in the building procurement process.

It is crucial to demonstrate the value of design quality and its connection to well-being in the budget planning stage, as monetising well-being outcomes may support a stronger Cost and Benefits Analysis (CBA).

It is through this exercise that we can capture the attention of investors by highlighting the neuroscience and newfound knowledge on monetary assessment of biophilic design. Architects and designers are uniquely suited to demonstrate how the environment impacts the bottom line.

Office Jungle

In-House Pilot Study*

Who:
5 Designers + Architects

What:
Carried out their daily work during three distinct environment scenarios

Where:
In an office meeting room at PLP

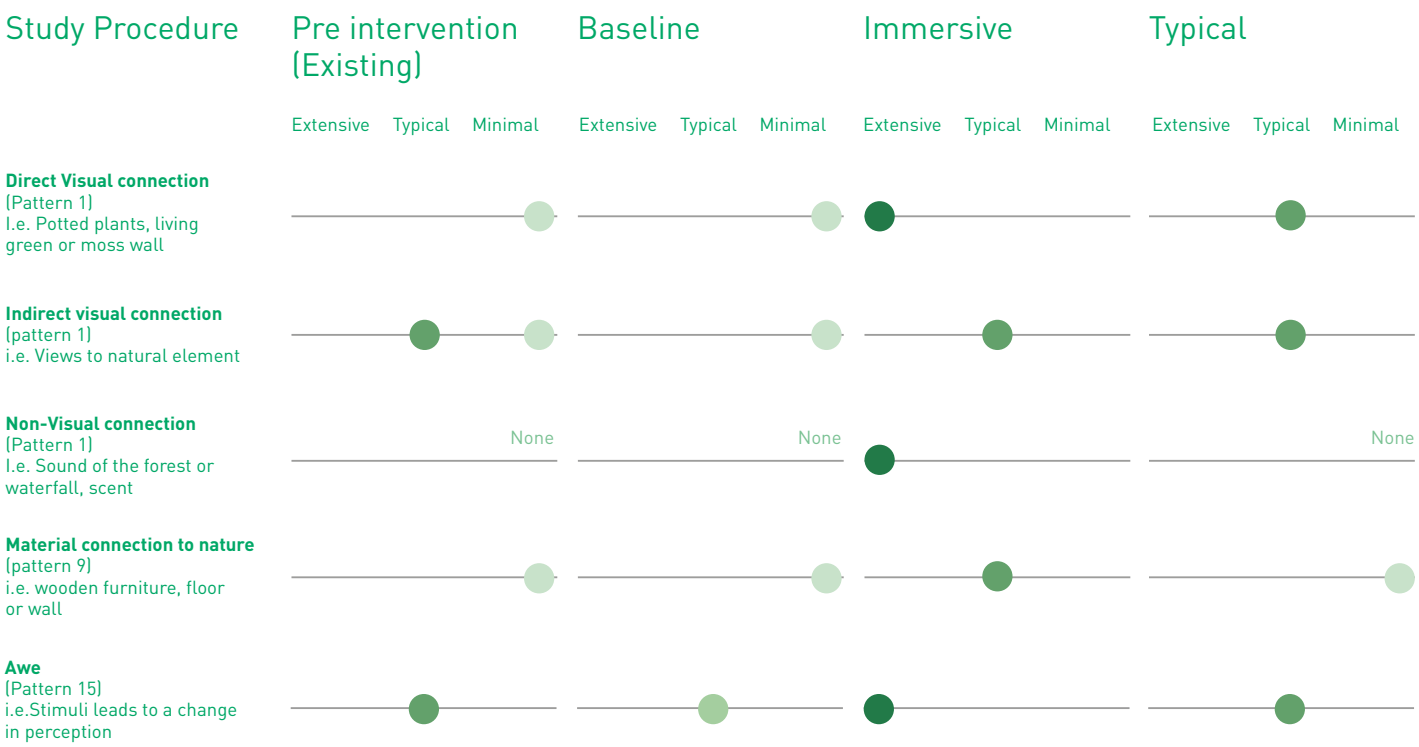
When:
Over course of 8 weeks

And Then:
Monitored participants through qualitative (questionnaires, interviews, journaling with diaries) and quantitative means (air quality, VOC, CO_2, temperature, humidity, light, heart rate, steps, sleep quality, noise level, brainwaves)

* This pilot study is part of a doctoral research project at Loughborough University, carried out by the Lead Investigator, Joyce Chan-Schoof, in 2022. She is the main author of the value-based approach to POE (Chan-Schoof et.al, 2022) and research findings.

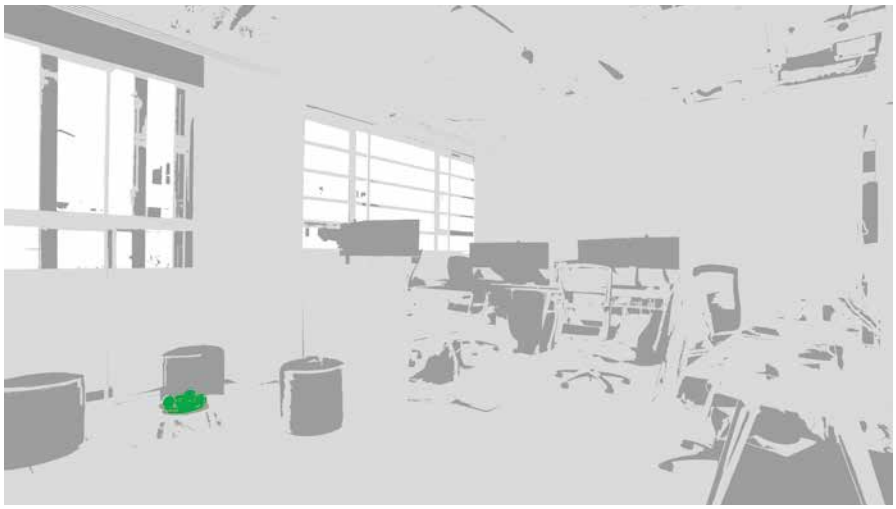
PLP Labs conducted a POE study in their London office to explore how the impact of biophilic design can be measured and monetarily valued.

Subjective Parameters



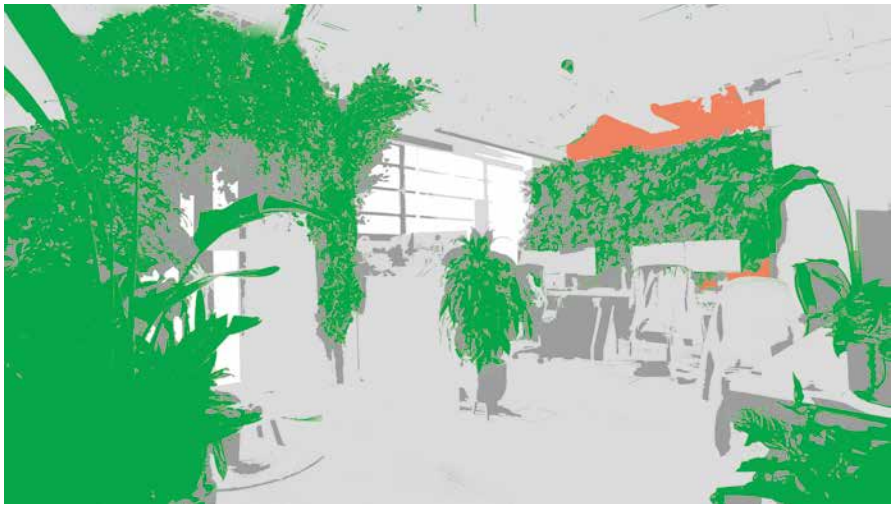
The study observed and measured the subjective parameters, chosen from the 15 patterns of biophilic design (10), to make comparisons between the three main scenarios.

10. Browning & Yran, 2020.



1. A cubicle-like workspace, i.e., a non-biophilic environment with no views out (windows with blinds).

2. A standard open-plan workspace, i.e. minimal biophilic elements in the existing workplace, such as small potted plants and views out from half-height view windows. This scenario represents a typical workplace.



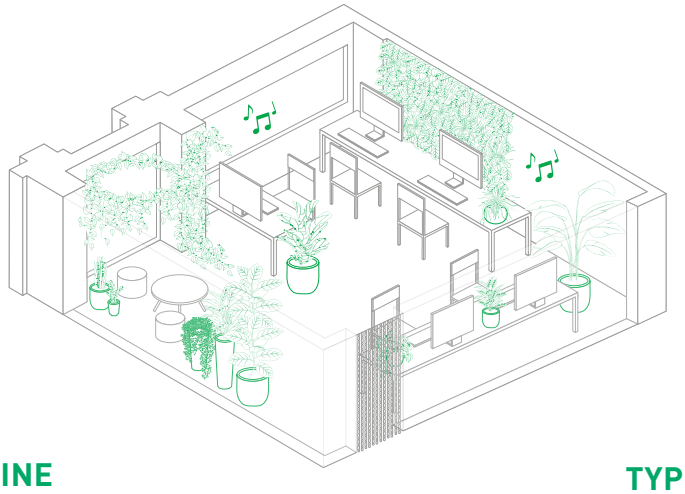
3. A biophilic workspace, with a dramatic increase in biophilic elements i.e. green potted plants with lush foliage introduced to the workstations, including green walls and hanging planters, with some coloured and aromatic plants. The participants relocated next to a full-height window with dual aspect views out.

- Background
- Indoor Green
- Natural Material
- Views Out

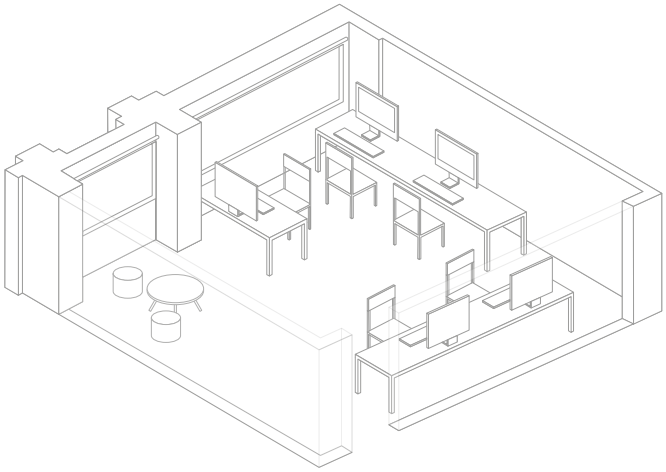
Three different physical environments were implemented during the study. The scenarios were designed to represent non-biophilic and various biophilic environments.

There were two key variables: indoor green and views out.

IMMERSIVE



BASELINE



TYPICAL

Existing

Pre-intervention 1

6th to 8th June
(3 days)

Baseline 1 2

1.1

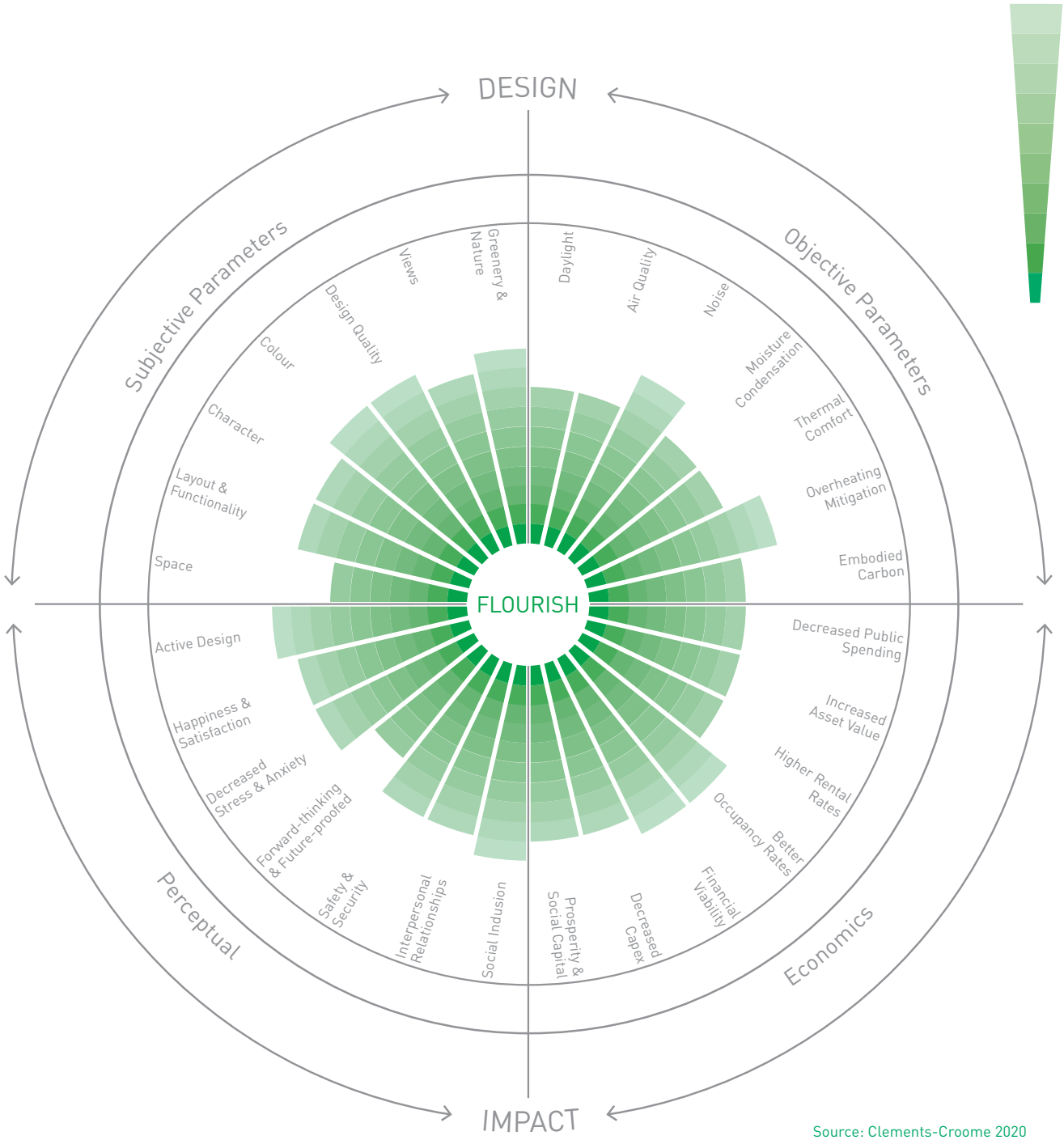
Break

13th to 23th June (9 days)
Tube strikes

Immersive 3

6

Break



Source: Clements-Croome 2020

27th to 29th June
(3 days)

Baseline 2

4

30th June to 12th July
(9 days)

Typical

5

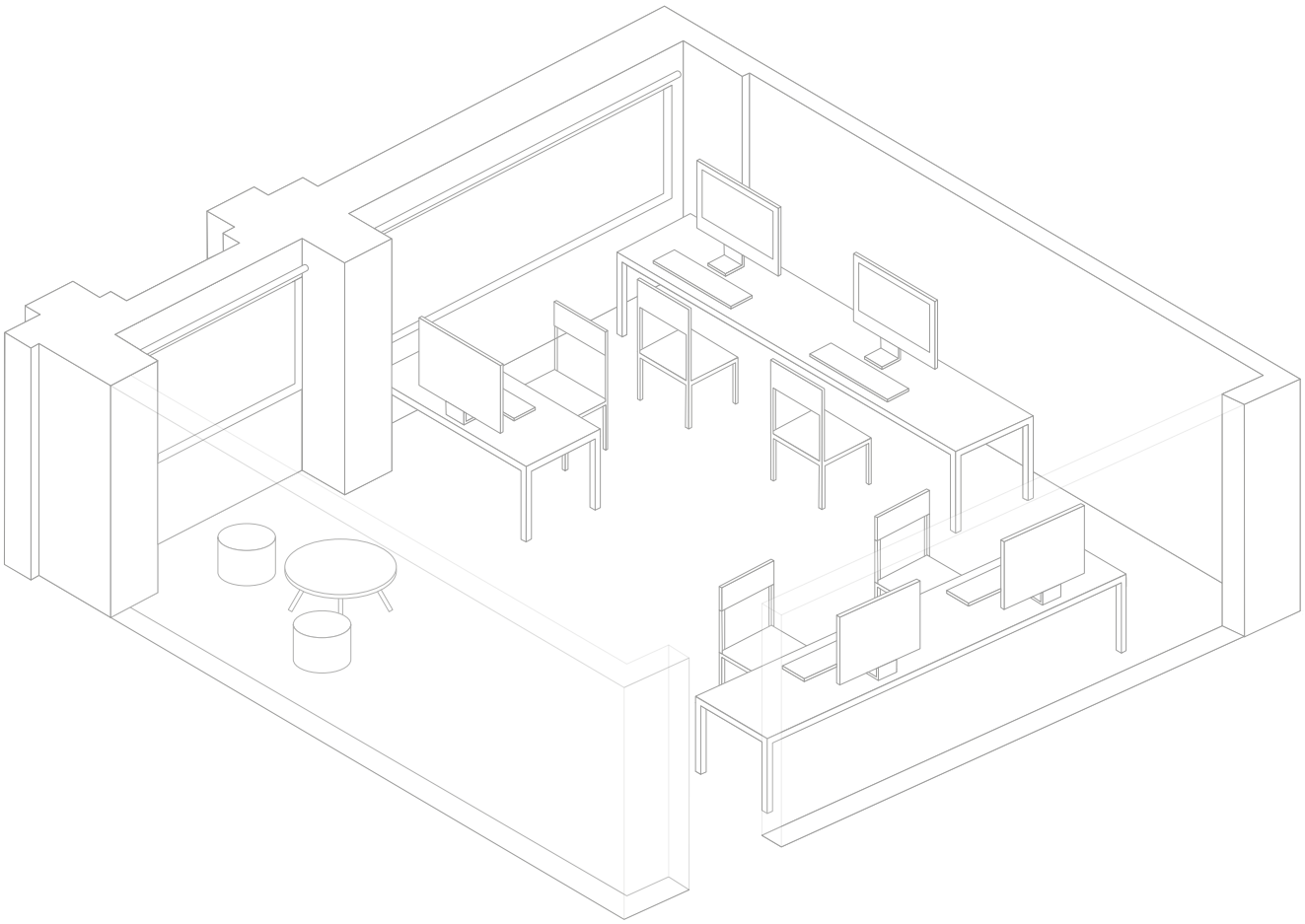
7

Break

Instant subjective measurement
(daily)

- Daylio App & Smartwatch
- Questionnaires (5 Participants)
- Questionnaires (All PLP)

Baseline



Existing

Pre-intervention 1

6th to 8th June
(3 days)

Baseline 1 2

1.1

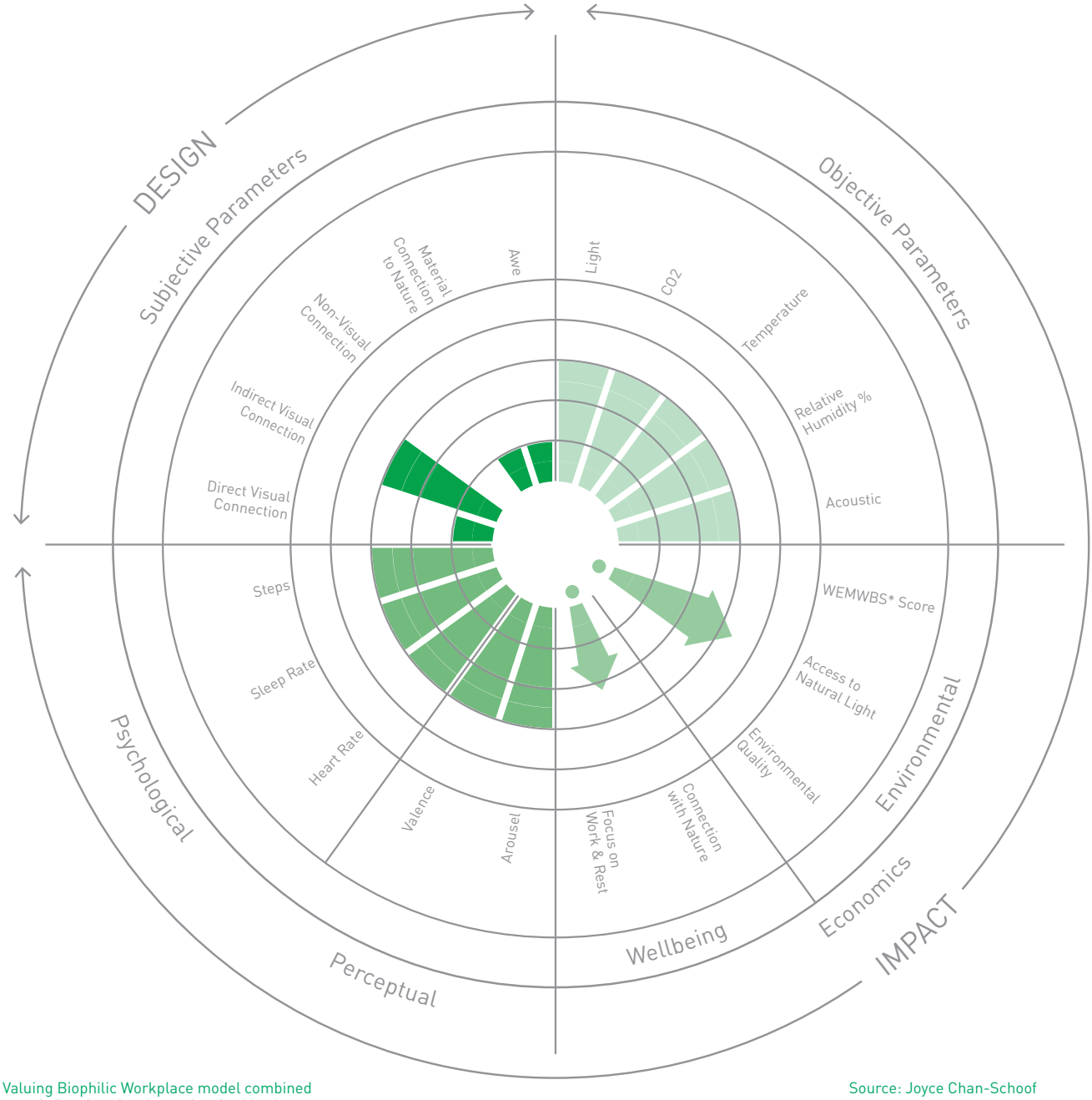
Break

13th to 23rd June (9 days)
Tube strikes

Immersive 3

6

Break



This Valuing Biophilic Workplace model combined various existing theories. It was inspired by the Flourish Framework (Clements-Croome, 2020), adopted the 15 Pattern of Biophilic Design (Browning& Ryan, 2020) as design parameters, referred to the UK's HM Treasury Green Book to design the valuation process and financial proxies as part of Joyce's doctoral research.

Source: Joyce Chan-Schoof

27th to 29th June
(3 days)

Baseline 2

4

30th June to 12th July
(9 days)

Typical

5

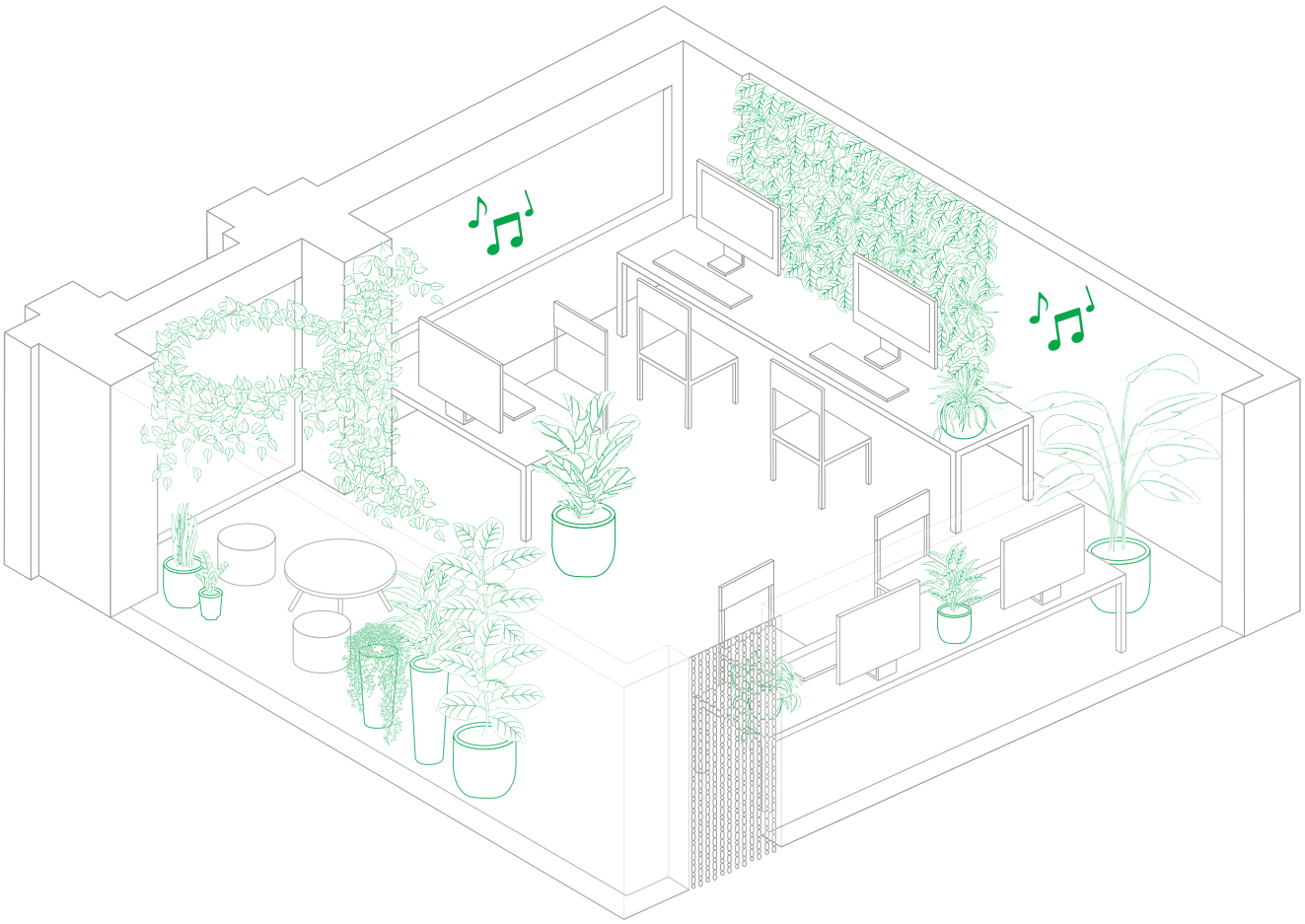
7

Break

Instant subjective measurement
(daily)

- Daylio App & Smartwatch
- Questionnaires (5 Participants)
- Questionnaires (All PLP)

Immersive



Existing

Pre-intervention 1

6th to 8th June
(3 days)

Baseline 1 2

1.1

Break

13th to 23rd June (9 days)
Tube strikes

Immersive 3

6

Break

Source: Joyce Chan-Schoof

27th to 29th June
(3 days)

Baseline 2

4

30th June to 12th July
(9 days)

Typical

5

7

Break

Instant subjective measurement
(daily)

- Daylio App & Smartwatch
- Questionnaires (5 Participants)
- Questionnaires (All PLP)

Typical

Existing

Pre-intervention 1

6th to 8th June
(3 days)

Baseline 1 2

1.1

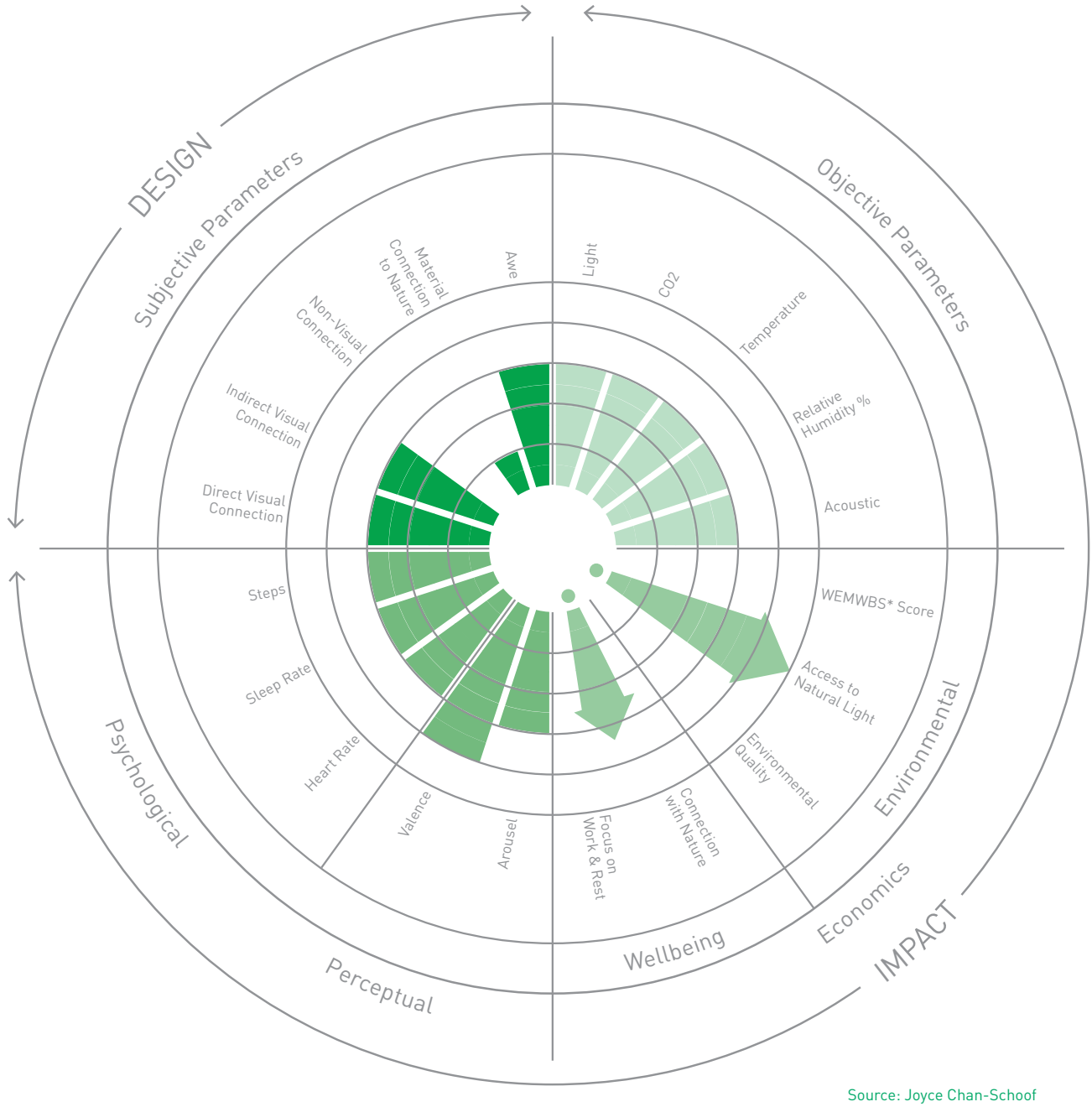
Break

13th to 23rd June (9 days)
Tube strikes

Immersive 3

6

Break



Source: Joyce Chan-Schoof

27th to 29th June
(3 days)

Baseline 2

4

30th June to 12th July
(9 days)

Typical

5

7

Break

Instant subjective measurement
(daily)

- Daylio App & Smartwatch
- Questionnaires (5 Participants)
- Questionnaires (All PLP)

1. Dracaena Fragrans
Dracaena Janet Craig – upright plant with lush dark green foliage proved to be highly effective at cleaning the air

2. Strelitzia Nicolai
Wild Banana or Giant White Bird of Paradise - impressive tall plant with large leaves to help create a lush, jungle-like effect

3. Sansevieria Zeylanica
Snake Plant - contrasting, architectural-looking, stripy foliage for visual variety

4. Philodendron Hederaceum
Philodendron Scandens – dark green trailing poliage proved to be highly effective at cleaning the air

5. Aglaonema Silver Bay
Chinese Evergreen - large leaves with contrasting, rubbery leaves for greater variety

6. Asplenium Antiquum
Bird's Nest Fern- vibrant bright green ferns

7. Epipremnum Pinnatum Aureum
Devil's Ivy- light green trailing foliage proved to be highly effective at cleaning the air

8. Hedera Helix Pittsburgh English Ivy
Small-leaved trailing ivies for a delicate foliage chandelier and excellent air-purifying properties

9. Neoregelia Carolinae
Blushing Bromeliad - Bromeliad to provide bright pops of colour in the living wall

10. Nephrolepis Exaltata
Sword Fern - lush ferns proved to be highly effective at cleaning the air

11. Rhipsalis Cassutha
Mistletoe Cactus - bright green delicate trailing plant with a hairy effect to contribute variety to the eclectic planting

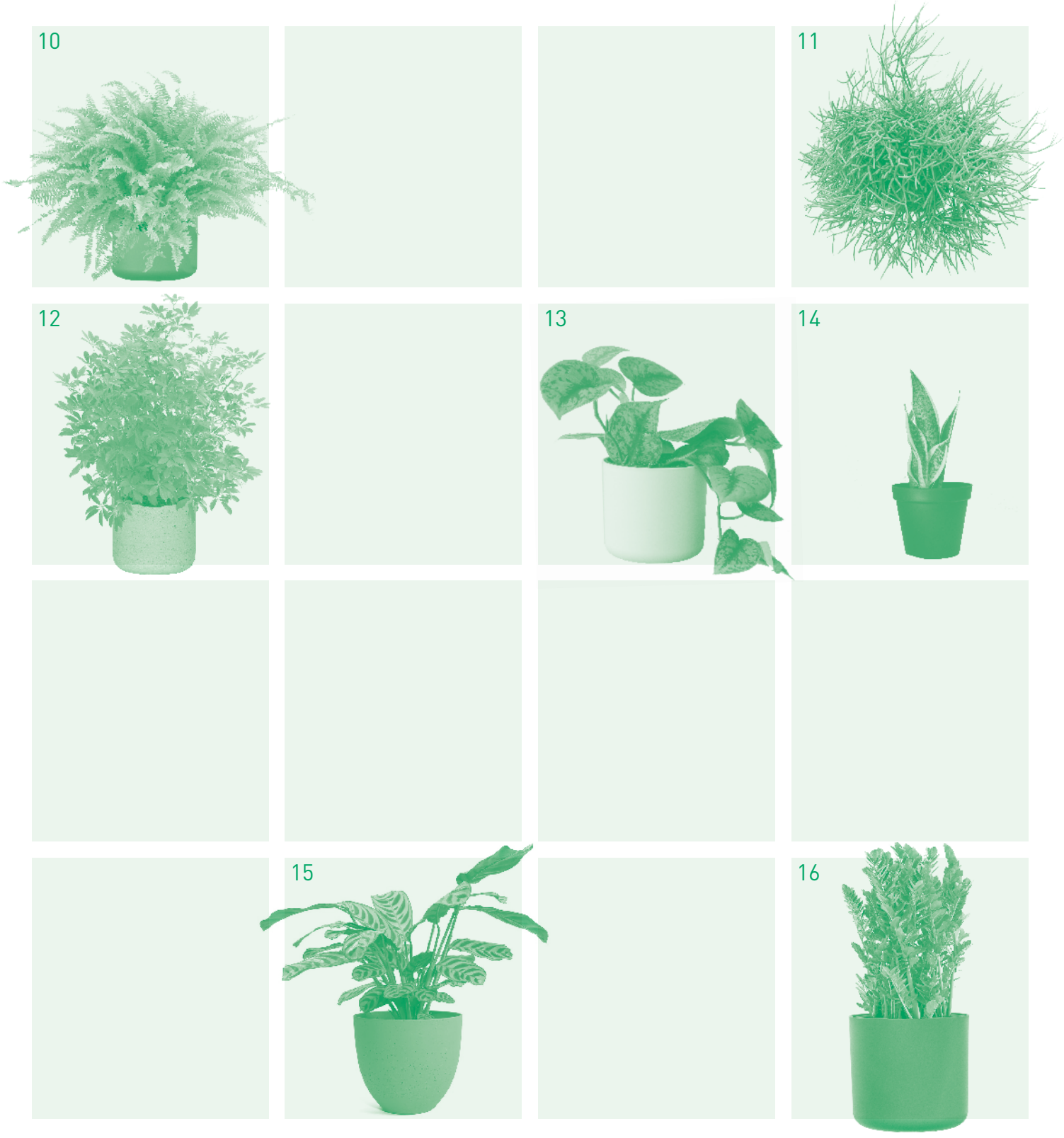
12. Schefflera Arboricola Compacta
Dwarf Umbrella Tree - lush green foliage plant with a natural, organic style and random shape

13. Scindapsus Pictus
'Trebie' or Silver Vine– a trailing plant with contrasting silvery-grey foliage and good air-cleaning properties

14. Spathiphyllum Vivaldi
Peace Lily - proven to be one of the best air-cleaning species with large lush green leaves and beautiful white flowers

15. Stromanthe Amabilis
Never Never Plant- distinctive stripy foliage to provide contrast and extra dimension in the living wall

16. Zamioculcas Zamiifolia
ZZ plant or Aroid Palm- stunning dark green glossy leaves providing visual contrast and contributing to a healthy environment



CO_2

Baseline

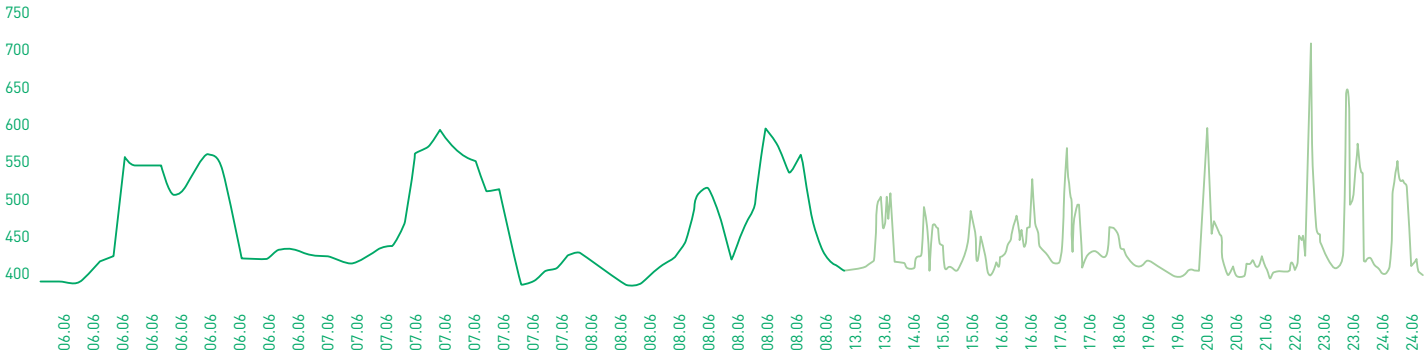
512 Lux on desk level

40-50db

Immersive

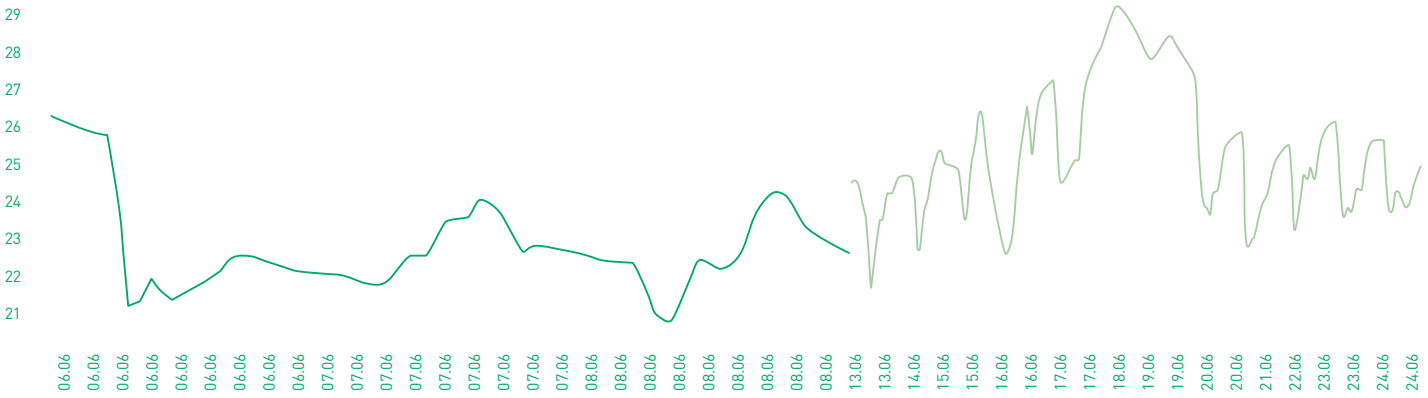
620 Lux on desk level

30-40db



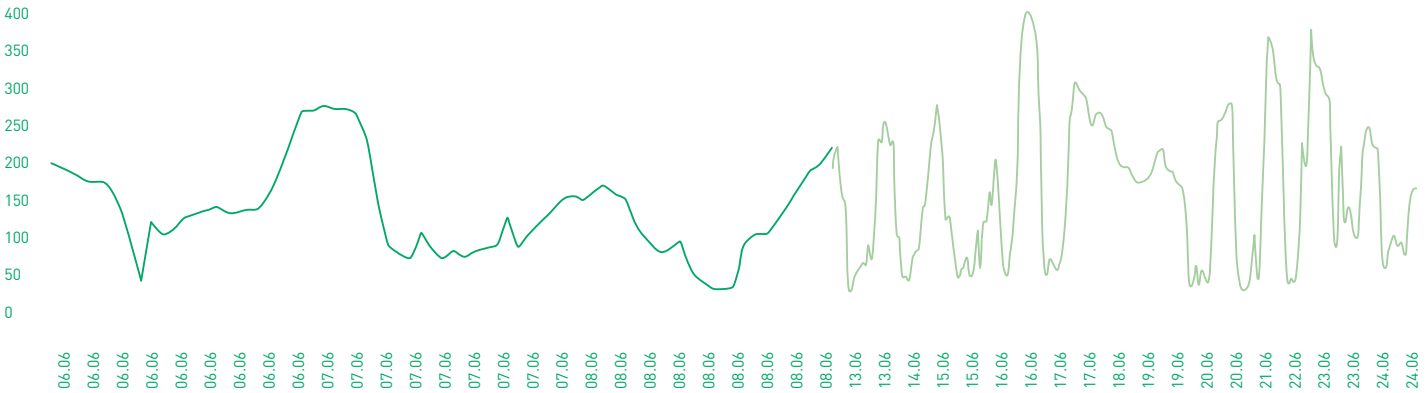
Value within opening hours	Average	Lowest	Highest	Average	Lowest	Highest
Meeting Room 6 Sensor Open-plan office	516 ppm	442 ppm	588 ppm	516 ppm	442 ppm	588 ppm

Temperature



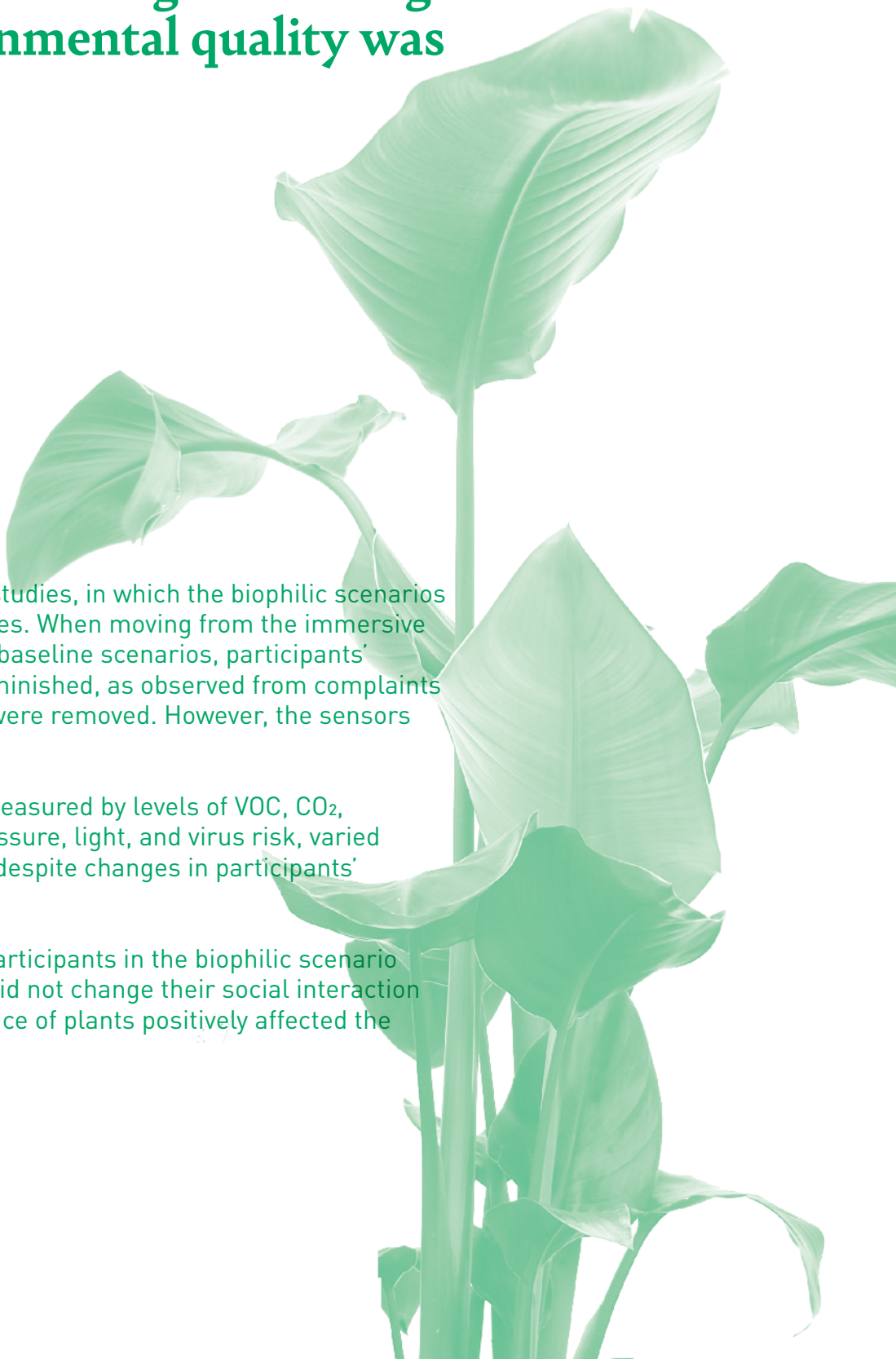
Value within opening hours	Average	Lowest	Highest	Average	Lowest	Highest
Meeting Room 6 Sensor Open-plan office	24.4 °C	23.2 °C	25.4 °C	24.4 °C	21.8 °C	588 ppm

VOC



Value within opening hours	Average	Lowest	Highest	Average	Lowest	Highest
Meeting Room 6 Sensor Open-plan office	107 ppd	46 ppd	181 ppd	89 ppd	46 ppd	256 ppd

After the immersive scenario, indoor plants were taken away. Our results reveal the baseline 2 scenario affected the participants' emotions negatively even though an average indoor environmental quality was maintained.



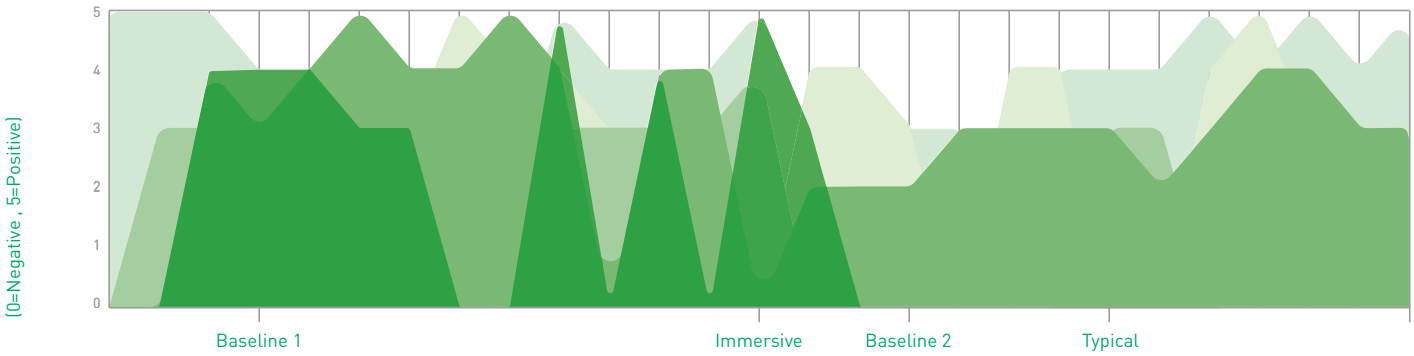
The results mirrored past studies, in which the biophilic scenarios had higher well-being scores. When moving from the immersive scenario to the typical and baseline scenarios, participants' perception of air quality diminished, as observed from complaints and remarks, once plants were removed. However, the sensors say otherwise.

The indoor air quality, as measured by levels of VOC, CO_2, humidity, temperature, pressure, light, and virus risk, varied little throughout the study despite changes in participants' perspectives.

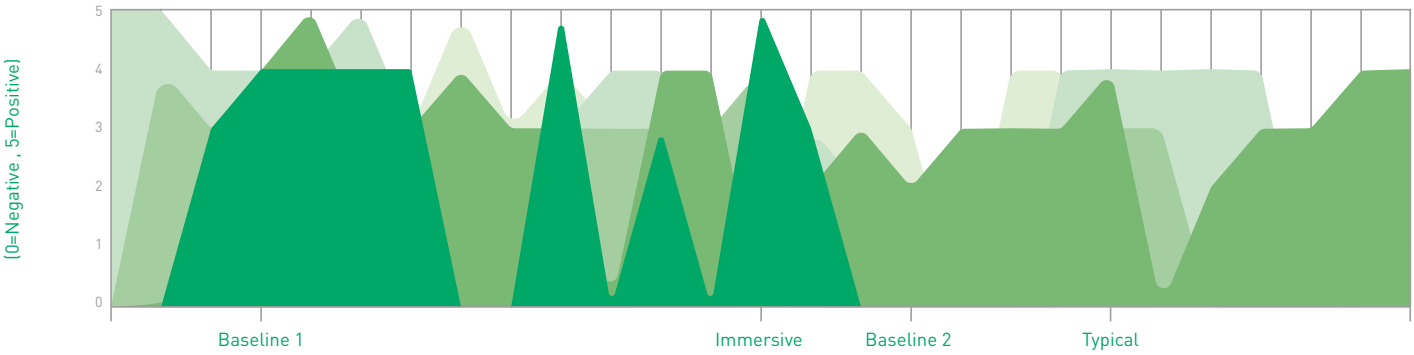
The diaries revealed that participants in the biophilic scenario believed the environment did not change their social interaction behaviours, but 'the presence of plants positively affected the mood.'

Instant emotion over time (Daily)

Valence: How positive or negative do you feel about your workplace now?



Arousal: How excited or bored do you feel about your workplace now?



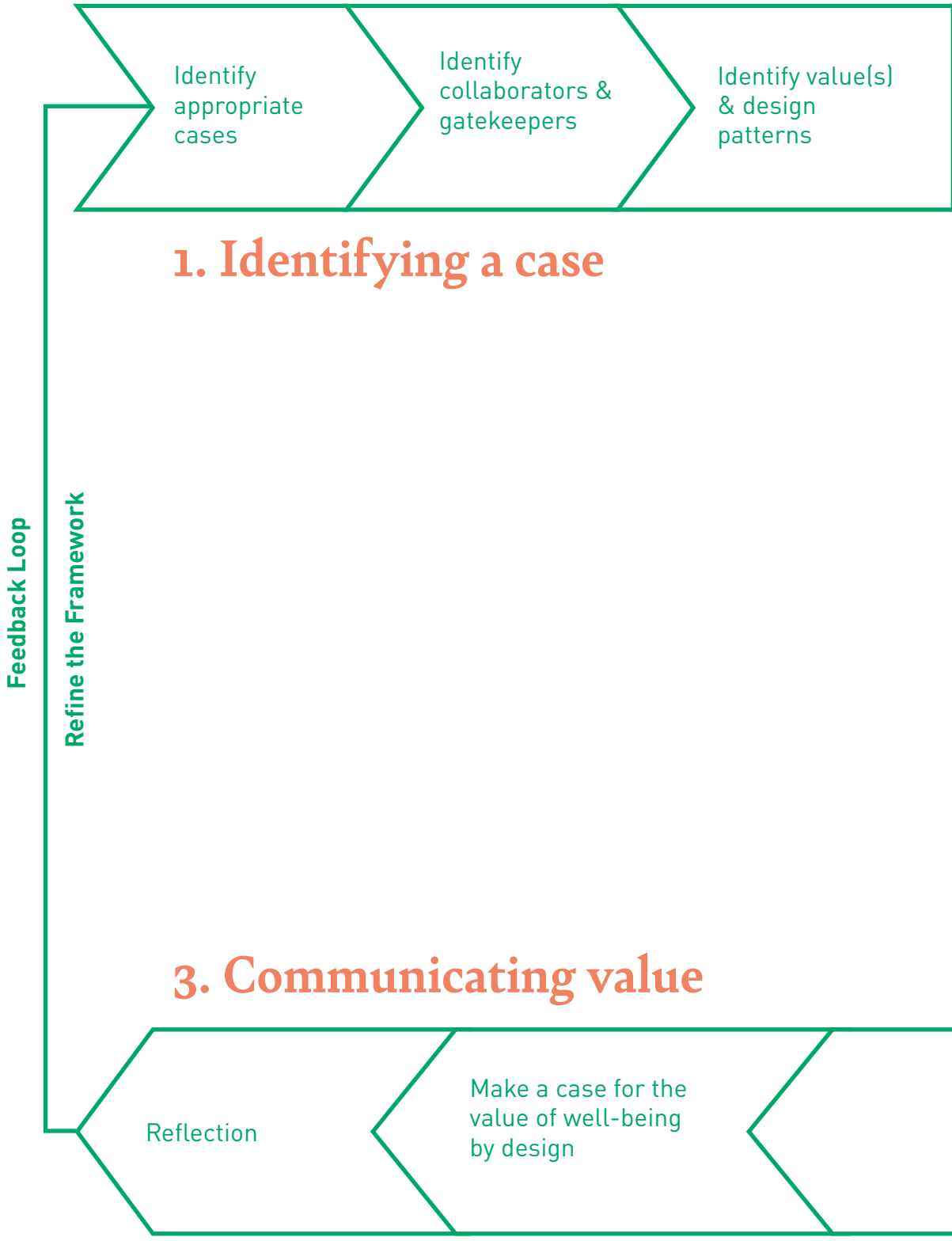
A value-based approach was used to monetise the well-being and environmental values. The Warwick Edinburgh Mental Wellbeing Scale (WEMWBS) and a set of healthy-building-related questions* were used in weekly questionnaires. This WEMWBS scale is a well-established and widely used well-being measurement scale in the UK. The life satisfaction score has a financial proxy in the evaluation for each of the scenarios.

* These questions used Willingness to Pay (WTP) as a method to create financial proxies to relate the WELL Building Standard concepts in this case study, which aims to explore the Social Value of healthy buildings.

Wearables tracked the participants heartbeat, step count, calorie intake, and sleep quality to measure their overall health. This information was helpful in determining the baseline and any improvements in the occupant's daily health.

An EEG headset was used to measure brain waves of a participant in the baseline scenario and the various biophilic scenarios. During each test, the participant completed their daily work and brain activity was subsequently measured.

A Value-based Approach to POE



Source: Joyce Chan-Schoof

2. Evidencing value

Results (£)

The biophilic scenarios generated more than double the economic value of the non-biophilic scenario.

These data informed the creation of a financial proxy, in a form of a price point, for well-being. Although the process can be nuanced and complicated, monetary values were derived from the breath of qualitative and quantitative data.

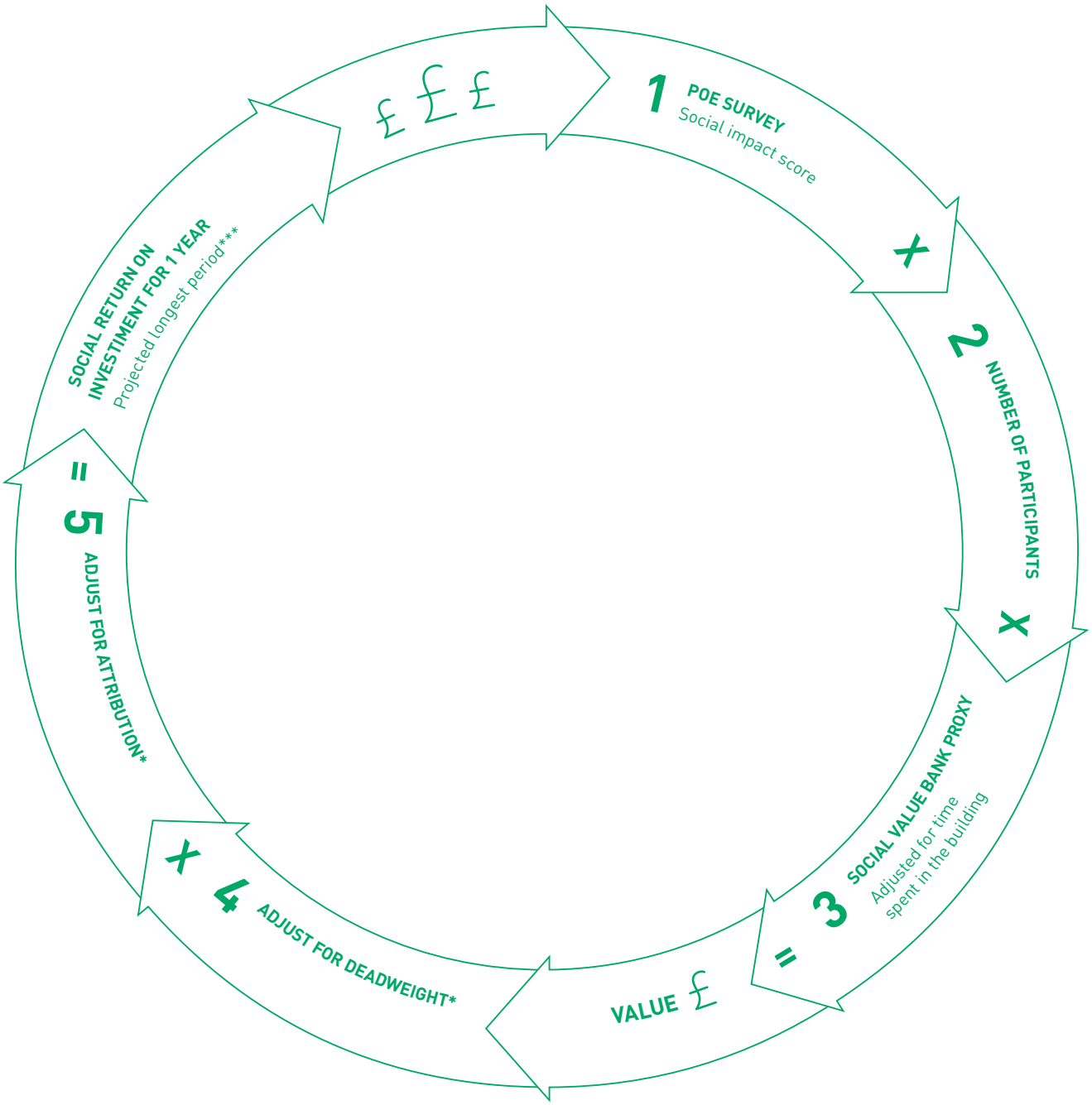
This valuation revealed the biophilic scenarios obtained the highest monetary value. The immersive scenario was valued at approximately £28,288 and the typical scenario was valued at £23,440, before accounting for costs. This is stark compared to the £11,627 valuation of the existing space.

Next, we identified the net financial gain of having a biophilic scenario, by subtracting the costs of delivering each environment from the monetised value of the spatial interventions.

Even when accounting for costs, the biophilic interventions were significantly more valuable monetarily than the non-biophilic scenario. This valuation is an effective tool in communicating with clients and investors about the value of holistic, quality space.

The scores were translated to monetised values to be used in commercial decision making, and to increase more awareness of the well-being and environmental impacts.

This finding offers an incentive for an organisation to embrace a more people-centric biophilic workplace for its employees and clients.



This generates a final impact figure (adjusted for deadweight and attribution) for that social outcome.

Source: Joyce Chan-Schoof

Financial

The data to prove how buildings and design are nurturing is vital for this POE to be successful.

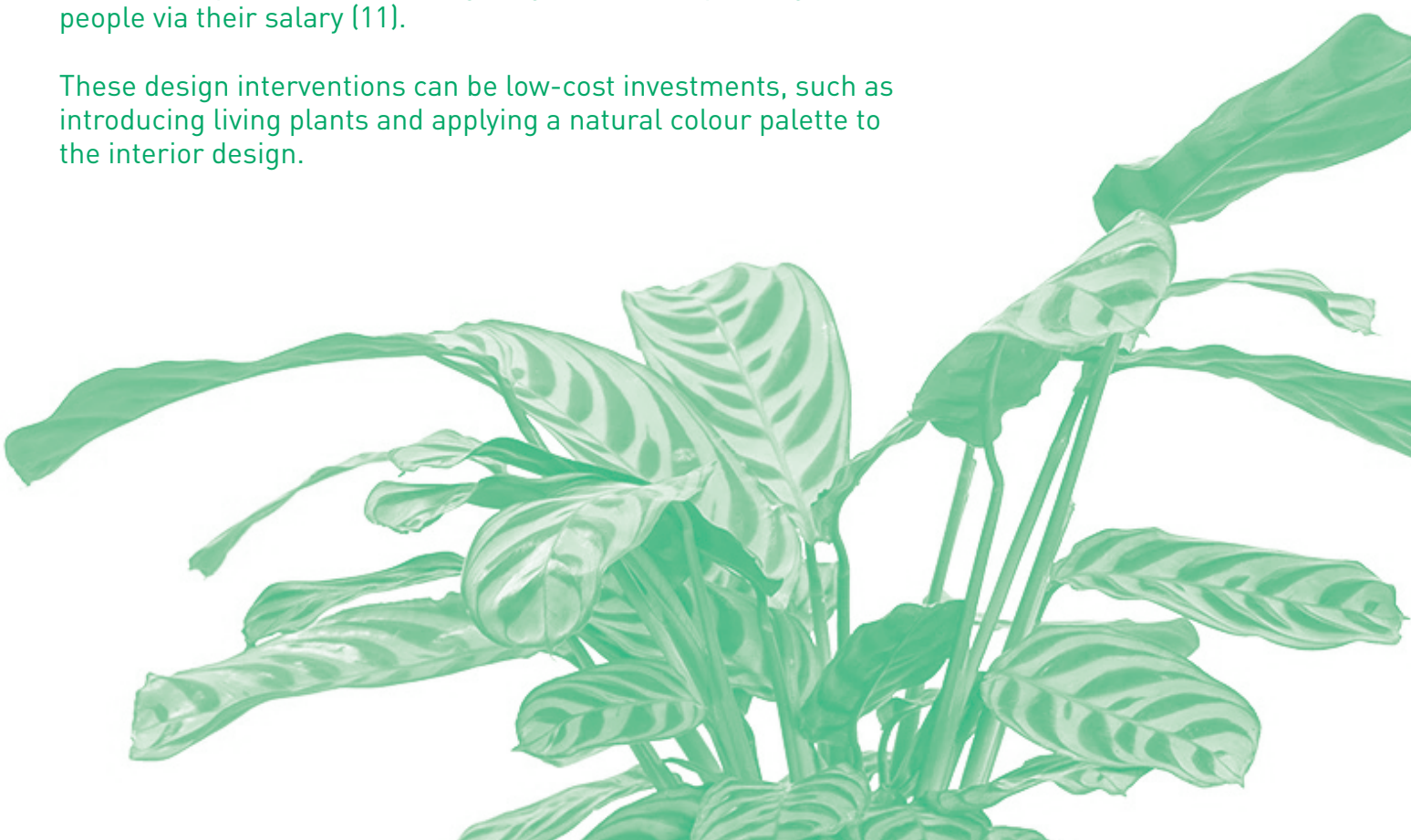
"Without data, we will not be able to prove the business case for biophilic design. We want to make a more direct link upfront to the budget planning stage of the design brief so that companies start having biophilic design in their projects. It will win half the battle for design teams because you will not have to negotiate once the design is finished to introduce biophilia – it would have been integrated into the process" – Joyce Chan

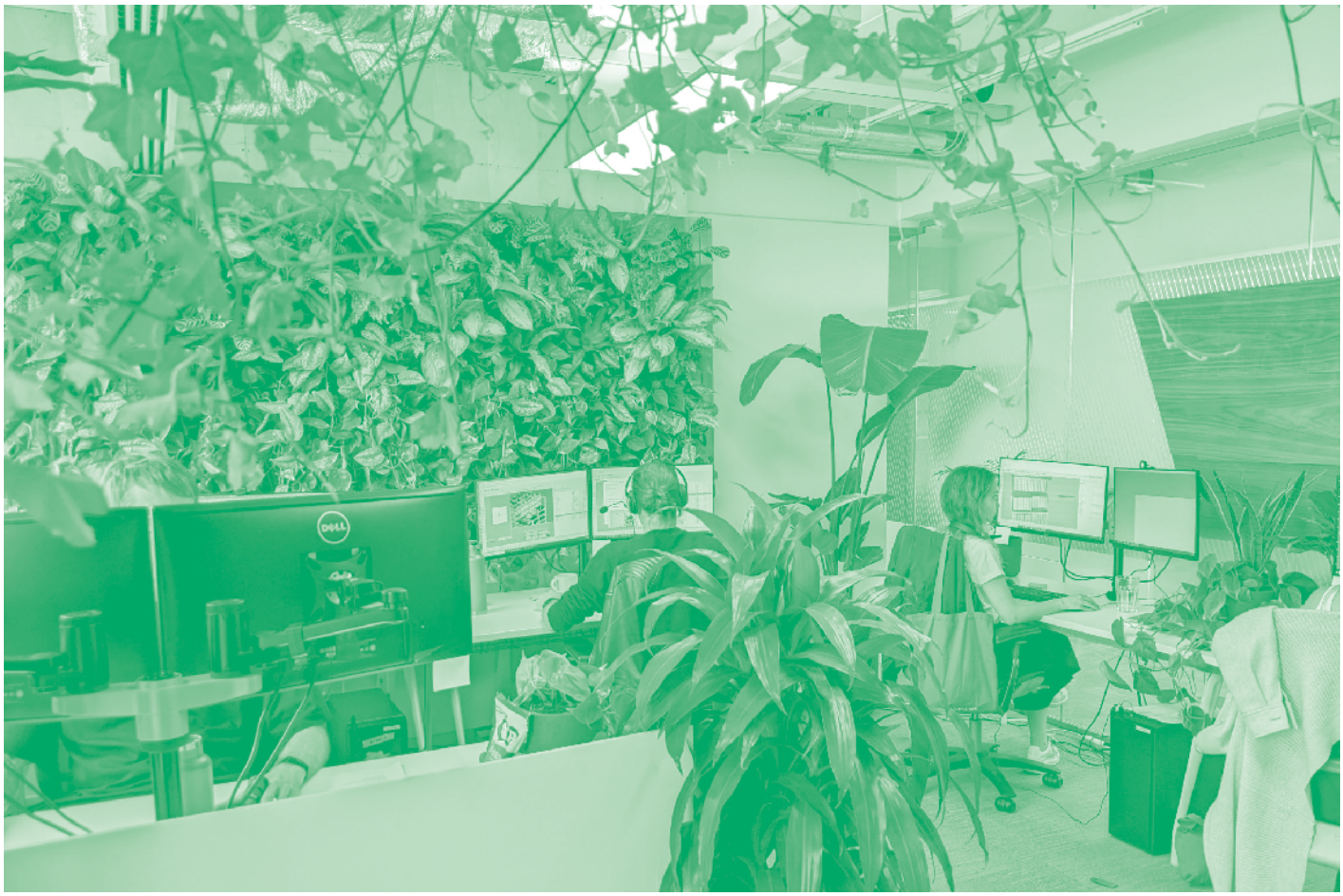
11. UKGBC, 2016; 2020b.

Biophilic design can potentially generate a major return on investment from even minor increases in employees' performance.

Because 90 percent of an average organisation's spending is on people via their salary (11).

These design interventions can be low-cost investments, such as introducing living plants and applying a natural colour palette to the interior design.





The study illustrated that an evaluation can establish non-financial benefits of the quality of biophilic design, however, its application in practice is not widespread. Given the introduction of wearables in the office and smart buildings, it will only become easier to collect data on the environment and human performance to make this argument going forward.

This pilot study sets up the first steps for a new POE methodology. This type of method puts people's health and well-being at the forefront of design. Beyond monetarily valuing the health of the building inhabitants, this perspective shift demonstrates to clients that their tenant's needs are both important and considered through building and space design. There is a clear advantage for architects and designers to adapt this perspective as well given that people love to think their needs are cared for, which may result in stronger and trusting client relationships.

If we integrate biophilia into the design process early and earmark investment for it, then the architectural design and mechanical, electrical, and plumbing (MEP) of the building can accommodate the plant life. We know plants affect building conditions like humidity and/or air flow, therefore these conditions need to be accounted for in the structural design of the building. Whereas, if the investment for these aspects is not secured, investors will likely need to design and spend on an MEP system later on or settle for spaces that are likely to be uninteresting, unhealthy, and plant-free to not harm the building's internal structure.

PLP In-house Pilot Study Monetary Outcomes

Monetisation				
Step 1	WEMWBS Score (Well-Being)			
	Access to natural light			
	Environment Quality			
	Access to nature			
	Focus on work and rest			
	Perceived productivity			
	Number of participants			
Step 2	Financial proxies for the well-being value			
	Financial proxies for the environmental value			
Step 3	Adjust for deadweight (deduct 27%)			
Step 4	Capital investment	**Existing**	**Immersive**	**Typical**
Net Value	Well-being value: Life satisfaction	£10,449	£12,648	£10,257
	Environment Value: Access to nature, light & environmental quality	£1,178	£15,640	£13,183
	Cost & benefits analysis	£11,627	£16,830	£22,211

The monetisation of biophilic design is an new area of research, it is yet to be peer reviewed. This Valuing Biophilic Workplace Model is referred to the UK's HM Treasury Green Book, 2022.

Source: Joyce Chan-Schoof

Ultimately, considering the health and well-being aspect of building design is beneficial for everyone involved, from the inhabitants to the designers and clients. In this consideration, facilities management and POE are vital to maintain a good relationship between building performance and the occupant, plus providing sustainability and well-being credentials which are likely to be more mandatory in the coming years. It is also certainly attractive to clients, as a building which enhances its inhabitants cognitive functioning, mood, and health is a valuable investment and through upkeep it is likely not to deprecate.

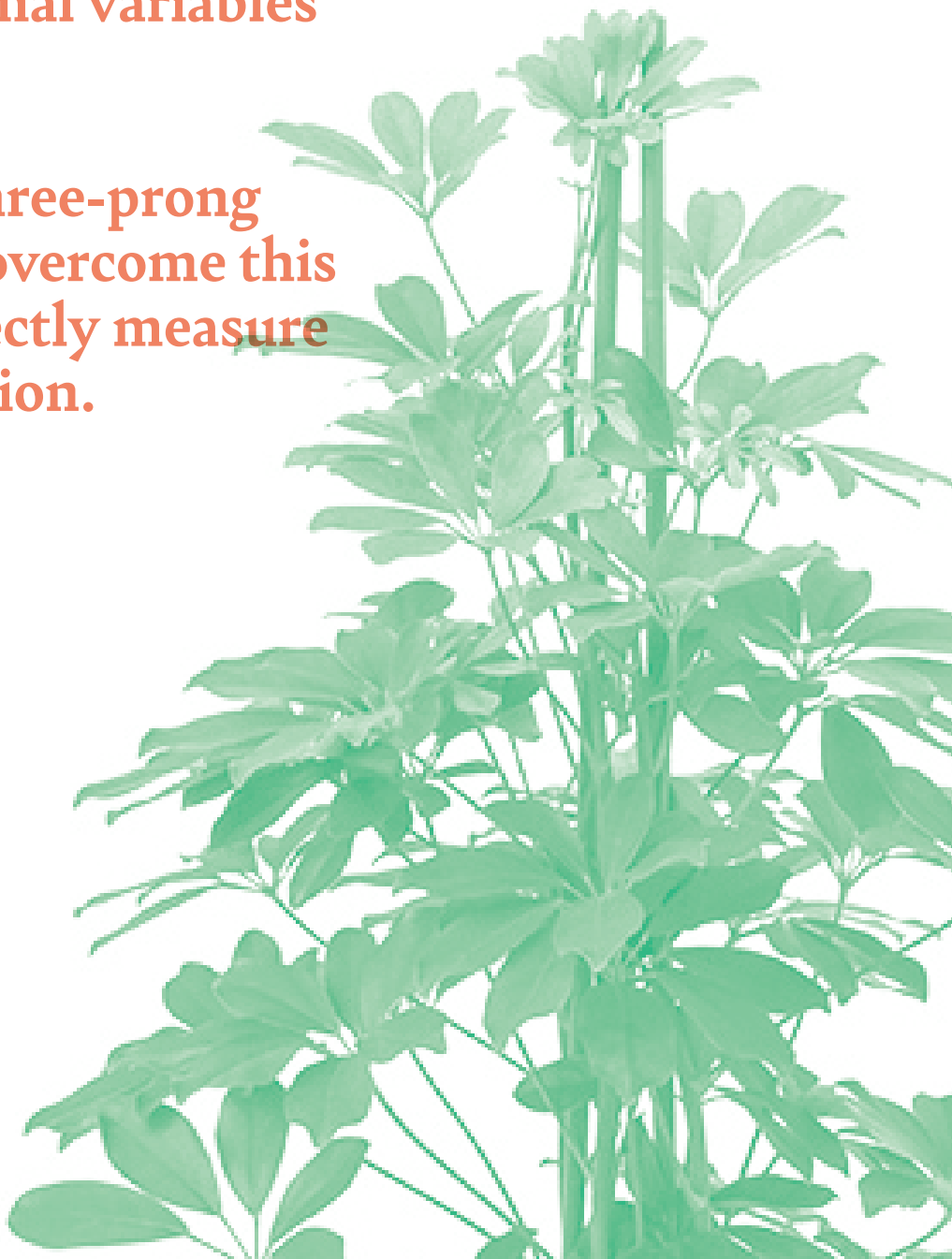
The balance sheet provides evidence on the importance of tangible access to nature.

There are methods to, and value in, consistently valuing these types of people-centric outcomes.

The designer must verify that the intervention, alone, is a significant factor in the increase of life satisfaction through a pre- and post-occupancy evaluation.

This must be a diligent process, to avoid accidently attributing the life satisfaction to other external and internal variables during the study.

We developed a three-prong approach to help overcome this challenge and directly measure one sole intervention.



1 Reference the specific intervention and ask about its direct effect in the survey, so that designers can identify to what extent their spatial design affects occupants' wellbeing.

Attribution is a measure of how much of the impact is caused by the intervention in question, rather than other factors.

2 Consider what would have happened regardless of the intervention. Deadweight is also a measure that can be used to adjust the outcome. The UK Government provides some suggested deadweight measures to be subtracted for each proxy.

3 Treat time spent in the physical workplace as a critical factor. For example, 50% deduction of Well-being Value if an employee only works 2.5 days a week.

Although most case studies use six to 12 months of data after the completion of a project, for impact, it is best to take a whole-life approach to value and consider the longer-term impact.

For example, a case study of two student accommodation buildings demonstrated that a total of £1.18 million of social value was generated in the first year. The value takes into consideration the value of a person's increased social interaction or from living next to open spaces. The final impact figure used a 20-year lifetime it accumulated to a total of £17.9 million (12).

12. HLM, 2020.

Conclusion

Above all, this study establishes that our surroundings are indivisible from health & well-being.

We presented our in-house pilot study to demonstrate the value of well-being by design, which uses a new value-based approach to capture its economic benefits and is ripe for further testing.

By using subjective and objective measurements, it is possible to create a financial proxy for well-being. Although the evaluation process can be complex, the outcome can be condensed into a single monetised figure. This price point allows commercial decision-making to compare spatial scenarios more holistically and accurately.

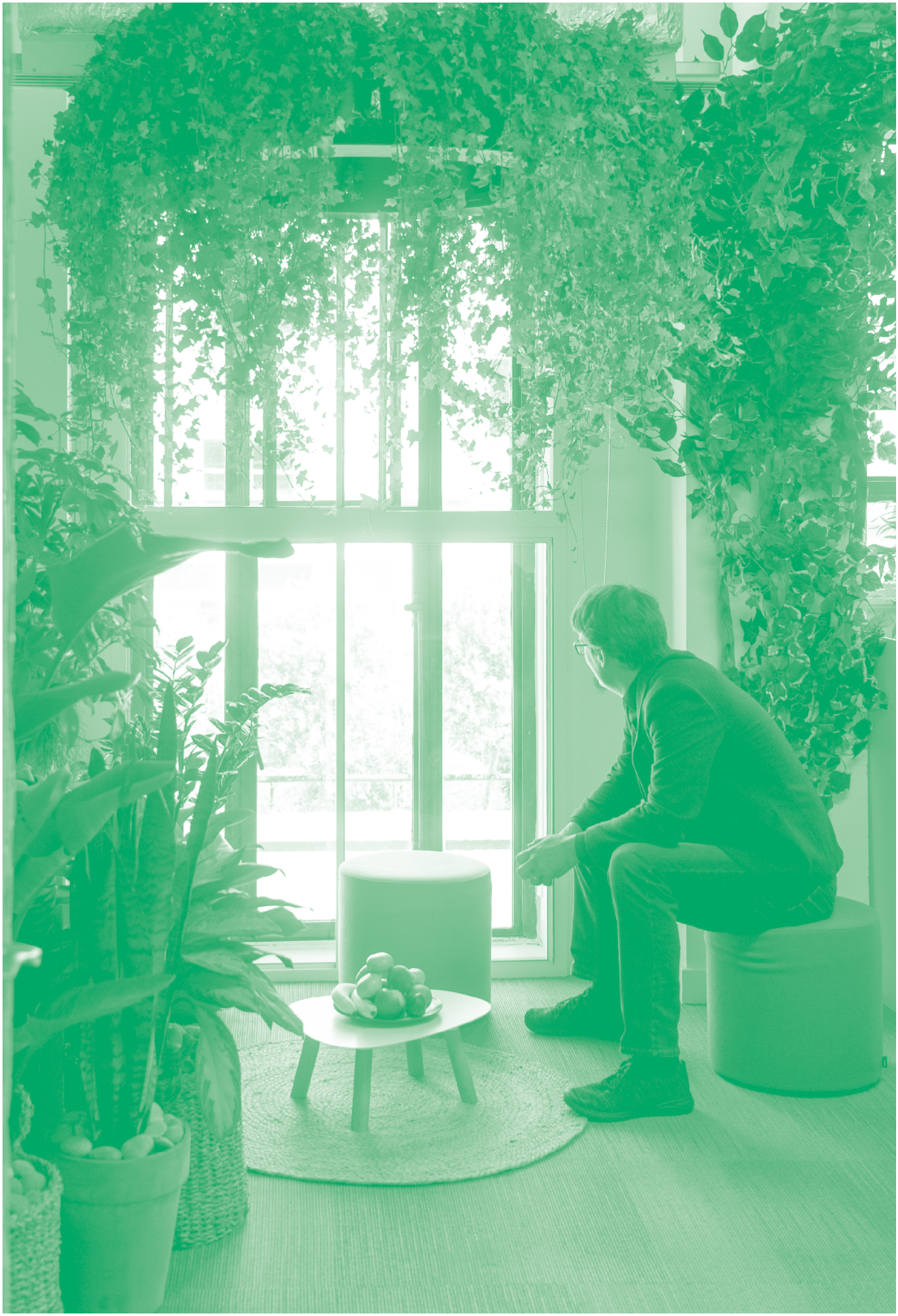
Finally, we provided a business case that is tailored to designers. Biophilic design has a tangible impact on employee productivity, retention absenteeism, satisfaction, and engagements. Given the extensive costs associated with talent, there are great economic benefits to be reaped from a healthier and happier staff. By extension to this argumentation, we provided a three-prong approach to generate economic values for spatial and environmental design.

A healthy environment elevates well-being and increases occupants' work engagement, in terms of creativity, relaxation, and concentration to name a few, which have direct monetary benefits.

As designers, the way we communicate these benefits of biophilic design is just as important as the methodology to study and value its benefits.

By valuing people-centric outcomes, we can encourage commercial decision-makers and by extension, the rest of the building sector, to create healthier and happier places. Places that encourage attention, productivity, creativity, and decrease stress are critical to both offices and employers.

If our workplaces are truly to be places of productive and thoughtful work, it is time we start designing and valuing them as such.



Key Take Aways

Clients & Investors:

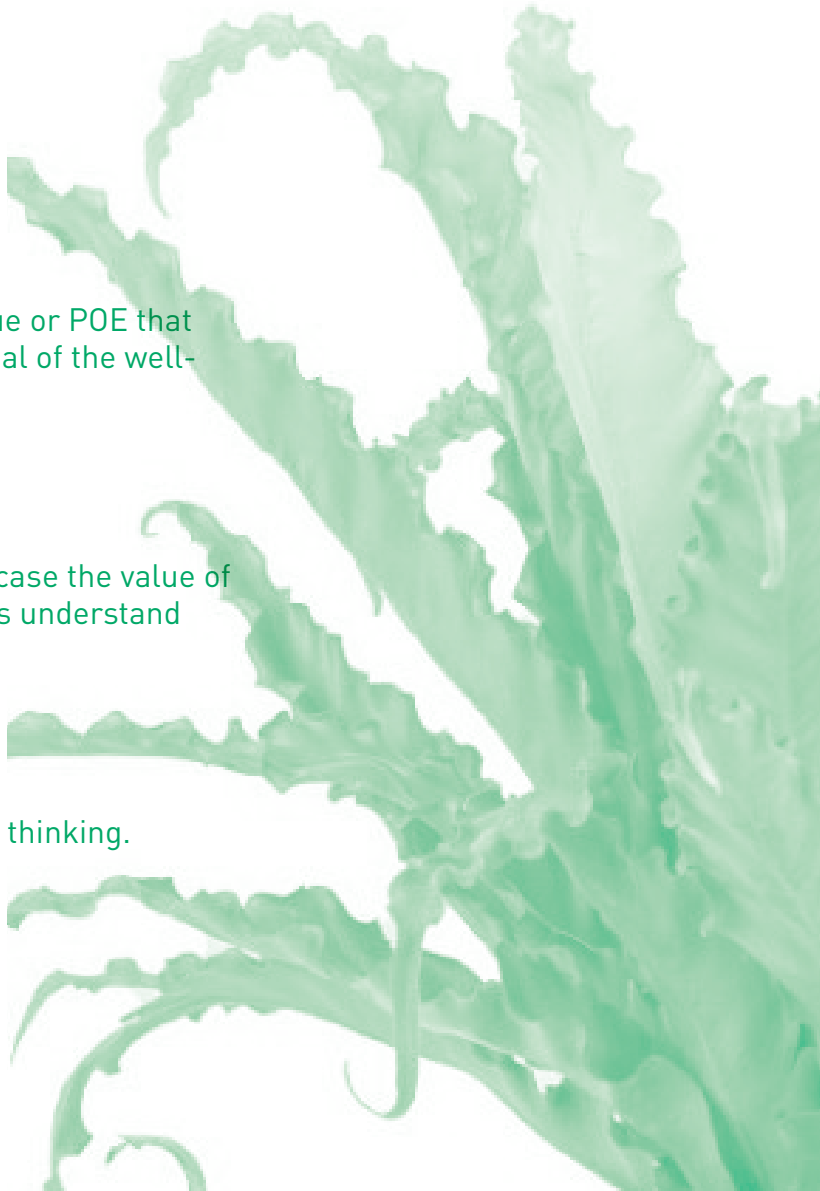
Associate biophilic design with a monetary value or POE that communicates the long-term value and potential of the well-being economy.

Designers:

Use this framework to communicate and showcase the value of biophilic design in a language that stakeholders understand and value.

Building Occupants:

Understand well-being to be the core of design thinking.



Authors & Collaborators

PLP Labs

Is a design research collaborative operating at the intersection of technology, culture and space. We investigate possibilities and define solutions for tomorrow's cities. We collaborate with leading experts from around the world and across a wide spectrum of disciplines to offer an expanded range of knowledge-based services.

Benholm Group

An industry leader, Benholm Group has become a go-to resource for planting design that pushes the boundaries of creativity thanks to an experienced team that live the company culture of being ceative, having a can-do attitude, and being caring.

Loughborough University

Joyce is a PhD Researcher at the Design School of Loughborough University. This case study is part of her doctoral field-study to develop a Valuing Biophilic Model to make a business case for human-centric design. She an Architect with two decades of experience in sustainable design; She is currently the Sustainability Lead of the UK Parliament's Design Authority. She is passionate about bring research into practice.

Reading University

Professor Clements-Croome is an Emeritus Professor in the School of The Built Environment at the University of Reading in Architectural Engineering research. His projects focus on the impact of wearables on office workers, and health and mental wellbeing in the workplace. Professor Derek Clements-Croome has co-authored numerous pieces reports and guidance.


Biophilia - Love of Life

Adamsson, M., Laike, T., Morita, T. (2018), Seasonal Variation in Bright Daylight Exposure, Mood and Behaviour among a Group of Office Workers in Sweden. Journal of Circadian Rhythms, 16(1), 1–17.
https://doi.org/10.5334/jcr.153

Allen, J. G., MacNaughton, P., Laurent, J. G. C., Flanigan, S. S., Eitland, E. S., Spengler, J. D. (2015), Green Buildings and Health. In Current environmental health reports.
https://doi.org/10.1007/s40572-015-0063-y

Ancona, Z. H., Bagstad, K. J., Le, L., Semmens, D. J., Sherrouse, B. C., Murray, G., Cook, P. S., DiDonato, E. (2022), Spatial social value distributions for multiple user groups in a coastal national park. Ocean & Coastal Management, 222(June 2021), 106126.
https://doi.org/10.1016/j.ocecoaman. 2022.106126

Anielski, M. (2018), An Economy of Well-Being: Common-sense tools for building genuine wealth and Happiness. New Society Publishers.

Arslan, M., Kalaylioglu, Z., Ekren, E. (2018), Use of medicinal and aromatic plants in therapeutic gardens. Indian Journal of Pharmaceutical Education and Research, 52(4), S151–S154.
https://doi.org/10.5530/ijper.52.4s.92

Arteaga, B. (2018), Wellness Matters. British Council for Offices (BCO), 91(1), 14–16.
http://search.proquest.com.ezproxy.library.yorku.ca/docview/1018483389?accountid=15182%5Cnhttp://sfx.scholarsportal.info/york?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&genre=article&sid=ProQ:ProQ:ericshell&atitle=Wellness+Matters&title=

Ayuso Sanchez, J., Ikaga, T., Vega Sanchez, S. (2018), Quantitative improvement in workplace performance through biophilic design: A pilot experiment case study. Energy and Buildings, 177, 316–328.
https://doi.org/10.1016/j.enbuild.2018.07.065

Balling, J. D., & Falk, J. H. (1982). Development of visual preferences for natural environments. Environment and Behavior, 14(5), 5-28.

Balling, J. D., & Falk, J. H. (2010). Evolutionary Influence on Human Landscape Preference. Environment and Behavior, 42, 479-493.

Benoit-Norris, C. (2013), The Methodological Sheets for Sub - Categories in Social Life Cycle assessment (S-Lca). Pre Publication- Version. The Methodological Sheets for Subcategories in Social Life Cycle Assessment (S-LCA).
https://doi.org/10.1007/978-1- 4419-8825-6

Berger, H. (1929), EEG: Über das Elektrenkephalogramm des Menschen. Archiv Für Psychiatrie Und Nervenkrankheiten, 94(1), 16–60.
https://doi.org/10.1007/BF01835097

Bradley, M. M., Lang, P. J. (1994), Measuring emotion: The self-assessment manikin and the semantic differential. Journal of Behaviour Therapy and Experimental Psychiatry, 25(1), 49–59.
https://doi.org/10.1016/0005-7916(94)90063-9

Brey, P. (2015), Design for the Value of Human Well-Being. Handbook of Ethics, Values, and Technological Design. Sources, Theory, Values and Application Domains. Springer, 365– 382.

British Council for Offices (2021). Use of Wearables in the Offices – Review and Examples in Practice.

Brown, L., Grundlehner, B., Penders, J. (2011), Towards wireless emotional valence detection from EEG. Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS, 2188–2191.
https://doi.org/10.1109/IEMBS.2011.6090412

Browning, W. D., Ryan, C. O. (2020), Nature Inside: A Biophilic Design Guide. Routledge, RIBA Publication.

Callway, R., Farrelly, L., Samuel, F. (2019), The Value of Design and The Role of Architects. Architects Council of Europe, March.

Carney, M. (2021), Value(s) : building a better world for all.

Chan-Schoof et.al. (2022), The Well-being Effects of Biophilic Design in Workplaces: A Value-Based Approach, 3rd TWR Conference proceeding.
http://www.twrnetwork.org/wp-content/uploads/2022/11/TWR-III-Proceedings.pdf

Clements-Croome, D. (2020), Designing Buildings for People: Sustainable liveable architecture. In The Crowood Press.

Clements-Croome, D., Chan, J. (2021), Use of Wearables in the Office. BCO, April. Celements-Croome, D., Chan-Schoof, S., PLP Architecture, and Winata ,P. (2021), Use of Wearables in the Office – A Review and Examples in Practice

Clements-Croome, D., Turner, B., Pallaris, K. (2019), Flourishing workplaces: a multisensory approach to design and POE. Intelligent Buildings International, January.
https://doi.org/10.1080/17508975.2019.1569491

Cooper, C., Browning, W., (2015) Human Spaces: The Global Impact of Biophilic Design in the Workplace
http://humanspaces.com and
http://humanspaces.com/global-report/keymessages/).

Durosaiye, I. O., Hadjri, K., Liyanage, C. L. (2019), A critique of post-occupancy evaluation in the UK. Journal of Housing and the Built Environment, 34(1), 345–352.
https://doi.org/10.1007/s10901-019-09646-2

Ekman, P. (2016), What Scientists Who Study Emotion Agree About. d.
https://doi.org/10.1177/1745691615596992

Elsadek, M., Liu, B. (2020), Effects of viewing flowering plants on employees' wellbeing in an office-like environment. Indoor and Built Environment, 0(1239), 1–12.
https://doi.org/10.1177/1420326X20942572

Fjeld, T., Veiersted, B., Sandvik, L., Riise, G., Levy, F. (1998), The Effect of Indoor Foliage Plants on Health and Discomfort Symptoms among Office Workers. Indoor and Built Environment, 7(4), 204–209.
https://doi.org/10.1159/000024583

Flora Samuel (2019), Social Value Toolkit for Architecture Research Practice Leads 2019. Research Practice Leads.

Fromm, E. (1974), The Anatomy of Human Destructiveness. Contemporary Sociology, 3(6), 513. https://doi.org/10.2307/2063568

Fujiwara, D., Dass, D. (2021), Life Satisfaction in Discrete Choice Experiments. 0–12.

Gartner (2018), Wearables Hold the Key to Connected Health Monitoring - Smarter With Gartner. Gartner Research.
https://www.gartner.com/smarterwithgartner/wearables-holdthe-key-to-connected-health-monitoring/

Gillis, K., Gatersleben, B. (2015), A review of psychological literature on the health and wellbeing benefits of biophilic design. In Buildings.
https://doi.org/10.3390/buildings5030948

Glasgow, T. E., Le, H. T. K., Scott Geller, E., Fan, Y., Hankey, S. (2019), How transport modes, the built and natural environments, and activities influence mood: A GPS smartphone app study. Journal of Environmental Psychology, 66(May), 101345.
https://doi.org/10.1016/j.jenvp.2019.101345

HACT (2016), Social Value and Procurement. A Toolkit for Housing providers and Contractors.

HACT (2018), "Valuing Improvements in Mental Health."
http://www.hact.org.uk/sites/default/files/uploads/Project Proposals/WEMWBS Proposal.pdf

Hay, R., Samuel, F., Watson, K. J., Bradbury, S. (2018), Post-occupancy evaluation in architecture: experiences and perspectives from UK practice. Building Research & Information, 46(6), 698–710.
https://doi.org/10.1080/09613218.2017.1314692

Heerwagen, J., Loftness, V., Painter, S. (2012), The Economics of Biophilia. Terrapin Bright Green, LLC, 1–40.

Heschong, L. (2021), Visual delight in architecture: daylight, vision, and view. Routledge.
https://www.routledge.com/Visual-Delight-in-Architecture-Daylight-Vision-and-View/Heschong/p/book/9780367563233

HLM (2020), Social Impact Report for the University of St Andrews Halls of Residence (Issue February).

HM Treasury (2020), Central Government Guidance on Appraisal and Evaluation. In The Green Book.

Homes & Communities Agency, U. G. (HCA) (2014), Additionality Guide (4th Edition).

Kalantari, S., & Shepley, M. (2020). Psychological and social impacts of high-rise buildings: a review of the post-occupancy evaluation literature. Housing Studies, 0(0), 1–30. https://doi.org/10.1080/02673037.2020.1752630

Kellert, S. R. (2018a), Nature by design: The practice of biophilic design. Nature by Design: The Practice of Biophilic Design, 1–214.

Kellert, S. R. (2018b), Nature by design: The practice of biophilic design. Nature by Design: The Practice of Biophilic Design, 1–214.

Kirschbaum, C., Pirke, K. M., Hellhammer, D. H. (1993), The "Trier social stress test" - A tool for investigating psychobiological stress responses in a laboratory setting. Neuropsychobiology. https://doi.org/10.1159/000119004

Li, P., Froese, T. M., Brager, G. (2018), Post-occupancy evaluation: State-of-the-art analysis and state-of-the-practice review. Building and Environment, 133(December 2017), 187– 202. https://doi.org/10.1016/j.buildenv.2018.02.024

Lindsay, C., Ball, P., Harper, M., Mussella, M., Lowe, J., Rowlatt, A. (2021a), Wellbeing discussion paper: monetisation of life satisfaction effect sizes. July.

Lindsay, C., Ball, P., Harper, M., Mussella, M., Lowe, J., Rowlatt, A. (2021b), Wellbeing Guidance for Appraisal: Supplementary Green Book Guidance. July.

Maltseva, K. (2020), Wearables in the workplace: The brave new world of employee engagement. Business Horizons, 63(4), 493–505. https://doi.org/10.1016/j.bushor.2020.03.007

Margaret M., Bradley, P. J. L. (1994), Measuring Emotion: The Self-Assessment Manikin and The Semantic Differential. Klinische Wochenschrift, 68(13), 678–684. https://doi.org/10.1007/BF01667016

Matlovic, T., Gaspar, P., Moro, R., Simko, J., Bielikova, M. (2016), Emotions detection using facial expressions recognition and EEG. Proceedings - 11th International Workshop on Semantic and Social Media Adaptation and Personalization, SMAP 2016, October, 18–23. https://doi.org/10.1109/SMAP.2016.7753378

McCarthy, S. (2018), Social Value and Design of the Built Environment. Supply Chain Sustainability School, 54.

OECD (2019), The Economy of Well-Being - OECD. The Organisation for Economic Co-Operation and Development. https://www.oecd.org/about/secretary-general/the-economyof-well-being-iceland-september-2019.htm

Oseland, N. (2018), Building Performance Evaluation, Chapter 2, From POE to BPE: The Next Era. https://doi.org/10.1007/978-3-319-56862-1

Pencheon, D. (2015), Making health care more sustainable: the case of the English NHS. Public Health, 129(10), 1335–1343. https://doi.org/10.1016/J.PUHE.2015.08.010

Pritchard, I., Brindley, R., Schagemann, R., Samuel, F. (2019), The Value of Design and the Role of Architects. March.

Raworth, K. (2017), Doughnut economics: seven ways to think like a 21st-century economist. London: Random House.

RIBA (2020a), Post occupancy evaluation: An essential tool to improve the built environment. In architecture.com https://doi.org/10.4324/9780080518251

RIBA (2020b), Social Value Toolkit for Architecture.

Samuel, F. (2020), Social Value Toolkit for Architecture.

Samuel, F., Hatleskog, E. (2020), Why Social Value? Architectural Design, 90(4), 6–13. https://doi.org/10.1002/ad.2584

Seppälä, A., Nykänen, P., Ruotsalainen, P. (2012), Development of personal wellness information model for pervasive healthcare. Journal of Computer Networks and Communications, 2012. https://doi.org/10.1155/2012/596749

Smedt, T. De, Menschaert, L. (2012), Valence: affective visualisation using EEG Valence: affective visualisation using EEG. 6268. https://doi.org/10.1080/14626268.2012.719240

Snow, S., Boyson, A. S., Paas, K. H. W., Gough, H., King, M. F., Barlow, J., Noakes, C. J., Schraefel, M. C. (2019), Exploring the physiological, neurophysiological and cognitive performance effects of elevated carbon dioxide concentrations indoors. Building and Environment. https://doi.org/10.1016/j.buildenv.2019.04.010

Taub, M., Lockhart, V., Clements-Croome, D. (2016), Wearables in The Workplace. In BCO (Issue October).

Tennant, R., Hiller, L., Fishwick, R., Platt, S., Joseph, S., Weich, S., Parkinson, J., Secker, J., Stewart-Brown, S. (2007), The Warwick-Edinburgh Mental Well-Being Scale. Health and Quality Of, 2007. https://doi.org/10.1186/1477-7525-5-63

TOMs (2012), The Social Value Portal. July 2019, 1–14.

Trotter, L. (2014), Social Value Bank. October.

UK Green Building Council (2016), Uk-Gbc Wellbeing Lab: Offices. www.ukgbc.org

UKGBC (2020a), Delivering Social Value : Measurement (Issue April).

UKGBC (2020b), Driving social value through real assets. April.

UKGBC (2020c), Driving social value through real assets (Issue April).

UKGBC (2021), Framework for Defining Social Value (Issue February).

Wang, B., Zhao, C., Wang, Z., Yang, K. A., Cheng, X., Liu, W., Yu, W., Lin, S., Zhao, Y., Cheung, K. M., Lin, H., Hojaiji, H., Weiss, P. S., Stojanović, M. N., Tomiyama, A. J., Andrews, A. M., Emaminejad, S. (2022), Wearable aptamer-field-effect transistor sensing system for noninvasive cortisol monitoring. Science Advances, 8(1), 1–16. https://doi.org/10.1126/sciadv.abk0967

Watson, K. J. (2017), Developing wellbeing valuation practices in the built environment. CIBSE ASHRAE Technical Symposium, April, 1–12. https://www.researchgate.net/publication/318419242_Developing_wellbeing_valuation_practices_in_the_built_environment

Watson, K. J., Whitley, T. (2017), Applying Social Return on Investment (SROI) to the built environment. Building Research and Information, 45(8), 875–891. https://doi.org/10.1080/09613218.2016.1223486

WGBC (2021), Beyond the business case: Why you can't afford NOT to invest in a sustainable built environment.

Wilson, O. E. (1984), Biophilia.

Wilson, E. O. (2018) The origins of creativity. New York: Liveright Publishing Corporation.

Wilson, F., (1984), A Graphic Survey of Perception and Behaviour for the Design Professions, New York: Van Nostrand Reinhold.

Xue, F., Lau, S. S. Y., Gou, Z., Song, Y., Jiang, B. (2019), Incorporating biophilia into green building rating tools for promoting health and wellbeing. Environmental Impact Assessment Review. https://doi.org/10.1016/j.eiar.2019.02.004

Yin, J, et, (2018), Physiological and Cognitive Performance of Exposure to Biophilic Indoor Environment. Building and Environment, 132, Pp. 255-262.

Zhang, X. C., Kuchinke, L., Woud, M. L., Velten, J., Margraf, J. (2017), Survey method matters: Online/offline questionnaires and face-to-face or telephone interviews differ. Computers in Human Behaviour, 71, 172–180. https://doi.org/10.1016/j.chb.2017.02.006

Zimmerman, A., Martin, M. (2001), Post-occupancy evaluation: Benefits and barriers. Building Research and Information, 29(2), 168–174. https://doi.org/10.1080/09613210010016857

Ibex House
42-47 Minories
London EC3N 1DY

T +44 (0)20 3006 3900

www.plplabs.com
www.plparchitecture.com