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Intelligent Buildings and COVID-19

LANDMARK RESEARCH PROJECT

EXECUTIVE SUMMARY AND MODULE 1

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Citation

Frost & Sullivan. (2021, February). *Intelligent Buildings and COVID-19: Impact review, technology potential and future readiness assessment*. Continental Automated Buildings Association (CABA).

Keywords: Intelligent buildings, COVID-19, health and safety, reentry planning, system recalibration, asset planning, safety guidelines, building reopening, mitigation measures

Acknowledgements

Frost & Sullivan wishes to acknowledge the support of Continental Automated Buildings Association (CABA) staff: Greg Walker, Senior Director, Research Operations, for his project management and liaison efforts; Ron Zimmer, President & CEO, for his recognition and promotion of this important topic; Conrad McCallum, Communications Director, for his assistance with the editing of the report; and CABA's Marketing and Business Development team for fundraising in support of this study. The Steering Committee contributed its time and expertise to the project through virtual group sessions, offline sessions with the research team, and through reviews of the research processes, discussion guides, and earlier drafts of this report. The organizations and their representatives are:

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EXECUTIVE SUMMARY

ES 1 PROJECT BACKGROUND AND INTRODUCTION

ES 1.1 Intelligent Buildings and COVID-19: An Unprecedented Transformation for the Industry

The COVID-19 pandemic has impacted nearly every industry and fundamentally changed the way business will be conducted going forward. Beyond health, safety and environmental risks, the impact of COVID-19 has already forced various industries to consider business-transformation initiatives to deal with the "new normal" circumstances resulting from this pandemic. The intelligent buildings industry is no exception. In many ways, this industry and its value chain will continue to be faced with acute recovery challenges for a much longer time given the fact that buildings and their occupants place significant restraints on rolling out reset and recovery measures effectively. For operators, building staff, city and municipal authorities and technology solution providers, this calls for tremendous recalibration and reorganization of initiatives to handle re-entry and building operation measures in the post COVID-19 scenario.

The objective of this engagement was to evaluate the key issues and challenges presented by COVID-19 for the intelligent buildings industry and provide an objective assessment of the current impact, the implications for present and future technology evolution to meet post-lockdown requirements, and the measures that will help build future resiliency for this industry. As intelligent buildings industry participants deal with the imminent slowdown and fundamental shifts brought about by COVID-19, there are distinct pockets of opportunity that the emerging future scenario could deliver. The goal of this project was to evaluate the key challenges and opportunities and identify response measures that will help build resiliency. The project was accordingly divided into three inter-related modules with succinctly defined scope and deliverables as depicted in the following exhibit.

Intelligent Buildings and COVID-19		
Module	**Scope Description**	**Focus**
I	Impact Review	Immediate implications, reentry measures, regulatory and guidelines review, mitigation measures
II	Technology Potential Evaluation	New requirements in technology implementation, technology innovation potential, prospective technology radar and potential assessment
Module	**Scope Description**	**Focus**
III	Future Readiness Assessment	Planning for future infrastructure needs and requirements, resiliency building measures and key milestones to achieve

This document encapsulates the findings of Module I of this project. Module II and III will be undertaken subsequently, and their findings will be consolidated and presented to the Steering Committee at a later date.

ES 1.2 Methodology

Frost & Sullivan used a combination of primary and secondary research methodologies to compile information for this project. This included qualitative research, primary interviews, review of information in the public domain and quantitative tools for analysis and projection of key issues. The discussion agenda for primary research was developed by Frost & Sullivan in consultation with the Steering Committee. The draft was reviewed at the early stages of the project and feedback was mutually exchanged between the project team and the Steering Committee.

Frost & Sullivan adopted extensively structured and high-profile discussion techniques with target participants for the industry-focused primary research, involving single or multiple senior-level personnel and Frost & Sullivan's team of analysts and consultants to engage in insightful deliberations on the subject. The data obtained from these discussions were analyzed and distilled into the report commentary.

Secondary research comprised the balance of the research effort and included published sources such as those from government bodies, think tanks, industry associations, Internet sources, the CABA Research Library, and Frost & Sullivan's repository of research publications and decision support databases. This information was used to enrich and externalize the primary data. A listing of all works cited is provided in the appendix. References are cited on the first instance of occurrence. Dates associated with reference materials are provided where available.

Any reference to Frost & Sullivan's research findings, industry interactions, and discussions in this report is made in the context of the present project, unless otherwise stated. However, the analysis and interpretation of data in this report are those of Frost & Sullivan's consulting team.

ES 2 SUMMARY OF KEY FINDINGS

The key findings of Module I are summarized in the subsequent sections. Each synopsis corresponds to a chapter in the report; for example, ES.1 corresponds to Chapter 1.

ES 2.1 Impact of COVID-19: The Scenario Now

The COVID-19 pandemic has had a dramatic effect on operations and business activities in the building technologies industry; however, Frost & Sullivan expects most segments of this industry to bounce back in the first quarter of 2021. Heating, ventilation, and air conditioning (HVAC) equipment, sensors, and controls; building automation system controls; light-emitting diode (LED) lighting; and fire safety and security systems suffered significant negative impacts due to manufacturing plant shutdowns, supply chain disruptions, and an acute drop in consumer demand caused by lockdowns and closures of commercial and industrial buildings around the world. Some business activity continued much as before, including in HVAC, fire safety, and security services for critical healthcare, data centers, pharmaceutical, food and beverage, and retail operations that continued to run during lockdowns. Segments that were relatively immune from immediate impact were those driven by digital transformation needs, such as artificial intelligence (AI)-driven building solutions and applications, building energy management systems, building information modeling and digital twin solutions. This can be attributed to their recurring revenue models combined with their ability to support remote applications and facilitate health and well-being requirements in rolling out re-entry measures in workplaces.

The commercial real estate (CRE) sector presents significant opportunities to the intelligent buildings industry. The sector posted strong performance until the World Health Organization (WHO) declared a pandemic on March 11, 2020. Frost & Sullivan expects the CRE sector to rebound in the first quarter of 2021, but lifestyle changes, new workplace policies, and sustained fear of virus spread and job losses will have lasting implications.

Building closures during lockdowns introduced other problems for facility managers, such as mold growth and Legionnaires' disease outbreaks related to improper maintenance of water systems. The American Industrial Hygiene Association (AIHA) emphasized the importance of maintaining workplace conditions and water quality during the closure period, and advised building owners to hire certified industrial hygienists and other health and safety professionals to assess the risk of COVID-19 transmission and other workplace hazards for occupants after their return.

Internet of Things (IoT)-enabled sensors, AI-driven building solutions, and cloud-based remote services will be crucial components of engineering control strategies that consider the nine foundational areas of healthy buildings[1] to meet standards and maintain business continuity.

ES 2.2 COVID-19 and the Re-evaluation of Technology and Services

Building owners and facility managers face an uphill battle in ensuring a safe return for workers. Facility managers, for their part, are following guidelines instituted by their respective industry associations such as the International Facility Management Association (IFMA) and complying with regulations for building health assessments, indoor environmental

quality, and health and wellness standards supported by data-driven services. Building owners and asset managers are evaluating requirements for system upgrades and space reconfigurations to ensure occupant safety and proper social distancing, despite constraints from severe working capital crunches. At the same time, companies are assessing long-term lease agreements and increasing remote-work capabilities, which could be a blow to the CRE sector. U.S. government financial support through Economic Injury Disaster Loans and the Paycheck Protection Program is helping small businesses and easing the shortage of capital for building owners.

ES 2.3 Health and Wellness Impact Review of COVID-19 in Buildings

As scientific analysis and research in this field has already proven, there are three critical viral loads to consider when the impact of COVID-19 on occupants' health and wellness is reviewed: airborne, surface-borne and behavioral viral load. COVID-19 can be spread through close contact with an infected person or via surfaces that an infected person has touched. Researchers continue to study how and to what extent the virus can also be spread through small, infected aerosol particles that remain suspended in air and become circulated in HVAC systems. Some specialized solutions combined with air filtration technologies and higher ventilation rates in buildings, as suggested by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), could dilute airborne infections and reduce the risk of contagion.

Employees working in a closed environment run a higher risk of contracting the virus either by touch or through droplet transmission. Doors, desks, chairs, coffee vending machines, elevators, break rooms, washrooms, and similar high-touch office objects and areas could be agents for spreading the virus. COVID-19 mitigation strategies in office buildings range from providing personal protective equipment for all occupants to enforcing strict social distancing rules and establishing work-from-home policies. However, these comprise the industries' initial response strategies only, and the need for more drastic measures cannot be ruled out if there are continued and more severe manifestations of COVID-19 going forward.

ES 2.4 Planning and Mitigation Measures in Buildings, Post-Lockdown

Building owners and managers implementing appropriate technologies and services for a phased workforce re-entry is expected to be guided by eight key components that will drive their pandemic recovery and mitigation strategy. These include:

- Federal, state, and local government regulations
- Stand-alone, equipment-level technologies and services
- Optimizing a building's sensor network
- Facilities management
- Workforce productivity
- MEP (mechanical, electrical and plumbing) safe-start strategies
- Healthy building standards
- Shared, transparent, and efficient communication

ES 2.5 Key Takeaways

- As immediate resolutions, building owners and facility managers are expected to follow U.S. Occupational Safety and Health Administration (OSHA) and Centers for Disease Control and Prevention (CDC) guidelines to implement effective COVID-19 control measures and strategies, as well as ASHRAE's MEP (mechanical, electrical and plumbing) safe-start strategies to implement effective system-level environmental, and health and safety standards and processes in workplaces.
- Facility managers need to consider successful examples of networked or integrated building systems that maintain occupant safety, health, and well-being and maximize productivity.
- Collaboration with international building health standard certification providers and accredited healthy building professionals in developing an index to assess and certify building performance will be the way forward.

ES 2.6 Towards a New Baseline for Intelligent Buildings

The essential technology and service requirements involving health and wellness, data-driven services, indoor air quality, and other innovations across different spaces in the office environment are visualized in the context of a regular day in the office, post-lockdown. The office spaces under consideration are lobbies and office entrances, elevators and common spaces, workspaces, conferences and meeting rooms, restrooms and break-out areas. The researchers completed a robust technology evaluation exercise involving 27 intelligent building technologies and applications identified based on the outcome of technologies and service requirements that were established in Module 1. The analysis resulted in a technology radar development looking at the projections for various technology solutions for the years 2020-2025; the "x" axis of the technology radar. The identified technologies and applications have the potential to create immense value to occupants in the form of health and wellness, energy savings, carbon footprint reductions and increased occupant's comfort and productivity.

These technologies and applications were evaluated based on five criteria—growth potential, technology disruptiveness, regional adoption potential, mega-events impact, and funding—leading to technology index scores ranging from 0 to 50 on the technology radar "y" axis. The technologies and applications are categorized based on five intelligent building segments: lighting and control; HVAC and indoor air quality (IAQ); automation and energy optimization; communication; and post-COVID applications. These elements are also assigned technology maturity criteria and identified as being in a "trial" phase, an "implementation" phase, or an "established" phase, based on the scale of technology deployment across a portfolio of buildings.

ES 2.7 The Emerging Intelligent Building Technology Landscape

A comparative analysis of intelligent building technologies and applications was carried out. These were then plotted on the technology radar in Chapter 6, highlighting "market readiness" and "future enterprise value." In our analysis, market readiness encompasses five aspects: funding and investments, industry participation, technology maturity, application scope and criticality and current level of adoption. "Future enterprise value" takes

into account technology drivers, the impact of particular regulations, the opportunity to address unmet segment needs, and cost reduction potential. Both market readiness and future value are analysed for different intelligent building segments such as lighting and control; HVAC and IAQ; automation and energy optimization; communication; and post-COVID applications. The comparative analysis also describes in detail the future value of these technologies and applications in the intelligent building setup, along with the key players offering technology-based solutions. Some of the key use cases and best practices on digital twin for future workplaces, touch-less elevator controls, and IAQ-based ventilation controls are discussed in this chapter as well.

ES 2.8 Business Model Innovation for Mainstream Market Adoption

This report evaluates eight critical existing and futuristic business models based on adaptability and resiliency during and after the pandemic. The business models evaluated are:

- Lighting-as-a-service
- Software-as-a-service
- Energy efficiency-as-a-service
- Standalone business models
- Digital transformation-as-a-service
- Health buildings benchmarking-as-a-service
- Pandemic response-as-a-service
- Air quality-as-a-service

The report applies the "Business Model Transformation Board" approach, which was originally developed and published in a book titled *Radical Business Model Transformation: Gaining the Competitive Edge in a Disruptive World*. Based on this approach, the above-mentioned business models are evaluated and classified according to four types: product, project, platform and solution. The outcome of the business model evaluation highlighted the need for companies to make the change from standalone, physical offerings with independent transactions to comprehensive and customized offerings with recurring transactions. Software-as-a-service and digital transformation-as-a-service business models are identified as forward-looking and resilient business models that are capable of including comprehensive and integrated offerings with recurring transactions.

ES 2.9 Key Takeaways

- This research predicts that nearly 12 technologies and applications with advanced cloud-based optimization capabilities, IAQ filtration techniques and critical washroom technologies will have accelerated deployments at mainstream level by the end of 2024 and 2025.
- Companies that offer remote cloud-based services, predictive maintenance, HVAC optimization, workplace analytics and washroom solution providers will play a crucial role in defining the workplaces of the future.
- The outcome of business model evaluation suggests that software-as-a-service and digital transformation-as-a-service business models are high on inclusiveness, whereas individualized business models such as energy efficiency-as-a-service,

lighting-as-a-service, and pandemic response-as-a-services are high on customization.
- Business model transformation from one type to a more resilient one to reclaim a company's competitive advantage requires a deep strategic renewal process that includes a change in the company's overall thought process.

ES 2.10 Future of Work – Design and Planning for Intelligent Building Infrastructure

The research identified key design and planning considerations for intelligent buildings and workplaces post-COVID-19 that will need to be evaluated by design teams to balance the logistics of office space with healthy building practices. Some of the design-based passive innovations available for improved office layouts are:

- More spacious layouts of workstations prioritizing social distancing and accommodating multiple occupants with flexible work schedules.
- Optimized open-office layouts with efficient use of space and low-density areas.
- Pandemic-proof furniture and appliances with lightweight, modular and flexible characteristics along with anti-microbial surfaces.
- Smaller meeting and conference rooms with sophisticated audio/visual communication technologies.
- Use of a six-feet office concept highlighting key elements such as six-feet quick scan, six-feet rules, six-feet routing, six-feet workstation, six-feet facility and six-feet certificate.

ES 2.11 Future Use Cases for Intelligent Buildings

The potential for alternate use cases for intelligent buildings was studied as part of the research effort, based on some examples of technology implementation. These examples were observed during the recent lockdown, when building decision-makers had to respond to emergency requirements and contribute to efforts to tackle the pandemic. Several buildings such as stadiums, offices, convention centers, hotels and banquet halls have been converted to 'pop-up' hospitals across the world to meet the growing demand for beds for COVID-19 infected patients. There is a strong possibility that building campuses in the future will need to allow for the possibility of temporary healthcare amenities and transitional infrastructure elements. There might be the need to identify dedicated floors for temporary clinics, testing centers, counselling rooms and individual rooms with beds and modified floor-space to support medical emergencies for future pandemics. Building energy and health and wellness certification standards will be in greater demand, and government regulations may also drive more adoption of these standards for buildings. The designations/organizations supporting these standards include, among others: Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), Indian Green Building Council (IGBC), WELL, and RESET. This chapter also highlights essential use cases and best practices for improving air quality and energy efficiency, return-to-work-readiness solution, command-center planning in buildings, emergency response management and other key uses, post-COVID-19.

ES 2.12 Innovations Supporting Resiliency and Future Readiness for Buildings

There are some emerging property technology innovations with strong potential to benefit intelligent buildings in the post-COVID-19 environment. They include elements that have grown significantly in the last five years, such as flexible spaces, IoT sensor networks, artificial intelligence, and cloud services. The research identifies and divides these innovations into the five main categories listed here:

- Health and well-being innovations, including IAQ-based ventilation, ultraviolet germicidal irradiation, high-efficiency particulate air filters and customized healthy-building programs.
- Design-based passive innovations, such as workstation layouts with safe physical distance, open office layouts, furniture and appliances with antimicrobial finishes, and small meeting spaces.
- Spatial intelligence, including workplace analytics, people counting, occupancy detection-based social distancing, indoor positioning-based contact tracing, and AI-based lighting control.
- Remote service-based innovations for safe operations of HVAC systems after the lockdown and post-COVID-19. These include cloud-based remote services, HVAC optimization, predictive maintenance and building energy performance optimization.
- Washroom innovations, among them touch-free bathroom fixtures, antimicrobial paints on washroom walls, UV-C disinfection, pathogen scanners, touch-free toilet seat cover cleaning and nanotechnology-based self-cleaning surfaces.

ES 2.13 Key Takeaways

- Open floor plans with the flexibility to change workstation layouts can reduce overcrowding and facilitate easier cleaning procedures.
- Organizations will opt for strategies that encourage virtual interactions with the team and reduce face-to-face work environment.
- Building owners will solicit the aid of property management consulting firms to implement low-cost strategies such as six-feet office concepts.
- Buildings will need to be increasingly self-sustaining, and, in several cases be designed to support healthcare needs and emergency medical support on premises.
- Existing buildings will be equipped with essential IoT sensor networks for HVAC and IAQ requirements to handle health and well-being of employees, future epidemic and pandemic responses and workplace requirements concurrently.
- Intelligent buildings-based property technology innovations in health and well-being, spatial intelligence, remote services, interior design layouts and washrooms are expected to bring new opportunities for real estate firms, property management companies, and technology solution providers.

ES 2.14 Conclusion and Recommendations

The research recommends a dedicated focus on eight key areas, based on the nine foundations of a healthy building identified by Harvard's Healthy Buildings Lab and discussions with industry participants. This can help with phased building re-entry planning and with the transition to truly intelligent buildings that can tackle unprecedented situations.

The research highlights the list of technologies that can transform buildings of the future under five major categories. These technologies can be implemented through existing or futuristic business models that reduce capital expenditure burden on building owners.

The research also identifies key prop-tech innovations that are expected to positively impact intelligent buildings post-COVID-19. They are classified into five main categories: health and well-being innovations, design-based passive innovations, spatial intelligence, remote service-based innovations and washroom innovations.

Based on the findings of this research, this report recommends the following:

1. Re-entry strategies informed by collaboration among intelligent building stakeholders, regulatory bodies and associations
2. Understanding of the goals of building owners, and identifying avenues for building improvements
3. Design of buildings with provisions for future repurposing
4. Deployment of touchless solutions in buildings: touchless elevators, automatic sanitizer dispenser, and touch-free washroom fixtures

MODULE 1

IMPACT REVIEW

1. IMPACT OF COVID-19: THE SCENARIO NOW

1.1 ECONOMIC IMPACT OF COVID–19 ON THE BUILDING TECHNOLOGIES INDUSTRY

The intelligent building industry is one characterized by constant evolution in technology, practices, ecosystems and delivery mechanisms. The presence of devices, controls, and systems that interconnect and communicate with one another to enable an environment that is responsive and adaptive to occupants' needs and comforts lies at the heart of intelligent buildings. The degree of "intelligence" varies by the sophistication underlying the software-aided applications and communication network that helps these devices and systems function in an interoperable manner. In addition to that, Internet of Things (IoT) penetration at the equipment and facility levels, and artificial intelligence (AI)-driven solutions and cloud-based analytics at the management level, have transformed the intelligent building and its various technology domains. This interconnected environment offers several benefits; however, it also can enable the negative influence of technology failures, health risks, occupant safety threats, and more importantly the economic downtrend to cut across all of these domains and segments serving the intelligent building. This was glaringly evident in the negative economic impact of COVID-19 felt across the key technology segments associated with intelligent buildings, including lighting and controls, heating, ventilation, and air conditioning (HVAC) equipment; building automation systems and controls; building energy management; fire safety; security systems; and facilities management. Discussed below are some of the performance impacts experienced by these segments as a result of COVID-19.

COVID-19's impact on this technology-driven industry differed by segments. For instance, the light emitting diode (LED) lighting and controls market declined[2] in the first half of 2020 because of the sudden drop in demand related to temporary closures of commercial and industrial buildings and businesses to limit the virus's spread. Table 1.1 shows the assessment and full-year prediction made by Frost & Sullivan on the impact of COVID-19 on the North American LED market in 2020 and the expected recovery.

Table 1.1: Impact of COVID-19 on the North American LED Lighting Market

Market	Growth Rate, 2020	Expected Recovery
LED lighting	-1.31%	End of first quarter of 2021

Source: CABA Intelligent Buildings and COVID-19 2021 Report

Some lighting leaders reported a significant decline (in the range of 3.5 percent to 22.4 percent) in digital solution sales revenue, including for LED products, for the first two quarters of 2020. However, awareness of digital lighting services has been increasing over the past few years and is only becoming more acute during the pandemic because of its potential in workforce re-entry and COVID-19 mitigation strategies. In fact, one lighting leader increased its installed base of connected lighting points by 8 million in the first half of 2020. Lighting companies also have shifted their focus towards enhancing and delivering their UV-C lighting products for deactivating the COVID-19 virus in the air and on surfaces and objects in indoor environments.

HVAC and refrigeration equipment, HVAC control and sensor, and building automation system (BAS) businesses also were deeply affected[3] by temporary manufacturing plant closures and supply chain disruptions, and witnessed a sharp decline in consumer demand in the first quarter and second quarter of 2020. Table 1.2 shows the assessment and full-year prediction made by Frost & Sullivan on the impact of COVID-19 on the North American HVAC and BAS Markets in 2020 and the expected recovery.

Table 1.2: Impact of COVID-19 on the North American HVAC and BAS Markets

Market	Growth Rate, 2020	Expected Recovery
HVAC equipment	-5.8%	Early first quarter of 2021
HVAC controls and sensors	-7.7%	Early second quarter of 2021
BAS controls	-9.3%	Mid-second quarter of 2021

Source: CABA Intelligent Buildings and COVID-19 2021 Report

Some leading HVAC companies reported a significant drop in sales revenue (in the range of 7 to 20 percent) for the first two quarters of FY 2020, but one reported a 40 percent increase in orders for its HVAC, refrigeration, and fire and security business in June in North America, which indicates the possibility of a turnaround or back-to-normal scenario in the second half of FY 2020. The pandemic has also emphasized the importance of cloud-based remote services for critical building systems to deliver and maintain healthy, safe, and productive environment as workers return. For instance, Carrier launched a Healthy Buildings Program in early June that includes a safe start service, indoor air quality (IAQ) assessment, remote airside management, wellness services, remote energy management, and advanced access control and security services to help commercial, healthcare, hospitality, education, and retail facilities restart operations with safe and healthy indoor environments.

Another key segment of the building technologies industry is facilities management, which normally contributes 70 percent of overall industry revenue. It witnessed a pandemic-related decline[4] in the first half of fiscal year (FY) 2020 and a similar trend is anticipated by Frost & Sullivan to continue for the rest of the year, as illustrated in Table 1.3.

Table 1.3: Impact of COVID-19 on the North American Facilities Management Market

Market	Growth Rate, %, 2020	Expected Recovery
Facilities management	-6.6%	End of first quarter of 2021

Source: CABA Intelligent Buildings and COVID-19 2021 Report

Building operation, maintenance, and support services were particularly hard-hit because of the closure of commercial and industrial facilities and disruption of air travel, but cleaning and disinfection services offered a glimmer of hope. One of the leading facility management companies reported an 11 percent dip in Americas revenue in the first half of FY 2020 because of the pandemic's effect on aviation and food services, but witnessed 45 percent growth in deep-cleaning and disinfection services. A leading real estate service company reported six percent growth in property and facilities management revenue in the Americas region in the first half of FY 2020.

Software services from building technology solution providers such as EcoEnergy Insights, FogHorn, and 75F have been least affected by the pandemic. Companies offering AI-driven building optimization solutions and cloud-based building energy management systems (BEMS) actually reported significant growth in the first half of 2020 due to continued business in the critical end-user vertical segments with flexible and recurring payment models in place. Table 1.4 shows the assessment and full-year prediction made by Frost & Sullivan on the impact of COVID-19 on the global AI-driven building technologies industry[5] and North American BEMS market.

Table 1.4: Impact of COVID-19 on the Global AI-Driven Building Technologies Industry and North American BEMS Market

Market	Growth Rate, 2020	Expected Recovery
Global AI-driven building technologies	18%	End of fourth quarter of 2020
North American BEMS	3.1%	End of first quarter of 2021

Source: CABA Intelligent Buildings and COVID-19 2021 Report

The high-growth building information modeling (BIM) and digital twin market has been relatively resilient during the pandemic. Frost & Sullivan expects[6] demand in the built environment of the architecture, engineering, and construction industry to increase from early first quarter 2021, as shown in Table 1.5.

Table 1.5: Impact of COVID-19 on the North American BIM and Digital Twin Solutions Market

Market	Growth Rate, 2020	Expected Recovery
BIM and digital twin solutions in the built environment	6.8%	Early first quarter of 2021

Source: CABA Intelligent Buildings and COVID-19 2021 Report

A leading BIM company reported 22.7 percent growth in the first-quarter and 14 percent growth in the second quarter of 2020.

1.2 COMMERCIAL REAL ESTATE PREPARES FOR THE NEW NORMAL

As the world becomes accustomed to a new normal, an understanding of how past outbreaks and other unprecedented events affected the commercial real estate (CRE) sector is important. Table 1.6 shows the sector's trajectory during three 21st-century events with global repercussions.

Table 1.6: Impact of 21st-Century Events on the CRE Sector

Key Index	Recession and 9/11 Attack (Q1 2001 to Q4 2001)	Severe Acute Respiratory Syndrome (SARS, Q4 2002 to Q2 2003)	Swine Flu and the Great Recession (Q1 2008 to Q1 2010)
Pre-Event (4 Quarters)			
GDP[7]	Increasing	Increasing	Increasing
CRE Price Index[8]	Increasing	Negative	Declining but positive
Real Estate Investment Trust (REIT) Index[9]	Increasing	Declining but positive	Declining but positive
During the Event			
GDP	Declining but positive	Increasing	Contracting
CRE Price Index	Declining but positive	Increasing	Negative
REIT Index	Declining but positive	Data not available	Negative
Post-Event (4 Quarters)			
GDP	Increasing	Increasing	Increasing
CRE Price Index	Negative	Declining but positive	Increasing
REIT Index	Declining but positive	Increasing	Increasing

Source: CABA Intelligent Buildings and COVID-19 2021 Report

COVID-19 had a more immediate effect on the CRE sector. It was thriving in early 2020, but its fundamental operations were shaken to the core in March after the World Health Organization (WHO) declared a pandemic. U.S. financial markets declined sharply, and lockdowns shuttered or limited access to many workspaces.

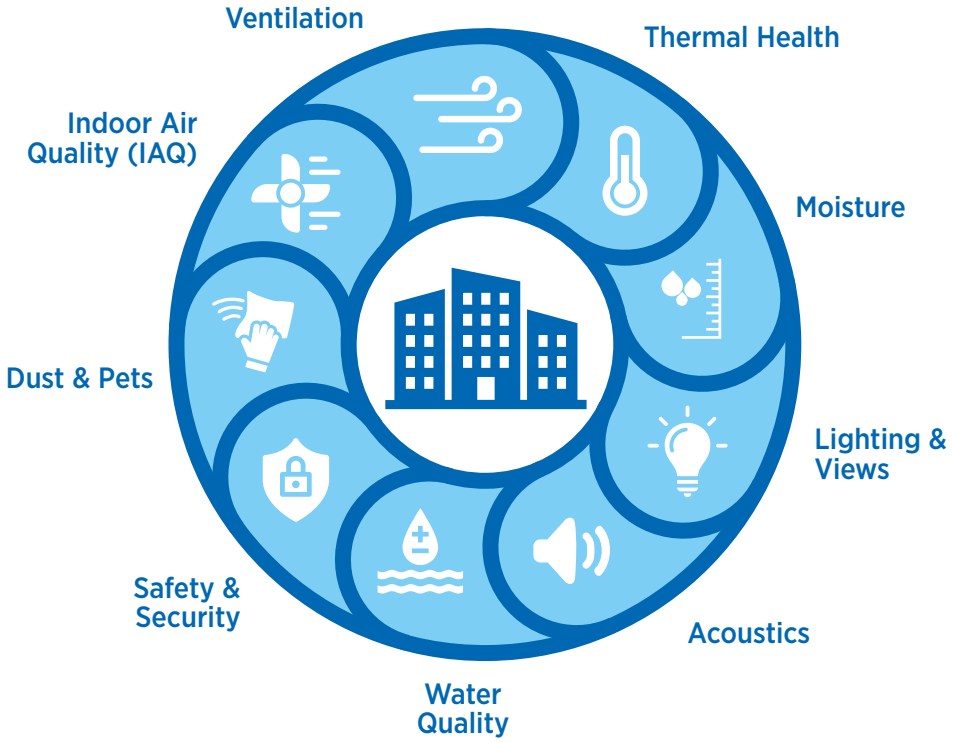
The combined effects of job losses, lifestyle changes, work policies, and sustained fear of virus spread will have larger and more lasting implications for the CRE sector. Along with the immediate focus on addressing issues related to liquidity management and operations support, building owners and facility managers will have to invest in technologies that make workplaces safer and more inviting to the cautious population.

1.3 IMMINENT BUILDING CLOSURES AND THE IMPLICATIONS FOR TECHNOLOGY AND RESOURCE PLANNING

Government-enforced lockdowns prompted the temporary closure of non-critical facilities to mitigate the risk of COVID-19 transmission, but building owners and managers still had to maintain and protect assets. The American Industrial Hygiene Association (AIHA) stressed the importance of relative humidity control to prevent mold and of water flow to prevent stagnation in water mains, plumbing lines, and cooling towers that could allow for Legionella colonization (Legionnaire's disease coincidentally has symptoms similar to COVID-19). AIHA advises building managers to hire a certified industrial hygienist and other occupational health and safety professionals to review the toxicity and effectiveness of disinfectant chemicals, assess the risk of COVID-19 transmission and exposure, develop a pandemic recovery plan, and control other building-related hazards as occupants return.[10]

Any building can attain a healthy building certification by focusing on the nine foundations of a healthy building that Harvard's Healthy Buildings Lab identified, based on 40 years of scientific evidence. These are shown in Figure 1.1.

Figure 1.1: Foundations of a Healthy Building



Source: CABA Intelligent Buildings and COVID-19 2021 Report

Building owners must adopt technology-based engineering controls and healthy building strategies based on these foundational areas to minimize workplace risks and maximize profits. AI-driven building solutions and cloud-based remote services are crucial for remote monitoring, fault detection and diagnostics, predictive maintenance, and building performance optimization during the pandemic—especially for mechanical, electrical, and plumbing (MEP) safe-start strategies prior to workforce re-entry. Intelligent building technologies have become more important for health and well-being than ever before; for instance, IAQ functions in HVAC automation and controls ensure an automatic supply of fresh air when carbon dioxide levels exceed acceptable limits. Body temperature and mask detection functions could be developed for access control systems so that people with fevers or no face protection would be denied entry to a workplace. Coordinated data from occupancy analytics would fine-tune ventilation systems for fresh air entry.

1.4 CURRENT BEST PRACTICE IMPLEMENTATION IN INTELLIGENT BUILDINGS

Fulton East, a 12-story, 90,000-square-foot office and retail building in Chicago's Fulton Market district, is the first commercial building to be designed, constructed, and commissioned for a post-COVID-19 environment. Structural and design features in response to the pandemic include:[11]

- A Toe-To-Go elevator system provided by MAD Elevator Inc. with foot-operated call buttons to reduce the spread of virus.
- An airPHX purification system that uses atmospheric cold plasma technology to convert some oxygen molecules into oxidizing molecules to kill pathogens in the air and on surfaces.
- Touch-free thermal scanning in the lobby to measure body temperature.
- A touch-free access control system with mobile access.
- Paint Shield, a microbicidal interior latex paint from Sherwin-Williams, on washroom walls to kill pathogens such as Staphylococcus aureus, methicillin-resistant Staphylococcus aureus (MRSA), Escherichia coli (E. coli), vancomycin-resistant Enterococcus faecalis (VRE), and Enterobacter aerogens.
- Sloan Touch-Free faucets, soap dispensers, and flush valves, and SloanTec hydrophobic glaze on washroom fixtures.

Other structural features include an 8,000-square-foot rooftop garden park for relaxation and informal meetings; and a building facade of continuous, 12-foot floor-to-ceiling, low-emissivity glass panels that allow for maximum daylight and views.

Given that the industry is still reeling under the pressures of reset and rebound, best practices are also emerging relatively slowly. Reliance on peer-to-peer advisories and experience sharing have worked as guiding principles for most industry participant groups. As temporary stability is achieved in a gradual manner, Frost & Sullivan expects use cases to emerge centering on technology innovation, service practices, equipment handling, and above all, occupant safety-related aspects that could offer valuable learning for industry participants to adopt. Some of these preliminary use cases that are already showing signs of application are discussed in subsequent chapters.

2. COVID-19 AND THE REEVALUATION OF TECHNOLOGY AND SERVICES

2.1 THE NEW NORMAL: TECHNOLOGY AND SERVICE REQUIREMENTS

As the workforce adjusts to a new normal until a COVID-19 vaccine is widely available, facility managers must find a balance between occupant well-being and productivity with no true precedent to guide them. Occupant safety, by far, emerges as the most important factor to focus on, as demonstrated by several independent perception studies and Delphi studies undertaken by leading industry associations as well as by Frost & Sullivan. For instance, Frost & Sullivan's recent research on *The Workplace of the Future post COVID-19* combined the perspectives of leading enterprises, asset management companies and business professionals across the globe to underscore that beyond the importance of enterprise and business flexibility, and the need for technology innovation, the single most important priority for all business leaders to address immediately is workplace and occupant safety. This finding is also substantiated in IFMA's latest research undertaking, *The Experts' Assessment: The Workplace Post-COVID-19*,[12] which compiles insights and views of over 248 globally recognized subject-matter experts on how new ways of working will develop when societies return to normal.

Intelligent technologies and innovative services will be in demand. Phased workforce reentry will involve a few broad focus areas along with basic operational changes to keep occupants safe and minimize anxiety.[13] Facility managers' priorities are discussed in Table 2.1.

Table 2.1: Facility Managers' Technology and Service Requirements During the Pandemic

Requirement	Description	Analyst Insights
Building health assessment	A comprehensive health assessment of buildings before workforce re-entry to identify potential high-risk areas; operational condition of mechanical, electrical, and plumbing systems; areas of focus; and more.	Priority to implement: medium to high Opportunities: Certified industrial hygienists and other occupational health and safety professionals will be hired to do the assessment. Current case studies on building health assessment are currently in progress and final outcomes of these assessments are not publicly available as yet.
Indoor air quality (IAQ) solutions	Heating, ventilation, and air conditioning (HVAC) automation systems that include air quality sensors to monitor levels of carbon dioxide, volatile organic compounds, and fine particulate matter; air purifiers; and air filtration technologies such as high-efficiency particulate air (HEPA) filters, minimum efficiency reporting value (MERV-13), and ultraviolet germicidal irradiation (UVGI) solutions.	Priority to implement: high Opportunities: Discussions with leading HVAC industry participants for the purpose of this research confirms that HVAC equipment providers and IAQ system providers will focus on the creation of autonomous ventilation systems that work based on the input given by IAQ sensors. Several of these initiatives involve co-creation with leading university labs such as the University of California, San Diego (UCSD), Los Alamos National Laboratory, and the Bioanalytical Microsystems and Biosensors Laboratory at Cornell University, to name a few.
Data-driven services	Artificial intelligence (AI)/ machine learning-driven platforms that gather useful data from critical building systems to provide real-time, actionable insights about limiting exposure risks and to simulate scenarios for future pandemic recovery plans.	Priority to implement: medium to high Opportunities: AI-based building optimization solution providers such as EcoEnergy Insights, Fog-Horn, BrainBox AI, BuildingIQ and incumbent building technology players such as Siemens, Honeywell, Johnson Controls International will compete hard in this space; the priority will be to integrate all building systems under a single platform.
Health and wellness standards	Assessment tools and services that help in the development of building operational policies, protocols, and pandemic recovery strategies. Regenerative Ecological, Social, and Economic Targets (RESET) and WELL are commonly used certification programs.	Priority to implement: high Opportunities: Third-party certification providers and accredited professionals will have a huge role to play in certifying a building based on its health index. This is already prompting facility management majors to look into certification programs for their internal staff proactively, as indicated by primary discussion with JLL and Cushman & Wakefield.

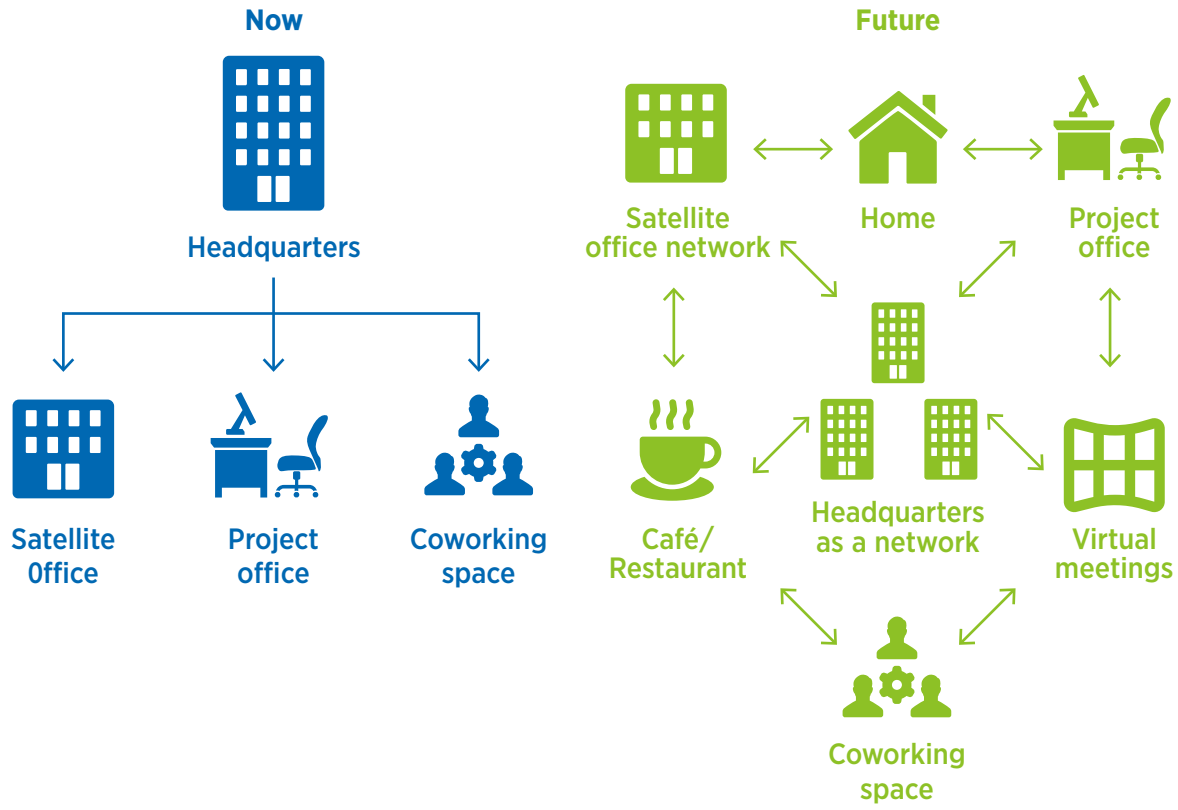
Source: CABA Intelligent Buildings and COVID-19 2021 Report

2.2 IMMINENT CHANGES FOR BUILDING MANAGEMENT

The priority in the commercial real estate (CRE) industry today is making buildings safer so that people feel comfortable returning to their workplaces.[14] If at least some work-from-home policies remain in place, however, tenants will become much more selective about location and pricing.

Pandemic-weary organizations are focusing more on tactical decisions, such as lease renewals, for the immediate future. Frost & Sullivan's research report *The Workplace of the Future post COVID-19* indicates that prolonged work-from-home policies and newfound fears of living in densely populated cities could influence a noticeable population shift to suburban and rural areas. The very definition of a workplace may change from a physical headquarters with a few offsite locations to a network of satellite offices, flexible office and co-working spaces, a variety of other connected locations, and virtual meeting rooms. Figure 2.1 illustrates this.

Figure 2.1: The Future of Workplaces



Source: CABA Intelligent Buildings and COVID-19 2021 Report

Future-proofing buildings to combat pandemics and natural disasters will be of prime importance for building owners and construction firms, with digitalization and remote monitoring of HVAC systems taking center stage to ensure IAQ and energy efficiency. Because COVID-19 can be spread through airborne respiratory droplets, system modifications such

as proper maintenance of HVAC equipment, increased outdoor air ventilation can alleviate some fears. A properly functioning system is important as employees begin to return.

Commercial buildings generally cater to a slew of activities, maintain higher occupancy levels and generally accommodate frequent visitors. There are concerns regarding the amount of fresh air circulation within buildings. CDC guidelines suggest a flow of outside air to the greatest extent possible to improve ventilation inside buildings. This can be achieved by running HVAC systems continuously throughout the day. Though this will have a bearing on the energy costs, it ensures air flow from outside the building is seamless. Increasing the filter efficiency by installing MERV-13 (minimum efficiency reporting value-13) air filters, which are efficient in capturing airborne viruses, will help with removal of particles from airstreams.

Building owners undoubtedly will incur new expenses in order to provide a safe and clean environment for tenants, with heightened sanitization measures, touchless entry points, and thermal checks all on the table.

The installation of a network of low-cost, wireless sensors that detect motion, occupancy, temperature, air quality, light, and other parameters would help numerous building systems communicate with each other.[15] The result would be an IoT-enabled smart building that automatically adapts to any changes in an indoor space and, more importantly, provides facility managers with a wealth of data that allow for more cost-effective operations and a smaller carbon footprint. That data will be even more important as employees gradually return to their workplaces: occupant density and movement can be monitored in real time to determine workplace cleaning and disinfection schedules, allow for real-time alerts when crowds congregate in violation of social distancing protocols, and enable digital contact tracing.

2.3 CIRCUMVENTING CAPITAL SHORTAGES

The U.S. and Canadian governments assembled emergency programs to help businesses weather the immediate effects of the pandemic and recover from the crisis. The Canada Emergency Commercial Rent Assistance program[16] offers help for small businesses experiencing financial hardship because of COVID- 19.

The U.S. Congress quickly passed the *Coronavirus Aid, Relief, and Economic Security* (CARES) *Act*,[17] and President Trump signed it into law on March 27, 2020. The CARES Act defined in Section 168 of the U.S. tax code allows full deduction of the cost incurred for all equipment and components associated with an HVAC system. For commercial buildings, the cost of HVAC equipment placed into service in 2020 may be fully deducted as a business expense. Chillers, furnaces, air handling units, exhaust fans, condenser and controls systems are covered under this Act.

Frost & Sullivan expects the CRE market to remain under pressure over the next 6 to 12 months and likely fuel further concessions in terms of rent. Even though buildings might not operate with full occupancy levels, tenants will be better positioned to secure advantageous leasing terms. Assuming the economic recovery continues and a vaccine is widely available in the next year, tenants may not have the upper hand for long.

Table 2.2: Incentive Programs for Improving Building Energy Efficiency

Incentive Program	Features	Additional Details
179D Energy Efficiency Tax Deduction[18]	This program is eligible for tenants in government or federal buildings for construction expenses. Highlight: Tax deduction of up to $1.80 per square foot can be accessed for installation of lighting, HVAC or building envelope that reduce energy consumption by 50%.	Set to expire by end of 2020. Project must be completed and approved by Dec. 31, 2020.
2020 *Coronavirus Aid, Relief, and Economic Security (CARES) Act* Deduction	All non-residential properties qualify for the program. Highlight: Tax deductions for the full amount of equipment and labor costs that are considered improvements to the interior of a non-resident building. No limitation on the cost of equipment that can be purchased.	CARES Act does not allow for the expansion of a building, larger improvements such as escalators and elevators, or improvements to the internal structural framework. However, it is still possible to improve air flow and containment, or better optimize existing infrastructure, by taking advantage of this fiscal relief.
Commercial Property Assessed Clean Energy (C-PACE) Program[19]	Facilities that require a long-term financing option (10+ years) for energy efficiency project, with option to transfer the financial obligation at the time of sale can opt for the C-PACE program. Private investors, banks or financial institutions can fund the project.	Only states with enabling legislation can carry out this program. 37 states in the U.S. have enabling legislation. The C-PACE program is now active (operating) in 24 states in the U.S.

Source: CABA Intelligent Buildings and COVID-19 2021 Report

Table 2.2 above illustrates the incentive programs in the U.S. that are aimed at improving building energy efficiency. Building owners can utilize these incentive programs to optimize their buildings for COVID-19 prevention.

3. HEALTH AND WELLNESS IMPACT REVIEW OF COVID-19 IN BUILDINGS

3.1 POTENTIAL VIRAL TRANSMISSION PROPAGATORS IN WORKPLACES OF BUILDINGS

According to the WHO, transmission of SARS-CoV-2, the virus that causes COVID-19 is primarily spread through direct contact with an infected person or through their respiratory droplets.

Droplet transmission occurs when an individual is in proximity (within 1 m/3.3 ft) with someone who has respiratory symptoms.[20] Tiny water droplets that contain salt and organic materials are expelled when an individual sneezes, coughs, or talks. The person infected with the COVID-19 also expels the virus, in amounts smaller than 100mm in size, through their droplets. These water droplets containing the virus evaporate inside buildings, leaving the microscopic matter which stays suspended within the air. Over time, the concentration of the virus builds up, which increases the danger of infection for people within the building, particularly if there's no proper air circulation.[21]

Airborne transmission may be possible inside a built environment that generates aerosols. Airborne transmission refers to the presence of microbes within droplet nuclei, which can remain in the air for long periods and can be transmitted to others at distances greater than 1 m/3.3 ft.

Respiratory droplets from infected individuals can also land on objects, contaminating the surfaces. It is highly likely that people can also be infected by touching these surfaces and touching their eyes, nose or mouth without cleaning their hands.

Transmission of COVID-19 is primarily through people having symptoms; however, it can also occur when they are asymptomatic, and are in close proximity to others for prolonged periods of time. Research is underway to investigate and establish how asymptomatic carriers pass the virus to others.

Some of the most likely areas for virus transmission in commercial spaces are listed below:

Office desks and common rooms

Employees working in shared spaces or a closed environment run a higher risk of contracting the virus either by touch or through droplet transmission. High-touch doors, desks, chairs, break rooms, washrooms, and coffee vending machines could help the virus spread.

Elevators

Elevators can be a hotbed for COVID-19 transmission. The small, enclosed spaces might only fit two people following social distancing guidelines. In larger offices and commercial buildings, social distancing becomes difficult to practice. Air circulation is limited to a few vents and the short time when doors are open.

HVAC systems

According to ASHRAE, the transmission of COVID-19 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning (HVAC) systems, can reduce airborne exposures.

Insufficient ventilation can increase disease transmission and hence, disabling of HVAC systems is not advisable. Ventilation and filtration provided by HVAC systems can reduce airborne concentrations of COVID-19 and thus the risk of transmission through the air.

3.2 SCIENTIFIC SUPPORT FOR TECHNOLOGIES TO MITIGATE COVID-19 SPREAD IN BUILDINGS

Continued adherence to the authoritative guidelines with respect to social distancing, regular sanitization of workplaces and hands, use of face masks, and avoidance of crowded areas and closed spaces with poor ventilation is the most effective way to reduce the spread of the virus. Best practices for buildings include thermal scanners at building entry, increasing touchless points in washrooms, elevators, and access control to ensure less transmission inside buildings.

Smart building sensor technology used for real-time monitoring of assets, occupancy, and other building parameters could be adapted to focus on the health and wellness of the occupants. Sensors embedded into employees' access cards can track their movement within the building and ensure that safe distance is maintained between employees by embedding alarms, when two employees are in proximity for longer duration.

Mechanical filters used in HVAC equipment are made of porous materials to trap airborne particles. These filters are also capable of trapping gases and pollutants. The minimum efficiency reporting value (MERV) is a measure to rate filters based on its efficiency, airflow and size of the particle it traps. ASHRAE recommends MERV 13 or higher to be implemented in commercial buildings. The higher the MERV rating, the finer the particles it can trap. According to the American Society for Microbiology (ASM),[22] viruses are expelled from the body by combining with water and other components, and rarely observed as individual particles. COVID- 19 has been observed in particles ranging from sizes including 0.25 to 0.5 microns. Figure 3.1 illustrates the different filtration technologies[23] and their advantages and limitations in combatting COVID-19.

Table 3.1: HVAC Filtration Technologies to Capture COVID-19

Filtration Technology	Applications	Methodology	Avantages in Addressing COVID-19 Virus Capture	Limitations in Addressing COVID-19 Virus Capture
Media filters (MERV 1-16)	Residential, Commercial and Industrial buildings	Captures particulates	• Simple installation • MERV 16 and higher effective against PM2.5	• Largely ineffective against particles the size of COVID-19
HEPA filters (MERV 17-20)	Hospitals, isolation ward, high-risk facilities	Captures particulates	• Effective against particles that carry COVID-19	• May increase energy use • May require HVAC system modifications
UVGI (GUV) and media filters	Commercial buildings, Healthcare, Residential	Degrades and inactivates virus, captures particulates	• Ideal for augmenting HEPA filtration systems	• May require HVAC system modifications

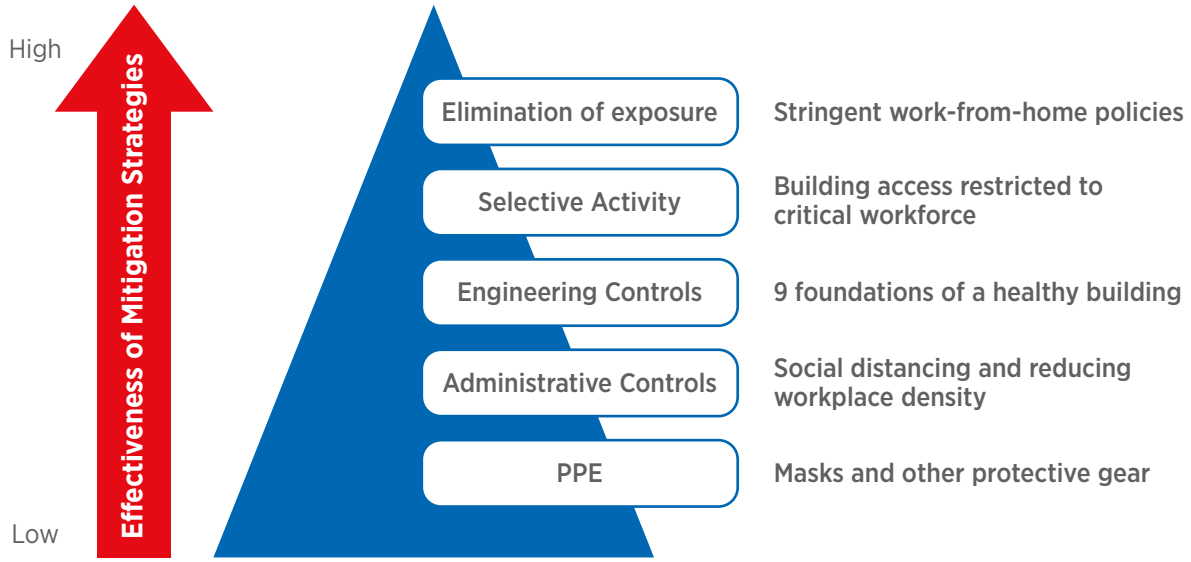
Source: CABA Intelligent Buildings and COVID-19 2021 Report

OSHA's guidance on preparing workplaces for COVID-19[24] has identified workplace controls—shown in Figure 3.1—that can minimize the risk of COVID-19 transmission in workplaces.

Personal protective equipment (PPE) is considered a simple but effective control measure. Employees must be advised to wear a mask and gloves[25] when they commute to and from work (so that they do not contract the virus on their way to work and become a carrier), and when they move around common areas like elevators, meeting rooms, etc.

Administrative controls involve devising schedules that focus on reducing congestion in workplaces. Virtual meetings, different work timings, repurposing unused spaces to decongest crowded areas can mitigate the risk of inflection.

Figure 3.1: Mitigation Strategies for COVID-19 in Workplaces



Source: CABA Intelligent Buildings and COVID-19 2021 Report

Engineering controls can reduce the likelihood of transmission. Building managers should focus on the nine foundations of a healthy building identified by Harvard's Healthy Buildings Lab, based on 40 years of scientific evidence. Frost & Sullivan recommends the use of portable air purifiers and embracing new technologies such as touchless gateways, elevators, faucets, and toilet flushes.

Selective Activity: By identifying critical, core workers who need to be on premises, access can be granted only to those personnel. As well, designating specific workplaces can help in isolating any objects that might have been in close contact with the infected person and in closing the infected area or floor, instead of imposing a whole-building lockdown.

Elimination of exposure: The most effective control is to minimize social interaction. Restricting employees inside office buildings and encouraging work from home will be the ideal way of reducing transmission inside office buildings. This comes at a higher risk for companies that are in rented spaces and have long-term leases.

4. PLANNING AND MITIGATION MEASURES IN BUILDINGS, POST-LOCKDOWN

The intelligent buildings industry and its various ecosystem partners are currently developing various mitigation measures and planning for future resiliency in buildings in a post-lockdown scenario. While this strategizing remains at an early stage, some clear and conceptual measures have emerged that could directionally lead the industry through this crisis. Frost & Sullivan carried out several brainstorming exercises with industry experts to understand the various hypothetical scenarios and actual planning strategies that are currently being put to the test. The following analysis is an outcome of these deliberations and consensus-driven resolutions that are being explored by these industry participants.

4.1 TOP EIGHT FOCUS AREAS TO ENSURE A SAFE WORKPLACE

There are major challenges centering on bringing employees with full occupancy safely back to workplaces following the guidelines of government bodies, as the lockdowns are relaxed. However, an efficient mitigation framework for phased workforce re-entry, with help from both public and private entities, can be created by focusing on eight key areas, as discussed below.

Federal, state, and local government regulations: It is recommended that facility managers follow the recommendations of bodies such as the Canadian Centre for Occupational Health and Safety, the Occupational Safety and Health Administration (OSHA) or OSHA-approved state-level COVID-19 planning guidance focusing on implementing engineering and administrative controls to identify risk levels, determine appropriate control measures, and mitigate further transmission and outbreaks in workplaces. Although OSHA follows Centers for Disease Control and Prevention (CDC) guidance, it is necessary for employers to frequently check OSHA and CDC websites for any updates on administrative and engineering controls. Additionally, employers and facility managers need to follow American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards and guidance for in-depth engineering controls in workplaces. ASHRAE's guidance agrees with guidance from CDC and WHO.

Stand-alone, equipment-level technologies and services: As employees return to workplaces it will be necessary to adopt critical technologies and services at equipment-level to comply with social distancing policies and other mitigation efforts. Among the relevant and key technologies that are currently implemented or under consideration are IAQ sensors to monitor indoor air quality detecting CO_2 levels, volatile organic compounds and other particulate matters, giving actionable insights to building managers on fresh air flow inside buildings. Related to this, installing an in-duct ultraviolet germicidal irradiation (UVGI) disinfection air system is more beneficial[26] when combined with high efficiency particulate air (HEPA) filters or minimum efficiency reporting value (MERV-13) filters for higher capture and inactivation of the virus in the system. For instance, if a particulate filter with 85 percent filtering efficiency and a UVGI solution with 85 percent single-pass efficiency are added in series, the combined single-pass capture and inactivation rate of the system increases to 98 percent.[27] Frost & Sullivan reviewed a number of use cases from leading and emerging lighting companies offering digital lighting services to support safe workforce re-entry and mitigate the spread of virus during the post-lockdown period. Installation of cost-effective LED integrated luminaires and other IoT-enabled sensors are being considered for social distancing and contact tracing through occupancy detection management, occupancy analytics and indoor positioning and navigation techniques. Other key technologies implemented are application of microbicidal paint on washroom walls, touch-free soap dispensers; faucets; and flush valves, temperature, mask and face detection involving face recognition and deep learning algorithms to monitor and identify occupants with high body temperature and not wearing masks.

Optimizing a building's sensor network: A sensor network can create an IoT overlay. Data would be fed into artificial intelligence-powered software platform and control systems and could allow for workspace designs that consider social distancing guidelines; contact tracing; constant temperature monitoring; mask detection; and communication with occupants through mobile apps. A networked light fixture could send occupancy data to a building automation system to accordingly adapt room temperature and air flow, and trigger UV-C light disinfection when occupants leave. A thermal imaging, face recognition, and mask detection camera connected to an access-control system would grant entry only to people who meet predefined standards. Facility-level technologies and services can be more effective than stand-alone systems.

Facilities management: Organizations should re-evaluate and improve service-level agreements around cleaning and disinfection of facilities before occupants return to their workplaces. The CDC's Resuming Business Toolkit[28] includes a readiness checklist to minimize the risk of virus transmission and maintain a healthy work and operational environment, as well as suggestions about worker protection. Some of the key items in the checklist to be followed are:

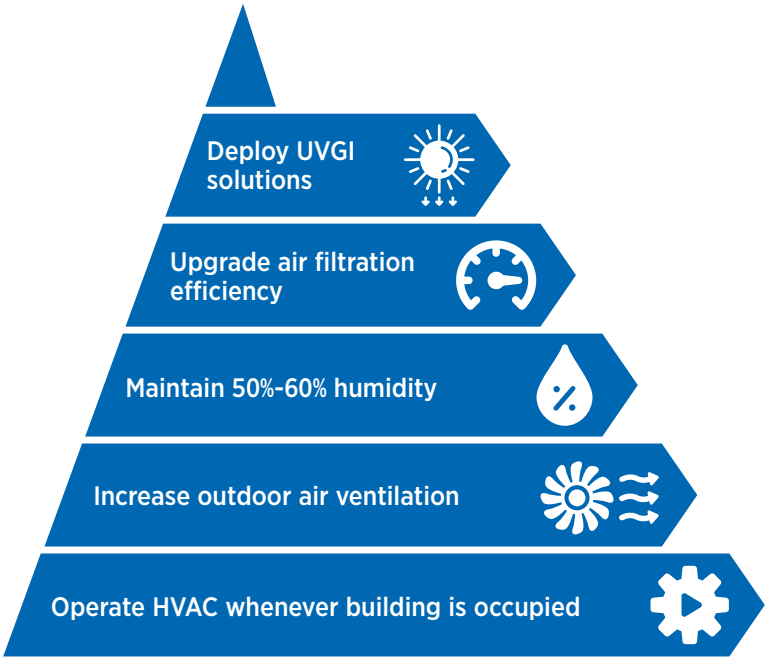
- Monitor federal, state, and local public health communications about COVID-19
- Plan for conducting daily in-person or virtual health checks
- Conduct a hazard assessment of the workplace
- Plan for what to do if an employee is sick at work

- Develop an action plan for suspected/confirmed cases
- Establish a COVID-19 coordinator
- Implement flexible and supportive sick-leave policies
- Assess essential business functions
- Communicate supportive workplace policies
- Implement controls according to the hierarchy of controls
- Modify ventilation systems and review the safety of water systems
- Supply occupants and visitors with necessary items to clean hands, and cover coughs and sneezes

Workforce productivity: Although workplace policies and safety protocols are critical aspects for successful return of employees to workplaces, it is equally critical to give priority on addressing workforce psychological and emotional challenges during the pandemic. Employees' anxieties regarding their current jobs and the future of the organization and industry could affect their productivity as well as company's productivity in the long run. A separate team should be in place to understand how the pandemic has affected employee work and personal life. It is also recommended to have a digital tool in place, requiring small investments, making it possible for employees to provide feedback and share concerns about their new experiences in the work environment to help them continue working in an organization.

MEP safe-start strategies: It is critical to thoroughly inspect the physical and operating conditions of MEP systems as the buildings were shut down for an extended time during the pandemic. Some of the MEP safe-start strategies involve rigorous re-commissioning of HVAC, plumbing and other critical building systems. Facility managers should involve remote safe-start services including IAQ assessment, airside management, temperature and humidity monitoring, fresh airflow requirements, equipment remote health assessment and more, for improved inspection efficiency and safety of building engineers and occupants. One consideration, as per interviews conducted among facility management companies for the purpose of this research, is infusing buildings with fresh air for a minimum of 24 hours, and ideally for 48 to 72 hours, consistent with the Leadership in Energy and Environmental Design (LEED) standard, Building Research Establishment Environmental Assessment Method (BREEAM), and ASHRAE guidelines. Another consideration is to follow manufacturer's recommendations for filter replacement, set-points and schedules and review water conditions in storage tanks, cooling towers and ensure appropriate water treatment services. Some of the recommended HVAC safe-start and post-lockdown strategies are shown in Figure 4.1 and discussed on the next page:[29]

Figure 4.1: Optimizing HVAC Systems to Reduce COVID-19 Transmission and Improve Effectiveness



Source: CABA Intelligent Buildings and COVID-19 2021 Report

Recommended HVAC safe-start and post-lockdown strategies derived from ASHRAE and the Federation of European Heating, Ventilation and Air-Conditioning Associations (REHVA) include the following:

- Operating HVAC system whenever the building is occupied, also during off-hours cleaning and disinfection services to ensure optimum building ventilation.
- Disabling demand-controlled ventilation and open-air dampers to increase outdoor air ventilation.
- Ensuring 40 percent to 60 percent humidity level to reduce the spread of COVID-19 virus and minimize risk of mold growth.
- Reviewing and upgrading air filtration technologies such as HEPA and MERV-13 for effective capture of transmission particles.
- Considering installing UVGI solutions.

Healthy building standards: In the long run, it is recommended that facility managers follow data-driven international healthy building standards such as WELL and RESET to plan, draft and implement new operational policies and emergency protocols, and assess building health performance focusing health and sustainability of the built environment. Some facility managers are currently pursuing WELL[30]- and RESET[31]- accredited professional certification for monitoring and assessing building health performance. Selected case studies on the adoption of WELL and RESET standards in commercial buildings are discussed in 4.2.

Shared, transparent, and efficient communication: A shared communication between employers, facility managers and occupants is necessary for successful workforce re-entry.

It is recommended that employers and facility managers develop communication strategies to address critical details of new guidelines and protocols that are in place and the timeline of adoption. A designated facility response team would have an open line of communication both internally (facility managers, HR, top management and employees) and externally, especially with public health authorities and be responsible for developing an outbreak contingency plan, assessing the economic impact of different pandemic scenarios, and ensuring that effective mitigation strategies are in place. Adopting digital tools for efficient and transparent communication, and a multi-channel approach to reach out to employees beyond emails would be more beneficial. Other strategies could include pulse surveys for employee feedback to assess the effectiveness new policies and guidelines, monitoring social media channels to assess employee thoughts and opinions, and using digital displays in lobby areas and the cafeteria to emphasize social distancing and establish transitions to boost employee confidence.

4.2 CURRENT AND NEAR-FUTURE BEST PRACTICES IMPLEMENTATION IN INTELLIGENT BUILDINGS

As stated earlier, the emergence of best practices is expected to be a slow process, given that industry participants are still coping with reset and rebound challenges. Due to the limited number of such best practices evident in the North American region at the moment, Frost & Sullivan undertook a global review of such best practices as demonstrated by building industry players in other countries. The findings of this global review are summarized below:

Best Practices Example 1: L&T, one of India's largest engineering and construction companies implemented an intelligent building solution for a Fortune 50 customer in Bangalore, India, as part of their COVID-19 response strategy. The 620,000-square-foot campus has 5,000 temperature monitoring points, 1,000 occupancy sensors, and 40 CO_2 sensors. The company offers AI-driven building analytics and space optimization solutions to promote energy savings and occupant comfort and productivity. The same solution, with a few updates and changes, is being used to provide essential insights to support workforce reentry during the pandemic.

Best Practices Example 2: One of the world's largest professional services companies headquartered in the United Kingdom was designing a workplace intended to encourage greater creativity and productivity in a 280,000 square feet building spread across 15 floors. It also required a workplace utilization solution using smart building technologies. Israeli start-up PointGrab offered an occupancy analytics solution using IoT-based sensors enabling the customer to accommodate 30 percent more people. This solution has now been updated for the customer to leverage occupancy insights in a post-lockdown mitigation strategy.

Best Practices Example 3: Dublin-based Iconic Offices undertook significant capital investments to implement various health and safety measures across its 16 workspaces complying with government guidelines.[32] Some of the measures include thermal camera checks,

hand sanitizing stations, shifting office traffic flows, providing health packs to its 2,200+ employees and staffs. The office buildings were recently awarded a WELL v2 level rating and evaluated based on ten categories of building performance: air, water, nourishment, light, movement, thermal comfort, acoustics, materials, mind and community.

Best Practices Example 4: Shanghai-based Crystal Plaza, a mix of commercial and residential complex developed and owned by Tishman Speyer, was the first to adopt RESET Air Core & Shell Certification (v1.0) in 2016.[33] Recently, all the Crystal Plaza buildings deployed RESET accredited in-duct air quality monitors complying with RESET Air certification requirements. The project demonstrated its ability to maintain IAQ within the limits required by RESET, and was awarded the RESET Air Certification for Core & Shell (v2.0).

5. KEY TAKEAWAYS

Frost & Sullivan identified and evaluated the key challenges prevailing in the intelligent buildings industry and prioritized key techology areas and service segments for industry participants to address, in order to enable safe workforce re-entry, backed by scientific evidence and current industry best practices. Some of the key takeaways from this research are discussed below:

Recap of the Economic Impact of COVID-19 on intelligent buildings

The intelligent buildings industry witnessed a downward growth trend in some of the key segments including lighting, heating, ventilation and air conditioning equipment and controls, building automation systems controls, and facilities management. However, there are some positive takeaways from software service segments such as digital lighting services, building energy management systems, artificial intelligence (AI)-driven building solutions, building information modeling, and digital twins due to continued demand for these features in critical infrastructure segments and a recurring payment model. The software service segments are set to play a critical role in providing data-driven insights to facility managers—not only for building performance optimization but also to assess, monitor and maintain health and well-being of occupants. Property management companies have started to implement and test effectiveness of some of the key technology-driven solutions in commercial buildings for post-lockdown mitigation measures.

COVID-19 Re-entry Measures and Mitigation Mechanisms

Post-lockdown, it is recommended that facility managers follow occupational safety and health administration (OSHA) COVID-19 planning guidance for effective control measures the OSHA and CDC websites should be visited for further updates on application of administrative and engineering controls in buildings. Likewise, ASHRAE-endorsed mechanical, electrical and plumbing (MEP) safe-start strategies for in-depth engineering controls in workplaces are recommended for thorough inspection of physical and operating conditions of MEP systems, as buildings were shut down during the pandemic.

Frost & Sullivan's research confirmed there are certain key changes that must be addressed in terms of comprehensive building health assessment, prioritizing indoor air quality, adoption of data-driven services and compliance with building health standards to meet the goals set out by various professional agencies to support the building industry post-lockdown. These guidelines recommend that facility managers adapt to the above-mentioned changes to evaluate the right balance between maintaining health and well-being as well as maximize productivity of occupants.

Technology and innovation will characterize the rebound phase

Convergence of intelligent building technologies is set to play a huge role during the post-lockdown period because of the increasing use cases of networked or integrated building systems combined with occupant's safety, health and well-being. Frost & Sullivan predicts potential increase in demand for data-driven services for autonomous operation at the management level will increase demand for IIoT-based sensors, AI-driven building solutions and cloud-based remote services. It is recommended that facility managers consider adopting such solutions for successful re-entry of occupants and to maintain business continuity in the post-lockdown environment.

Healthy building certifications and standards will become increasingly integral to this industry

International healthy building standards such as WELL and RESET will grow in importance and have a key role to play in the post-lockdown environment. Guided by those standards, building owners are developing key performance indicators of building health. Facility managers and other third-party certification providers will be working to ensure that accredited professionals can assess and certify the health performance of buildings against these new standards.

Final Word

The findings of Module I of this research clearly indicate the critical significance of technology implementation to enable the right environmental conditions, mechanical improvements, process changes and above all ensure health and well-being of occupants inside these buildings.

While technology options available today can be optimally leveraged to address immediate concerns around health and safety issues, long-term infrastructure planning for ongoing resiliency building will require investigations into more innovative technology solutions, some of which are either at incubation stages, or, under various co-creation arrangements and intellectual property (IP) transfer processes.

Frost & Sullivan recommends a deeper dive into the technology innovation landscape for intelligent buildings, particularly focusing on cutting edge sensor-based solutions, pathogen detection and elimination technology options, touchless and mobile applications, as well as the potential for service-based offerings that can be combined with such technologies to make them feasible for quick implementation in intelligent buildings. In the present scenario, where capital shortages and budget crunches are imminent, exploring the right solutioning vehicles that will make innovative technologies readily accessible will need to be a key consideration. These components should be extensively explored as part of the subsequent research modules of this project.

APPENDIX A: GLOSSARY

AI: Artificial Intelligence

AIHA: American Industrial Hygiene Association

API: Application Programming Interface

ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASM: American Society for Microbiology

BAS: Building Automation System

BEMS: Building Energy Management System

BHPB: Building Health Performance Benchmarking

BIM: Building Information Modeling

BLE: Bluetooth Low Energy

BMS: Building Management System

BREEAM: Building Research Establishment Environmental Assessment Method

C-PACE: Commercial Property Assessed Clean Energy

CABA: Continental Automated Buildings Association

CARES Act: Coronavirus Aid, Relief, and Economic Security Act

CDC: Centers for Disease Control and Prevention

CH_20: Formaldehyde

CO_2: Carbon Dioxide

COVID-19: Coronavirus Disease 2019

CRE: Commercial Real Estate

E. coli: Escherichia coli

ESRC: Energy Saving and Performance Contracting

FY: Fiscal Year

GDP: Gross Domestic Product

HCL: Human-centric Lighting

HEPA: High-Efficiency Particulate Air

HVAC: Heating Ventilation and Air Conditioning

IAQ: Indoor Air Quality

IFMA: International Facility Management Association

IP: Intellectual Property

IoT: Internet of Things

ISHRAE: Indian Society of Heating, Refrigerating and Air Conditioning Engineers

kWh: Kilowatt-hour

LED: Light-Emitting Diode

LEED: Leadership in Energy and Environmental Design

MEP: Mechanical, Electrical and Plumbing

MERV: Minimum Efficiency Reporting Value

MRSA: Methicillin-resistant Staphylococcus aureus

NEEA: Northeast Energy Efficiency Alliance

NRC: National Research Council

NYSERDA: New York State Energy Research and Development Authority

OD: Occupancy Detection

OSHA: Occupational Safety and Health Administration

PACE: Property Assessed Clean Energy

PoE: Power over Ethernet

PPE: Personal Protective Equipment

ppm: Parts per million

Proptech: Property Technology

REHVA: Federation of European Heating, Ventilation and Air-Conditioning Associations

REIT: Real Estate Investment Trust

RESET: Regenerative Ecological, Social, and Economic Targets

SARS: Severe Acute Respiratory Syndrome

TVOC: Total Volatile Organic Compounds

UAE: United Arab Emirates

UL LLC: Underwriters Laboratories

UCSD: University of California, San Diego

UV-C: Ultraviolet Lighting at "C" Frequency (200 – 280 nanometers (nm)

UVGI: Ultraviolet Germicidal Irradiation

VOC: Volatile Organic Compounds

VRE: Vancomycin-resistant Enterococci

WHO: World Health Organization

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