stōk

THE FINANCIAL CASE FOR **HIGH PERFORMANCE BUILDINGS**

QUANTIFYING THE BOTTOM LINE OF IMPROVED PRODUCTIVITY, RETENTION, AND WELLNESS

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WELCOME

ABOUT THIS REPORT

Compiling and analyzing the growing body of evidence connecting the built environment to human performance, satisfaction, and wellness, this report outlines the financial benefits to owner-occupants and tenants that invest in High Performance Buildings.

ACKNOWLEDGEMENTS

This report is inspired by all of stok's partners that have helped co-create the next generation of High Performance Buildings together over the past decade. stok thanks its fellow thought leaders across industries for sharing their research and insights in support of this report. Lastly, this report would not be possible without the deep and diverse expertise of stok's team that is always striving for better.

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ABOUT STOK

Founded in 2008 with offices in San Francisco and Denver, stok provides value-aligned real estate services to developers, property owners, and corporations around the world. By integrating finance with design, engineering, and management services, stok optimizes the real estate design and development process, yielding cost savings and radically better projects.

stok's growing team of multidisciplinary professionals guides clients from early due diligence, site selection, and space acquisition through the process of financial analysis, project management, biophilic design, performance engineering, and building certification achievement. Through this integrated approach, stok has delivered accretive returns to more than 150M square feet of high performance real estate.

The stok team draws on decades of diverse industry experience and specialized technology, fostering an efficient, data-driven, and joyful approach to real estate.

Contact stok to discover how to develop High Performance Buildings. stok.com | hello@stok.com | @teamstok

ACRONYMS

HPB - High Performance Building
NPV - Net Present Value
OpEx - Operational Expenditure
SF - Square Foot

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Reference: Attema, J.E., Fowell, S.J., Macko, M.J., & Neilson, W.C. (2018). The Financial Case For High Performance Buildings. San Francisco: stok, LLC.

Cover image: Ronald Tilleman, The Edge (Deloitte Amsterdam office)

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"People should think things out fresh and not just accept conventional terms and the conventional way of doing things."
— R. BUCKMINSTER FULLER

1. EXECUTIVE SUMMARY

The business case for High Performance Buildings (HPBs) traditionally cites energy savings and increased asset value as the most appealing incentives. But another – and arguably greater – form of enhanced value creation that comes through HPBs is rarely discussed: HPBs benefit the people who occupy them, which in turn produces significant positive impacts on a company's bottom line.

This is a remarkable oversight, as companies make tremendous investments in employees by way of the design, construction, and operation of their workspaces, but don't often draw the full connection between employees and their space. This paper provides commercial real estate owner-occupants and tenants with metrics to evaluate the financial impact of HPBs on occupants.

By applying financial impact calculations to findings from over 60 robust research studies on the effect of HPBs in three key occupant impact areas (Productivity, Retention, and Wellness), this paper arrives at the financial impacts below to help owner-occupants and tenants quantify the benefits of investing in HPB strategies. The calculations assume a hypothetical company in a 150,000 square foot (SF) building or space, and an average 183 SF per person, totaling 820 employees.[1]

Because a first cost is required to calculate Net Present Value (NPV), stok assigns a $20 per SF cost premium for HPBs. This is a conservative assumption based on an analysis of research on the cost premium for HPBs to date (referenced in Section 3.2).[2]

Based on the analysis below, by designing for the occupant, owner-occupants and tenants can gain $3,395 per employee in annual profit, or $18.56 per SF in annual profit. This is an NPV of $21,172 per employee, or $115 per SF, over ten years, assuming the conservative $20 per SF cost premium stated above. This total only includes productivity, retention, and wellness findings. Include utility and maintenance savings, and the total NPV of HPBs results in $23,584 per employee, or $129 per SF, over ten years (Figure 1, Figure 2).

Although utility and maintenance cost savings are the most frequently cited benefit of HPBs, they offer some of the smallest financial value. As shown in this report, 43% of the total value comes from enhanced employee productivity, 41% from increased employee retention, 7% from improved employee wellness, 7% from utility savings, and 2% from maintenance savings. Given this breakdown, human-centered design should be a critical consideration when creating an HPB.

COMBINED BENEFITS PER HIGH PERFORMANCE BUILDING / SPACE*

DUE TO OCCUPANT PRODUCTIVITY, RETENTION, AND WELLNESS BENEFITS

$3,395

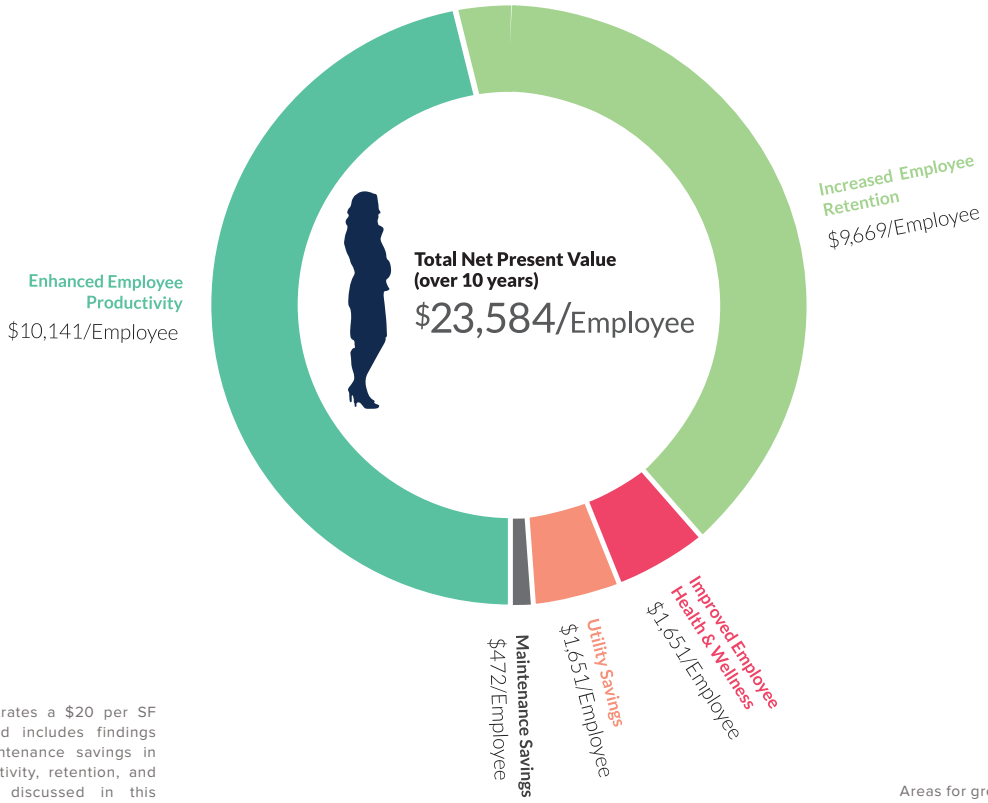
ANNUAL PROFIT PER EMPLOYEE

$18.56

ANNUAL PROFIT PER SQUARE FOOT

*Based on assumption of company in 150,000 SF building or tenant space, with 183 SF per employee. See Figure 8 (p. 9) for complete list of baseline assumptions in calculations.

NPV PER EMPLOYEE OVER 10 YEARS**

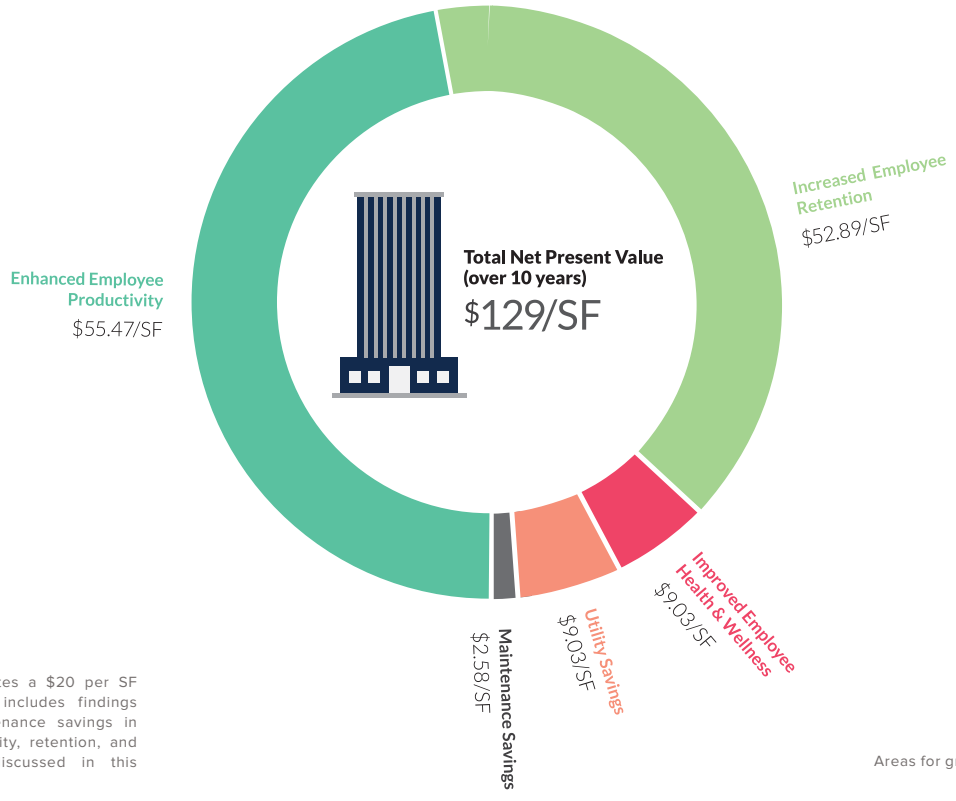


**Analysis demonstrates a $20 per SF cost premium[3] and includes findings of utility and maintenance savings in addition to productivity, retention, and wellness benefits discussed in this report.

FIGURE 1

Areas for greatest financial impact due to HPB benefits, per employee

NPV PER SQUARE FOOT OVER 10 YEARS**



**Analysis demonstrates a $20 per SF cost premium[4] and includes findings of utility and maintenance savings in addition to productivity, retention, and wellness benefits discussed in this report.

FIGURE 2

Areas for greatest financial impact due to HPB benefits, per SF

SENSITIVITY ANALYSIS

A sensitivity analysis was completed on the full data set. An analysis of the combined benefit of productivity, retention, and absenteeism at a cost premium of $20 per SF was determined to establish an NPV range (Table 1). Additionally, an analysis of low, mid, and high cost of HPB cost premiums was analyzed based on the estimate (mid) for productivity, retention, and absenteeism (Table 2). An NPV range including utility and maintenance savings was also calculated for both sensitivity analyses.

SENSITIVITY ANALYSIS: COMBINED BENEFIT

	LOW	ESTIMATE	HIGH
Cost premium[5]	$20/SF	$20/SF	$20/SF
Enhancement in productivity	1%	3%	9%
Reduction in separation rate (assuming baseline of 34% separation rate)	1%	5%	10%
Reduction in annual sick days	10%	30%	50%
Profit gained per employee	$928	$3,395	$8,328
Profit gained per SF	$5.07/SF	$18.56/SF	$45.52/SF
Total profit gained per HPB	$761K	$2.78M	$6.82M
NPV of profit gained per SF over 10 years	**$17/SF**	**$115/SF**	**$313/SF**
NPV of profit gained per SF over 10 years* **	**$30/SF**	**$129/SF**	**$326/SF**

***Including utility and maintenance savings
See Section 8. Endnotes for full list of sources

TABLE 1

Sensitivity analysis on cumulative benefit due to HPBs

SENSITIVITY ANALYSIS: COST PREMIUM

	LOW	ESTIMATE	HIGH
Cost premium	$5/SF	$20/SF	$50/SF
Enhancement in productivity	3%	3%	3%
Reduction in separation rate (assuming baseline of 34% separation rate)	5%	5%	5%
Reduction in annual sick days	30%	30%	30%
Profit gained per employee	$3,395	$3,395	$3,395
Profit gained per SF	$18.56/SF	$18.56/SF	$18.56/SF
Total profit gained per HPB	$2.78M	$2.78M	$2.78M
NPV of profit gained per SF over 10 years	**$131/SF**	**$115/SF**	**$86/SF**
NPV of profit gained per SF over 10 years* **	**$144/SF**	**$129/SF**	**$99/SF**

***Including utility and maintenance savings
See Section 8. Endnotes for full list of sources

TABLE 2

Sensitivity analysis on cost premiums of HPBs

2. INTRODUCTION

Employees spend at least 40 hours at the office each week, totaling 2080 hours every year, or about 1980 hours when adjusted for vacation and sick leave. Given the immense percentage of time that people spend at work, wanting a workplace that fosters productivity, happiness, and health seems logical. That desire is increasingly becoming a reality for millions of employees worldwide. Employers are rapidly realizing the need for greater investment in their most valuable asset – their people.

A growing body of research has emerged demonstrating the increasing importance of HPB design strategies for the occupant (Figure 3). This research has fueled the building discussion around people in the built environment and how to design for the occupant as a key component of HPB strategies. By combining productivity gains, reduced separation rates, and decreased absenteeism, the benefits of adopting HPB strategies for owner-occupants and tenants can be quantified.

While this paper focuses on owner-occupants and tenants, the advantages to investors for advancing HPBs will become even more obvious as occupants are better able to calculate and articulate the value of HPBs and begin demanding such assets from investors.[6]

THE MULTI-DIMENSIONAL IMPACT OF REAL ESTATE

Real estate is by far the dominant asset class globally, worth nearly 3 times the world's GDP.[7] At the same time, buildings account for over 40% of U.S. and E.U. energy consumption,[8] use nearly 14% of all potable water,[9] and create over 500 million tons of construction and demolition debris annually in the U.S. alone.[10] Beyond these financial and environmental impacts, humans spend 90% of their lives indoors.[11] With real estate at the nexus of global economics, environmental sustainability, and human health, investments in HPBs will generate multi-dimensional impact.

In addition, human environment and behavior make up 70% of what influences human health.[12] However, only approximately 10% of U.S. health spending is associated with improved human environment and behavior.[13] To address this, companies have two primary investment options:

1. Invest in extensive ongoing employee health and wellness programs for an average $700 per employee annually,[14] which tend to have poor participation and lack effectiveness.[15]

2. Make a one-time investment in HPB design and operating practices that passively provide a healthy environment as well as promote occupant well-being.

For these reasons, many owner-occupants and tenants are increasingly eschewing lower first cost, code-compliant construction and choosing to develop HPBs. In turn, HPBs deliver greater financial value, as well as a plethora of environmental and social benefits.

CUMULATIVE STUDIES OF KEY DESIGN ELEMENTS AFFECTING OCCUPANTS

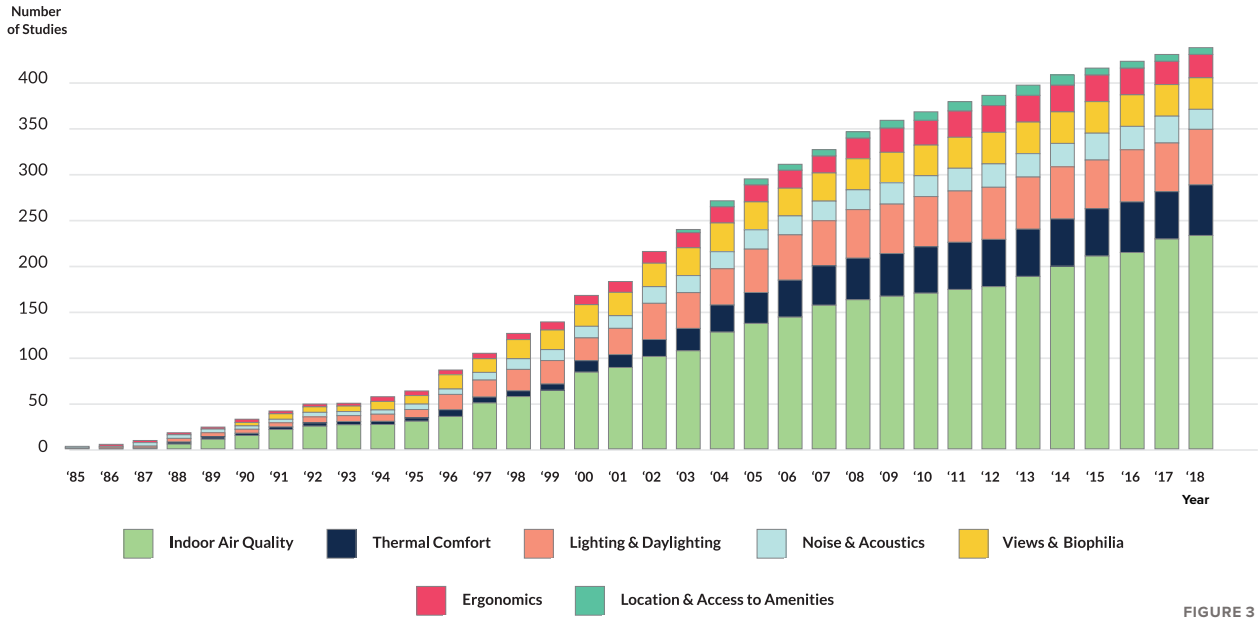


FIGURE 3

Growing body of evidence linking human productivity, satisfaction, and health to HPBs[16]

3. HIGH PERFORMANCE BUILDINGS: A NEW TAKE

3.1 COMPONENTS OF A HIGH PERFORMANCE BUILDING

Most people work in buildings that were not designed to support their well-being. They may have been created to house people, but cost was the driving force behind a majority, if not all, of design and construction decisions. In this traditional model, not only are resources wasted, but occupants suffer from poor indoor air quality, inadequate lighting, substandard acoustics, and unnatural spaces.

HPBs are based on an entirely different premise. They are buildings that, first and foremost, are designed to enhance the occupant experience. The structure fosters productivity, comfort, and health, all while reducing energy use and environmental impact. Essential design strategies for HPBs include, but are not limited to, indoor air quality and ventilation, thermal comfort, natural and artificial lighting attuned to circadian rhythms, noise and acoustics, active design, and views and biophilia.

Despite these key design strategies, there is no authoritative checklist that defines an HPB. HPB requirements are often communicated through various HPB rating systems including LEED, the WELL Building Standard, the Living Building Challenge, BREEAM, CASBEE, and Green Star, among others. Regardless of whether a space pursues certification, each building must be designed specifically for the needs of the occupant. These needs may include the tenant's business model, company culture, brand, and products or services. However, all HPBs do share some fundamental similarities.

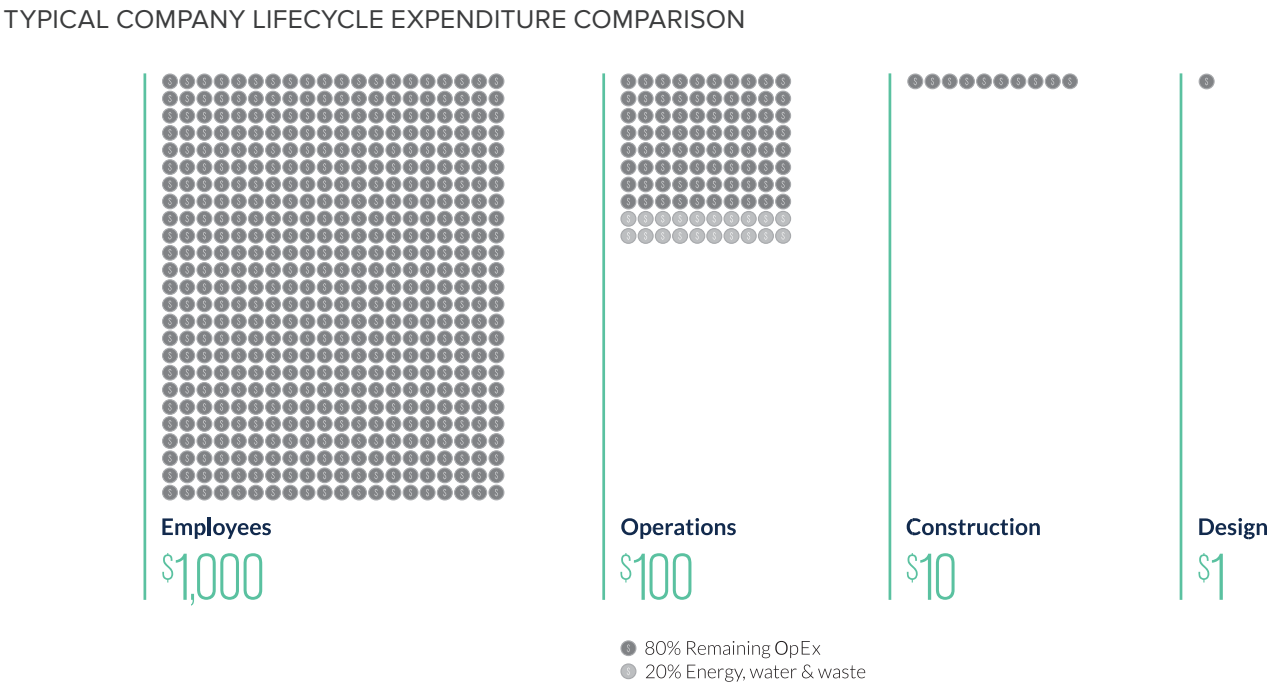


FIGURE 4

Typical company spend breakdown throughout real estate / space lifecycle, referred to as the 1-10-100-1000 phenomenon

HPBS DEFINED: THE FUNDAMENTALS

As defined by the National Institute of Building Sciences' High Performance Building Council, "HPBs, which address human, environmental, economic, and total societal impact, are the result of the application of the highest level design, construction, operation, and maintenance principles – a paradigm change for the built environment."[17]

While design decisions for traditional buildings are based on first cost, HPBs utilize life cycle cost thinking and are designed to enhance occupant experience and financial performance while mitigating the environmental impacts of traditional real estate.

WHAT MAKES A HIGH PERFORMANCE BUILDING?

Credit: Horizon Photography (The Bullitt Center)

Enhanced occupant experience

Thoughtfully embedding human health, wellness, and comfort into every aspect of the design, construction, and operations of a building or space within a building.


Credit: Benjamin Benschneider (Federal Center South Building 1202)

Optimized resource efficiency

Providing greater value with less input by using the Earth's finite resources without risking the future generation's ability to utilize those same resources.


Credit: Nic Lehoux (Bullitt Center)

Minimized environmental impacts

Using strategies from design to demolition that significantly reduce or eliminate negative impacts on the natural environment without jeopardizing the intention or function of the building.


Credit: Shutterstock

Embedded resiliency

Building in the capacity for spaces, buildings, landscapes, communities, and regions to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance.


Credit: Unsplash

Improved financial performance

Delivering a higher financial return than traditional buildings of the same use type due to thoughtful integration of sustainable design principles.

FIGURE 5

Components of a High Performance Building (HPB)

3.2 REDEFINING VALUE: A NEW WAY TO LOOK AT COST

A SMARTER WAY TO MAKE COMMERCIAL REAL ESTATE DECISIONS

While the upfront cost to build an HPB may appear greater than a traditional building, low-cost construction options can stifle performance and will soon be obsolete. HPBs, on the other hand, provide thriving and healthy workplaces, which are only increasing in demand.

Rather than focusing on the lowest costs possible, owner-occupants and tenants should shift their perspective to the long-term opportunities of HPBs. Today, the lower the value to an occupant, the higher the risk for owner-occupants of holding an asset that, over time, will decrease in demand, and thus in value. The same is true for tenants, as a significant amount of financial benefits can accrue from an HPB tenant improvement in an existing building.

FIRST COST PLAYS A SMALL ROLE IN TOTAL COSTS

Annualizing the cost of a building, multiple reports show only 1% to 4% of the total price goes towards the initial design and construction. For the other costs, a company will spend 80% to 92% on people in the form of wages and benefits,[18] and 6% to 15% on operations and maintenance (Figure 6).[19]

Because HPBs enhance productivity, increase retention, and improve employee health and wellness, as well as cut operating expenses and improve resiliency, they bring in a larger return over the life of the investment.

Ultimately, no matter the cost to build an HPB, the continuous benefits are large enough to outweigh the initial cost over the life of the investment.[20] The analysis outlined in this report demonstrates why first cost should not be the determining factor when making design decisions.

HPB PREMIUMS: THE FACTS

NEW CONSTRUCTION:

As referenced in Section 1, an industry study assessed the cost of building "Next Generation Green" buildings to determine their cost premium. It assessed 67 Next Generation Green buildings against 75 control buildings and found the cost premium to be roughly $20 per SF.[21]

Another study found that the cost premium derived from 33 buildings with various LEED for New Construction certifications were on average 1.8% higher, or $2 to $5 per SF.[22] Based on research findings from various sources, actual design and construction costs are in the range of -0.4% to 12.5% of code-compliant buildings, with the premium typically ranging from less than 0% to 4%.[23] A similar and more recent study found the average premium for "green" buildings ranged from 0% to 35%,[24] or $0 to $17 per SF for LEED buildings.[25]

In addition to sustainable building cost premiums, experts in the wellness real estate field have estimated the cost of implementation for new WELL Building Standard construction projects to be $1.50 to $2.20 per SF.[26] However, the true costs of this human-centric design standard are still being discovered due to its relatively new market presence.

DEEP RETROFITS:

The cost premiums for high performance retrofits are not well documented. Furthermore, the wide variability in cited retrofit costs per SF make it difficult to define HPB premiums in terms of a percentage premium. Thus, it is best to discuss cost premiums of HPBs in terms of dollars per SF. One reputable report estimates these costs to range anywhere from $2 to $7 per SF,[27] or approximately $2.40 to $8.40 per SF adjusted to today's dollars.[28]

Given all the research on the cost premium for HPBs to date, for the purposes of this report, stok assumes a conservative $20 per SF cost premium for HPB new construction and retrofits.

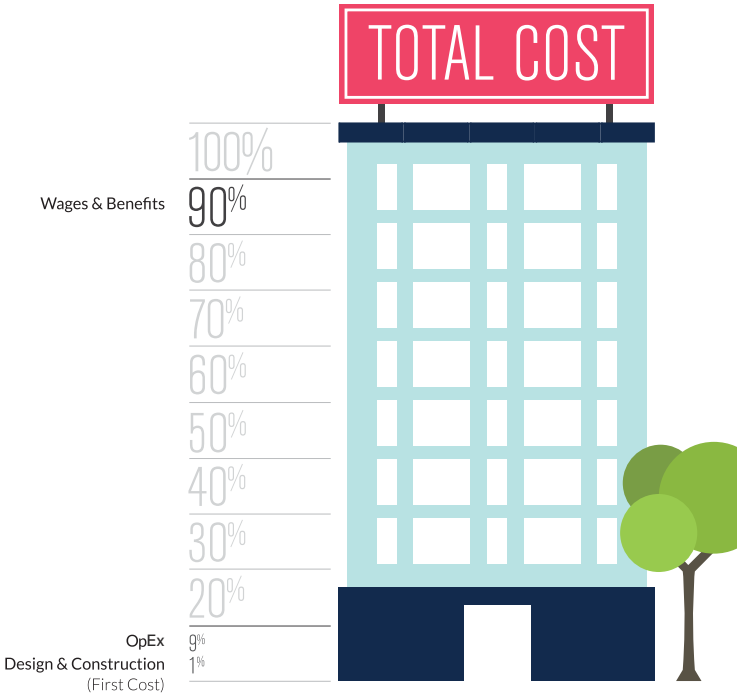


FIGURE 6

Representative averages based on 1-10-100-1000 lifecycle expenditure comparison

3.3 PEOPLE MATTER MOST: DESIGN FOR THE OCCUPANT

The drivers of business value have evolved over the last 40 years. In the 1970s, the U.S. was driven by capital investment and manufacturing. Today, the foundation of the U.S. economy is services, which are driven by intellectual capital rather than tangible assets (Figure 7). If more than 80% of a company's value is based on its people,[29] shouldn't buildings be designed to optimize their performance and wellness?

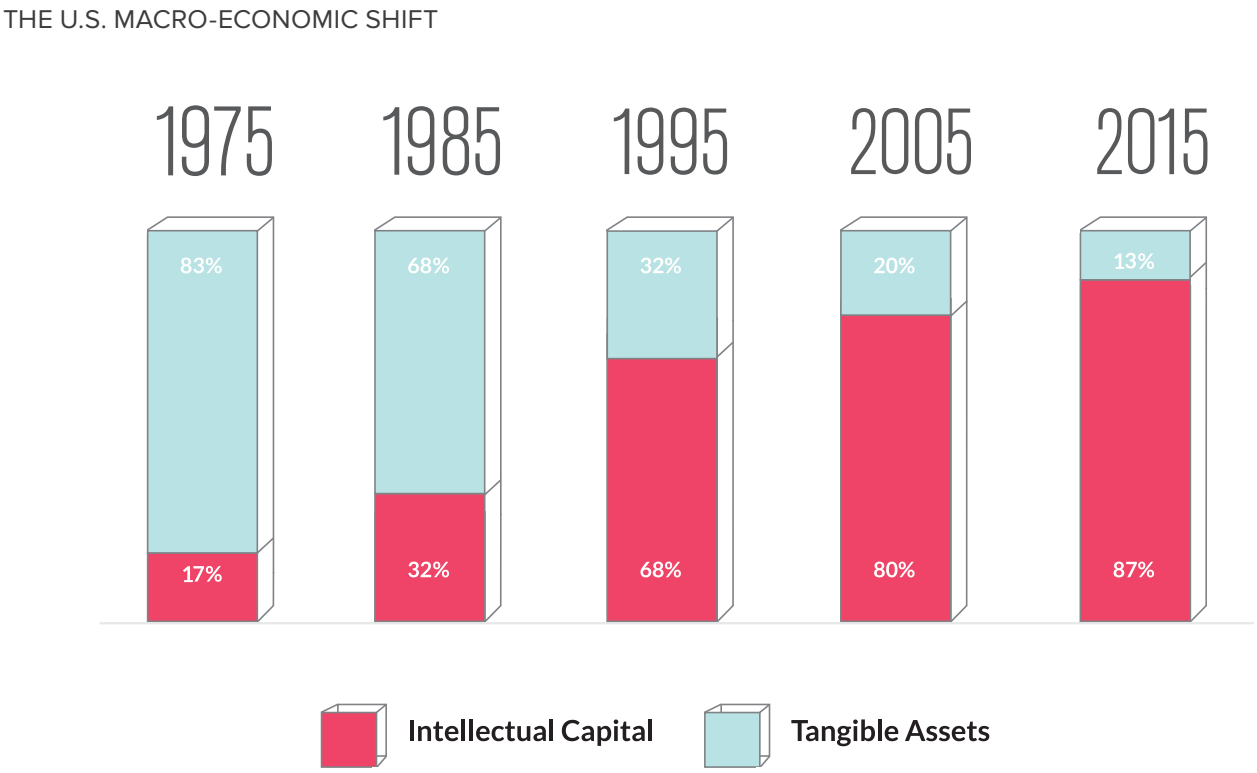


FIGURE 7

Shift in valuation of S&P 500 companies[30]

4. OWNER-OCCUPANTS & TENANTS: THE BENEFITS

4.1 PROVIDING CONTEXT: METHODOLOGY

DETERMINING THE VALUE

stok used a discounted cash flow methodology to estimate the NPV to owner-occupants and tenants pursuing HPB design. To do this, stok identified the additional costs and benefits of HPBs through the analysis of over 60 robust research studies.

For owner-occupants and tenants, these go well beyond energy savings. The largest, yet unrecognized benefits of HPBs come in the form of more productive, satisfied, and healthy employees. This is especially important for firms in the service sector and other human capital-intensive industries. An HPB can increase productivity, help recruit and retain employees, and improve employee health and wellness. The methodology and findings for each respective impact area are described herein below.

THE SCENARIO

stok created a relevant hypothetical example to illustrate the benefits of an HPB (Figure 8). The hypothetical HPB assumes a 150,000 SF building and an average of 183 SF per person, totaling 820 employees.[31] Given this hypothetical building, stok applied a sensitivity analysis to determine the benefits of low, mid, and high impact scenarios on employee productivity, retention, and absenteeism.

The hypothetical company occupying this building achieves an average annual revenue per employee of $540,000 based on the relevant corporate industry sectors that stand to benefit the most from HPBs,[32] an average fully-burdened employee salary of $100,000,[33] 265 workdays per year, and a profit margin of 10%.[34] These numbers may not transfer to every company, but this analysis provides a baseline methodology that is easy to apply to any real company.

BASELINE BUILDING & COMPANY

FIGURE 8

Representative scenario used as baseline for calculations throughout report (sources cited in Section 4.1 above)

4.2 PRODUCTIVITY FINDINGS: ENHANCE EMPLOYEE PRODUCTIVITY

HOW THE INDOOR ENVIRONMENT ENHANCES PERFORMANCE

HPBs provide occupants with a controlled environment that best suits their activity. These strategies include, but are not limited to, incorporating enjoyable views of nature, immersing workspaces in natural elements through biophilic design, maintaining thermal comfort and air quality, maximizing natural light while reducing glare, and eliminating common office distractions through smart design to provide both quiet and collaborative spaces for employees.

While some of these design elements have shown a greater impact than others on workforce productivity, all of them can be measured. For example, studies show that connecting workers to natural elements reduces stress and improves brain activity, both of which lead to increased productivity.[35] However, it is important to note HPBs include all or most of these design elements in tandem to provide a true impact.

Research methodology can vary when measuring productivity. Likewise, certain design strategies have been examined more than others, but findings continue to show a fairly consistent correlation between HPB environments and enhanced productivity (Figure 9). Note, "Combined Design Elements" are not the cumulative of all research findings, but rather the research where multiple design elements were implemented so that not one particular design element could be attributed to the benefit.

Productivity is often difficult to quantify, especially within service-based industries. Once determined, stok uses a simple methodology to quantify the value of enhanced productivity.

RESEARCH FINDINGS COMPARISON: PRODUCTIVITY ENHANCEMENT

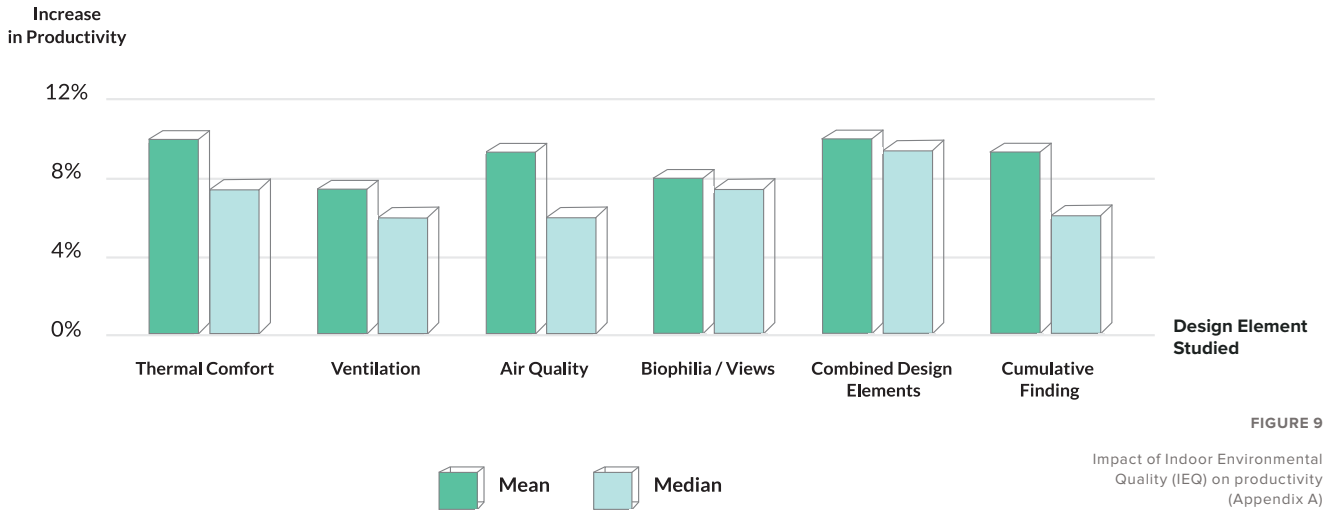


FIGURE 9

Impact of Indoor Environmental Quality (IEQ) on productivity (Appendix A)

TO MEASURE THE FINANCIAL IMPACT OF AN ENHANCEMENT IN PRODUCTIVITY DUE TO HPBS:

1. Take the average revenue per person for a company, building occupants, or team;
2. Multiply this by a productivity enhancement that HPBs have proven to increase;
3.Multiply this revenue enhancement by the company's profit margin.

This results in bottom line value. There are variables and factors other than the workspace that can impact a revenue per employee metric, but an environment that optimizes performance can only increase the top line, and all else equal, the bottom line.

STUDIES COMPILED: stok reviewed over 35 peer-reviewed academic and industry articles on HPB design and productivity impacts (Appendix A). There are many different methodologies that have been used to measure productivity (for example, satisfaction surveys, cognitive function tests, and sales) and the results necessarily vary depending on the productivity metric.[36]

SENSITIVITY ANALYSIS: The sensitivity analysis for productivity ranges from 1% to 9% in productivity gains (Table 3). This is a modest range given the plethora of research behind the correlation between indoor environments and occupant productivity. However, as stated prior, the research methodology behind the reviewed research findings varies. Accordingly, stok assumes a conservative 3% occupant productivity enhancement due to HPBs.[37]

The exact same calculation methodology described earlier was used for each low through high estimate, with enhancement in productivity as the only changing variable. The NPV calculations are based on a $20 per SF cost premium (i.e. $3M), 10-year timeframe, discount rate of 8%, and an inflation rate of 2.2%.

ESTABLISHING "PER EMPLOYEE" METRICS: stok applied the revenue per employee metric to an average annual revenue per employee of $540,000,[38] a conservative 3% productivity enhancement due to HPBs, and a profit margin of 10%,[39] to arrive at a profit of $1,620 per employee.

ESTABLISHING "PER SQUARE FOOT" METRICS: stok applied the profit per employee metric to an employee base of 820 employees in a 150,000 SF building, to arrive at a profit of $8.86 per SF – an NPV of $44.80 per SF profit over ten years when assuming a $20 per SF cost premium.

TOTAL BENEFIT: $1.33M profit per year or 3.0% of the company's annual profit (assuming one building with company's total workforce) due to productivity enhancement in HPBs (Figure 10).

SENSITIVITY ANALYSIS: PRODUCTIVITY ENHANCEMENT

	LOW	ESTIMATE	HIGH
Average revenue per employee	$540,000	$540,000	$540,000
Enhancement in productivity	1%	3%	9%
Revenue gained per employee	$5,400	$16,200	$48,600
Profit margin	10%	10%	10%
Profit gained per employee	$540	$1,620	$4,860
Number of employees	820	820	820
Total profit gained per HPB	$443K	$1.33M	$3.9M
Office size	150,000 SF	150,000 SF	150,000 SF
Profit gained per SF	$2.95/SF	$8.86/SF	$26.57/SF
NPV of profit gained per SF over 10 years	**$1.58/SF**	**$44.80/SF**	**$174.33/SF**

See Section 8. Endnotes for full list of sources

TABLE 3

Sensitivity analysis on productivity enhancement due to HPBs

HPBs are estimated to enhance productivity by 9%.

A conservative 3% productivity enhancement is used in this report.

TOTAL BENEFITS DUE TO ENHANCED PRODUCTIVITY

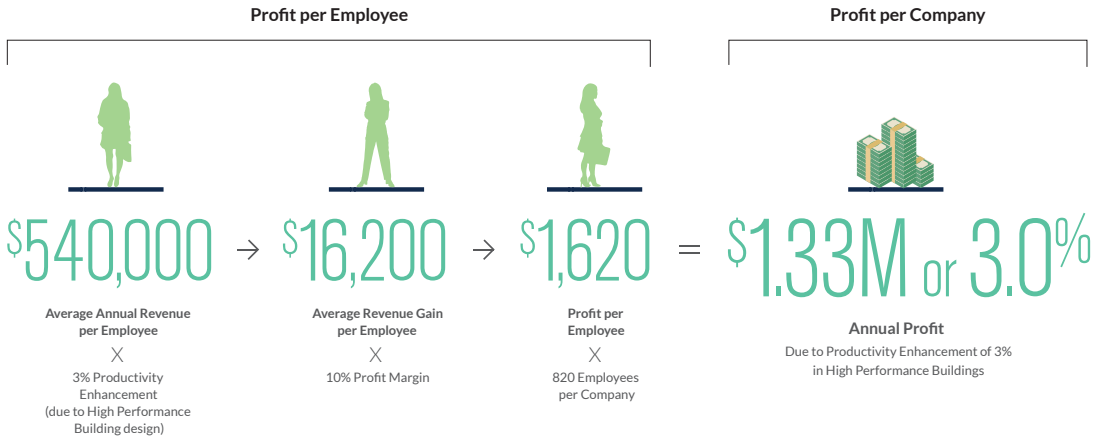


FIGURE 10

Financial benefit of HPBs due to productivity enhancement (assuming 150,000 SF space housing 820 employees)

4.3 RETENTION FINDINGS: ATTRACT TALENT, INCREASE RETENTION

Talent is paramount. Every business owner understands that their products and services are only as good as their people. But while it is increasingly challenging to attract skilled workers, it is nearly as difficult to retain them. In fact, hiring is a major issue for 56% of mid-sized companies,[40] and a recent study of owner-occupiers found that 57% of corporate real estate executives identify talent attraction and retention as a key business driver.[41]

HPBs serve as powerful recruiting and retention tools. People are attracted to employers with high performance workspaces, as they are designed with the occupant in mind. According to a survey, employees regularly cite dissatisfaction with their physical workspace when planning to leave a company.[42]

LESS EMPLOYEE SEPARATION CREATES MORE VALUE

When companies lose an employee, they lose more than that individual's expertise and institutional knowledge. The cost of an empty desk can range from 90% to 200% of their annual salary (Figure 11).[43] With $100,000 being the average fully-burdened salary cost for management, professional, and related occupations, this means employers pay at least $90,000 for each worker that leaves the company.

RETENTION VS. SEPARATION

Retention in the context of this report is defined as an effort by a business to maintain a working environment that supports current staff in remaining with the company, whereas separation is defined as workforce employees who voluntarily leave their position in pursuit of something else. Therefore, separation rate is used to quantify retention impacts in this report.

TO DETERMINE THE FINANCIAL IMPACT OF AN INCREASE IN RETENTION DUE TO HPBS:

1. Take the average cost of an employee for a company, building, or team;
2. Multiply this by the actual cost of losing an employee, which can be estimated to be at least 90% of an employee's salary;[44]
3. Multiply by an average separation rate of 34% in human capital-intensive industries (meaning on average, according to the Bureau of Labor Statistics, 34% of the workforce in those industries voluntarily leaves their position in pursuit of something else each year);[45]
4. Once this baseline is established, apply a reduction to this separation rate.

STUDIES COMPILED: stok analyzed 7 peer-reviewed academic and industry articles on HPB design and retention impacts (Appendix B). These reports primarily demonstrate the qualitative impacts HPBs will have on employee satisfaction. It is important to note that these figures are based on a relatively small number of studies on this issue, demonstrating the greatest opportunity area for future research in quantifying retention impacts through HPBs.

HPBs serve as powerful retention tools.

SENSITIVITY ANALYSIS: The sensitivity analysis for retention ranges from 1% to 10% in reduced separation rate (Table 4). The impact of HPBs on retention is not well documented, likely due to the confidential nature of this information for most companies. Nonetheless, a number of companies have provided estimates, and it is only logical that occupant-centric work environments in HPBs will attract and retain top talent. Based on this research, stok places an estimated 5% reduction in separation rates in HPBs.[46]

The exact same calculation methodology described earlier was used for each low through high estimate, with the retention percentage as the only changing variable. The NPV calculations are based on a $20 per SF cost premium (i.e. $3M), 10-year timeframe, discount rate of 8%, and an inflation rate of 2.2%.

COST OF SEPARATION

FIGURE 11

Average cost of separation to company

SENSITIVITY ANALYSIS: SEPARATION RATE REDUCTION

	LOW	ESTIMATE	HIGH
Average employee salary	$100,000	$100,000	$100,000
Cost of separation	90%	90%	90%
Average separation rate	34%	34%	34%
Average retention cost per employee	$30,600	$30,600	$30,600
Reduction in separation rate	1%	5%	10%
Savings gained per employee (i.e. profit)	$306	$1,530	$3,060
Number of employees	820	820	820
Total profit gained per HPB	$251K	$1.25M	$2.51M
Office size	150,000 SF	150,000 SF	150,000 SF
Savings gained per SF	$1.67/SF	$8.36/SF	$16.73/SF
NPV of profit gained per SF over 10 years	**($7.79/SF)**	**$41.14/SF**	**$102.36/SF**

See Section 8. Endnotes for full list of sources

TABLE 4

Sensitivity analysis for separation rate reduction due to HPBs

For this hypothetical company, a 1% impact on retention produces a failing investment. However, HPBs are not subject to sole strategies nor sole impacts. Furthermore, a 34% average separation rate was used for this analysis. A 1% impact on a company currently experiencing a 55% separation rate would see positive financial results in retention alone.

ESTABLISHING "PER EMPLOYEE" METRICS: stok applied the retention benefits per employee metric to an average fully-burdened employee salary of $100,000,[47] a 90% of employee salary estimated cost of separation, a 34% average separation rate, and a 5% reduction in separation due to HPBs, to arrive at $1,530 profit per employee. Note that applying the profit margin multiplier is not necessary for this calculation, as the base metric "employee salary" is an expense, not revenue.

ESTABLISHING "PER SQUARE FOOT" METRICS: stok applied the retention benefit per employee metric to an employee base of 820 employees in a 150,000 SF building, to arrive at $8.36 profit per SF – an NPV of $41.14 per SF savings over ten years when assuming a $20 per SF cost premium.

TOTAL BENEFIT: $1.25M profit per year or 2.83% of the company's annual profit (assuming one building with company's total workforce) due to increased retention in HPBs (Figure 12). Over a 10-year time span, a company leasing 150,000 SF can expect to gain an additional $1.3M in NPV.

TOTAL BENEFITS DUE TO INCREASED RETENTION

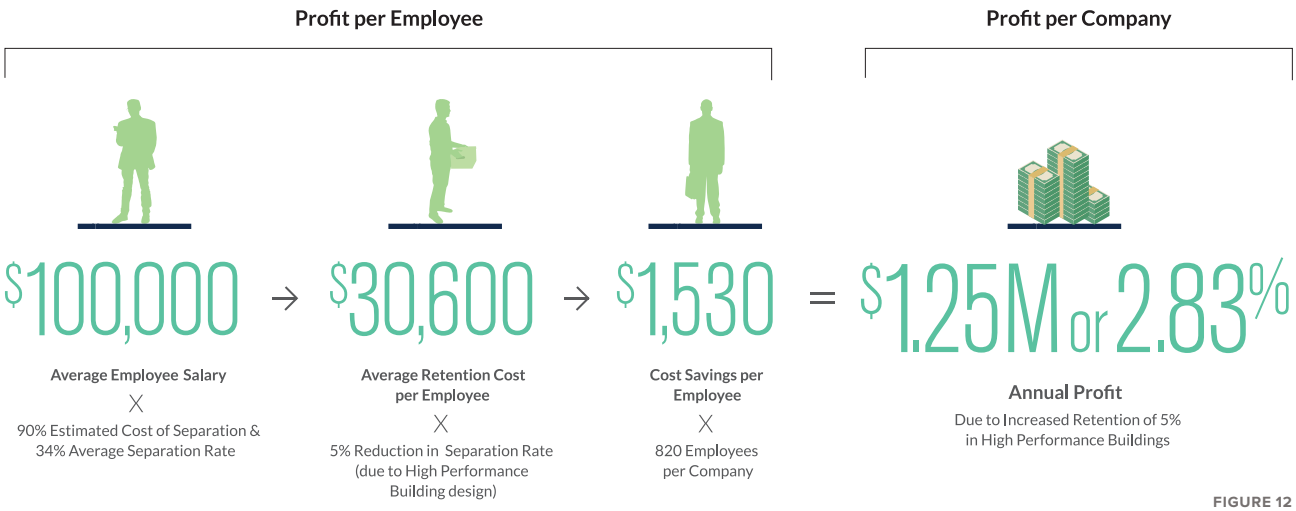


FIGURE 12

Financial benefit of HPBs due to increased retention (assuming 150,000 SF space housing 820 employees)

4.4 HEALTH & WELLNESS FINDINGS: WELLNESS AS A BUSINESS STRATEGY

THE CURRENCY OF HEALTHIER EMPLOYEES

More and more organizations have made the connection between employee wellness and revenue. A recent study found that 75% of job seekers care that their potential employer supports and values their health and wellness, and 57% are more likely to stay with the company longer if they do.[48] Accordingly, 69% of employers offer wellness programs,[49] 67% of U.S. building owners are interested in creating healthier buildings for people,[50] 91% of employers report offering health and wellness programs for reasons beyond medical cost savings,[51] and 73% of employers believe their responsibility to ensure the health and wellness of their employees will increase in the next 3-5 years (2017).[52]

HPBs play an integral role in that goal. When connected to the environment through generous amounts of daylight and natural materials, and more comfortable due to improved ventilation, thermal systems, and ability to control their environments, employees can realize a reduction in absenteeism through improved health and wellness.

The average percentage of lost worktime rate, defined as hours absent as a percentage of hours usually worked, equates to 1.4%, while the absence rate, defined as the ratio of workers with absences to total full-time wage and salary employment, equates to 2.8%.[53] Because the equation to calculate additional revenue through HPBs due to healthy employees is based on time, the percentage of lost worktime rate is used, as it is a metric of time. 1.4% of lost worktime due to illness or injury equates roughly to 4.0 days a year in a 265-day work year.

TO CALCULATE THE FINANCIAL IMPACT OF A REDUCTION IN ABSENTEEISM DUE TO HPBS:

1. Take the average revenue per employee per day;
2. Multiply by an annual reduction in worktime per employee (an established absenteeism reduction percentage applied to an average 4 sick days, to arrive at the number of workdays gained per year);
3. Apply a 10% profit margin to the average annual revenue gain per employee metric calculated above.

STUDIES COMPILED: stok analyzed over 15 peer-reviewed academic and industry articles on HPB design and wellness impacts (Appendix C).

SENSITIVITY ANALYSIS: The sensitivity analysis for reduced absenteeism ranges from 10% to 50% (Table 5). Thus, based on the compiled studies, stok uses an estimated 30% reduction in absenteeism due to HPB design strategies.[54] While the positive impacts of HPBs on absenteeism are well documented, the savings are modest when only a few days throughout the year are gained as working days for companies. In this sensitivity scenario, the $20 per SF cost premium is too large for the benefits of reduced absenteeism alone to pay out. However, as mentioned previously, HPBs are not subject to sole strategies, nor sole impacts, so the minor financial impact as a result of increased absenteeism can be considered a misnomer, as all impacts will be combined in an HPB.

75%

OF JOB SEEKERS

Care that their potential employer supports and values their health and wellness

57%

OF JOB SEEKERS

Are more likely to stay with the company longer if their employer supports and values their health and wellness

91%

OF EMPLOYERS

Report offering employee health and wellness programs for reasons beyond medical health savings

73%

OF EMPLOYERS

Believe their responsibility to ensure the health and wellness of their employees will increase in the next 3-5 years (2017)

ESTABLISHING "PER EMPLOYEE" METRICS: stok applied the health and wellness metric to an average revenue per employee per day of $2,038 ($540,000 average annual revenue per employee with 265 workdays per year), a national average of sick days per employee per year of 4 days,[55] a 30% reduction in sick days due to HPBs, and a 10% profit margin, to arrive at $245 profit per employee.

ESTABLISHING "PER SQUARE FOOT" METRICS: stok applied the health and wellness profit per employee finding to an employee base of 820 employees in a 150,000 SF building, to arrive at $1.34 profit per SF.

TOTAL BENEFIT: $201K profit per year or 0.45% of the company's annual profit (assuming one building with company's total workforce) due to improved health and wellness in HPBs (Figure 13).

SENSITIVITY ANALYSIS: ABSENTEEISM REDUCTION

	LOW	ESTIMATE	HIGH
Average sick days per year	4	4	4
Reduction in annual sick days	10%	30%	50%
Added days at work	0.4	1.2	2
Average revenue per employee per day	$2038	$2038	$2038
Average revenue gain per employee (due to additional days at work)	$815	$2,246	$4,076
Profit margin	10%	10%	10%
Profit gained per employee	$82	$245	$408
Number of employees	820	820	820
Total profit gained per HPB	$67K	$201K	$334K
Office size	150,000 SF	150,000 SF	150,000 SF
Profit gained per SF	$0.45/SF	$1.34/SF	$2.23/SF
NPV of profit gained per SF over 10 years	**($16.71/SF)**	**($10.20/SF)**	**($3.69/SF)**

See Section 8. Endnotes for full list of sources

TABLE 5

Sensitivity analysis for absenteeism reduction due to HPBs

HPBs are not subject to sole strategies, nor sole impacts.

TOTAL BENEFITS DUE TO ABSENTEEISM REDUCTION

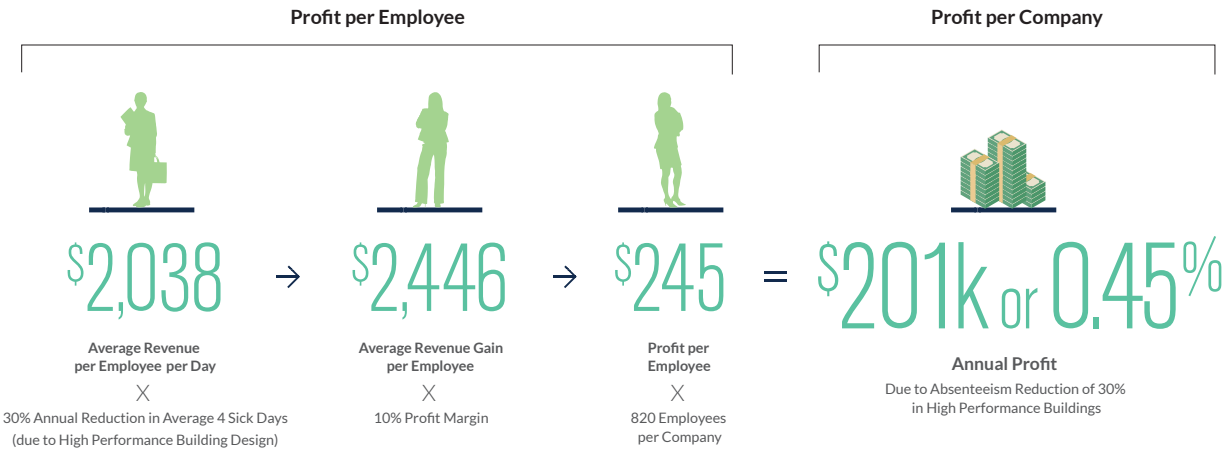


FIGURE 13

Financial benefit of HPBs due to absenteeism reduction (assuming 150,000 SF space housing 820 employees)

4.5 CUMULATIVE FINDINGS & SENSITIVITY ANALYSIS

Prior to applying any cost premiums to HPBs, and combining enhanced productivity, increased retention, and reduced absenteeism, the following cumulative findings in various metrics help owner-occupants and tenants quantify the benefits of adopting HPB strategies (based on the scenario outlined in Figure 8, p.9):

PROFIT PER EMPLOYEE: $3,395 annual profit
PROFIT PER SQUARE FOOT: $18.56 annual profit
COMBINED TOTAL BENEFIT: $2.78M annual profit or 6.29% of total annual company profit (assuming one building with company's total workforce) due to cumulative occupant benefits in HPBs (Figure 14).

Assuming a conservative $20 per SF cost premium, stok calculates an NPV of $21,172 per employee, or $115 per SF, over ten years,. This total only includes productivity, retention, and wellness findings. Include utility and maintenance savings, and the total NPV of HPBs results in $23,584 per employee, or $129 per SF, over ten years (Figure 1, Figure 2). The combined benefit demonstrates a near single-year simple payback period for the conservative cost premium assumed above. Cut the benefits of an HPB by 50% and companies could retain a two-year simple payback period. When these metrics are applied to companies of different sizes and spaces, the benefits of investing in HPBs clearly outweigh the costs.

Although utility and maintenance cost savings are the most frequently cited benefit of HPBs, they offer some of the smallest financial value. As shown in this report, 43% of the total value comes from enhanced employee productivity, 41% from increased employee retention, 7% from improved employee wellness, 7% from utility savings, and 2% from maintenance savings. Given this breakdown, human-centered design should be a critical consideration when creating an HPB.

TOTAL BENEFITS DUE TO INVESTMENT IN HPBS

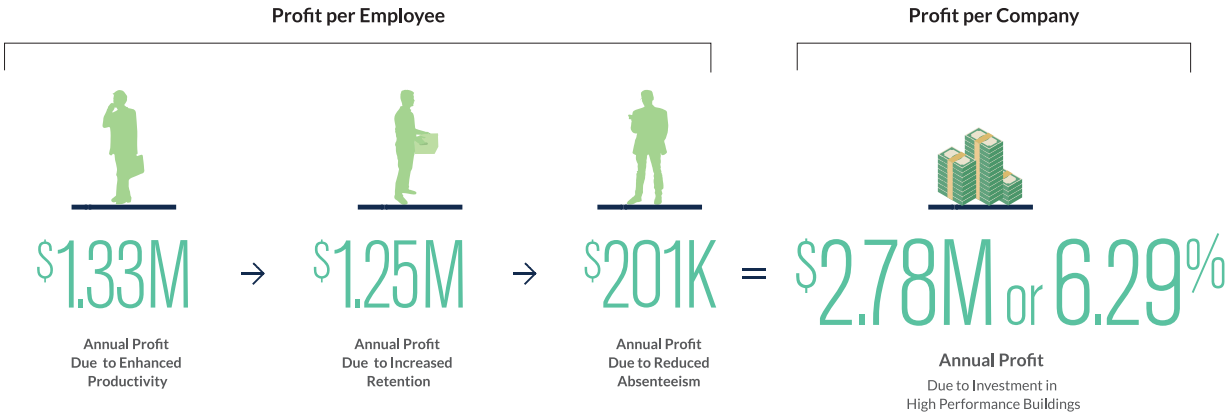
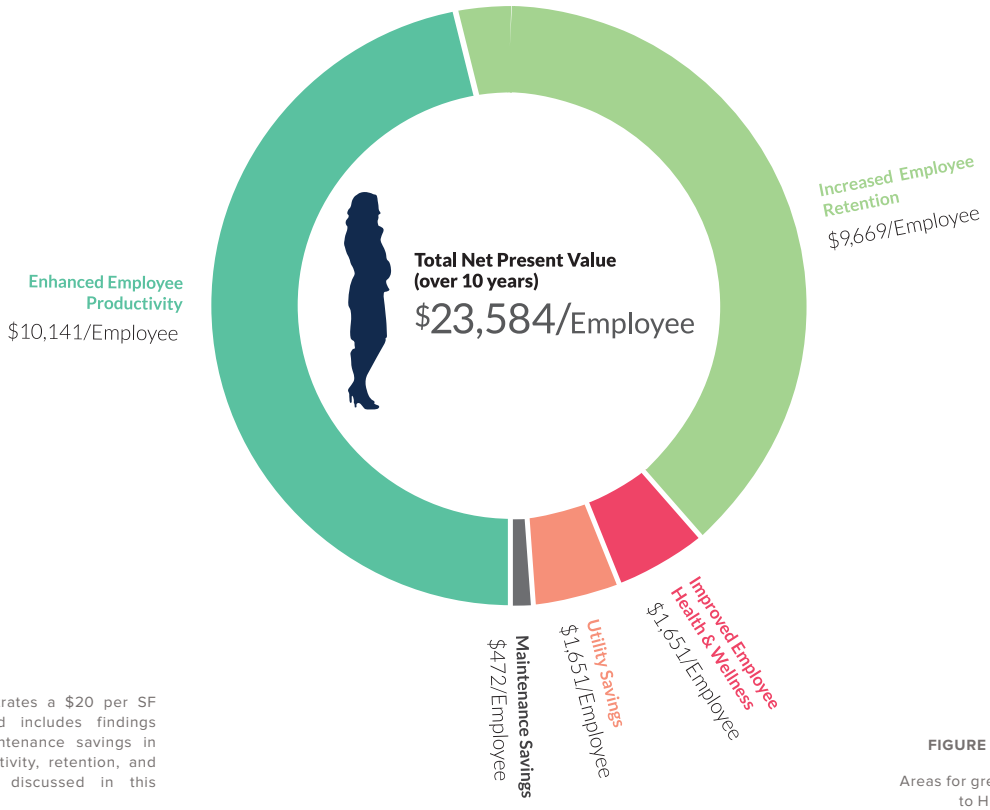


FIGURE 14

Cumulative financial benefit of HPBs due to enhanced productivity, increased retention, and reduced absenteeism (assuming 150,000 SF space housing 820 employees)

NPV PER EMPLOYEE OVER 10 YEARS**

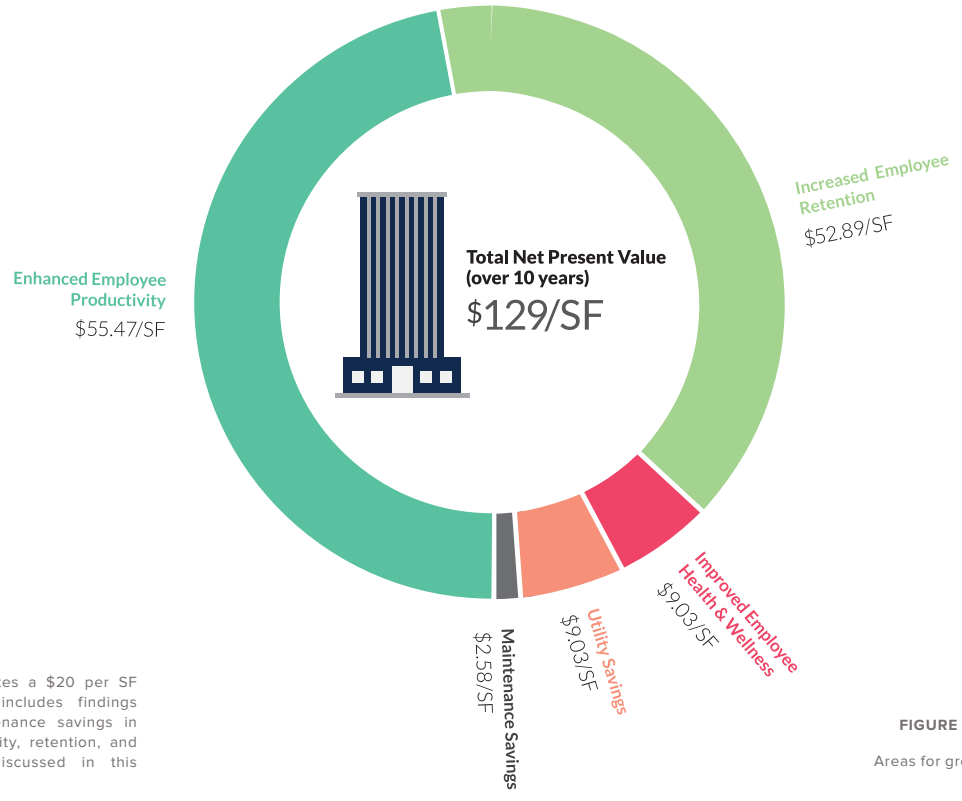


**Analysis demonstrates a $20 per SF cost premium and includes findings of utility and maintenance savings in addition to productivity, retention, and wellness benefits discussed in this report.

FIGURE 1 (referenced in Section 1)

Areas for greatest financial impact due to HPB benefits, per employee

NPV PER SQUARE FOOT OVER 10 YEARS**



**Analysis demonstrates a $20 per SF cost premium and includes findings of utility and maintenance savings in addition to productivity, retention, and wellness benefits discussed in this report.

FIGURE 2 (referenced in Section 1)

Areas for greatest financial impact due to HPB benefits, per SF

SENSITIVITY ANALYSIS

Like the sections above, a sensitivity analysis was completed on the full data set. An analysis of the combined benefit of productivity, retention, and absenteeism at a cost premium of $20 per SF was determined to establish a total NPV range (Table 1). Additionally, an analysis of low, mid, and high HPB cost premiums was analyzed based on the estimate (mid) for productivity, retention, and absenteeism (Table 2). An NPV range including utility and maintenance savings was also calculated for both sensitivity analyses.

A NOTE ABOUT METHODOLOGY

stok cannot guarantee that a 3% increase in productivity will equate to a 3% increase in revenue. However, assume a 3% increase in productivity delivers a 1.5% increase in revenue or half the amount the findings support. Apply this 50% reduction to this report's entire model and companies realize $1.4M of profit per year. Even if the reduction is 75%, companies will realize $965K of profit per year.

The profit numbers in this paper may not apply to every company, but the evidence indicates that the impacts are measurable and substantial. This analysis is merely demonstrating the fact that these impacts exist, and that they should be factored into design and construction budgets. These impacts should also be part of the overall justification of potential cost premiums towards enhancing occupant experience, which will in turn boost the bottom line.

It is impossible to guarantee financial benefits based on individual circumstances, which is why stok has not only been rigorous in its assumptions, but also transparent with its methodology. Owner-occupants and tenants must adjust this approach for their own business models.

SENSITIVITY ANALYSIS: COMBINED BENEFIT

	LOW	ESTIMATE	HIGH
Cost premium	$20/SF	$20/SF	$20/SF
Enhancement in productivity	1%	3%	9%
Reduction in separation rate (assuming baseline of 34% separation rate)	1%	5%	10%
Reduction in annual sick days	10%	30%	50%
Profit gained per employee	$928	$3,395	$8,328
Profit gained per SF	$5.07/SF	$18.56/SF	$45.52/SF
Total profit gained per HPB	$761K	$2.78M	$6.82M
NPV of profit gained per SF over 10 years	**$17/SF**	**$115/SF**	**$313/SF**
NPV of profit gained per SF over 10 years* **	**$30/SF**	**$129/SF**	**$326/SF**

***Including utility and maintenance savings
See Section 8. Endnotes for full list of sources

TABLE 1 (referenced in Section 1)

Sensitivity analysis on cumulative benefit due to HPBs

SENSITIVITY ANALYSIS: COST PREMIUM

	LOW	ESTIMATE	HIGH
Cost premium	$5/SF	$20/SF	$50/SF
Enhancement in productivity	3%	3%	3%
Reduction in separation rate (assuming baseline of 34% separation rate)	5%	5%	5%
Reduction in annual sick days	30%	30%	30%
Profit gained per employee	$3,395	$3,395	$3,395
Profit gained per SF	$18.56/SF	$18.56/SF	$18.56/SF
Total profit gained per HPB	$2.78M	$2.78M	$2.78M
NPV of profit gained per SF over 10 years	**$131/SF**	**$115/SF**	**$86/SF**
NPV of profit gained per SF over 10 years* **	**$144/SF**	**$129/SF**	**$99/SF**

***Including utility and maintenance savings
See Section 8. Endnotes for full list of sources

TABLE 2 (referenced in Section 1)

Sensitivity analysis on cost premiums of HPBs

5. HIGH PERFORMANCE BUILDING PROFIT ACROSS INDUSTRIES

stok applied this methodology to multiple different human capital-intensive industry sectors using publicly-available data.[56] As previously stated, each business is unique, but this exercise demonstrates the financial return that can be achieved by investing in people through high performance real estate. Each analysis assumes a 150,000 SF HPB is constructed.

The methodology for calculating benefits of productivity, retention, and wellness was applied to multiple relevant industry sectors (Figure 15). Average revenue per employee, average profit margins, and cost data were pulled from various sources within the U.S. (summarized in Figure 8, p.9). The data represents a 3% increase in productivity, 5% increase in retention, and 30% reduction in absenteeism across all sectors.

This analysis is purely to demonstrate the applicability and potential of HPBs across many sectors in the U.S. Due to a combination of revenue per employee and profit margin metrics, the conglomerate, financial services, professional services, and technology industries are poised to gain the most benefit from HPBs. This makes logical sense, as these industries tend to have stronger profit margins and rely a considerable amount on the intellectual capital of their employees.

CUMULATIVE ANNUAL PROFIT BY SECTOR

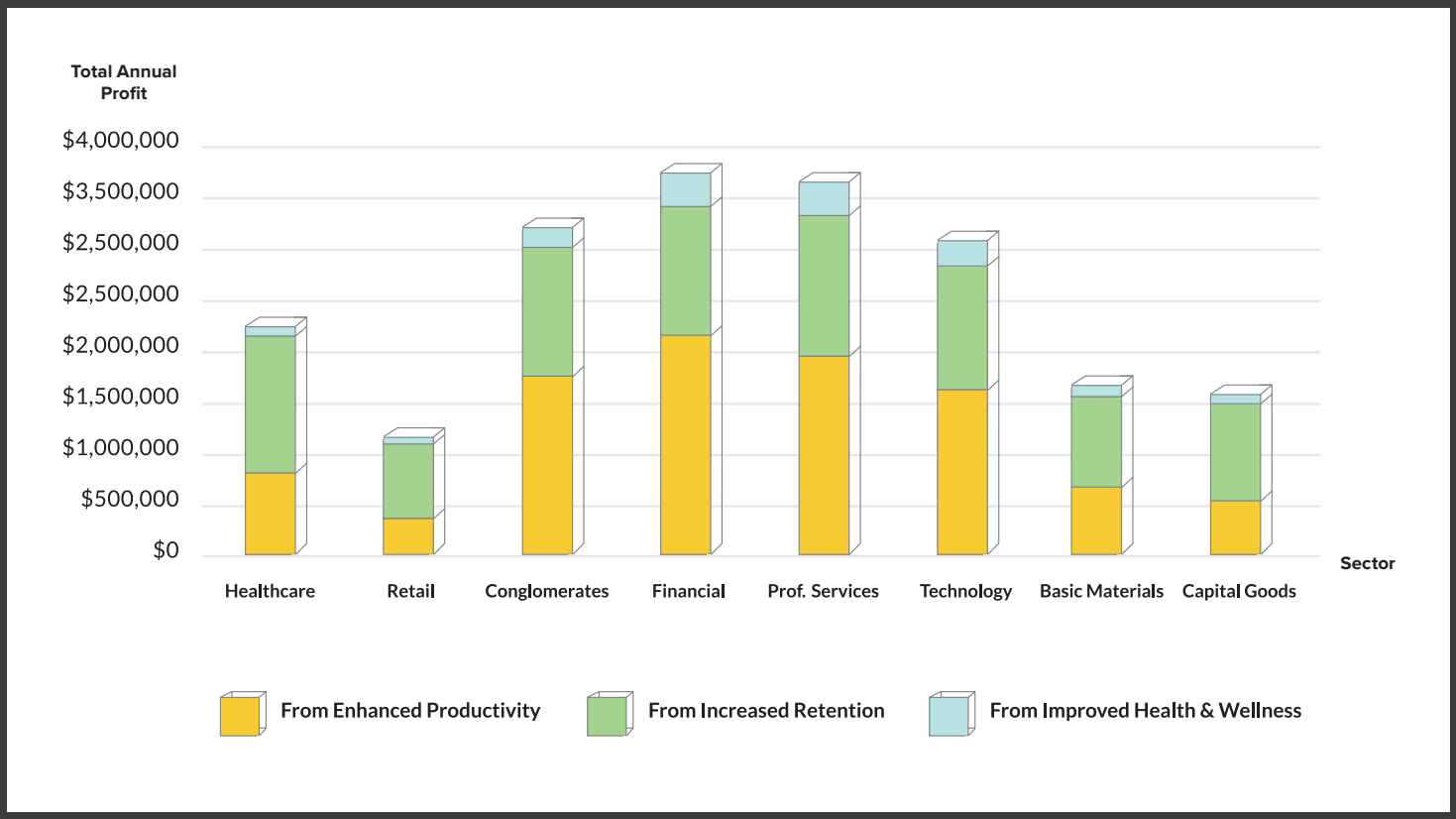


FIGURE 15

Total annual profit by sector due to enhanced productivity, increased retention, and reduced absenteeism

Credit: Garry Belinsky (DPR Construction San Francisco office)

6. A LOOK FORWARD: DISCUSSION & LIMITATIONS

Beyond direct improvement of the occupant experience, there are several ways that HPBs deliver more value to owner-occupants and tenants.

ANTICIPATE THE FUTURE, REDUCE THE RISK

Companies implement long-term thinking into their business, sales, marketing, and product development plans. By preparing for the future, they increase their odds of success while reducing potential risks. Companies should also apply that mindset to their office space – the place where employees spend their days executing those plans.

Employee productivity, recruitment, and retention are among some of the most acute risks for businesses. In a 2013 survey of over 600 corporate real estate executives, 68% cited enhancing the productivity of their real estate portfolio and 46% cited attracting and retaining talent as key areas of increasing demand being placed on them.[57] HPBs can help mitigate this risk by providing a workplace that actively enhances productivity and increases retention.

HPBs go a long way towards establishing a strong corporate reputation. Doing so has been proven to deliver favorable credit terms, reduce the risk of default, and ensure long-term marketability of the property.[58]

Tenants now insist on this new standard for spaces, with 41% to 48% of new builds expected to be high performance.[59] Buildings that do not maintain pace with increasingly stringent environmental and human health requirements will drop in demand and lose value. It is becoming more difficult to justify design and construction based on standard building codes, as the fast-paced industry regulation updates will soon render these conventional assets functionally obsolete. HPBs provide better long-term value and reduce risk.

41% - 48% of new builds are expected to be high performance.

A WORKPLACE THAT ADAPTS TO CHANGING FUNCTIONS

In a bygone era, offices remained the same for years, even decades. Work functions were stagnant, as were the norms of how people performed their jobs. But with the 21st century's constantly evolving technological requirements, as well as cultural shifts in office life, workspaces must easily adapt to new physical configurations. HPBs provide that flexibility by using modular systems, personal environment controls, and multi-use spaces.

ENHANCE THE BRAND

A company's brand goes far beyond its logo, color palette, and tagline. More than ever, consumers want to buy from purpose-aligned and mission-driven companies. In fact, a study found that 91% of consumers are more likely to buy from an authentic brand than from one they find dishonest.[60] On the business side, a survey found that 82% of key stakeholders, including investors, lenders, and potential employees, consider brand strength as an increasingly important decision-making factor.[61] As such, job seekers have taken on a similar mindset, insisting on high performance workplaces as much as they demand comprehensive benefits packages.

Beyond enhancing a company's ability to recruit and retain talented employees, an HPB also becomes part of the brand story and boosts the company's reputation, which can be promoted via marketing campaigns. This arguably has a significant impact on a company's bottom line.

COMPREHENSIVE UTILITY & MAINTENANCE COST SAVINGS

HPBs minimize the need for artificial lighting, heating, and cooling. Energy and water efficient fixtures, renewables, and storage systems assure sustainable consumption of resources.

According to the General Services Administration (GSA), the energy costs for traditional sustainable buildings are 28% lower than the national average.[62] But when retrofitting a building with the types of improvements associated with HPBs, energy costs would be cut by 50%, with maintenance savings being cut by approximately 12% of the national average.[63] Given that the national average spent on utilities is $2.61 per SF, a reduction in utility costs equates to an annual saving of $1.30 per SF.[64] Seeing as the average maintenance cost for the U.S. private sector is $3.84 per SF, a 12% reduction equates to an annual saving of $0.46 per SF.[65] Combined and discounted over 10 years, this results in approximately $13 per SF in savings, which is less than 10% of the profit produced from the cumulative findings of productivity, retention, and wellness impacts.

Credit: Jasper Sanidad (NRDC San Francisco office)

Although utility savings are the most frequently cited benefit of HPBs, investing in building occupants through design and operations delivers a larger financial value.

LIMITATIONS

BASELINE

Like any analysis, the findings are completely dependent on a baseline. In the hypothetical example discussed in this report, a code-compliant building is the baseline. A code-compliant building in California is vastly different than a code-compliant building in Alabama. Thus, depending on stringencies of code, the less stringent, the greater the benefit.

Furthermore, occupants may be moving from a building constructed under a 20-year-old code. Benefits will be larger for occupants transitioning from a 20-year-old building to an HPB compared to switching from a new construction code-complaint building to an HPB.

PRODUCTIVITY

As mentioned, productivity is a difficult metric to measure. Studies have attempted to track productivity or performance using various methodologies. Additionally, some believe that productivity will have the Hawthorne effect: that benefits will diminish over time.[66] This is referred to as decay. Due to limited research on long term studies of occupants in HPB buildings, decay may in fact be a factor in estimating true impacts.

Synergistic effects are also a concern when evaluating the combined effect of HPBs. Like energy models, all systems need to be evaluated in concert to understand the true impact. In other words, the value is less than the sum of its parts. It is not clear if occupant benefits would behave in the same fashion.

Valuing productivity through revenue as opposed to cost is another consideration used for this analysis. The approach in this study is best justified by Brock Birkenfeld, et al.[67] stating the following:

"Incremental improvements in revenue represent values larger than an equal percentage reduction in cost for a profitable company. For example, a 5% improvement in one person's sales is worth more than a 5% reduction in the salesperson's salary, assuming the employee is already selling more than his cost of his wages. Since the goal of most businesses is to operate at a profit, revenue is generally some multiple of cost. Thus, using revenue to value productivity improvement is more meaningful than using costs."

RETENTION

Limitations on data availability inhibit the true value of retention in association with HPBs to be factually understood. Not only are there data availability limits, but companies typically withhold retention or turnover rates from public knowledge, thus making it difficult to model.

ABSENTEEISM

Of all the impacts evaluated in this report, absenteeism is the easiest to measure for organizations and the methodology is consistent. As such, the findings show smaller variability when studied. While absenteeism may have the smallest impact, it is the most reliable effect of HPBs.

FUTURE RESEARCH

Studies continue to document HPB impacts on premier tenant attraction, demand, retention, rents, occupancies, and absorption, as well as investor demand, risk analysis, and mitigation, but there is still more to be done. With a body of additional research, the scope of this analysis can be expanded to include impacts on talent attraction, presenteeism, brand equity, risk, and resiliency for owner-occupants and tenants.

Other research has been completed on this subject using different methodologies in calculating the benefits of HPBs on occupants. A recent report on healthy building return on investment (ROI) by the Muldavin Company, Bard Consulting, and the Haas School of Business demonstrates calculating the benefits of HPBs on a cost savings model as opposed to profit generation.[68] Similarly, a 2011 study by the Texas A&M University Mays Business School of Cooperative Study demonstrates an example of how to implement an ROI analysis on a remodel project.[69] This model uses a rating system on current IEQ conditions and expected new IEQ conditions and applies a sensitivity analysis on potential impacts.

However, regardless of methodology, there has yet to be a real world project that baselines all the metrics listed in this report and compares them to an occupant moving into an HPB. For a comprehensive study to occur, an organization's human resources, finance and accounting, IT, management, and others would all need to work together and transparently share resources and data. The combined impacts of an actual comprehensive study will provide invaluable data in support of the shifting paradigm of designing spaces to enhance occupant performance and experience rather than to simply be occupied.

Credit: Jasper Sanidad (NRDC San Francisco office)

7. CONCLUSION

Until recently, many companies viewed their workplaces as independent of their core corporate responsibilities and sources of profit. Even when they did see the draw of high performance offices, companies couldn't quantify the financial value. But now there are clear metrics that show the correlation between high performance workplaces and enhanced productivity, increased retention, and reduced absenteeism for employees.

Prior to applying any cost premiums to HPBs, and combining enhanced productivity, increased retention, and reduced absenteeism, the following cumulative findings in various metrics help owner-occupants and tenants quantify the benefits of adopting HPB strategies (based on the scenario of a hypothetical company in a 150,000 SF building or space, and an average 183 SF per person, totaling 820 employees,[70] as fully outlined in Figure 8, p.9).

PROFIT PER EMPLOYEE: $3,395 annual profit
PROFIT PER SQUARE FOOT: $18.56 annual profit

THIS TOTALS TO A COMBINED BENEFIT PER HPB OF:

$2.78M
Annual profit

$17M
NPV over 10 years at $20 per SF cost premium

These metrics all only include productivity, retention, and wellness benefits, and demonstrate how High Performance Buildings significantly impact the bottom line through improved occupant experience. The question is no longer "How much do High Performance Buildings cost?"; it is "How much can my company benefit by working in a High Performance Building?"

TOTAL BENEFITS DUE TO INVESTMENT IN HPBS

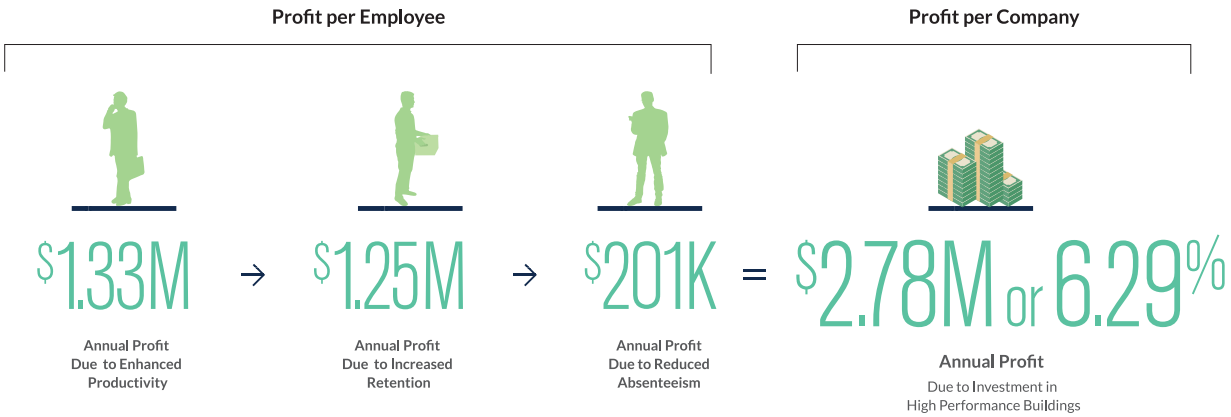


FIGURE 14 (referenced in Section 4.5)

Cumulative financial benefit of HPBs due to enhanced productivity, increased retention, and reduced absenteeism (assuming 150,000 SF space housing 820 employees)

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9. APPENDIX

CONTENTS

APPENDIX A (P1)

PRODUCTIVITY RESEARCH

YEAR	TITLE (AUTHOR)	DESIGN ELEMENT STUDIED	PRODUCTIVITY ENHANCEMENT FINDING
2017	Snow Ball Effect of Healthy Buildings (CBRE)	Combined Design Elements	10% to 45%
2016	Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: a controlled exposure study of green and conventional office environments (Allen, J. G., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J., & Spengler, J.D.)	Air Quality	13%
2016	The Business Case for Green Building (Laski, J., WorldGBC)	Combined Design Elements	3%
2016	The Business Case for Green Building (Laski, J., WorldGBC)	Combined Design Elements	16%
2015	Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: a controlled exposure study of green and conventional office environments (Allen, J. G., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J., & Spengler, J.D.)	Air Quality	20%
2015	Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: a controlled exposure study of green and conventional office environments (Allen, J. G., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J., & Spengler, J.D.)	Ventilation	18%
2014	Workspaces That Move People (Waber, B., Magnolfi, J., & Lindsay, G.)	Combined Design Elements	10%
2012	Influence of carbon-dioxide concentration on human well-being and intensity of mental work (Kajtár, L. & Herczeg, L.)	Air Quality	5.9%
2012	Is CO2 an indoor pollutant? Direct effects of low-to-moderate CO2 concentrations on human decision-making performance (Satish, U., et al.)	Air Quality	35%
2012	Ventilation rates in schools and pupils' performance (Bakó-Biró, Z.S., Clements-Croome, D.J., Kochhar, N., Awbi, H.B., & Williams, M.J.)	Ventilation	2.2% to 15%
2011	Quantitative measurement of productivity loss due to thermal discomfort (Lan, L., Wargocki, P. & Lian, Z.)	Thermal Comfort	1.4% to 25%

APPENDIX A (P2)

PRODUCTIVITY RESEARCH

YEAR	TITLE (AUTHOR)	DESIGN ELEMENT STUDIED	PRODUCTIVITY ENHANCEMENT FINDING
2011	The effects of outdoor air supply rate on work performance during 8-h work period (Mark, J.S. & Yoon, C.H.)	Ventilation	2.5% to 5%
2010	Evaluating user experience in green buildings in relation to workplace culture and context: Emerald Insight (Brown, Z., Cole, R., & Robinson, J.)	Combined Design Elements	12%
2010	Effects of Green Buildings on Employee Health and Productivity: American Journal of Public Health (Grady, S.C., Syal, M., Singh, A., & Korkmaz, S.)	Combined Design Elements	3%
2009	The impact of indoor environment quality on occupant health, well being and productivity in a sustainable office building: Proceedings of Healthy Buildings. (Paevere, P. & Brown, S.)	Combined Design Elements	11%
2007	Indoor climate and productivity in offices: How to integrate productivity in life–cycle cost analysis of building services (Andersson, J., Boerstra, A., Clements–Croome, D., Fitzner, K., & Hanssen, S. O.)	Thermal Comfort	5%
2007	Indoor climate and productivity in offices: How to integrate productivity in life–cycle cost analysis of building services (Andersson, J., Boerstra, A., Clements–Croome, D., Fitzner, K., & Hanssen, S. O.)	Ventilation	1% to 6%
2007	Indoor climate and productivity in offices: How to integrate productivity in life–cycle cost analysis of building services (Andersson, J., Boerstra, A., Clements–Croome, D., Fitzner, K., & Hanssen, S. O.)	Air Quality	10%
2007	Indoor climate and productivity in offices: How to integrate productivity in life–cycle cost analysis of building services (Andersson, J., Boerstra, A., Clements–Croome, D., Fitzner, K., & Hanssen, S. O.)	Air Quality	1% to 5%
2007	The effect of speech and speech intelligibility on task performance (Venetjoki, N., Kaarlela-Tuomaala, A., Keskinen, E., & Hongisto, V.)	Acoustics	7%
2006	Effect of temperature on task performance in office environment (Seppänen, O., Fisk, W.J., &Lei, Q.H.)	Thermal Comfort	8.9%

APPENDIX A (P3)

PRODUCTIVITY RESEARCH

YEAR	TITLE (AUTHOR)	DESIGN ELEMENT STUDIED	PRODUCTIVITY ENHANCEMENT FINDING
2006	Ventilation and performance in office work (Seppänen, O., Fisk, W.J., &Lei, Q.H.)	Ventilation	0.8% per 10 CFM per person increase in ventilation rate
2005	Office noise and employee concentration: identifying causes of disruption and potential improvements (Banbury, S.P. & Berry, D.C.)	Acoustics	99%
2004	The Effects of Indoor Air Quality on Performance and Productivity (Wyon, D.P)	Air Quality	6% to 9%
2003	Windows and classrooms: a study of student performance and the indoor environment (Heschong-Mahone Group)	Biophilia / Views	0.6%
2003	Windows and Offices: A Study of Office Worker Performance and the Indoor Environment (Heschong, L., Heschong Mahone Group)	Biophilia / Views	6% to 7%
2003	Linking Energy to Health and Productivity in the Built Environment: Evaluating the Cost-Benefits of High Performance Building and Community Design for Sustainability, Health and Productivity (Loftness, V., Hartkopf, V., & Gurtekin, B.)	Air Quality	0.48% to 11%
2003	Linking Energy to Health and Productivity in the Built Environment: Evaluating the Cost-Benefits of High Performance Building and Community Design for Sustainability, Health and Productivity (Loftness, V., Hartkopf, V., & Gurtekin, B.)	Ventilation	0.62% to 7.7%
2003	Linking Energy to Health and Productivity in the Built Environment: Evaluating the Cost-Benefits of High Performance Building and Community Design for Sustainability, Health and Productivity (Loftness, V., Hartkopf, V., & Gurtekin, B.)	Air Quality	1.1% to 3.25%
2002	Subjective perceptions, symptom intensity, and performance: a comparison of two independent studies, both changing similarly the pollution load in an office (Wargocki, P., et al.)	Air Quality	4%
2002	Subjective perceptions, symptom intensity, and performance: a comparison of two independent studies, both changing similarly the pollution load in an office (Wargocki, P., et al.)	Air Quality	1%

APPENDIX A (P4)

PRODUCTIVITY RESEARCH

YEAR	TITLE (AUTHOR)	DESIGN ELEMENT STUDIED	PRODUCTIVITY ENHANCEMENT FINDING
2002	Daylight and Productivity: A Field Study (Figueiro, M., Rea, M., Stevens, R., & Rea, A.)	Lighting	15%
2002	Pilot Study Report: Wilkinson Building (Rowe, David)	Ventilation	18%
2002	Work Environment Effects on Labor Productivity: An Intervention Study In a Storage Building (Niemela, R., Rautio, S. et al.)	Combined Design Elements	9%
2002	Personal computers pollute indoor air: effects on perceived air quality, SBS symptoms and productivity in offices (Bako-Biro, Wargocki, P., Wchler, C.J., & Fnager, P.O.)	Air Quality	9%
2001	Daylighting in schools: reanalysis report (Heschong-Mahone Group)	Biophilia / Views	2% to 20%
2001	Productivity Improvement. Buildings in Value (Leaman, Adrian)	Ventilation	10%
2000	Productivity is affected by the air quality in offices (Wargocki, P., et al.)	Air Quality	4%
2000	Productivity is affected by the air quality in offices (Wargocki, P., et al.)	Ventilation	2% to 6%
2000	Do Green Buildings Enhance the Well Being of Workers? (Heerwagen, J.)	Combined Design Elements	0.22%
1999	Perceived air quality, sick building syndrome (SBS) symptoms and productivity in an office with two different pollution loads (Wargocki, P., et al.)	Air Quality	4%
1999	Daylighting in schools: an investigation into the relationship between daylighting and human performance, detailed report (Heschong-Mahone Group)	Biophilia / Views	2% to 20%
1998	Healthy, Wealthy, and Wise (Pape, William R.)	Combined Design Elements	5%
1990	Interior Plants may Improve Worker Productivity and Reduce Stress in a Windowless Environment (Lohr, V.I., C.)	Biophilia / Views	12%
Est.			**3%**

APPENDIX B

RETENTION RESEARCH

The following reports primarily demonstrate the qualitative impacts of HPBs on employee retention. It is important to note HPB impacts on retention have the smallest amount of research available and is the greatest opportunity area for future research.

YEAR	TITLE (AUTHOR)	DESIGN ELEMENT STUDIED	SEPARATION RATE REDUCTION FINDING
2016	The Business Case for Green Building (Laski, J., WorldGBC)	Combined Design Elements	27%
2016	Americas Occupier Survey 2015/16 (CBRE)	Combined Design Elements	Attraction and retention of employees is the top focus of corporate real estate executives, with 57% saying it was a key area of focus driving their business.
2014	The Economics of Biophilia: Why Designing with Nature in Mind Makes Financial Sense (Terrapin Bright Green)	Combined Design Elements	Top five criteria for occupant function in an office that can lead to dissatisfaction: need for change (light levels, temperature, etc.); ability to act on the workplace environment, and notice effects; meaningful stimuli to avoid stagnation; one's own territory to indicate safety and identity; and, view to the outside world.
2014	Survey Research (Global Workplace Solutions, CBRE, & CoreNet Global)	Combined Design Elements	75% of those surveyed said that when seeking a new position, it's important that a potential employer support health and wellbeing. Once in the job, more than half (57%) said they would likely stay longer if their employer valued health and wellbeing.
2012	Satsifaction and self-estimated performance in relation to indoor environmental parameters and building features (Wargocki, P., Frontczak, M., Schiavon, S., Goins, J., Arens, E., & Zhang, H.)	Combined Design Elements	Each of the following contribute significantly to happiness at work: sitting within 4.6m of a window; visual and sound privacy; color and texture of surroundings; temperature; air quality; amount of light; and cleanliness.
2004	The Effects of School Facility Quality on Teacher Retention in Urban School Districts (Buckley, J., Schneider, M., & Shang, Y.)	Combined Design Elements	5%
1998	The Second Bottom Line: Competing for talent Using Innovative Workplace Design (Knoll & DYG, Inc.)	Combined Design Elements	Employees that are planning to leave a company routinely list their physical workplace as a desired characteristic.
Est.			**5%**

APPENDIX C (P1)

HEALTH & WELLNESS RESEARCH

YEAR	TITLE (AUTHOR)	DESIGN ELEMENT STUDIED	ABSENTEEISM REDUCTION FINDING
2016	The Business Case for Green Building (Laski, J., WorldGBC)	Combined Design Elements	58%
2016	The Business Case for Green Building (Laski, J., WorldGBC)	Combined Design Elements	44%
2016	The Business Case for Green Building (Laski, J., WorldGBC)	Combined Design Elements	19%
2016	The Business Case for Green Building (Laski, J., WorldGBC)	Combined Design Elements	25%
2011	Daylighting-Bias and Biophilia: Quantifying the Impacts of Daylight on Occupants Health (Elzeyadi, I.)	Biophilia / Views	10%
2010	Comfort, perceived air quality, and work performance in a low-power task–ambient conditioning system Building and Environment (Zhang, H., Arens, E.A., Kim, D., Buchberger, E., Bauman, F.S., & Huizenga, C.)	Air Quality	30%
2010	Effects of Green Buildings on Employee Health and Productivity: American Journal of Public Health (Grady, S. C., Syal, M., Singh, A., & Korkmaz, S.)	Combined Design Elements	50%
2009	Green Buildings and Productivity (Miller, N., Pogue, D., Gough, Q.D. & David, S.M.)	Combined Design Elements	39%
2007	Indoor climate and productivity in offices: How to integrate productivity in life–cycle cost analysis of building services (Andersson, J., Boerstra, A., Clements–Croome, D., Fitzner, K., & Hanssen, S. O.)	Ventilation	34%
2004	The Influence of Indoor Environment in Office Buildings on Their Occupants: expected—unexpected (Muhic, S. & Butala, V.)	Ventilation	34%
2004	Workplace air-conditioning and health services attendance among French middle-aged women: a prospective cohort study (Preziosi, P., Czerniichow, S., Gehanno, P., & Hercberg, S.)	Ventilation	57%
2003	Economizer System Cost Effectiveness: Accounting for the Influence of Ventilation Rate on Sick Leave (Fisk, W.J., Seppänen, O., Faulkner, D., & Huang, J.)	Ventilation	30%

APPENDIX C (P2)

HEALTH & WELLNESS RESEARCH

YEAR	TITLE (AUTHOR)	DESIGN ELEMENT STUDIED	ABSENTEEISM REDUCTION FINDINGS
2002	Association of ventilation system type with SBS symptoms in office workers. Indoor Air (Seppänen, O.A. & Fisk, W.J.)	Ventilation	30%
2002	The Effect of Plants and Artificial Daylight on the Well-being and Health of Office Workers, School Children and Health Care Personnel (Fjeld, T.)	Biophilia / Views	63%
2000	Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints (Milton, D.K., Glencross, P.M., & Walters, M.D.)	Ventilation	35%
1998	Healthy, Wealthy, and Wise (Pape, William R.)	Combined Design Elements	40%
1995	Daylighting & Productivity at Lockheed Solar Today (Thayer, Burke Miller)	Daylight	15%
1994	Greening the Building and the Bottom Line (Romm, Joseph J. & Browning, William D.)	Biophilia / Views	15%
1992	NMB Bank Headquarters: The impressive performance of a green building (Browning, William D.)	Combined Design Elements	15%
Est.			**30%**