



Honeywell

**PUT YOUR BUILDINGS TO WORK:
A SMART APPROACH TO BETTER BUSINESS OUTCOMES**

A White Paper Authored by Honeywell and IHS, Inc.

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Executive Summary

Like many countries, the United States has seen an increasing proportion of its population migrate to metropolitan centers. Nearly one in three Americans today resides in one of the country's 10 most populous metropolitan areas (New York, Los Angeles, Chicago, Dallas-Fort Worth, Houston, Philadelphia, Washington, Miami, Atlanta, and Boston), according to 2014 U.S. Census Data. In fact, about a third of U.S. population growth in 2013 occurred in these big cities.¹

City centers will continue to be a strong draw for the foreseeable future. The United Nations projects that by 2020 there will be over 53 urban areas in the United States with more than a million residents each, up from 41 in 2010, and just 12 in 1950.²

Meanwhile, due to climate change, natural resource constraints and the increasing demands of a digital society, the nation's cities are facing considerable challenges in providing the necessary physical and technical infrastructure to support sustainability and the quality of urban life, while both accommodating and driving economic growth. To address these issues, a number of American municipalities are launching the kinds of smart city programs that have sprung up elsewhere around the world. And the lynch pin of all these programs is the place where people spend most of their waking, and all their sleeping hours – the buildings in which they work and live.

What Makes a Building Smart

In the past, as long as a building was safe and secure, and it could be heated and cooled adequately, its technology was deemed to be doing its job. But times have changed. Economic and social demands continue to move the goalposts, driving innovation.

As technology advances, buildings become more complex. Building operators are faced with rising energy costs that only will increase in the years ahead. The focus on counter terrorism and the proliferation of gun violence at schools and on college campuses is ensuring security will be an integral part of building design.

In sum, today's buildings are being pushed to become smarter.

¹ <http://www.census.gov/popest/data/metro/totals/2013/index.html>

² World Urbanization Prospects 2014, United Nations Department of Economic and Social Affairs, <http://esa.un.org/unpd/wup/>

There are few definitions of what constitutes a smart building, but in this white paper we will refer to a smart building as one that:

- Provides the highest-possible level of asset utilization
- Achieves sustainable energy savings throughout its lifetime
- Redefines the development and modernization process rather than playing catch-up with new technologies

In our research on this subject, we encountered multiple evaluation frameworks for smart buildings. However, there was no single framework that could be used by all stakeholders (users, occupants, developers, and policymakers, among others), and across nations (most frameworks are driven by industry associations within a particular geography). There is agreement, however, that smart buildings should be green, safe, and productive.



Green: The economic and sustainability benefits of green buildings has been established through extensive academic and applied research.



Safe: Smart buildings place the highest priority on the value and quality of the lives of the people who live and work in them.



Productive: The conversation around productive buildings is still in its early stages. However, this is the area likely to see the fastest changes, driven by two major megatrends: connectivity and big data.

The Honeywell Smart Building Score™ was developed as a universal framework for the quick, comprehensive, and easy assessment of any building. It can be administered across countries, with minimal adaptation. The framework of the Honeywell Smart Building Score is flexible and adaptable to account for evolving smart business applications and solutions. Based on defined parameters of capability, coverage and uptime, the framework scores 15 elements in each building by their green, safe and productive outcomes. The Honeywell Smart Building Score is an average of these outcomes.

The Honeywell Smart Building Score was applied to close to 500 buildings across seven key cities to validate the tool, and assess building smartness. Key takeaways from the research are:

- Safety is perceived as the most critical indicator of a smart building.
- According to the survey, the top three scoring assets in U.S. buildings are fire-detection systems, efficient appliances and fixtures, and remote access/wired infrastructures.
- Public buildings score higher than private buildings across all three categories.
- Airports, government offices and hospitals are the smartest buildings; high-rise residential and private offices are the least smart.
- Buildings managers across all verticals give themselves much higher self-reported assessments than their actual scores, suggesting a disconnect between their perceptions and reality.

Finally, this white paper identifies a clear call to action for key stakeholders in the smart building ecosystem:

- **Government and policymakers:** The Honeywell Smart Building Score could help guide smart building strategies and guidelines. Public buildings could set benchmarks for private participation in the drive toward smart buildings.
- **Users, owners and developers:** The Honeywell Smart Building Score could be used to assist in making purchase and leasehold decisions, and to contribute to decisions regarding industry-specific strategies for smart buildings.
- **Industry associations, consultants, architects and service providers:** These influencers could create benchmarks, drive education and demonstrate the economic argument for—and benefits of—smart buildings to build smarter cities.

Both this research and white paper are part of a comprehensive movement toward smarter buildings, which are fundamental elements of a smart city. The Honeywell Smart Building Score has been launched in India and the United States, and is intended to help further the discussions on data, analytics, and action in smart buildings around the world.

Why Smart Buildings

Buildings are integral constituents of any city's ecosystem and, after people, perhaps the most important.

In the modern era, buildings no longer serve solely as physical structures to shelter their inhabitants, but increasingly define the quality of life of the people that dwell and work in them. Americans spend as much as 90% of their lives in buildings—whether in homes, offices, recreational, retail or public-service facilities.³ Commercial and industrial buildings are responsible for 39% of all U.S. energy consumption, 68% of electricity use, 38% of carbon dioxide emissions and 12% of water consumption, at a total cost of \$400 billion annually.⁴

Modern buildings are complex structures with multiple systems controlling lighting, heating, ventilation and air conditioning (HVAC), waste disposal, and security. In most traditional buildings, even new ones, such systems exist in silos. This produces inefficiencies in energy consumption, building usage and cost effectiveness. It also results in lower quality of services.

By contrast, smart buildings take advantage of new technologies to connect these pieces and systems in an integrated, dynamic and functional way, and not simply to reduce operating costs. System integration within smart buildings also increases sustainability, safety and productivity, while improving the quality of life for those who work and live inside their walls over the structure's long life cycle. Consequently, it is expected that annual expenditures on smart building applications that integrate operational functions, as measured by equipment supplier revenues, will boom in the near future. The North American market will see the second-fastest growth rate (behind Asia), with revenues almost doubling from \$4.7 billion in 2012 to \$8.9 billion in 2017, according to IHS.⁵

Large buildings are also vulnerable to disasters, both manmade and natural, that lead to loss of life and assets. Smart buildings can reduce the negative impacts of such events, and may also allow for proactive measures to help prevent them from occurring.

³ <http://www.epa.gov/region1/communities/indoorair.html>

⁴ <http://archive.epa.gov/greenbuilding/web/html/whybuild.html>

⁵ <https://technology.ihs.com/488046/annual-supplier-revenues-for-smart-building-applications-to-grow-150-percent-globally-by-2017>

⁶ <http://www.sfwater.org/index.aspx?page=583>

⁷ <http://www.sfwater.org/index.aspx?page=583>

⁸ "Administration Announces New 'Smart Cities' Initiative to Help Communities Tackle Local Challenges and Improve City Services," September 14, 2015, <https://www.whitehouse.gov/the-press-office/2015/09/14/fact-sheet-administration-announces-new-smart-cities-initiative-help>

Smart Buildings Today

Smart building planning and construction is already underway in cities around the United States. San Francisco's Water Power and Sewer's new headquarters, for example, incorporates an integrated, hybrid solar array and wind turbine installation that will generate 227,000 kilowatt-hours per year (or 7% of the building's annual energy needs)⁶; an onsite "Living Machine" that reclaims and treats building wastewater to satisfy 100% of the building's water demand; a raised flooring system that will reduce the building's heating, cooling, and ventilation costs by 51%; a digital arts wall displaying real-time data such as current reservoir levels, hydro-electricity and solar energy generation; and a wide variety of building diagnostics.⁷

In addition, the Obama administration recently announced more than \$3 million over three years in proposed funding to advance technologies for self-configuring, self-commissioning and self-learning buildings. In September 2015, the White House also announced plans to invest more than \$160 million in federal research for programs like these.⁸ The initiative is intended to create test beds for Internet of Things applications, develop new collaborative models among cities, countries and industries, and leverage existing federal activity in related technologies. Coming on the heels of smart city road maps laid out by other national governments—including India, Singapore and the United Kingdom—this release of federal funds likely will spur more U.S. smart city and building projects in coming years.

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The Benefits of Smart Buildings

The economic and sustainability benefits of smart buildings have been proven through extensive academic and applied research. Smart buildings have been shown to save energy, streamline facilities management and prevent expensive equipment failures. Smart buildings outperform traditional buildings on three key economic indicators: the number of years it will take before the investment pays for itself (the payback period); how much the building will cost to purchase, own, operate, maintain and decommission over its lifetime (its life-cycle cost); and the savings achieved by the new or retrofitted facilities as compared to the initial capital investment (the savings-to-investment ratio), according to The Energy and Resources Institute.

The state of Georgia, for example, implemented an advanced energy code in 2011 and saw the pace of commercial construction increase.⁹ While the capital costs for developing smart (as opposed to conventional) buildings are higher, the smart building's life-cycle cost is lower and the payback period of the capital cost is often shorter. In addition, the property value of commercial facilities conforming to Leadership in Energy and Environmental Design (LEED) certification increased by 8.5% to 25%, generating higher value for building owners, according to the U.S. Green Building Council.¹⁰

Intelligent building management systems can also detect faults in systems—and even predict when a piece of equipment is about to fail—alerting facilities personnel. That extends the life of building machinery, reduces maintenance-related costs and can prevent complete failures (which could lead to everything from loss of reputation to loss of life in the case of medical facilities). Accordingly, by 2017 the market for fault detection based on big-data building analytics will expand at a compound annual growth rate (CAGR) of more than 40%, according to IHS.¹¹

Smart buildings are simply safer buildings. Twelve of the 15 most costly insured catastrophes in the world in the past 45 years have occurred in the last 15, since 2000, and 75% of

them took place in the United States.¹² The total hurricane-related risk insured by the government alone has increased fifteenfold, to \$885 billion, since 1990, according to the Insurance Information Institute.¹³

Finally, smarter structures can enhance the health, happiness and productivity of the people in them. Improved air quality (IAQ, which includes such factors as temperature, humidity, quantity of oxygen, presence of chemicals and other contaminants, and the quality of outdoor air brought inside) has been shown to boost worker productivity by anywhere from .05% to 5%, according to a study by Lawrence Berkeley National Laboratory. That translates to a productivity impact of from \$20 billion to \$200 billion.¹⁴

Smart, healthy hospital buildings not only improve clinical staff productivity, but healthcare facilities with enhanced IAQ also help reduce hospital-acquired infections and increase patient comfort. The Center for Disease Control estimated in 2010 that hospital-acquired infections account for 99,000 deaths annually.¹⁵

Just as smart hospitals improve outcomes, smart school buildings enhance learning. Students in America miss approximately 14 million school days per year because of asthma. Controlling exposure to indoor environmental factors, such as carbon monoxide, dust, and pollen, could prevent more than 65% of asthma cases among elementary school-age children, according to the *American Journal of Respiratory and Critical Care Medicine*. Another government report found that test scores went up along with school air quality, while comfortable indoor temperatures enhanced productivity and helped keep students more alert.¹⁶

Green schools, with features like acoustical ceiling tiles, lined ductwork and appropriately placed vents, create fewer distractions and increase student participation.¹⁷ The skylights and large windows that are often featured in smart buildings let in daylight, rather than relying on melatonin-sapping artificial lighting. This has been shown to improve students' concentration.¹⁸

⁹ "Efficiencies pay dividends," December 31, 2014, AJC.com, <http://atlantaforward.blog.ajc.com/2014/12/31/efficiencies-pay-dividends-high-tech-wood/>

¹⁰ Green Building Market and Impact Report, 2011, U.S. Green Building Council.

¹¹ <https://technology.ihs.com/488060/the-big-growth-opportunity-for-big-data-in-smart-buildings>

¹² http://www.systemic-risk-hub.org/CUNY_Conference_June_2015/Kunreuther_slides.pdf

¹³ <http://www.eesi.org/briefings/view/insurance-industry-perspectives-on-extreme-weather-events>

¹⁴ http://bookstore.ashrae.biz/journal/journal_s_article.php?articleID=387

¹⁵ <http://www.nytimes.com/2010/02/27/business/27germ.html?em=&adxnnl=1&adxnnlx=1267412412-yP2bfi/3pu4+g34XVmluJA&r=0>

¹⁶ The Journal of Indoor Air, December 2006

¹⁷ Center for Green Schools at the U.S. Green Building Council

¹⁸ Figueiro & Rea, 2010

Smart Building Growth: Influencing Factors

Technology Adoption

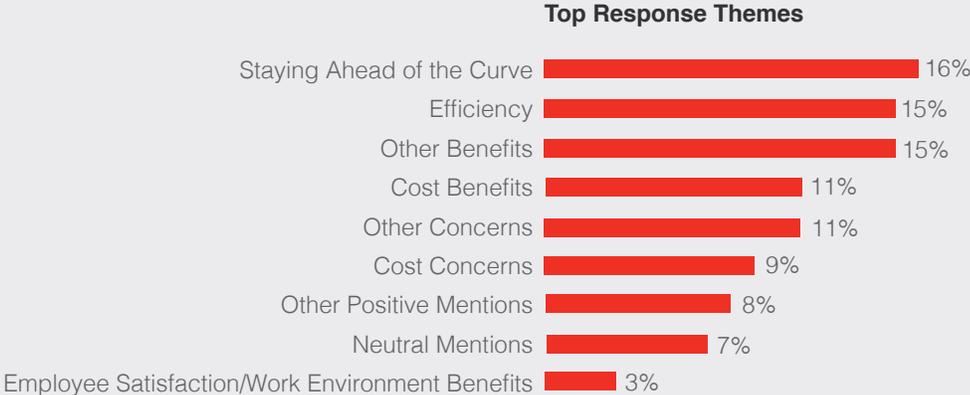
As everyone knows, technology is evolving rapidly. As is the case with leaders in other industries, building owners need to adapt to—and adopt—new, smarter technologies to keep up. But the pace of change is forcing owners and facility manager to play catch-up. Naturally, they have mixed feelings about the transformations roiling their industry.

In interviews with building owners and managers on the subject of smart building technology, it appears the majority are focusing largely on either cost or the general idea of efficiency (which is not far removed from cost). As a result, the financial aspects of adopting smart building technologies—cost savings and return on investment versus capital expenditure costs—dominate their decision making processes.

Curiously, while many building managers felt that staying ahead of the curve was the most important reason to keep up with the latest technologies, no airport building managers agreed, despite the fact that airports are the smartest buildings, according to the Honeywell Smart Building Score. Airport managers focused on other benefits of smart technology awareness, such as user safety—not

surprising given the airport environment. Only a small percentage of building managers cite employee satisfaction with the work environment as a reason to become technologically savvy. Managers of private offices are significantly more likely than those managing government offices, high rises, hospitals, hotels, retail stores, and malls to rate employee satisfaction and other work environment benefits as important. This suggests that private offices—structures that are developed purely as workplaces—are placing more emphasis on their human capital than managers of other, more multi-functional types of buildings.

Why do you feel it is or isn't important to keep up with the latest technologies to keep your building smart?



Certification

Airports, which have the highest Honeywell Smart Building Score, according to the study referred to above, are certified (LEED, GRIHA, IGBC or other) at a rate of 89%, suggesting that more certifications lead to a higher building score. However, a large proportion of high-rise residential properties are certified and yet they score second to last. Private offices are least likely to get certified and they have the lowest smart building score of all eight building types.

Some organizations have started to create programs for smart building certification, but these programs are very early in their inception and development. The Texas-based Smart Buildings Institute provides certification for smart buildings that:

- Provide actionable information regarding the performance of building systems and facilities;
- Monitor and detect errors or deficiencies in building systems before they snowball;
- Integrate systems for real-time reporting, allowing managers to adjust operations for energy efficiency and occupant comfort; and
- Incorporate the tools, technologies, resources and practices to contribute to energy conservation and environmental sustainability.

The U.S. Green Building Council (USGBC) is the pioneer behind LEED, a certification program for buildings, homes and communities that guides the design, construction, operation and maintenance of high-performance green buildings. According to the USGBC, more than 54,000 projects are currently participating in LEED, representing over 13.8 billion square feet of construction space. This year alone, McGraw Hill Construction suggests that an estimated 40% to 48% of new non-residential construction will be green, which amounts to a \$120 billion to \$145 billion opportunity. It also suggests that LEED is referenced in project specifications for 71% of all projects valued at \$50 million and over.

Buildings are one of the heaviest consumers of natural resources, and account for a significant portion of the greenhouse gas emissions that affect climate change.

They are also a large consumer of raw materials. Green buildings, however, consume less energy and fewer resources. According to the U.S. Department of Energy, buildings certified LEED Gold consume 25% less energy, 11% less water, emit 34% less greenhouse gases than non-LEED certified buildings and, perhaps more interestingly, score 27% higher in occupant satisfaction.

System Integration

Airports are significantly more likely than all building types to be integrated across systems, while private office buildings are most likely to have no system integration. This suggests that the more integrated a building's systems are, the higher a smart building score it will receive.

Arguably, one of the key drivers for integrating systems and making buildings more intelligent is the energy savings that can be achieved. However, the operational benefits obtained from integration are equally important. For example, human resource departments can use access control information to track billable hours; lighting and building management systems can be used for space planning; and video surveillance systems can be used to track consumer behaviors, leading to a more informed, strategic approach to store configuration.

Bringing different systems together within a single platform allows building operators, owners and facilities management to control and view their buildings more efficiently. A single platform can save time operationally when multiple systems are engaged simultaneously. For example, if there were a fire in one part of a building, operators working with a single, unified platform would be able to activate the fire suppression equipment, view the scene from the security cameras, open doors using an access control system and turn off the ventilation system feeding fresh air to the fire. This would save lives as well as reduce damage. Furthermore, rather than learning multiple systems, operators only would need to learn how to use a single system, promoting efficiency and saving on training costs.

When many subsystems within a building use the same Internet Protocol (IP) network, combined costs can fall. Installing an IP network is more cost-effective than installing low-power wiring. Installation costs also fall when one system can use inputs from another. For example, the lighting control system may require a light sensor and an occupancy sensor to determine optimal illumination levels. The building automation system requires a similar occupancy input to determine whether to heat or cool the same space. When the two systems are integrated, they can both use the same sensor, saving on equipment costs and installation time.

Traditional building systems may have had a simple thermostat on the wall, which would set the temperature, often within a given range. Some legacy systems are so complicated that occupants have a hard time changing set points, or even turning lights on and off. Smart building systems allow for access to the building equipment through occupants' desktops or even their mobile devices. Internal areas can be zoned to allow for personalization, thereby maximizing user comfort.

Many new building systems allow for independent remote control and remote operation. For example, many video management software (VMS) or access control systems incorporate independent remote access platforms. Increasingly, providers of building automation equipment are starting to offer similar features. However, there are operational efficiency benefits from using a single mobile app to access all of the building's systems (given a unified platform). A building with its systems integrated on a single platform permits a simple and cost-effective expansion of that solution in the future when new systems may be required due to legislative change, technology improvements or building expansion.

Most large, newly constructed or refurbished buildings have at least a basic level of integration. Over time, the level of integration in larger buildings is expected to rise. There are economies of scale that apply to larger buildings, creating more favorable and faster payback for systems integration than can be found in smaller and medium-sized buildings.

Regulations

There are two sides to every story, and it's no different with regulations. Many building managers see regulations as hindering smart building efforts rather than accelerating them. The cost of meeting requirements, the short windows in which to meet them and their complexity are seen as further challenges. However, those in favor of regulations tend to see the rules as a much-needed spur to the industry, causing it to make changes that would otherwise be resisted. Hotels, government offices and airports are typically in favor of regulations, and see them as a key accelerator of their smart building efforts. Unsurprisingly, private offices, hospitals and retail are in the other camp.

Planned Upgrades

When planning upgrades, most building managers are thinking about a building's infrastructure. In contrast, managers mention updates to security and safety systems much less often, suggesting that they are satisfied with what they have in place. This would fit with their assessment that safety is the most critical aspect of a smart building. Of the verticals assessed in this white paper, education, followed by private offices, were found to be the most likely to be making infrastructure upgrades, significantly more so than other verticals, such as airports, government offices, hospitals and hotels.

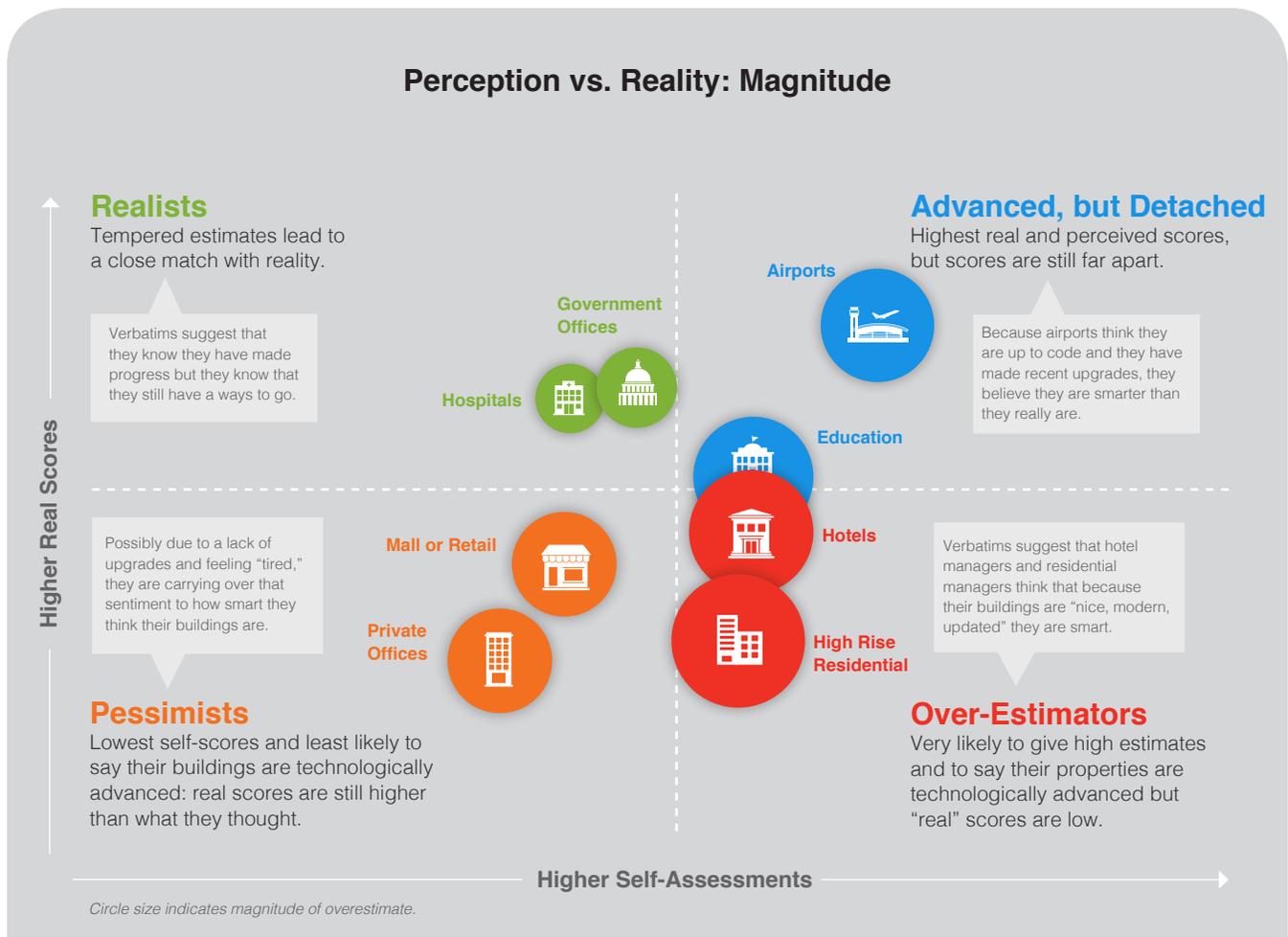
Perception vs. Reality

Every day, building owners and facility managers make decisions about what is important to them and to their buildings, and what is not. With respect to smart buildings, the perception of where buildings are on the smart building spectrum and what actually is the case differs considerably by vertical.

Interestingly, building managers in all verticals gave their buildings higher “smartness” assessments than their actual scores revealed. This suggests that more can be done with buildings than their owners and facility managers realize, and points to the need for greater education about smart buildings.

To date, smart building initiatives in the United States have focused largely on cost savings and risk mitigation, which also suggests that there is a huge opportunity for productivity gains that is currently being missed. The challenge facing the industry today is one of perception. Buildings are certainly an expense, but by leveraging smart technologies and certifications, buildings can be transformed into assets that can be assessed by something beyond the bottom line—and truly fulfill a mission to improve society and individual quality of life.

How can we quantify and compare degrees of smartness in order to achieve this mission? What can we use to benchmark progress, and see what remains to be done and how to do it? In the next section we will see how by applying the Honeywell Smart Building Score, stakeholders can measure themselves across three dimensions – green (or sustainability), safety and productivity – to identify both gaps and opportunities.



Four Smart Cities Getting Smarter

Smart cities apply new technologies to address growing urban challenges such as traffic, waste, energy, transportation, lighting, parking, healthcare, employment and security. There will be at least 88 of these “smart” cities across the globe by 2025—up from 21 in 2013—and annual investments in these projects will surpass \$12 billion, according to a study by IHS Technology.¹⁹

Most U.S. smart city programs are in the early stages of implementation. But even in their nascence, they already illustrate the market potential for such efforts.

New York City has been adopting smart city technology for several years. Among the initiatives underway in the Big Apple are City 24/7, a real-time interactive platform that integrates information from government programs, local businesses, and citizens. Plans include the nation’s largest citywide wireless network, and a \$20 billion residential development (the largest since Rockefeller Center) that automatically will track environmental and lifestyle data such as traffic, energy consumption and air quality.²⁰

San Francisco is also at the forefront of smart city projects, particularly in the area of sustainability.²¹ The city mandates separate waste collection, enables mobile access to near-real-time energy use data and provides automobile charging stations for electric vehicles throughout the area.²²

Boston’s leaders are harnessing digital and sensor technology along with crowdsourcing to increase government efficiency and reduce headaches for city residents. A growing digital 311 service enables the online (and mobile) submission of more than 150 transactions online, from paying parking tickets to requesting hypodermic needle removal.²³ Boston’s Street Bump app (a public-private collaboration) uses a smartphone’s accelerometer and GPS to locate, record and report potholes when volunteers press “send.”²⁴ The city also applied a new method of spatial analysis to more than 800 schools in eastern Massachusetts to define safe and optimal routes for kids walking to school.²⁵

Chicago launched the Array of Things last summer, installing interactive, modular sensor boxes that will be used to collect real-time data on the Windy City’s environment, infrastructure and activity for both research and public use.²⁶

¹⁹ <http://press.ihs.com/press-release/design-supply-chain-media/smart-cities-rise-fourfold-number-2013-2025>

²⁰ <http://www.hudsonyardsnewyork.com/the-story>

²¹ “The Rise of the Smart City,” The New Economy, March 27, 2014, <http://www.theneweconomy.com/technology/the-rise-of-the-smart-city>

²² <http://blogs.ptc.com/2014/08/06/technology-helps-5-us-cities-become-smart/>

²³ <http://www.cityofboston.gov/311/>

²⁴ “Street Bump: An App That Automatically Tells The City When You Drive Over Potholes,” FactCoExist, February 15, 2012, <http://www.fastcoexist.com/welcome.html?destination=http://www.fastcoexist.com/1679322/street-bump-a-smartphone-app-automatically-tells-the-city-when-you-drive-over-potholes>

²⁵ <http://walkboston.org/what-we-do/initiatives/research>

²⁶ <https://arrayofthings.github.io/>

Smart Building Evaluation Framework

In our research on this subject, we came across multiple evaluation frameworks for buildings: Asian Institute of IntelligentBuilding, Building Research Establishment, Continental Automated Building Association, Intelligent Building Society of Korea, Shanghai Intelligent Building Appraisal Specification, Shanghai Construction Council, Intelligent Building Assessment – Architecture and Building Research Institute, and Leadership in Energy and Environmental Design (LEED) green building rating system. However, there is no single framework that can be used by all stakeholders such as users, occupants, developers, and policymakers; across countries (most frameworks are driven by industry associations within a geography); and comprehensively across the three broad aspects of smart buildings: green, safe, and productive. The most popular and successful rating system is LEED certification by the U.S. Green Building Council.

LEED focuses on impact related to green and some aspects of comfort (productivity). Similar deliberation on each of these scales leads to the conclusion that it will be useful to have a comprehensive and simple framework to drive smart building assessment and improvement.²⁷

The Honeywell Smart Building Score has been developed as a universal framework for quick, comprehensive, and easy assessment of any building. It can be administered across countries with minimal adaptation. The framework of the Honeywell Smart Building Score is also flexible and adaptable for future enhancements as applications and solutions for smart buildings continue to evolve.



²⁷ Chen Z., Clements-Croome D., Hong J., Li H., Xu Q. (2006). A Review of Quantitative Approaches to Intelligent Building Assessment, Renewable Energy Resources and a Greener Future, VII-6 (2).

Honeywell Smart Building Score

In simple terms, the Honeywell Smart Building Score focuses on scoring assets that make buildings green (energy efficiency, reuse of resources, use of clean energy), safe and secure (detection and response to threats, controlling access to the facility, securing lives and assets), and comfortable and productive (illumination, thermal comfort, air quality, connectivity, energy availability).

The Honeywell Smart Building Score has been developed with three broad guidelines:

- Only active components (devices/equipment or software, all referred to as “assets” hereafter) of a smart building have been considered for evaluation. The passive components (architectural design, building location, building materials) once constructed rarely change much, and hence have not been considered in scoring. This feature also makes the Honeywell Smart Building Score relevant for both new and existing buildings.

- The Honeywell Smart Building Score measures the following:
 - Capability of assets in the building
 - Coverage or spread of the assets within the building
 - Uptime of assets
- The Score is an average of three outcomes of a smart building:
 - Green
 - Safe
 - Productive

Honeywell Smart Building Score



GREEN

- Flexible cooling and heating
- Power consumption monitoring and control
- Energy-efficient electrical appliances and plumbing fixtures
- Conservation and efficient use of natural resources



SAFE

- Surveillance and intrusion monitoring
- Fire detection and notification
- People and vehicle screening and access control
- Disaster response
- Gas and water leakage detection and notification
- Worker safety and personal protection



PRODUCTIVE

- Uninterrupted power supply
- Wired communication and data infrastructure
- People, vehicle, and cargo movement management
- Wireless communication and data infrastructure
- Indoor environment comfort, quality, and control

**Each of these 15 assets was assessed on asset capability, asset coverage, and asset uptime.*



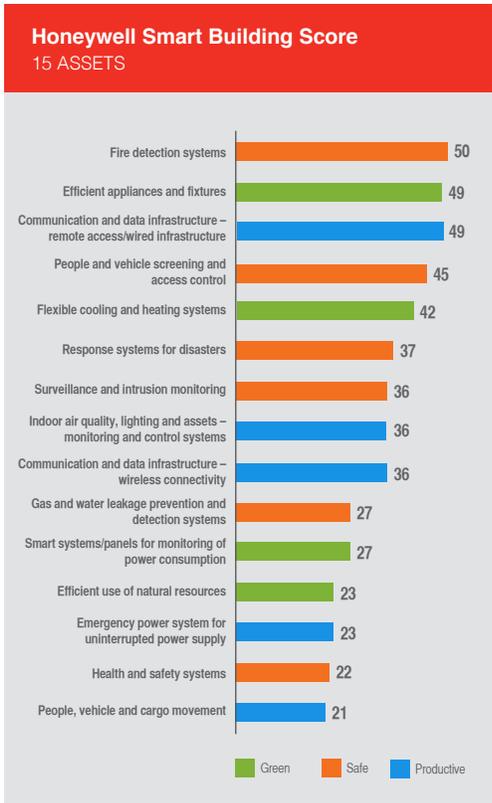
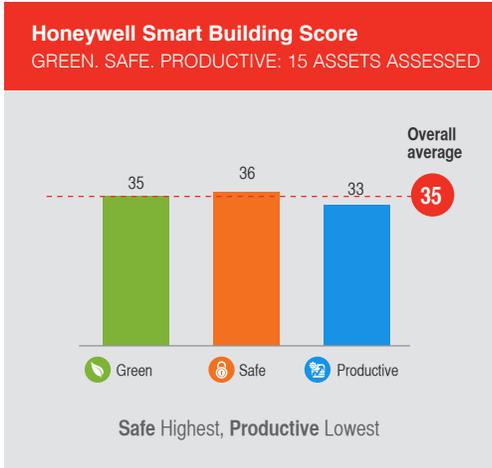
487

Buildings including 7 key cities

National Survey using Honeywell Smart Building Score

Key takeaways from the analysis of the Honeywell Smart Building Score survey include:

- Survey results show safety is perceived as the most critical indicator of a smart building:** Safety is considered the most essential measure of smartness. For example, nearly 3 in 4 respondents agree that a smart building “allows for improved security and business continuity” – one of the top-testing statements measured. Ever since the events of 9/11, a heightened sensitivity to security has been a part of American life. Today, heightened tensions in the Middle East and the rise of terrorist groups like Islamic State have brought security back to the forefront, with many Americans feeling less safe now than since the early days after the 2001 terrorist attacks. As a result, safety is expected to remain the pillar of any smart building. The only vertical categories where safe building scores did not rank highest were education and private offices. Scores on green buildings rate second. Interestingly, those who say greenness is the most critical factor are most likely to have received LEED certifications (44% vs. 25% for those who say safe or productive is most critical). Productivity scored the lowest, which suggests the ability for a building to contribute to productivity is the least known capability of smart buildings by building managers in the U.S. Productivity needs tend to focus on communication and data infrastructure, as well as on comfort benefits such as indoor air quality and lighting control.
- According to the survey, the top three scoring assets in U.S. buildings are fire detection systems, efficient appliances and fixtures, and remote access/wired infrastructure:** Each of the 15 asset groups that drive the smart scores can be grouped into three buckets. The first bucket includes five assets that are driving the higher smart scores. These include fire detection systems, efficient appliances and fixtures, remote access/wired infrastructure, people and vehicle screening and access control and flexible cooling and heating systems. In the second bucket, there are four assets driving smart scores in some verticals, while bringing down scores in others. For example, video surveillance, which ranked high in airports, retail and government, ranked lower in education, high rise residential and private offices. The last bucket includes six assets that to some extent are bringing down smart scores. For example, with the exception of airports, each of the other verticals analyzed in the research ranked lowest in terms of their efficient use of natural resources.





Airports



Hotels



Hospitals



Private Offices



Government Offices



Education



Mall or Retail

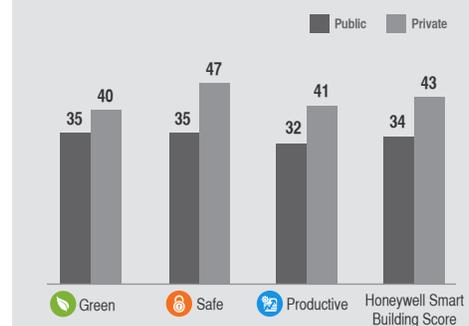


High Rise Residential

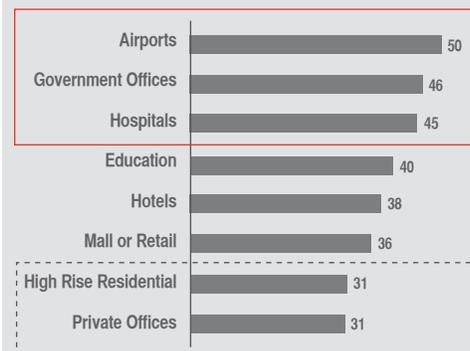
Survey Across 8 Verticals

- Public buildings score higher than private buildings across all three categories:** Contrary to what might be expected, publicly-owned buildings, not private ones, receive the highest smart scores. This finding is true for the overall rating, and for each of the three categories that make it up: green, safe, and productive. On September 14th, 2015, the U.S. Government announced a new Smart Cities Initiative that will invest more than \$160 million in federal research. The initiative has four key goals: Creating test beds for IoT applications and developing new multi-sector collaborative models, collaborating with the civic tech movement and forging intercity collaborations, leveraging existing federal activity in ICT, and pursuing international collaboration. This announcement comes after a series of smart city investment packages and roadmaps were announced by a number of national governments, including India, Singapore and the United Kingdom. Although the initial funding package is quite modest, with government support we expect to see an increase in the number of U.S. smart building projects in the next few years. As funding is often a key challenge to getting projects off the ground, this initiative will help encourage smart building development in the United States.
- Airports, government offices, and hospitals have the smartest buildings; high rise residential and private offices have the least smart buildings:** The Honeywell Smart Building Score results vary widely depending on building type. Airports score highest, while high-rise residential buildings and private offices score lowest. It is notable that critical infrastructure, serving important segments of the public, such as government offices, hospitals and, schools have scored highest. This should present a clear case for building owners, developers, and operators of private buildings (hotels, retail, residential, and private offices) to do more to make their buildings smarter. Detailed analysis and strategies for each of the eight verticals studied is presented in the annexure to this white paper.
- Perception versus reality is out of sync:** Building managers in each vertical give their buildings higher “smartness” assessments than their true scores reveal. This suggests more can be done with a building than owners and facility managers realize, and thus points to the need for greater education. The focus of smart building investment to date in the U.S. has been cost savings and risk mitigation. This suggests that there is a huge opportunity for productivity gains that are currently being missed. The challenge facing the industry today is one of perception. Buildings are certainly an expense, but smart technologies can transform them into assets that function in greater harmony with the mission of the organization.

Honeywell Smart Building Score PRIVATE VS. PUBLIC BUILDINGS



Honeywell Smart Building Score 8 VERTICALS: OVERALL SCORE



Airports, Government Offices, and Hospitals have the smartest buildings

High Rise Residential and Private Offices have the least smart buildings

Conclusion: Need for Action for Smart Buildings

Results from this research to assess building smartness suggest a clear need for action from all stakeholders.

Government and Policymakers



- Might consider widening the focus of incentives and guidelines for buildings beyond sustainability to also include safe and productive components.
- Might consider providing leadership and engaging stakeholders. City governments, private and public building owners, and technology vendors share similar goals for operational efficiencies, facility cost reductions, and sustainability improvements.
- Leverage existing federal government activity. Whether it is research on sensor networks or investments in broadband infrastructure, the federal government has an existing portfolio of activities that could provide a strong foundation for a wider Smart Cities effort.
- Use public buildings as a proof-of-concept for smart building improvements in the private sector.

Users, Owners, and Developers



- Enhance building smartness by focusing on all three aspects: asset capability, asset coverage, and asset uptime.
- Use vertical-specific strategies to drive building smartness effectively and efficiently.

Industry Associations, Consultants, Architects, and Service Providers



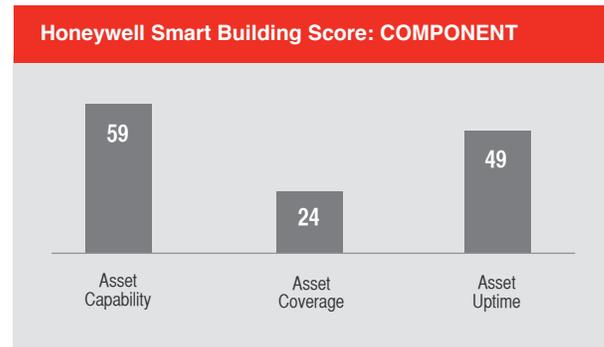
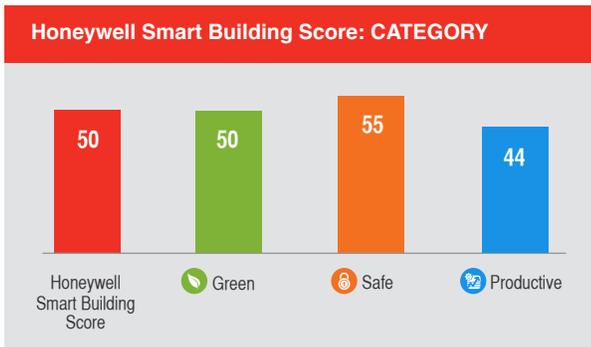
- Building on increased awareness and impact of the green building movement, also push similar research on benefits of safe and productive buildings.
- Deploy best practices and benchmarks identified in this white paper.
- Educate users and owners, and advocate to policymakers about the benefits of smart buildings.
- Demonstrate the economic argument for smart buildings to make smarter cities.





AIRPORTS

The airports vertical includes domestic and international passenger terminal buildings.



Assets that significantly drive the Honeywell Smart Building Score for airports:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient use of natural resources Efficient appliances and fixtures 	<ul style="list-style-type: none"> People and vehicle screening and access control Fire detection systems 	<ul style="list-style-type: none"> Indoor air quality, lighting and assets – monitoring and control systems Communication and data infrastructure – wireless connectivity

The score for airports, the highest scoring building type, was boosted by safety ratings, specifically “people and vehicle screening access control,” which was the highest score for this capability across building types. While this is not the top scoring safety asset overall, it illustrates airports’ well known need to screen people and materials for security purposes. Airports are vast in size, and a large consumer of energy. Through their efforts to improve energy efficiency in order to reduce cost, there is a clear opportunity for airports to improve their Honeywell Smart Building Scores. Further, most of the assets in this vertical have relatively higher uptime but the lowest coverage compared to other building verticals.

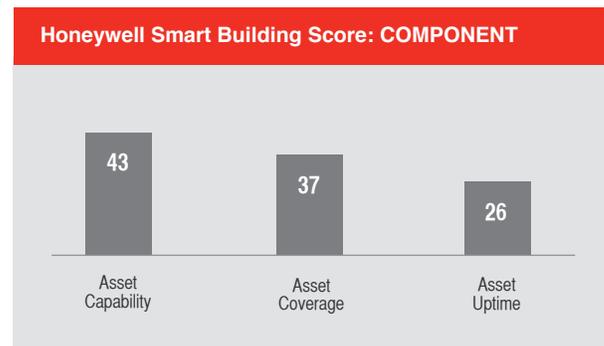
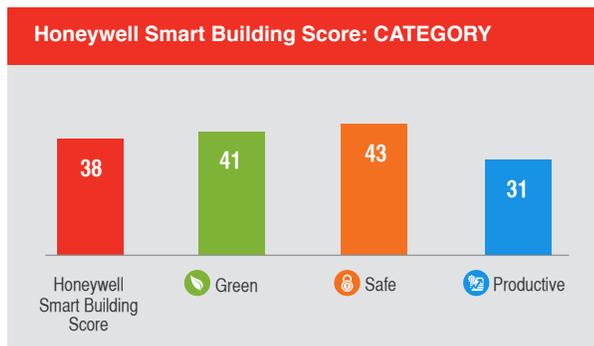
How can airports become smarter?

- Green:** Investigate additional opportunities to reduce energy demand and optimize energy supply. Better understand recycling and waste reduction activities, increase biodiversity and preserve natural areas.
- Productive:** Improve indoor environment comfort, quality and control management, as well as people, vehicle and cargo movement management.



HOTELS

The hotels vertical includes luxury, mid-segment, and budget hotels.



Assets that significantly drive the Honeywell Smart Building Score for hotels:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient appliances and fixtures Flexible cooling and heating systems 	<ul style="list-style-type: none"> People and vehicle screening and access control Fire detection systems 	<ul style="list-style-type: none"> Communication and data infrastructure – remote access/wired infrastructure Indoor air quality, lighting and assets – monitoring and control systems

Hotels, like airports and high rise residences, place great emphasis on people and vehicle screening and access control. A higher score for this particular asset suggests a hotel’s need for prioritizing visitor flow and security, a focus different from that of other building types. Further, hotels were found to have below average uptime and coverage scores.

How can hotels become smarter?

- Green:** Focus on conservation and the efficient use of natural resources. Hotels can deploy solar water heaters to provide pre-heated water for boilers for laundry and kitchen applications, and use renewable energy sources such as wind power and solar cells for power generation. Rainwater harvesting can also increase efficient use of resources.
- Productive:** Focus on indoor environment comfort, quality, and control systems. Improve productivity and user experience by making wireless communication and data infrastructure seamless and available across the building. Also improve systems for people and vehicles with technologies such as automated parking systems.
- Safe:** Focus on health and safety systems for security and support staff. This would include man-down systems to identify when individuals are horizontal, thereby pinpointing their exact location to make rescue faster and more efficient.

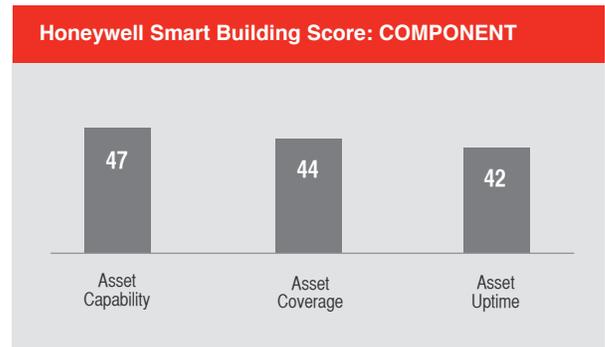
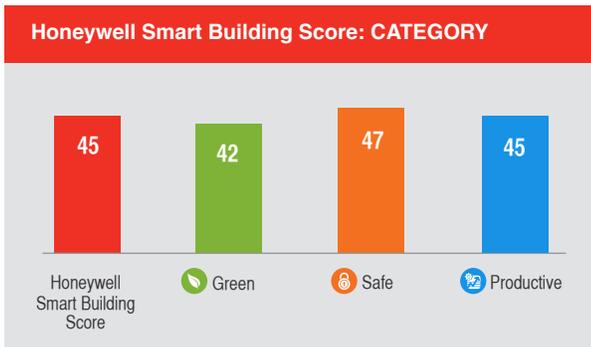


HOSPITALS

← EMERGENCY

← Main Entrance

The hospital vertical includes hospitals, secondary-care hospitals, and other healthcare facilities.



Assets that significantly drive the Honeywell Smart Building Score for hospitals:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient appliances and fixtures Flexible cooling and heating systems 	<ul style="list-style-type: none"> People and vehicle screening and access control Fire detection systems 	<ul style="list-style-type: none"> Communication and data infrastructure – remote access/wired infrastructure Communication and data infrastructure – wireless connectivity

Hospitals were found to have the top scores of any building type in three of the five productive categories, including “communication and data infrastructure – remote access/wired infrastructure” and “wireless connectivity.” These scores contribute to hospitals having the highest productive scores measured, in fitting with their need to process large amounts of data. Further, hospitals were found to be above average in terms of capability, uptime, and coverage.

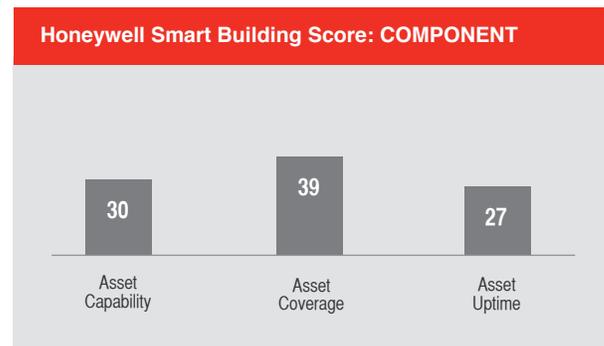
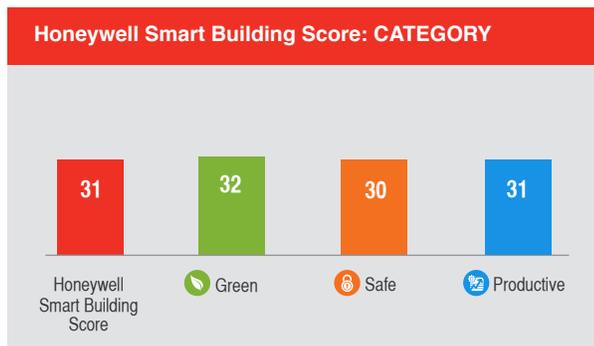
How can hospitals become smarter?

- **Green:** Focus on solar water heating systems to effectively manage constant hot water demands.
- **Productive:** Improve systems for people and vehicles by using automated parking systems. Enhance productivity by providing the ability to track both people and assets.
- **Safe:** Improve gas and water leakage detection and notification systems. Enhance video surveillance systems by empowering them to automatically transmit video clips to first responders who can then pinpoint violations and problems and prepare for them before arriving on the scene.



PRIVATE OFFICES

The private offices vertical includes high-end and mid-segment office spaces.



Assets that significantly drive the Honeywell Smart Building Score for private offices:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient appliances and fixtures Flexible cooling and heating systems 	<ul style="list-style-type: none"> People and vehicle screening and access control Fire detection systems 	<ul style="list-style-type: none"> Communication and data infrastructure – remote access/wired infrastructure Communication and data infrastructure – wireless connectivity

Private offices have the lowest safe score, which is notable because more than half of the respondents felt safety is the most critical indicator of a smart building, and private offices make up 45% of this survey. Private offices have the lowest scores for 7 of the 15 dimensions. Further, private offices scored the lowest in terms of capability, and were below average in terms of uptime.

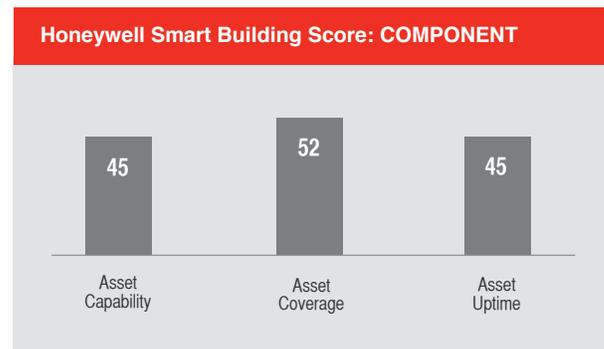
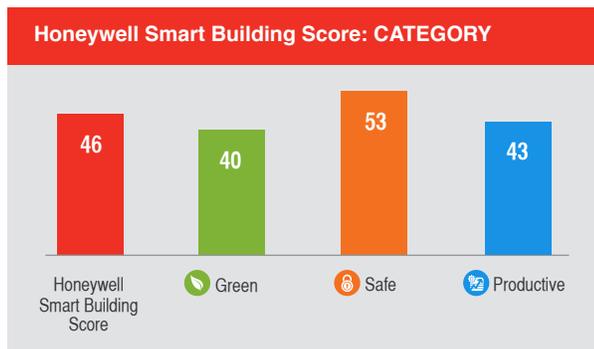
How can private offices become smarter?

- **Green:** Efficient use of natural resources such as solar panels for electricity generation and water heating, and solid waste and water recycling.
- **Productive:** Improve systems for people and vehicles, such as automated parking systems. Integrate backup power systems with building management systems (BMS).
- **Safe:** Emulate airports in terms of vehicle screening and access control. Deploy gas and water leakage detection and notification systems. Install video surveillance systems, with automated Guard Tour, to supplement physical guards.



GOVERNMENT OFFICES

The government offices vertical includes administrative buildings for federal, state and municipal agencies.



Assets that significantly drive the Honeywell Smart Building Score for government offices:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient appliances and fixtures Flexible cooling and heating systems 	<ul style="list-style-type: none"> People and vehicle screening and access control Fire detection systems 	<ul style="list-style-type: none"> Communication and data infrastructure – remote access/wired infrastructure Indoor air quality, lighting and assets – monitoring and control systems

Government offices have the highest asset score for “fire detection systems” and “response systems for disaster,” and prioritize fire safety and emergency preparedness more than any other building type. Further, while capability and uptime scored well above average, coverage within government offices scored the highest across all verticals.

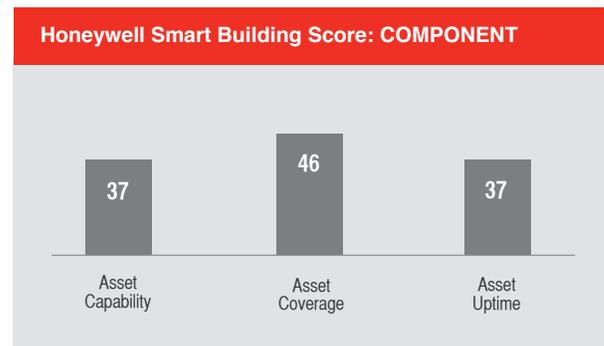
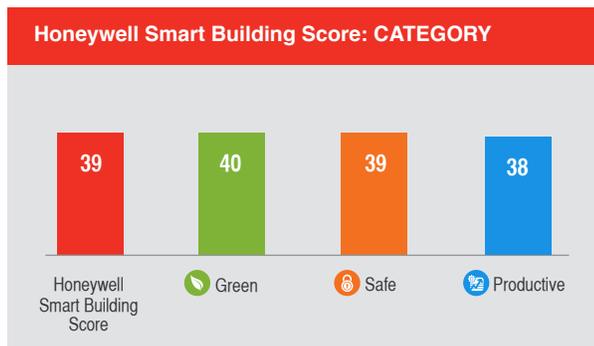
How can government offices become smarter?

- Green:** Focus on conservation and efficient use of natural resources, such as the use of solar water heaters, solid waste and water recycling, and rainwater harvesting.
- Productive:** Improve systems for people and vehicles, implementing automated parking systems. Integrate backup power systems with building management systems (BMS).
- Safe:** Focus on health and safety systems by using smart phones integrated with a video/ access platform for comprehensive monitoring and alerts. Install gas and water leakage detection and notification systems.



EDUCATION

The education vertical includes public and private, primary, and secondary education buildings and universities.



Assets that significantly drive the Honeywell Smart Building Score for education:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient appliances and fixtures Flexible cooling and heating systems 	<ul style="list-style-type: none"> People and vehicle screening and access control Fire detection systems 	<ul style="list-style-type: none"> Communication and data infrastructure – remote access/wired infrastructure Communication and data infrastructure – wireless connectivity

Education buildings do not have any top scoring assets in any category. They also have the lowest score for “surveillance and intrusion monitoring,” creating a low overall safety score, that is comparable to malls and retail properties. Uptime and coverage within the education vertical are in line with the industry average.

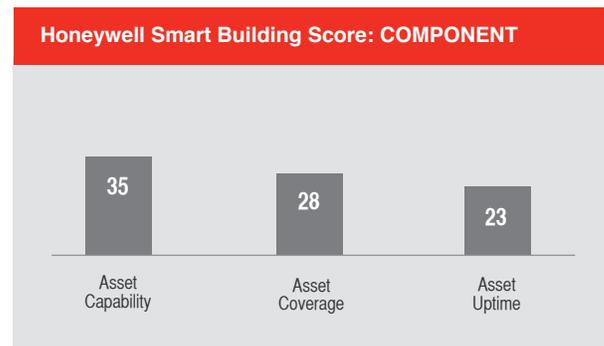
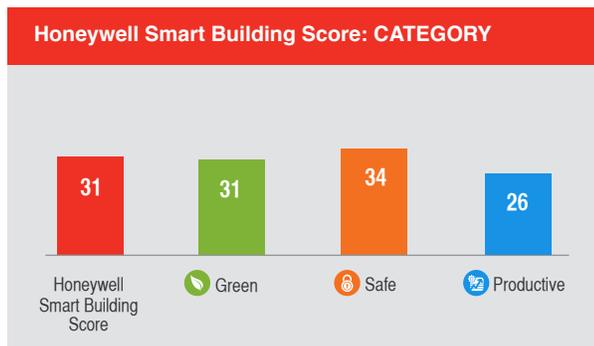
How can educational buildings become smarter?

- Green:** Focus on conservation and the efficient use of natural resources by using solar water heaters to supply hot water to the cafeteria and gymnasium. Also implement solid waste and water recycling, and rainwater harvesting.
- Productive:** Focus on indoor environmental comfort, quality, and control systems. Controlling exposure to indoor environmental factors – such as carbon monoxide, dust, and pollen – can reduce sickness and improve attendance. Monitoring and then adjusting air quality and temperature can also keep students more alert.
- Safe:** Improve health and safety systems by installing sensors capable of detecting an intruder based on factors such as glass breakage, and dual technology motion and seismic technology. Given the recent increase in school shootings and vandalism, focus on cameras with advanced firmware providing enhanced analytics to catch perpetrators.



HIGH RISE RESIDENTIAL

This vertical includes high rise apartment units in both private and public sector housing complexes.



Assets that significantly drive the Honeywell Smart Building Score for high rise residential:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient appliances and fixtures Flexible cooling and heating systems 	<ul style="list-style-type: none"> People and vehicle screening and access control Fire detection systems 	<ul style="list-style-type: none"> Communication and data infrastructure – remote access/wired infrastructure Indoor air quality, lighting and assets – monitoring and control systems

High rise residences have the lowest green and productive scores across all building types, as well as the lowest score for fire detection systems. In fact, high rise residences have the lowest scores in 7 out of 15 dimensions. Furthermore, high-rise residential had the lowest uptime and second lowest coverage compared to other building verticals.

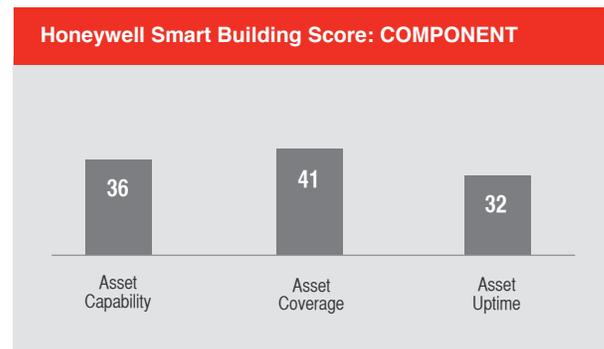
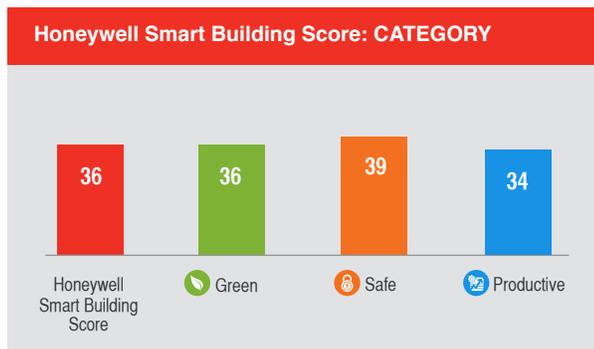
How can high rise residential buildings become smarter?

- Green:** Focus on the conservation and efficient use of natural resources by using solar water heaters, solid waste and water recycling, and rainwater harvesting. Lighting is also an integral part of any building. Lights incorporating daylight harvesting can detect the amount of daylight coming in and change the internal light levels to compensate and provide an even amount of internal illumination. Vacancy/occupancy detectors allow lights to turn on when motion is detected, and turn off when there is no motion detected, conserving energy.
- Productive:** Improved indoor air quality (IAQ) is a critical component of green building design. Increased attention to IAQ provides a number of benefits to residents and building owners. Good IAQ improves the well-being of residents as colds and infectious diseases spread less widely, and reduces the incidence of respiratory illnesses, such as asthma.
- Safe:** Look to deploy cameras with advanced firmware providing enhanced analytics. Enable first responders' remote access to digital video feeds. Improve fire detection and notification capabilities by integrating public address voice alarm (PAVA) systems. Place greater emphasis on evacuation systems.



RETAIL

This vertical includes malls and shopping complexes.



Assets that significantly drive the Honeywell Smart Building Score for retail:

Green	Safe	Productive
<ul style="list-style-type: none"> Efficient appliances and fixtures Flexible cooling and heating systems 	<ul style="list-style-type: none"> Fire detection systems Surveillance and intrusion monitoring 	<ul style="list-style-type: none"> Communication and data infrastructure – remote access/wired infrastructure Indoor air quality, lighting and assets – monitoring and control systems

Malls and retail stores have the second lowest score for efficient use of natural resources, which could suggest that these properties struggle to sustain day-to-day business while also prioritizing environmentally friendly building practices. Uptime and coverage within the retail vertical are in line with the industry average.

How can retail buildings become smarter?

- Green:** Focus on conservation and the efficient use of natural resources through the use of solar water heaters, solid waste and water recycling, and rainwater harvesting.
- Productive:** With consumers using their smart devices to shop while in-store, Wi-Fi has become a must-have for all retailers, enabling them to engage with customers both directly and indirectly. Improve indoor environment comfort levels to enhance the overall shopping experience.
- Safe:** Video surveillance is an effective tool across all aspects of a security solution. Clearly, visible cameras can provide a strong deterrent against misbehavior, and when linked to a central monitoring station can provide better coverage than manned guarding, alerting individuals to suspect situations. Video analytics continue to improve while also becoming less expensive, providing marketing departments with useful customer data on a variety of metrics.



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