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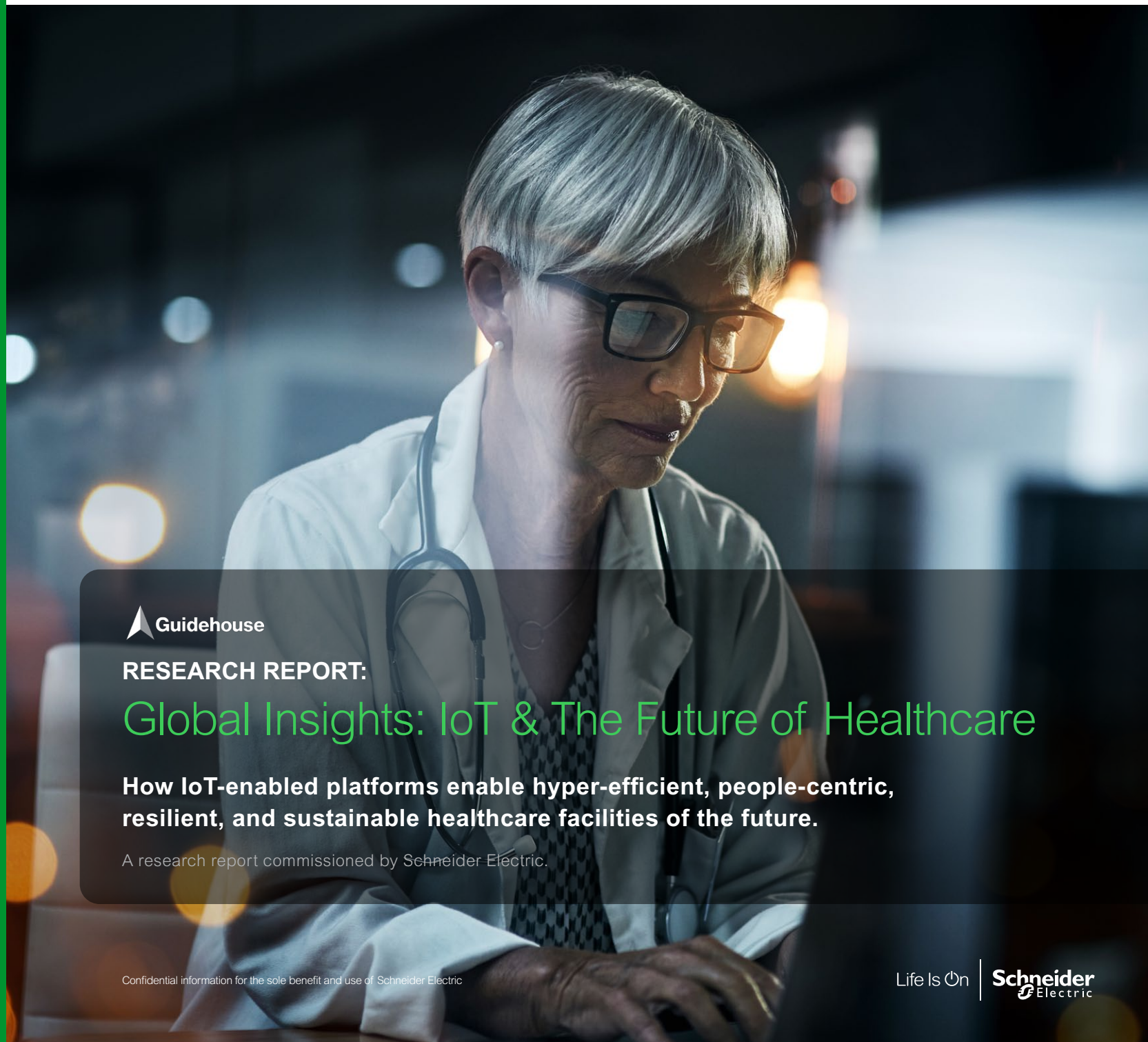

Guidehouse

RESEARCH REPORT:

Global Insights: IoT & The Future of Healthcare

How IoT-enabled platforms enable hyper-efficient, people-centric, resilient, and sustainable healthcare facilities of the future.

A research report commissioned by Schneider Electric.

Life Is On Schneider Electric

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Introduction

This research report, commissioned by Schneider Electric, demonstrates how IoT-based, open, interoperable platforms enable hyper-efficient, people-centric, resilient, and sustainable healthcare facilities of the future.

The report offers insights from 600 global healthcare facility executives into IoT investment priorities and a simple framework to help you implement an IoT-based platform in your healthcare facility. Read this report to understand:

- The market drivers and barriers behind IoT platform adoption
- End-to-end system benefits of IoT-enabled platforms
- Practical use cases for IoT-based solutions in healthcare facilities

Published 3Q 2021
Commissioned by Schneider Electric

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Hospitals Face Unprecedented Challenges

Facility managers in healthcare buildings face the onerous task of maximizing operational performance while maintaining patient and staff safety, despite staff shortages, shrinking operational budgets and dozens of other constraints.

The coronavirus pandemic has only exacerbated these challenges. According to the World Health Organization, nearly every country experienced some disruption to health services. Of the 135 countries included in the WHO's "pulse survey", more than 40% reported disruptions that affect the availability of and access to primary care, rehabilitative, palliative, and long-term care.[1] In addition to the profound human toll these disruptions cause, they also represent a challenge to the ongoing operations of hospitals. According to the AHA, hospitals in the US incurred roughly $323 billion of losses in 2020 as optional procedures and non-essential treatments were deferred, and that figure likely understates the full economic impact.[2]

At the same time, patient concerns over safety, air quality, and overall experience have only grown. With the population aging, these concerns will continue to mount, even as hospitals lose their most experienced staff to retirement—a trend that the pandemic has also accelerated.

IoT-based Platforms Help Overcome these Challenges

IoT-based, open, interoperable platforms drive energy efficiency and smart, connected healthcare systems, but they also drive improved outcomes across patient experience, system resiliency, and sustainability targets. An IoT platform is foundational to advancing a hospital's energy, operational, financial, and patient satisfaction targets.

In an industry hit hard by the pandemic, the decision to make measurable financial investments in IoT platforms can be difficult—but hospital and medical facility administrators must weigh more than simply the hard-monetary benefits of reduced energy and utility bills.

> 50% of hospital executives that do not intend to implement IoT over the next 12 months say that insufficient payback/ROI is the primary barrier to adoption.
>
> GUIDEHOUSE INSIGHTS SURVEY RESULTS

[1] World Health Organization, "Pulse survey on continuity of essential health services during the COVID-19 pandemic". 2021. https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-EHS-continuity-survey-2021.1

[2] American Hospital Association, "New AHA Report Finds Losses Deepen for Hospitals and Health Systems Due to COVID-10," 2020, https://www.aha.org/issue-brief/2020-06-30-new-aha-report-finds-losses-deepen-hospitals-and-health-systems-due-covid-19.

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Hospitals Face Unprecedented Challenges

IoT platforms unlock a multitude of soft benefits that extend to patient experience, staff retention, and a healthier, more pleasing environment for all. Such benefits may be difficult to quantify in the near-term, but in the long-term, they can add markedly to hospital or clinic success.

Of course, deployment of an open, integrated IoT platform comes with challenges that go beyond upfront costs. Healthcare facilities are complex and—from applications designed for different functions at different operational levels, to legacy systems owned and managed by siloed stakeholders, and system integration limitations—investing in and deploying an IoT platform may seem daunting. However, for healthcare administrators with a clear long-term vision into the future of healthcare, an IoT-enabled platform must be part of the picture.

The Benefits of IoT Aren't Fully Understood, Despite Familiarity

The IoT, or Internet of Things, refers to the far-reaching, interconnected networks of internet-accessible devices equipped with software and firmware to collect, store, and transmit data to other connected devices. IoT-enabled platforms deepen the value of intelligent building technologies by delivering unprecedented visibility into healthcare facility performance.

Guidehouse surveyed 600 global healthcare executives regarding their understanding of and activity around IoT investments. For the purposes of the survey, IoT devices were defined as having:

- Two-way data communication (connected devices that can send and receive data)
- Embedded control and computation capabilities (providing advanced integration into other management, automation, or control systems)

Guidehouse's survey of 600 hospital executives worldwide captured insights from:
200 C-Suite Executives | **200** Specifiers | **200** Facility Directors

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Hospitals Face Unprecedented Challenges

More than 80% of surveyed healthcare executives indicated they were 'somewhat' or 'very' familiar with IoT platforms.

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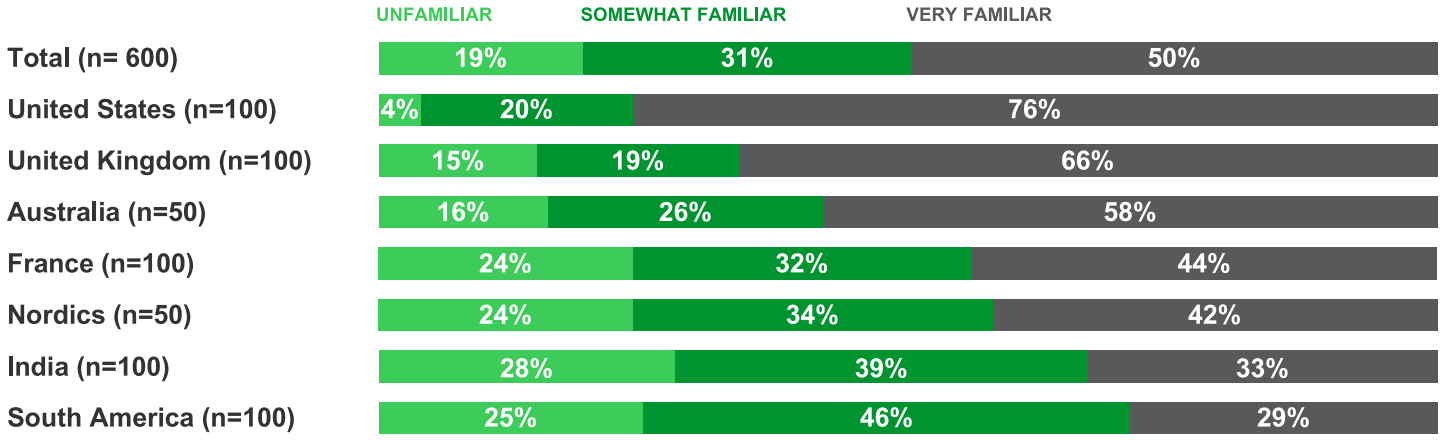
Chart 1. How familiar are you with Internet of Things (IoT) platforms?



(Source: Guidehouse Insights)

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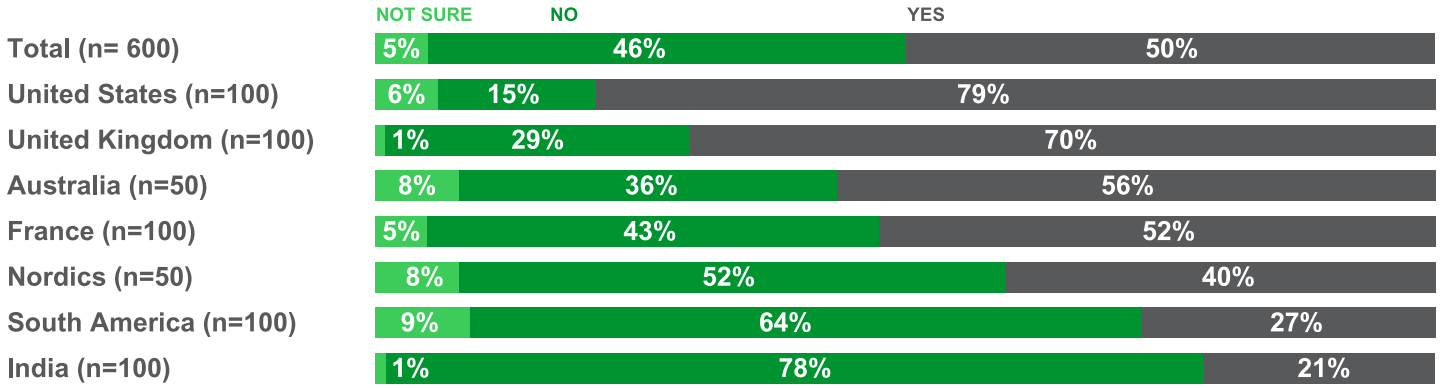
Hospitals Face Unprecedented Challenges

The US and UK familiarity rates with IoT platforms, 96% and 85% (chart 1) , respectively, tie to higher IoT technology implementation rates (chart 2), the US at 79%, and the UK at 70%. The data pattern suggests that higher familiarity rates with IoT platform leads to higher implementation rates.

High familiarity rates, countered by low implementation rates (chart 2) as seen in Australia, France, and the Nordics, indicate some confusion around the benefits of IoT enabled platforms and a lack of perceived value of these solutions.

Chart 2. Has your company or organization implemented IoT technology in the past 12 months?



(Source: Guidehouse Insights)

Despite low implementation rates, IoT adoption in India and Southern America is set to increase, with over 50% of respondents in both regions indicating plans to implement IoT in the next year.

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Until hospital executives fully understand the benefits of the investment and adoption of IoT platforms, adoption is expected to remain low. The responsibility of educating healthcare executives on such benefits falls largely to solutions vendors, research and consulting firms and peer hospitals that have deployed these solutions.

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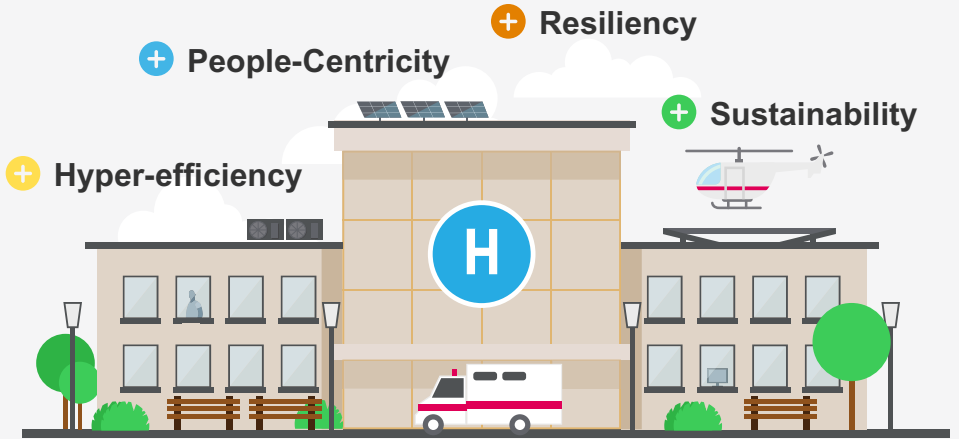
IoT platforms Enable Healthcare Facilities of the Future

IoT Benefits Go Beyond Quantitative Return on Investment

Guidehouse Insights research indicates that legacy solutions, including building management systems (BMS), building energy management systems (BEMS), and smart lighting or HVAC systems, can save hospitals and clinics upwards of 20% on their energy costs annually. But newer, IoT-based systems extend those benefits to increasingly important operational realms.

Healthcare facilities of the future must be hyper-efficient, but they must also be resilient, sustainable, and deliver a level of patient care not often seen previously. IoT-enabled platforms are the key to bringing your healthcare facility into the future and achieving quantitative and qualitative improvements across efficiency, people-centricity, resiliency and sustainability.

Healthcare facilities of the future will leverage IoT-enabled platforms to drive better outcomes across four key pillars.



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IoT platforms Enable Healthcare Facilities of the Future

Healthcare Facilities of the Future are Hyper-Efficient.

Seamlessly Control Your Healthcare Facility With an IoT-Enabled Platform

The energy efficiency of any given healthcare facility varies widely based on building location, local climate, building size and age, equipment types and age, and other factors. However, value can be achieved in many areas for a healthcare facility through the introduction of an IoT-based platform that enables energy efficiency upgrades.

Healthcare facilities face many specific challenges. They have strict requirements for energy and clean water resources. According to ASHRAE, the average hospital uses 2.5 times the amount of energy as other commercial buildings of similar size. Unlike in other building types, energy- and water-related disruptions can be life-threatening events in healthcare facilities. Yet, according to the US Environmental Protection Agency and the US Department of Energy, every $1 a hospital saves on energy is equivalent to generating $20 in new revenue. This level of return must not be overlooked.

Healthcare executives view energy efficiency and improved patient experience as the most important factors contributing to IoT investment decisions.

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In addition to the operational risks of running a facility, the overall business environment for healthcare-related buildings is extremely competitive. Healthcare executives are under tremendous pressure to contain costs while maintaining exemplary patient experiences and high satisfaction ratings. The installation of an IoT-enabled platform can help healthcare facilities face these challenges in three significant ways:

- **Reduce energy bill costs:** Ample opportunities exist for IoT-enabled platforms to reduce energy-related costs in healthcare buildings due to the relatively high consumption rates and around-the-clock operation of these facilities.
- **Improve Efficiency of Facilities Personnel:** Increased data and analytics from IoT-based solutions can equip the facilities team with an improved view into the condition of building products, systems, and high-risk assets. This insight can reduce maintenance time by proactively addressing a facility's failures and ensure a facilities team is better equipped for decision making.
- **Improve environmental characteristics:** IoT-enabled platforms can improve the internal environmental characteristics of a healthcare facility, creating a healing environment that improves patient care and satisfaction.

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IoT platforms Enable Healthcare Facilities of the Future

IoT-enabled platforms can also accelerate the digital transformation of a hospital or clinic, creating a more intelligent, efficient building by:

- **Automating shifts** in system operations and onsite resources in response to grid signals, weather, or other external triggers.
- **Digitizing power** and building management systems, helping to reduce energy use.
- **Enabling remote service** capabilities that allow facility management personnel to address issues while working remotely.
- **Deploy sensors** that detect and record actual conditions to identify when issues occur and ensure adherence to regulations.

Furthermore, in some cases, solution vendors will guarantee a minimum level of energy savings, reducing the investment risk for the decision maker. Vendors may also retrain maintenance personnel on the new systems and requirements. Healthcare facility administrators should consider their solution vendors as trusted advisors who each stand to benefit from a long-standing, engaged relationship.

84% of Healthcare executives view improving operational efficiency as a significant factor in IoT investment decisions.

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Actions you can take to evaluate hyper-efficiency in your facility.

1. Assess current utility, operations, and maintenance costs
2. Determine how much time and resources are spent checking regulatory compliance
3. Automate process flow enabling facility teams to focus on issues that could impact patient care

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IoT platforms Enable Healthcare Facilities of the Future

Healthcare Facilities of the Future are People-Centric.

Create a Healing Environment Responsive to Staff and Patients with an IoT-Enabled Platform

Healthcare facilities place an increasingly strong emphasis on patient experience and outcomes. In the US, the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) provides standardized, publicly reported surveys of patient perspectives. In England, the National Health Service (NHS) publishes the Overall Patient Experience Score results, a statistical report measuring overall patient views of care and services provided by the NHS.

This data influences patient behavior, ultimately impacting facility selection and financial performance.

IoT-enabled platforms and solutions can optimize the operations of a healthcare facility. Basic applications such as wayfinding—which help staff and families move expediently throughout the facility—can improve the experience of being in a hospital and reduce staff and patient frustration. As hospital stays are often stressful, even this simple benefit can have a meaningful impact on patient experience.

38% of hospitals and outpatient facilities surveyed have implemented patient room experience IoT solutions and 53% plan to do so over the next 12 months.

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IoT platforms also allow for integrated, intelligent patient room technology.

Intelligent patient room technology enables patient control over environmental preferences (lighting, temperature, etc.) and opens-up access toimportant care information such as upcoming consults, release dates, and provider teams.

Placing this level of control in the patients' hands deliver many benefits to the provider team, including:

- Minimized nurse calls, freeing up providers to focus on delivering care
- Elevated efficiency and accuracy of patient care with clear communication on treatments and medications

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IoT platforms Enable Healthcare Facilities of the Future

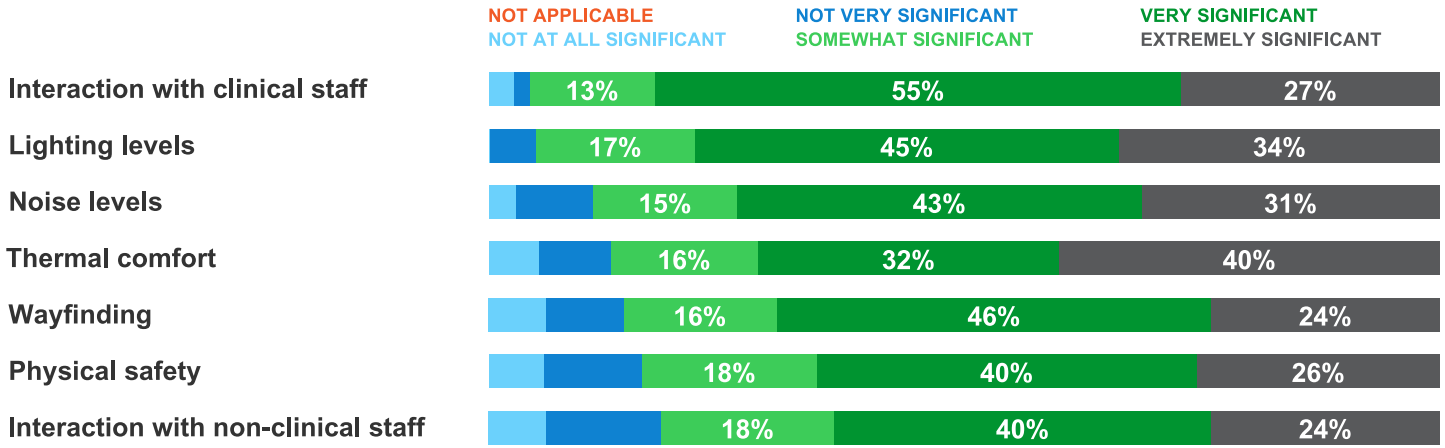
In this Guidehouse survey, interaction with clinical staff was considered the top factor improving patient room experience, with 83% naming it the top concern across all surveyed regions. Comfort factors such as lighting, noise, and thermal comfort came next, followed by wayfinding, physical safety, and interaction with non-clinical staff.

Actions you can take to evaluate people-centricity in your facility.

1. Audit the physical environment to make sure safety and infection control are maintained to the highest level
2. Assess current safeguards against electric shocks and fires in operating rooms
3. Evaluate patient ability to control in-room IoT devices (i.e., television, media) and systems (i.e., temperature, lighting)

Chart 3. How important are the following factors in improving the experience for your patients?

(n=600)



(Source: Guidehouse Insights)

IoT platforms Enable Healthcare Facilities of the Future

87% of Healthcare facility executives view improving resiliency as a significant factor in IoT investment decisions.

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Healthcare Facilities of the Future are Resilient.

Create a Healthcare Systems That Recovers Quickly With an IoT-Enabled Platform

Power availability is the most foundational aspect of facility operations and is critical to a hospital's ability to achieve its mission. Maintaining high quality, clean power is vital for ensuring sensitive healthcare equipment always performs properly. Patient safety and operational continuity depend on it 24/7. But a reactive approach to asset performance management exposes hospitals and clinics to critical risks and uncertainty. In contrast, IoT-based asset management and predictive maintenance systems support real-time, data-driven repair and replacement decisions through predictive analytics.

Hospital executives interviewed for this study emphasized the importance of asset management solutions which optimize asset availability and performance. Rather than facing downtime due to unexpected repairs, maintenance crews are alerted to potential problems before critical shutdowns. Operations remain seamless and egregious overtime repair expenses can be avoided. Most importantly, downtimes are eliminated or minimized, keeping operations productive and profitable.

Actions you can take to evaluate resiliency in your facility.

1. Assess condition of existing infrastructure and equipment
2. Assess maintenance backlog relative to business disruption risk, flagging systems at or near capacity
3. Evaluate downtime risk due to utility failure and local breaker trips
4. Assess system flexibility, particularly in critical areas like operating rooms and ICUs
5. Implement procedures to ensure HVAC system efficiency
6. Establish protections to mitigate cyber risks associated with IT and digital infrastructure
7. Conduct regular compliance checks on critical systems and equipment (generators, fire alarms, etc.)

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IoT platforms Enable Healthcare Facilities of the Future

Healthcare Facilities of the Future are Sustainable.

Environmentally Friendly and Efficient Equipment, Flexible Energy Assets and Power Sources Connected Across an IoT-enabled Platform

Healthcare buildings represent a significant opportunity to reduce country-specific and global greenhouse gas (GHG) emissions and energy consumption. According to the World Health Organization, healthcare activities in the US and EU regions account for between 3% and 8% of global GHG emissions. Healthcare buildings often house departments that use a lot of energy, such as laundry, sterilization, food service, refrigeration facilities, and computer and data centers.

The activities and services of the healthcare sector can have a large impact on the health of local environments and communities. As the healthcare industry works to treat people, its commensurately large operational footprint is also harming human health due to the higher-than-usual energy intensity of its buildings. Although they can vary by region, some of the issues that healthcare facilities face include:

- Inherently high energy and clean water resource requirements
- 24/7 operations
- No tolerance for operational downtime
- Energy inefficient buildings, medical equipment, and appliances
- Inefficient procurement of supplies, equipment, and energy
- High energy costs due to long hours of operations and strict compliance requirements (e.g. air flow)
- High requirements for sewage and medical waste management, treatment, and disposal

Organizations that have set sustainability targets are significantly more likely to have implemented IoT in the past 12 months.

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IoT platforms Enable Healthcare Facilities of the Future

Investment in IoT platforms enabling integration of building energy management systems (BEMS) can support sustainability mandates. Enterprise-level environmental, social, and governance (ESG) programs are seeing increased adoption across industries, leading to increased demand for cost-effective solutions that can meet more rigorous operational/savings targets. This increased adoption is also a significant support to corporate public relations initiatives around sustainability.

Indeed, as the call for ESG-based operations grows, patients, nurses and doctors alike are apt to favor hospitals and clinics with identifiable sustainability targets and initiatives.

Prioritization of ESG initiatives is also indicative of growing IoT investment by hospitals. In the Guidehouse Insights survey, 72% of organizations that have set sustainability targets said they have implemented IoT in the past 12 months, compared to only 1% of organizations that have not set targets.

The need for IoT, such as lighting controls, is being driven by cost improvement and sustainability goals.

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Actions you can take to evaluate sustainability in your facility.

1. Set and measure performance vs. sustainable development goals
2. Assess greenhouse gas emissions:
   a. **Scope 1:** Direct emissions including on-site fuel combustion, heating & cooling activities, vehicles, etc.
   b. **Scope 2:** Indirect emissions including purchased electricity, heat, steam, etc.
   c. **Scope 3:** Other indirect emissions including purchased goods & services, employee commuting and transportation, etc.
3. Address energy inefficient building products and systems through energy efficient upgrades
4. Invest in renewable energy solutions, such as solar or wind

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How the IoT Improves Healthcare Systems

The functionality and benefits that legacy systems provide can be enhanced through IoT technology. Moreover, IoT unlocks the possibility to provide completely new systems to improve efficiency, sustainability, and improve healthcare outcomes.

Figure 1 shows how and where the IoT augments various legacy systems around comfort, safety and security, management, and infrastructure. Subsequent sections provide greater detail on the features and applications of these solutions and how they benefit from the IoT. The following table is not meant to be exhaustive of all legacy systems but is rather meant to provide an example.

Figure 1. IoT Solutions Benefits

	IoT Benefits			
	Hyper-Efficient	People-Centric	Resilient	Sustainable
COMFORT				
HVAC Controls	X	X		X
Lighting Controls	X	X		
Air Quality Sensing	X	X		X
MANAGEMENT SOFTWARE				
Building Automation Systems	X			
Building Management Systems	X			
Building Energy Management Systems	X		X	X
Workplace Management	X	X		
SAFETY AND SECURITY				
Fire and Life Safety Systems		X	X	
Power Backup			X	
Access Controls		X	X	
Cybersecurity			X	
INFRASTRUCTURE				
Power Managment Systems	X		X	
Real-time Location Systems		X	X	X
Asset Managment	X	X		

(Source: Guidehouse Insights)

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How the IoT Improves Healthcare Systems

Comfort Systems: HVAC Controls, Lighting Controls and Air Quality Sensing

Traditional comfort systems in hospitals typically refer to **HVAC controls** and **lighting controls** with **air quality** requirements awkwardly lumped in. In reality, "comfort" in a healthcare setting is often sacrificed to maintain the humidity levels, air flow, and temperature necessary to minimize microbial growth. IoT provides an interconnection across disparate systems to allow for a more nuanced, multi-faceted control. This enables hospitals to provide patients and staff a complete comfort profile that includes temperature, humidity, and light levels – all while maintaining air quality.

IoT provides the opportunity to seamlessly interconnect disparate systems, shifting the focus of building control to a more complete experience. Moreover, this interconnectedness can transform the patient room experience. IoT can automatically adjust room conditions based on occupancy data, such as a new temperature setting or light level when occupied. Additionally, for patients requiring long-term care, allowing patient interaction for specified settings can provide patients greater comfort and ease, which can increase rest, a benefit especially important in the healthcare industry.

> "If someone is in the right temperature and is more comfortable, they will recover more quickly."
>
> HOSPITAL FACILITY EXECUTIVE IN UK, GUIDEHOUSE INSIGHTS

Management Software: BAS, BMS, BEMS, and WMS

Building automation systems (BAS), Building Management Systems (BMS), and Building Energy Management Systems (BEMS) are areas of high interest among hospital administrators and managers thanks to their tangible ROI in terms of real reductions in energy consumption. BEMS that were once the foundation of the market are being rebranded and their applications' suites expanded, beyond a focus purely on energy. BMS that once delivered the technical details of automation and controls to engineering and operations teams are being integrated with greater analytics capabilities and remote accessibility. Today, remote accessibility and expanding software application suites are blurring the lines between BMS and BEMS., **Leveraging IoT technology, these systems are becoming more sophisticated, and enable applications that go well beyond energy efficiency. Enhancements in computing capabilities and diminishing costs make intelligent IoT platforms competitive with traditional BAS.**

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How the IoT Improves Healthcare Systems

> Of those hospital executives who implemented IoT over the past 12 months, 55% deployed BEMS, while 57% deployed workplace management systems.
>
> GUIDEHOUSE INSIGHTS SURVEY RESULTS

Traditional energy management software applications inform customers on the bottom-line impacts of their building operations in terms of utility cost. Since the mid-2000s, when the intelligent buildings market first emerged, energy cost savings have been the core measure of ROI. The analytics initially identified energy waste from issues such as improper scheduling, equipment failures, or repair needs. Even as other use cases such as space utilization or healthy buildings emerge, energy management remains important because of the straightforward measure of operational improvements through utility bill savings. Energy management applications are valuable to the C-suite, but also functional decision makers such as energy managers or sustainability leads.

A Workplace Management System (**WMS**) integrates multiple core functional areas which were previously organizationally and operationally independent, unlocking new synergies. A WMS can help hospitals manage real estate activities, capital upgrades, facilities maintenance, energy efficiency, and more, in one integrated system. Through the IoT, data is shared across departments and systems, improving efficiency and awareness. WMS is evolving into a cloud-based software platform that is built with the workplace experience at the center. Providing an interactive user interface across multiple devices, modern WMS enable employees to access a variety of workplace services from a mobile app, kiosk, or desktop. WMS can deliver an accurate picture of facility data enterprise-wide, providing reports and dashboards with embedded key performance indicators to quickly identify areas of concern or inefficiencies in real time.

Safety and Security: Fire and Life Safety Systems, Power Backup, Access Controls, and Cybersecurity

The safety and security of medical facilities is a growing critical concern among hospital and clinic managers. Traditional physical safety solutions include **fire and life safety systems**, which rely on sensors, controllers, master panels, actuators, and communications for fire detection and control. These systems can detect smoke, CO2, heat, and have integrated uninterruptible power supply for use during an outage event such as a hurricane. Fire and life safety systems can benefit from IoT-enabled solutions by reducing time and cost of inspection and ensuring there are no system failures in these critical systems. Additionally, integrating these systems into a broader IoT-based solution can deliver sensor data for innovative solutions.

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How the IoT Improves Healthcare Systems

75% of healthcare organizations worldwide have already been the victim of a cybersecurity attack.

PONEMON INSTITUTE

Patient safety and reduced risk is of top concern for healthcare facilities. Utilizing IoT solutions with advanced sensors, nursing staff can be alerted when a patient leaves their room. These solutions reduce hospital risk associated with a frail patient falling and getting injured, or a patient with dementia getting lost. Beyond this, staff are not required to physically check and ensure patients are in their rooms. This task reduction can allow them to increase focus on direct patient care, leading to improved job satisfaction and operational efficiencies.

Facility access is another area of growing emphasis. **Access control and security systems** rely on sensors and cameras along with software and user interfaces to provide real-time information on the movement of people throughout the hospital. For example, integrating an alarm system with access control can provide hospitals benefits in the case of an active shooter. Gun-shot detection can prompt the system to lock down pertinent areas of a building, reducing potential harm to staff and patients. Beyond gun-shot detection, they can record video information and send the video to the cloud for future review.

A similar value proposition utilizing a real-time location system (**RTLS**) is possible for infant care and kidnapping prevention. If an infant is taken in a delivery ward, doors can be sealed for that area of the hospital, the alarm system could be integrated with the RTLS, and an infant wearing a Bluetooth tag could be located within the building.

Finally, cybersecurity is paramount in healthcare facilities. Not only must sensitive patient data be accessible to medical personnel, it must be safe from hackers who might try to leverage the data for financial gain. Ransomware attacks cost the healthcare industry $20.8 billion in downtime in 2020—twice the number from 2019—according to an annual report by Comparitech, a company that reviews technology products.

Infrastructure: Power Management Systems, RTLS and Asset Management

Power Management Systems optimize power system performance and reliability by monitoring the electrical network and identifying issues with availability and quality. Medical equipment requires a substantial, reliable source of power. Problems with harmonics or voltage fluctuations can shorten equipment lifespan, increase operating costs, and even force shutdowns. Moreover, Power management systems provide medical staff with critical environment and power information to ensure patient safety during surgeries. Without IoT, this information may be inaccessible and siloed. Real-time monitoring, alarming, and power quality information provide root cause analysis to help avoid critical conditions that can cause equipment failures and downtime.

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How the IoT Improves Healthcare Systems

With **RTLS**, hospitals can monitor equipment location, conserving staff time spent searching for equipment and saving costs from lost or stolen equipment. The system can also be integrated with security and access systems for a safer, more controlled environment. Wayfinding can also be enabled. Wayfinding refers to information systems that guide people through a physical environment and enhance their understanding and experience of the space. Wayfinding is particularly important in complex built environments such as healthcare campuses. As architectural environments become more complicated, people need visual cues such as maps, directions, and symbols to help guide them to their destinations. In the often high-stress hospital environment, effective wayfinding systems contribute to a sense of well-being, safety, and security and can improve facility efficiency and reduce wait times.

RTLS solutions also provide a better understanding of patient journeys throughout the hospital. Gaining insight into where and how long patients spend their time is vital to improving patient experiences and, in particular, reducing wait times. RTLS can translate to an improved staff experience by enabling them to spend time on patient care, rather than worrying about inefficiencies in workflows. Additionally, for patients that require longer hospital stays, RTLSs integrated with patient apps can provide family and visitors a more seamless experience when visiting. For example, family and visitors can be notified when a loved one is out of surgery, reducing experience stress.

Asset location management is vital within the healthcare sector. Monitoring where assets are located within a hospital can not only save time for staff looking for a heart rate or blood pressure monitor but can also be lifesaving in the case of tracking the location and use of equipment such a defibrillator. Knowing when an asset is in use, or when it is available, if it has been cleaned, or at what stage of this process it is in, can also provide insights into bottle necks for healthcare facilities. This location information improves workflow when it is embedded into a task request for the use of that equipment. For instance, a patient transport request can provide location information, such as where an available wheelchair is and what the best route to take is, as part of the task description.

Additionally, asset tracking can reduce the amount of lost and stolen equipment within the medical industry. This leads to the second piece of this driver, cost savings, in terms of both equipment costs and staff hours looking for the equipment.

> Any technology that focuses on asset management is helping to create better patient outcomes."
>
> MOUNT SAN RAFAEL HOSPITAL

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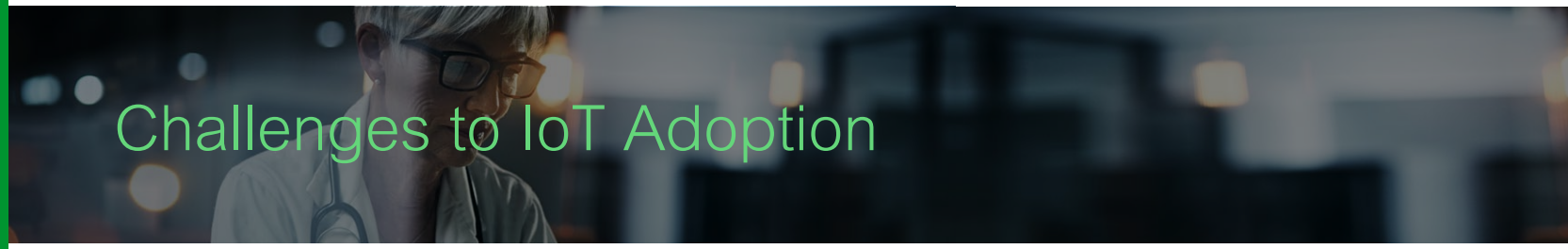

Challenges to IoT Adoption

Healthcare industry weaknesses have been made more obvious in the time of the coronavirus pandemic. Hospitals have increased patient loads and improving operational efficiencies is even more of an urgent need compared with pre-pandemic days—when financial pressures were already evident. According to Guidehouse's analysis of 2,000 hospitals from 2015 to 2017, average operating margins had fallen from 5.6% to 3.6%. Additionally, growth in OPEX (14.6%) outpaced net patient revenue (11.6%) over that timeframe.

As such, costs and uncertainty around ROI are the biggest hurdles for hospital administrators weighing IoT investments. High upfront CAPEX for efficient or intelligent building technologies compete with other healthcare CAPEX priorities such as purchasing the latest operating room equipment. However, the wide range of benefits to these installations, including enhanced patient experience and ancillary operational efficiencies such as wayfinding and asset management, should not be ignored.

Beyond financial barriers, however, there are significant practical hurdles to widespread IoT adoption in hospitals and clinics. For example, interoperability with legacy systems may be difficult. Most of the building automation solutions developed and introduced into the market over the past 20-30 years were proprietary in nature. While industry leaders today recognize the challenge and are now delivering open, interoperable IoT platforms allowing for systemwide integration, there are several reasons why proprietary systems persist:

- Facilities managers and other customer perceptions vary widely on the cost and benefits of interoperability.
- Individual building systems, particularly security systems, can have sensitive information that needs to be restricted. To simplify permissions across multiple types of operators, such systems are often kept on a separate network.
- Proprietary system owners often must rely on a single manufacturer for future device replacements unless a complete retrofit of the BAS is performed, which raises the cost of switching to a new manufacturer with more smart building or IB capabilities.

Furthermore, the early stage of market deployment can limit the number of successful case studies available to healthcare facilities considering deploying IoT-based solutions. Without seeing how their peers are deploying the technology, the successes, and ROI that is possible, healthcare facilities may be hesitant to adopt.

Finally, cybersecurity and data protection concerns are worth noting. Solutions providers have done much to address this concern through additional security work

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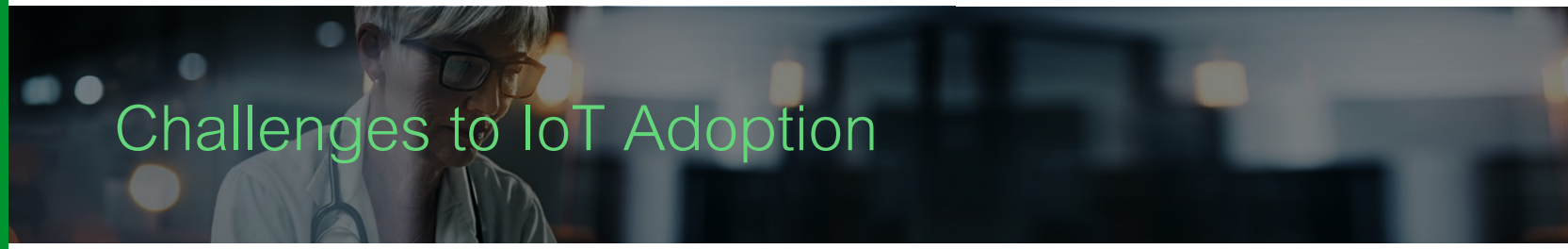


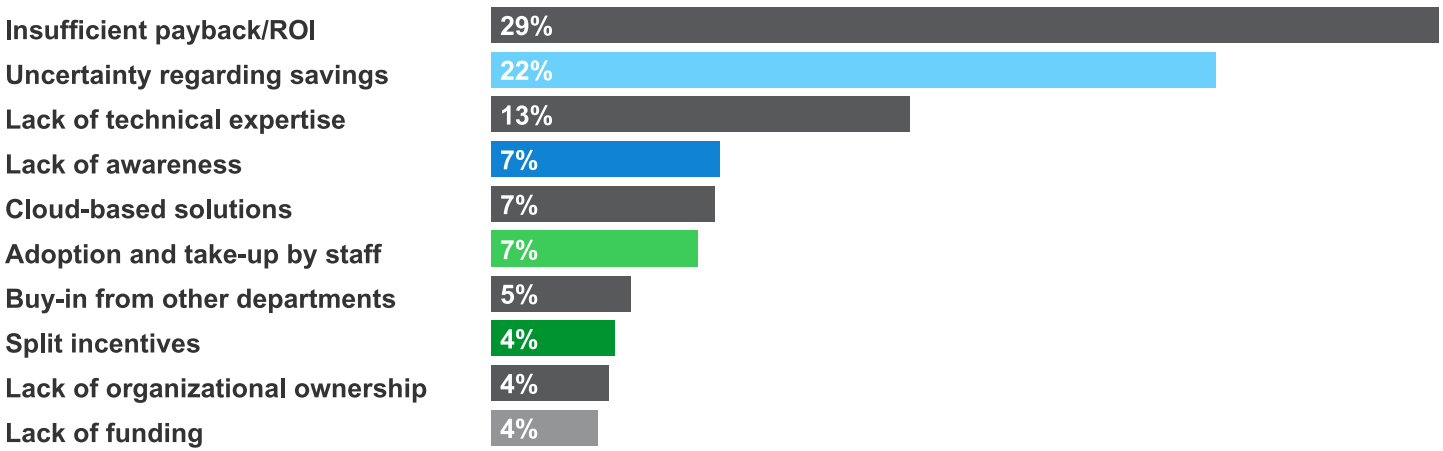
Challenges to IoT Adoption

and third-party verification. Effectively communicating data protection fortification to hospital administrators will address concerns and overcome any perceived barriers associated with cybersecurity. Beyond communication to ease concerns, training is a core part of addressing this barrier and vendors are required to provide the right awareness and support to healthcare personnel.

In the Guidehouse survey, financial concerns represented the majority of respondents' top barrier to IoT implementation, with 29% citing insufficient payback/ROI and another 22% citing uncertainty around savings and performance. Beyond financial concerns, a lack of technical expertise for project evaluation and execution was the next biggest barrier to IoT implementation cited by healthcare executives.

Generally, the risk-averse nature of healthcare facility executives may result in IoT-enabled platforms being seen as a risk to critical patient care obligations. Any change to a facility's operational systems will come with some measure of apprehension that core processes will be disrupted. As administrators begin to fully understand the capabilities an open, integrated IoT platform can bring not only to facility operations but also patient and staff experience, they are expected to begin to embrace the IoT transformation.

Chart 4. What is the top barrier to installing IoT for your organization?



(Source: Guidehouse Insights)

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Conclusions

Healthcare facility executives, while familiar with IoT-based solutions, need to have a clear understanding of just how far beyond energy efficiency the benefits of these systems can go. In addition to financial benefits, hospitals and clinics can benefit from improved patient experience, system resilience, and meeting long-term ESG directives.

In the highly competitive healthcare industry, each of these factors is growing in importance and attracting staff and patients will increasingly hinge on how well facilities meet these requirements. Healthcare facility executives should think of their solution provider as a trusted partner in the deployment of IoT solutions. There is a growing ecosystem of participants that combine IT innovation, facilities and energy expertise, and business strategy in support of healthcare facility managers and owners. These trusted advisors can helpnavigate the digital transformation with guidance on technology selection, implementation and management, and long-term strategies that encompass the four pillars of the future of healthcare: hyper-efficiency, people-centricity, resiliency, and sustainability.

Healthcare facilities of the future will leverage IoT-enabled platforms to drive better outcomes across four key pillars.

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The IoT Implementation Framework: Prioritize Needs and Evaluate Readiness

As healthcare facility executives consider IoT platforms, they must take a holistic view of facility status and needs; evaluating where they are in their IoT journey today vs./versus where they need to be in the future and over what time frame.

In Figure 2, we leverage the HIMMS INFRAM framework, and alongside it have added an assessment model to help you understand your technology maturity and guidance to help you engage a vendor at each stage.

Figure 2. Implementation Framework

INFRAM TECHNOLOGY MATURITY STAGE	INFRAM Maturity Stage Description	Application in Healthcare	Engage a solution vendor or specialist to…
7	Adaptive And Flexible Network Control With Software Defined Networking; Home-Based Tele-Monitoring; Internet/ TV On Demand	Real-time health systems: Outcome-based workflows and self-optimizing facility.	Build an adaptive, flexible platform leveraging data across all systems to drive better clinical and facility outcomes.
6	Software Defined Network Automated Validation Of Experience; On-Premise Enterprise/Hybrid Cloud Application And Infrastructure Automation	OT and IT Integration: Connection to clinical systems to optimize processes, mobile-based applications for clinical and facility interaction	Define strategy for software-defined solutions to impact clinical processes, integrate systems for enhanced efficiency and patient experience, and tap expertise for mobile based applications.
5	Video On Mobile Devices; Location-Based Messaging; Firewall With Advanced Malware Protection; Real-Time Scanning Of Hyperlinks In Email Messages	Optimizing systems and acting based on data: Insight driven facility management, remote service centers for facility support, data driven design choices (room size, space, flow, etc.), automation of processes for facility systems	Leverage insights from advanced IoT systems to define and implement value-based services. Implement process improvement in workflows around facility automation
4	Multiparty Video Capabilities; Wireless Coverage Throughout Most Premises; Active/Active High Availability; Remote Access VPN	Utilizing analytics: Connection to cloud-based analytics to drive business improvements around maintenance efficiency and sustainability.	Define and implement cloud-based technology in a cyber secure environment to report on systems performance
3	Advanced Intrusion Prevention System; Rack/Tower/Blade Server-Based Compute Architecture; End-To-End QoS; Defined Public And Private Cloud Strategy	Digitized infrastructure: IP devices throughout the infrastructure. Room level controllers deployed to connect to a range of sensors and devices using both wired and wireless networks (i.e., noise, lights, shades, nurse call, medical gas and HVAC.) IP-based devices on electrical equipment ready to be connected. Defined cybersecurity policy for OT systems	Modernize systems and implement new technology to deliver value-based solution. Develop proof-of-concepts to test and validate new technology before roll out. Access and audit OT systems and provide cybersecurity assessment
2	Intrusion Detection/Prevention; Informal Security Policy; Disparate Systems Centrally Managed By Multiple Network Management System	Integrated Building Management: Building management HVAC, energy management, power, and security for energy efficiency and alarm management and single seat control. Siloed systems centrally managed on multiple networks	Conduct site surveys and assessment of existing installation, what systems are deployed (state, age, etc.) and what data is available. Together, define a roadmap for digitization and implementation of solutions to meet priorities and deliver value-based results
1	Static Network Configurations; Fixed Switch Platform; Active/ Standby Failover; LWAP-Only Single WirelessController; Ad-Hoc Local Storage Networking; No Data Center Automation	Alarm level integration: Multiple systems in use with some connectivity to a building management system for alarming. Open protocols such as BACnet, LON utilized but still siloed in operations.	
0	No VPN, Intrusion Detection/Prevention, Security Policy, Data Center Or Compute Architecture	Siloed systems: Multiple systems using proprietary networks and protocols with no data sharing. Products installed with no connectivity, i.e., circuit breakers not monitored centrally	

(Source: Adapted from INFRAM from HIMMS)

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Scope of Study

Guidehouse Insights has prepared this white paper, commissioned by Schneider Electric, to provide a roadmap for how the IoT enhances traditional building management solutions in healthcare settings. It describes the need for hospitals and clinics to consider benefits ranging from energy efficiency and sustainability to resilience and patient centricity. It describes the key use cases for IoT in hospitals and clinics and also presents findings from a survey of 600 hospital and clinic executives.

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Sources and Methodology

Guidehouse Insights' industry analysts use a variety of research sources in preparing research reports and white papers. The key component of Guidehouse Insights' analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Guidehouse Insights' analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Guidehouse Insights' reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

Guidehouse Insights is a market research group whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. Guidehouse Insights is not beholden to any special interests and is thus able to offer clear, actionable advice to help clients succeed in the industry, unfettered by technology hype, political agendas, or emotional factors that are inherent in cleantech markets.

Published 3Q 2021