The 9 Problems Nobody Talks About

Why Commercial Buildings Struggle to Deliver on Green Building Promise and Smart FM Vision

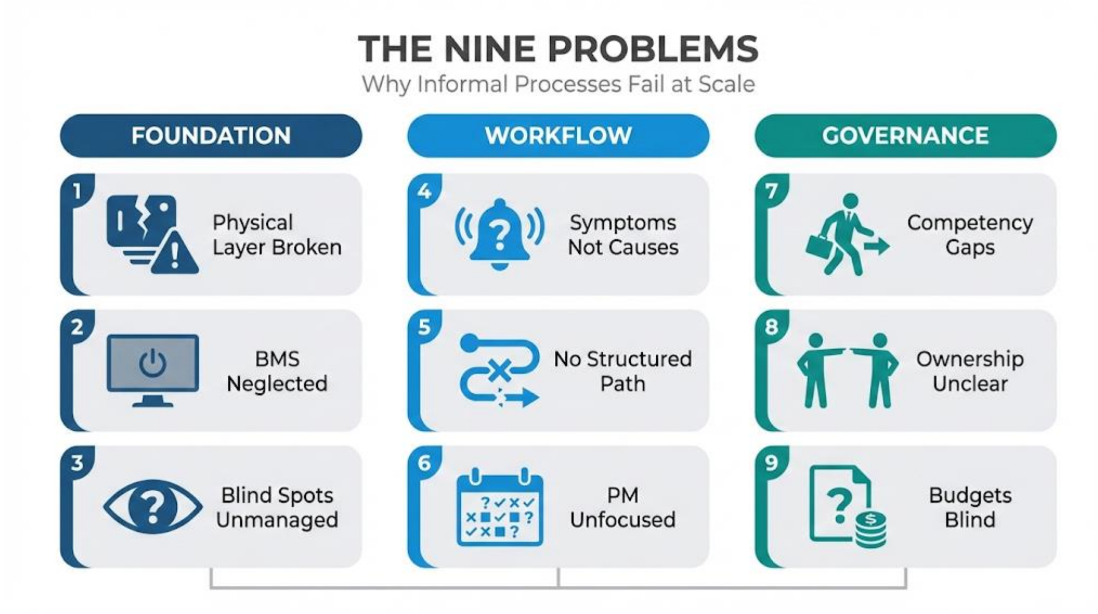
With Focus on HVAC Systems

A White-paper by Sustain Synergy Pte Ltd

Swarup Biswas and Dr Terence Tan

January 2026

SUSTAINSYNERGY



Executive Summary

The built environment accounts for up to 40% of global energy consumption and emits an equivalent share of carbon. Commercial buildings represent a significant portion of this footprint. Sustainability commitments across governments, corporations, and institutions depend on these buildings performing as designed. Most don't.

The problems that explain this gap are not unknown. Experienced operators recognise them. Facilities directors live with them daily. Service providers work around them. These are shared challenges across the industry — not failures of any single party, but structural gaps that emerge when complex systems outgrow the processes designed to manage them.

This paper brings them into the open so we can address them together.

For many building owners, sustainability is not the primary concern. Tenant comfort complaints, energy costs, maintenance budgets, equipment reliability — these are the daily pressures. Sustainability targets matter to some; operational performance matters to all. The 9 problems in this paper undermine both. A building that cannot resolve detected faults will fail its tenants before it fails its carbon targets. The operational breakdown comes first. The sustainability failure follows.

Despite billions invested in building technology over the past 2 decades, the gap between projected and actual performance persists. Buildings have more sensors, more sophisticated Building Management Systems (BMS), more Fault Detection and Diagnostics (FDD) platforms, and more analytics dashboards than ever before. The data is there. The outcomes are not.

The industry has focused on design-phase sustainability: certifications earned at handover, specifications met on paper, technology installed and commissioned. What happens after the ribbon-cutting receives far less attention. Yet operations is where sustainability is actually won or lost. A building certified to the highest green standard can drift into mediocrity within 2 to 3 years if operational performance degrades.

This paper identifies 9 specific problems that explain the gap between sustainability promise and operational reality. These problems are organised into 3 themes: a compromised physical foundation, detection that fails to lead to resolution, and missing capability and governance. The problems are structural. They persist across geographies, building types, and ownership models. They are not failures of effort or intent by building operators. They are failures of the operational infrastructure to match the complexity of modern Heating, Ventilation, and Air Conditioning (HVAC) systems.

The root cause is straightforward: buildings are trying to manage genuinely complex systems with processes that lack specificity. Tribal knowledge instead of structured documentation. Generic work orders instead of actionable tickets with root cause and required action. Calendar-based maintenance instead of condition-driven priorities. Implicit scope instead of explicit accountability. These approaches worked for simpler buildings. They collapse under the weight of modern building complexity.

Until the industry addresses these 9 problems directly, the full potential of technology investments will remain unrealised. This paper is a diagnosis and an invitation. The first step toward solving a problem is understanding it clearly — together.

1. The Technology Investment Gap

Commercial buildings have invested heavily in technology over the past 2 decades. BMS platforms, FDD systems, Internet of Things (IoT) sensors, energy analytics, predictive maintenance tools. The promise was clear: visibility would lead to control, control would lead to efficiency, efficiency would lead to outcomes. Better comfort. Lower costs. Reduced energy consumption. Longer equipment life. Fewer surprises.

The investment happened. The outcomes didn't follow.

Facilities directors still field the same tenant complaints. Maintenance budgets still get consumed by reactive repairs. Equipment still fails before its expected life. Energy costs still exceed projections. The technology generates data. It does not generate results.

This is not a sustainability problem, though sustainability suffers too. The built environment accounts for up to 40% of global energy consumption, with commercial buildings representing a major share. Green certifications have proliferated. Design standards have tightened. Yet studies consistently show buildings consume 20-30% more energy in operation than their design models predicted, with some cases reaching 2-3 times higher [1][2]. Poorly maintained and operated building systems waste up to 30% of total energy consumed [3]. Certified green buildings show wide variation in actual performance.

But sustainability is a trailing indicator. The operational failures come first. A building that cannot maintain comfort will lose tenants before it misses carbon targets. A building that cannot control maintenance costs will face budget pressure before it faces regulatory scrutiny. The 9 problems in this paper undermine operational performance directly. Sustainability failure is a consequence.

The technology paradox deepens this problem. Buildings today have more monitoring capability than ever. BMS platforms can track thousands of data points. FDD systems can flag hundreds of deviations. Energy analytics can benchmark performance against targets and peers. The data is abundant.

Action is not. Alerts pile up in inboxes. Dashboards go unviewed. Reports are generated and filed. The path from data to decision to action to verification barely exists in most buildings. Detection happens. Resolution doesn't.

This paper exists because we believe the industry is ready for a different conversation. One that moves beyond technology features to operational infrastructure. Beyond detection capability to resolution pathways. Beyond what systems can see to what organisations can do.

9 problems stand between detection and resolution. They are structural, not personal. They reflect the growing complexity of building systems, not the shortcomings of the people who manage them. Understanding them is the first step toward solving them.

2. Complexity Is Not an Excuse

Before diagnosing the 9 problems, we must acknowledge a truth the industry often uses as a shield: HVAC systems in commercial buildings are genuinely complex.

A typical 50,000 square metre commercial building contains hundreds of pieces of HVAC equipment: Air Handling Units (AHU), fan coil units, chillers, cooling towers, pumps, Variable Air Volume (VAV) boxes, exhaust fans. Thousands of sensors measure temperature, humidity, pressure, flow rate, CO_2 concentration, and occupancy. Thousands of actuators control valves, dampers, and variable frequency drives. Hundreds of control loops maintain setpoints while responding to changing conditions.

Multiple parties operate this system. In-house facilities teams manage day-to-day operations. BMS vendors maintain control systems. Mechanical contractors service equipment. Energy managers push for efficiency. Occupants complain about comfort. Each party sees a slice of the system. Nobody sees the whole.

Multiple software systems layer on top. The BMS itself, sometimes multiple BMS platforms from different eras. FDD platforms analysing data for faults. Computerised Maintenance Management System (CMMS) platforms managing work orders. Energy analytics benchmarking consumption. Each system has its own logic, its own alerts, its own view of the building.

This is not a machine. It is a complex adaptive system. Components interact. Changes cascade. Symptoms in one area trace to root causes elsewhere. No single person can hold the entire system in their head.

Complexity, however, is not an excuse for poor outcomes.

Other industries manage similar complexity and achieve high reliability. Aviation operates fleets of aircraft, each with millions of components, across global networks with multiple operators and service providers. Every incident is tracked to root cause, and findings trigger procedure updates across the fleet. Manufacturing runs continuous processes with tight quality tolerances and efficiency requirements. Statistical process control defines response thresholds—deviations trigger specific, predetermined actions, not ad-hoc investigation. Healthcare manages complex equipment in life-critical settings with stringent regulatory oversight. Equipment maintenance is documented with compliance traceability—every task tracked to completion with audit trails.

What do these industries have that buildings lack? Not simpler systems. Operational infrastructure. Structured processes for knowledge capture and transfer. Actionable workflows that connect detection to resolution with specificity about what's wrong and what action is required. Clear ownership and accountability. Condition-based maintenance driven by evidence rather than calendars. Systematic approaches to managing what complex systems require.

Buildings, by contrast, are often managed with approaches designed for a simpler era. When a building had a handful of equipment and a chief engineer who knew every valve personally, informal processes worked. The chief engineer carried the system model in their head. They knew the patterns. They made the calls.

Modern buildings have outgrown this model. The complexity has increased. The management infrastructure has not. Good people work hard within broken systems. The outcomes disappoint anyway.

The 9 problems that follow are not criticisms of building operators. They are a diagnosis of structural mismatch: complex systems managed with simple-system approaches. The problems are fixable. But fixing them requires acknowledging them first.

3. The 9 Problems

Theme 1: The Foundation Is Compromised

Between the BMS and the HVAC equipment sits a physical layer: sensors that measure conditions, actuators that execute commands. This layer is the nervous system of building automation. In most buildings, it is quietly degrading.

The BMS, designed to optimise performance, sits underused. Detection systems have limits that nobody maps or manages. Before any sophisticated analysis can begin, the foundation on which sustainability depends is already compromised.

Problem 1: The Physical Layer Is Broken

Industry research shows that on any given day, up to 40% of AHUs experience a reported fault of some kind [4]. Temperature sensors read 2-3 degrees off. Valves stick partially open or closed. Dampers fail to respond to commands. Pressure sensors deliver readings that haven't been accurate in years.

This happens because no structured process exists for ongoing verification. Sensors are installed and commissioned. They are then assumed to work indefinitely. Calibration, if it happens at all, occurs during initial commissioning and never again. Nobody checks whether the temperature sensor in AHU-7 still reads accurately 2 to 3 years later. Problems remain invisible until something breaks conspicuously.

The BMS makes control decisions based on sensor inputs. When those inputs are wrong, the BMS optimises toward the wrong targets. A supply air temperature sensor drifted 2 degrees low causes the BMS to overcool continuously. A stuck chilled water valve means the system works harder to compensate for capacity it thinks it has but doesn't. Energy waste is baked into the automation itself.

In a simple system with a dozen sensors, a drifted reading would be noticed. In a complex system with thousands of sensors, drift is invisible. Problems compound. The building consumes more energy than it should because the control system operates on a false picture of reality. The automation runs, but it runs blind.

Problem 2: The BMS Is Neglected and Underused

Modern BMS platforms are capable systems. They can regulate cooling demand dynamically. They can sequence equipment optimally based on load conditions. They can respond to changing occupancy, weather, and utility signals. They can optimise for energy efficiency while maintaining comfort. Hundreds of control loops. Sophisticated sequences. Real capability.

Most BMS installations are used as monitoring screens. Operators check current temperatures. They respond to alarms. The sophisticated control capabilities sit unused. Too complex. Not enough training. No time.

The BMS reflects the system's complexity. Operating it well requires understanding how subsystems interact. Most facilities teams don't have that background, and the day-to-day pressure of keeping occupants comfortable and responding to complaints leaves no time for learning. The BMS was designed by controls engineers. It is operated by generalists with competing demands.

Buildings paid for sophisticated control capability. They receive basic monitoring. The investment in efficiency capability depreciates while the potential goes unrealised. The building could perform better. The tool to make it happen sits unused.

The problem often starts before handover. Budget constraints during design and construction frequently reduce the BMS scope from optimal to affordable. A building that needs 10,000 monitoring points for comprehensive visibility might be delivered with 8,000. The missing 2,000 points create permanent blind spots that no amount of operational excellence can overcome. The system was never complete. Nobody documents what was cut or why.

Problem 3: Detection Is Incomplete

Every detection system has limits. Some faults produce clear signatures in BMS data. Others require physical inspection. Some conditions can only be caught by a technician walking past and noticing something wrong. Every building has blind spots.

The question most buildings cannot answer: what percentage of potential faults can we detect automatically, and what percentage requires human inspection? This question should be answerable. The building has a finite number of equipment items, a defined set of possible fault types, and a known set of detection methods. Yet most buildings have never mapped detection coverage against failure modes. They cannot say whether their FDD system covers 30% or 80% of potential faults. They operate on assumption, not measurement. Without mapping these limits, buildings manage what is visible and ignore what is not.

Problems develop in the gaps. A failing component that does not trigger an alarm degrades silently. A refrigerant leak in a chiller produces subtle performance decline that standard FDD rules miss. A damper actuator fails in a position that happens to be close to the normal operating range. Months of inefficiency accumulate before anyone notices. The building was never performing as designed. Nobody knew.

More sensors do not automatically mean better visibility. They mean more data with the same fundamental blind spots. Unless someone explicitly manages what the system can and cannot see, blind spots remain unmanaged. The foundation stays compromised in ways nobody tracks.

Theme 2: Detection Doesn't Lead to Resolution

Buildings have invested in detection technology. FDD platforms flag deviations. BMS systems generate alarms. Sensors report anomalies. Detection happens.

Resolution doesn't. Alerts pile up. Nobody acts. The path from seeing a problem to fixing it does not exist in any structured form. Detection without resolution is noise. And noise gets ignored.

Problem 4: FDD Flags Symptoms, Not Root Causes

Fault Detection and Diagnostics platforms analyse building data and flag deviations. Temperature outside the expected range. Valve position anomaly. Energy consumption spike. Simultaneous heating and cooling. These are symptoms.

FDD does not tell you why. Is the temperature deviation caused by a failed sensor, a stuck damper, a control logic error, or an operator override? The same symptom can trace to 5 distinct root cause categories: device or component failure (mechanical), controls or sequence fault (BMS logic), upstream supply issue (chilled water, air handling dependencies), setpoint or configuration error, or operator override. Each requires a different diagnostic approach. Each demands a different corrective action. Each is the responsibility of a different party.

Without root cause categorisation, alerts are undifferentiated. The BMS vendor gets dispatched for what turns out to be a mechanical problem. The mechanical contractor investigates what turns out to be an operator override. The in-house team tries to adjust setpoints for what turns out to be a sensor failure. Time is wasted. The actual issue persists. Energy waste continues.

This lack of specificity flows downstream. When a CMMS ticket is created from a generic FDD alert, the ticket inherits that vagueness. "AHU-3 fault" tells the technician nothing about what's actually wrong or what action is required.

Alert fatigue is the rational response. When every alert looks the same, when most investigations lead nowhere, when the detection system has cried wolf hundreds of times, ignoring alerts becomes the sensible choice. The problem is not lazy operators. The problem is a detection system that creates noise rather than clarity.

Even a well-functioning FDD system can generate hundreds of alerts per week. Staff cannot investigate every one. Without a mechanism to separate the vital few from the trivial many, the important signals drown in noise. The system detects everything. The organisation can act on almost nothing.

Problem 5: No Structured Path to Resolution

Something gets flagged. Then what?

Who owns it? Is it a corrective maintenance issue requiring immediate attention, or a Preventive Maintenance (PM) task for the next scheduled visit? Who assigns the work? Who tracks progress? Who verifies that the issue was actually resolved?

Buildings without a CMMS rely on informal processes. A capable facilities manager keeps track mentally. They know which technician to call. They follow up personally. They remember to check back. When that individual is on leave, overloaded, or has moved on, the process collapses.

Buildings with a CMMS have workflow, but often lack specificity. The contrast is stark:

A generic ticket reads: "AHU-3 fault." The technician visits, sees nothing obviously wrong, closes the ticket. The underlying issue remains.

An actionable ticket reads: "AHU-3: Supply air temp sensor reading 3°C low, causing continuous overcooling. Root cause: sensor drift. Action required: recalibrate or replace sensor." The technician knows exactly what to check, what's wrong, and what to do.

The first creates activity. The second creates resolution. Most buildings generate the first kind.

The issue is not whether workflow exists. The issue is whether tickets are actionable: specific enough to direct the right person to the right equipment with the right information about what's wrong and what action is required.

Detected problems accumulate. Energy efficiency degrades month over month. The building performs worse over time, not because problems were not detected, but because detection was never connected to effective resolution.

Work in complex systems crosses boundaries constantly. In-house to vendor. Vendor to vendor. Mechanical to controls. Without actionable specificity, issues fall between roles and remain there.

Problem 6: Preventive Maintenance Is Unfocused

Preventive maintenance is supposed to prevent failures. Regular attention keeps equipment healthy before problems escalate. The concept is sound.

The execution is not. PM schedules in most buildings are driven by calendars and contracts, not by building condition. Equipment showing early signs of deviation receives the same attention as equipment running perfectly. Equipment due for a check gets checked regardless of need. Equipment starting to fail might not be on the schedule.

PM effort is finite. Technicians have limited hours. When effort is allocated by schedule rather than evidence, it is spent on equipment that does not need it and withheld from equipment that does. Activity happens. Impact does not.

Equipment degradation causes efficiency loss. A chiller operating 5% below design efficiency because of fouled tubes wastes energy every hour it runs. If the PM schedule calls for tube cleaning annually, and the fouling developed 3 months after the last cleaning, the problem persists for 9 months before attention. The data to detect early fouling may exist. The connection between that data and the PM schedule does not.

The information to drive intelligence-based PM exists in most buildings. FDD systems flag early warning signs. Energy analytics show efficiency decline. The connection between these signals and PM prioritisation rarely exists. PM and fault management operate in separate silos. Neither adjusts based on what the other knows.

Theme 3: The Capability and Governance to Act Is Missing

Even if the physical foundation were solid and detection led reliably to resolution, buildings would face a deeper problem: they lack the capability and governance to act.

Technical competency is disappearing as experienced engineers retire. Ownership between internal teams and external vendors is unclear. Budget decisions are made without visibility into actual building condition. Complex systems require structured coordination. Most buildings have informal arrangements that work until they do not.

Problem 7: Technical Competency Is Disappearing

The engineers who can trace symptoms through a complex system to root causes are retiring. They carry decades of pattern recognition built through direct experience. "When I see this combination of readings, it usually means that valve." "This kind of complaint typically traces back to that control sequence." This knowledge lives in their heads. It walks out the door when they leave.

Expertise in complex systems is tacit knowledge. It cannot be captured in a procedure manual. It develops through years of exposure to the system's patterns and peculiarities. Younger team members inherit the complexity without the mental models to navigate it. They see the same data the senior engineers saw. They do not see the patterns.

The trajectory is clear. Every year, more institutional knowledge disappears. Dependency on vendor support increases. Response times lengthen. Costs rise. Internal capability to diagnose problems and direct work appropriately atrophies.

The external labour market compounds the problem. In mature markets like Singapore, skilled building technicians and controls specialists are scarce. When experienced staff leave, replacements are difficult to find. Buildings compete for a shrinking pool of qualified candidates. The choice often becomes: hire less experienced staff and invest in training, or leave positions unfilled. Neither option addresses the immediate competency gap.

Without diagnostic capability, problems take longer to resolve. Misdiagnosis wastes time and effort. Multiple site visits address symptoms while root causes persist. The building underperforms while teams struggle to understand what is wrong. Energy is wasted during every delay.

Problem 8: Governance Is Unclear

Internal teams and external vendors operate in silos. Scope is defined in contracts but interpreted differently by each party. When something fails, fingers point. "That's not our responsibility." "We thought you were handling that." "The contract doesn't cover this condition."

The question that stalls more work orders than any technical problem: is this in scope? Is it covered by the contract?

The work itself might take 2 hours. Determining who should do it takes 2 weeks. Emails are exchanged. Contracts are reviewed. Meetings are scheduled. Meanwhile, the fault persists. Energy waste continues. The building does not care about contractual ambiguity. It just runs inefficiently until someone fixes the problem.

Complex systems with multiple operators require explicit governance. Who owns what category of issue. What falls within each party's scope. How handoffs work when issues cross boundaries. Most buildings have implicit arrangements built on history and relationships. These work when everyone is cooperative and nothing unusual happens. They collapse when relationships fray or unusual conditions arise.

Governance gaps create delays. Delays extend periods of underperformance. Every week spent determining responsibility is a week of wasted energy.

Problem 9: Budgets Are Flying Blind

Maintenance budgets are constrained and under increasing scrutiny. Every expenditure needs justification. Capital is limited. Operating costs are challenged.

Decisions about where to allocate resources are made without visibility into actual building condition. What is emerging? What is the risk of failure? What should be prioritised? Budget planning relies on historical spending patterns and contract schedules, not on current reality.

Issues stay hidden until they escalate. What could have been a minor adjustment becomes a major repair. A valve that could have been recalibrated for a few hundred dollars fails completely and requires replacement for thousands. Scheduled maintenance becomes emergency breakdown. Planned expenditure becomes crisis spending.

Budget gets consumed by surprises. Resources chase breakdowns instead of preventing them. The building could have maintained efficiency with targeted preventive investment. Instead, it experiences cycles of degradation, crisis, and recovery. Average performance over time is worse than it needed to be.

Reactive maintenance costs more than preventive maintenance. Emergency repairs are inefficient. Buildings that could have achieved sustainability targets with smart allocation miss them because budget decisions were made blind.

4. The Common Root

These 9 problems share a common origin: informal processes trying to manage a complex system.

Buildings are managed today with approaches designed for a simpler era. When buildings were smaller and systems were simpler, a knowledgeable chief engineer could hold the whole system in their head. They knew every piece of equipment personally. They remembered the history. They made judgment calls based on experience. Informal processes worked because the system fit within human cognitive capacity.

Modern commercial buildings have outgrown this model. The complexity exceeds what any individual can hold. The interactions between subsystems are too numerous to track mentally. The multiple parties involved create handoff points that informal coordination cannot reliably manage.

What works for simple systems fails at scale:

Simple System Approach	What Complex Systems Need
Tribal knowledge	Structured knowledge capture
Generic work orders	Actionable, specific tickets with root cause and required action
Calendar-based maintenance	Condition-based maintenance
Implicit scope agreements	Explicit ownership and accountability
Reactive response	Systematic detection and resolution

The building industry has evolved from the left column and is moving toward the right. The transition is underway, but incomplete. Recognising this gap is the first step toward closing it.

This is not a criticism of the people who operate buildings. They work hard within the systems they inherited. But good people working hard in broken systems produce disappointing outcomes. The structure is mismatched to the task.

The 9 problems are symptoms of this mismatch. Each problem emerges from applying simple-system management to complex-system reality. The physical layer degrades because no structured process monitors it. The BMS goes underused because operating it requires expertise that informal training does not develop. Detection fails to lead to resolution because workflows lack the specificity to drive action. Capability erodes because knowledge is not captured. Governance falters because coordination is implicit rather than explicit.

The opportunity is clear. Buildings that develop operational infrastructure matched to their complexity will outperform those that rely on informal approaches. Design-phase sustainability sets the potential. Operational infrastructure determines whether that potential is realised.

The path from detection to resolution is the path from promise to performance.

5. Implications and Path Forward

Naming these problems is the first step. Understanding them creates the opportunity to solve them.

The building industry has made remarkable progress in technology capability. BMS platforms are more sophisticated than ever. FDD systems can detect subtle deviations. Sensors have become affordable and ubiquitous. Analytics tools can process vast amounts of data. This investment represents genuine commitment to better outcomes.

The opportunity now is to complete the picture. Technology provides detection. What's needed is the operational infrastructure to turn detection into resolution: actionable workflows with specificity about what's wrong and what action is required, clear ownership, defined accountability, captured knowledge. This is not a criticism of what exists. It is a recognition of what comes next.

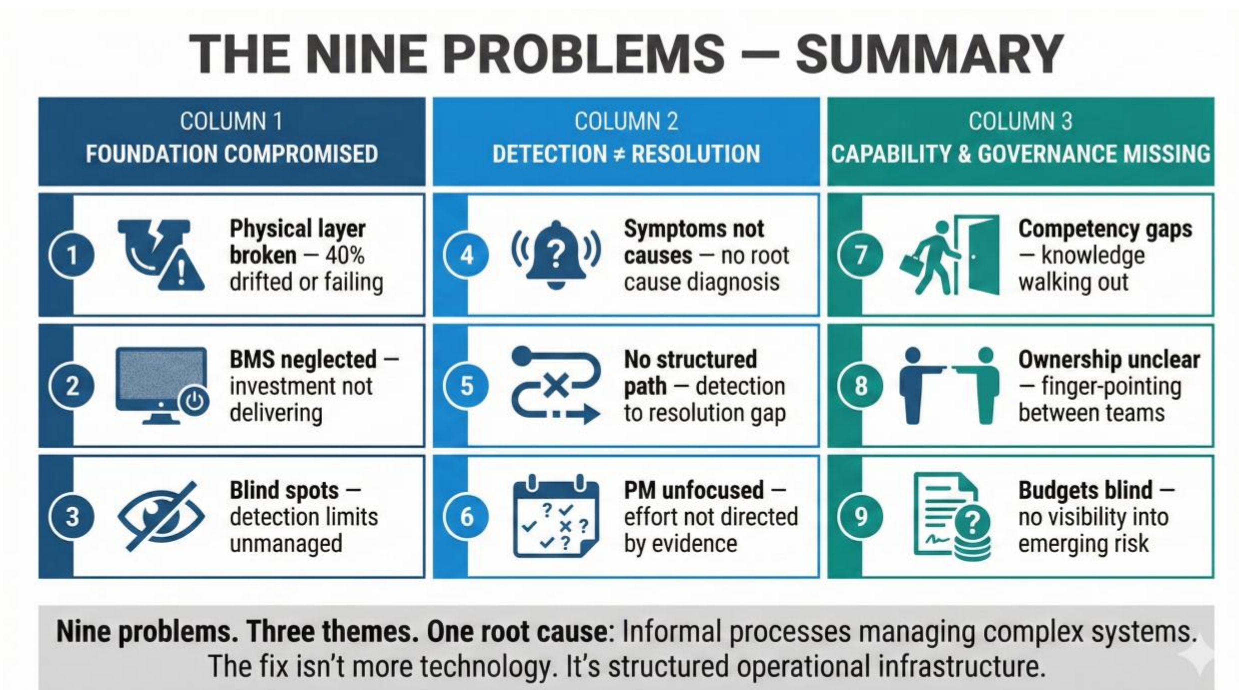
The path forward requires collaboration. Building owners, FM companies, service providers, and technology vendors all have roles to play. No single party can solve these problems alone, because the problems span boundaries. They exist in the handoffs between design and operations, between detection and action, between in-house teams and external vendors. Solutions require working together.

Technology will remain essential, but technology alone will not be sufficient. More sensors will not address governance gaps. Better FDD will not create resolution pathways. AI-powered analytics will not transfer competency to the next generation. The missing layer is operational infrastructure: structure, process, accountability. Technology can support that infrastructure. It cannot replace it.

The stakes are rising, but so is the opportunity. Tenant expectations are increasing. Energy costs are climbing. Sustainability commitments are becoming regulatory requirements. Buildings that solve these problems will be better positioned: fewer comfort complaints, lower maintenance costs, reduced energy spend, higher asset values, documentable sustainability outcomes. The buildings that invest in operational infrastructure will outperform those that invest only in technology.

The conversation is changing. Across the industry, we see growing recognition that detection without resolution creates noise, not value. That complex systems need structured management. That operational performance determines whether technology investments pay off.

This paper is an invitation to that conversation. 9 problems. 3 themes. One shared opportunity to close the gap between what buildings can detect and what they can resolve.



About the Authors

Swarup Biswas has over 30 years' experience in the built environment, spanning from hands-on field engineer to executive leader of a US$1B+ service business at Johnson Controls, where he spent 26 years and served as Vice President, Service for Asia Pacific. He is an award-winning leader, recognised for both commercial excellence and operational excellence during his tenure. His expertise spans HVAC, building automation, IoT, AI-powered analytics, and ESG integration. He holds a Bachelor of Engineering (Electronics), a Post Graduate Program in AI & Machine Learning from the University of Texas at Austin, and is a GSDC Certified Sustainability Coach. He is the founder of Sustain Synergy Pte Ltd, a Singapore-based company focused on operational intelligence for building HVAC systems. The patterns described in this paper emerged from direct observation across hundreds of buildings over 3 decades of operational leadership.

Dr Terence Tan has 35 years of experience in regional leadership, sales, services, and technological solutions for the built environment across its entire life cycle value chain. His expertise spans high-performance and energy-efficient buildings, green buildings, net-zero buildings, smart buildings, and smart cities. He served 33 years with Johnson Controls across different lines of business with revenue exceeding US$100 million, including roles as Regional Director (SEA) for Digital Solutions and Director of Integrated Buildings Solutions, Services & Innovations. His expertise covers regional business leadership, strategic management and innovation, sustainability and ESG, building technologies and digital transformation, and coaching and mentoring of startups and SMEs. He holds a PhD by Portfolio from SSBR Switzerland (Distinction), an MSc in Sustainable Building Design from Nottingham University (Distinction), an MBA from University of Leicester (Merit), and a Specialist Diploma in Energy Efficiency & Management from Singapore Polytechnic (Distinction).

This paper reflects their shared diagnosis of why operational performance consistently disappoints despite substantial technology investment. It is offered as a contribution to an industry conversation that needs to happen.

References

[1] International Partnership for Energy Efficiency Cooperation (2019). "Building Energy Performance Gap: An International Review." Australian Government Department of the Environment and Energy.

[2] Van Dronkelaar, C. et al. (2016). "A Review of the Regulatory Energy Performance Gap and Its Underlying Causes in Non-domestic Buildings." Frontiers in Mechanical Engineering.

[3] Alencastro, J. et al. (2018). "The relationship between quality defects and the thermal performance of buildings." Renewable and Sustainable Energy Reviews.

[4] Crowe, E. et al. (2023). "Empirical Analysis of the Prevalence of HVAC Faults in Commercial Buildings." Science and Technology for the Built Environment. Lawrence Berkeley National Laboratory.

Abbreviations

Abbreviation	Full Term
AHU	Air Handling Unit
BMS	Building Management System
CMMS	Computerised Maintenance Management System
FDD	Fault Detection and Diagnostics
HVAC	Heating, Ventilation, and Air Conditioning
IoT	Internet of Things
PM	Preventive Maintenance
VAV	Variable Air Volume

For inquiries: info@sustainsynergy.com