



Artificial Intelligence in Building Services Engineering in Hong Kong: Applications, Evidence, and a Research Agenda

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Abstract

Artificial intelligence (AI) is bringing about a major revolution in building services engineering (BSE) in Hong Kong. This paper reviews the AI applications in BSE in relation to Hong Kong, synthesising evidence from government initiatives, industry deployments, academic research and pilot projects. The scope of the analysis includes four important areas, i.e., AI-based energy optimisation (for chiller plants and HVAC control), fault detection and diagnosis (FDD) for building energy systems, predictive maintenance for building services equipment, and building management utilising digital twin. The article explores the institutional ecosystem that enables AI adoption, including the Electrical and Mechanical Services Department (EMSD), the E&M AI Lab and collaborative platforms like the Global AI Challenge for Building E&M Facilities, and reviews the empirical evidence of energy savings, operational efficiency and maintenance improvements. The key findings include the quantifiable benefits of AI applications in Hong Kong BSE, such as 5–6.1% energy savings for chiller plant optimisation, up to 40% reduction in daily energy for AI-empowered digital twin deployments, and significant maintenance efficiency improvements. However, the evidence base is still fragmented with few peer-reviewed empirical studies, inconsistent evaluation methodologies and a dominance of pilot-scale deployments. Important research gaps identified in the article include the lack of longitudinal performance evaluations, standardised evaluation frameworks, and research on scalability, interoperability, and human factors impacting AI adoption. A research agenda is proposed to move the field from pilot demonstrations to system-wide integration.

Keywords: artificial intelligence, building services engineering, energy optimisation, fault detection and diagnosis, predictive maintenance, smart buildings

I. Introduction

Building services engineering is the design, installation, operation and maintenance of the mechanical, electrical and plumbing (MEP) systems that make buildings habitable, safe and efficient (Lobato-Cordero & da Cal Seixas, 2021). These include heating, ventilation and air conditioning (HVAC), lighting, electrical distribution, plumbing and drainage, fire services, lifts and escalators and building management systems (BMS). In a subtropical, densely populated high-rise city like Hong Kong, BSE systems are particularly important. Buildings account for approximately 90% of total electricity consumption, and cooling systems are the main source of carbon emissions. Therefore, BSE systems performance has significant repercussions to energy consumption, carbon emissions, occupant comfort and operational costs.

Artificial intelligence integration in BSE has emerged as a revolutionary development. Artificial intelligence (AI) technologies, such as machine learning, deep learning, reinforcement learning, natural language processing and agent-based systems, enable capabilities that go beyond traditional building automation. Unlike traditional BMS that are rule-based and operate on a pre-defined schedule, artificial intelligence systems can learn from past and real-time data, forecast future conditions, dynamically optimise operations, identify anomalies, and support human decision-making through intelligent interfaces. The Hong Kong SAR Government regards AI as one of the key industries, and its application to the construction of E&M systems is a strategic priority for smart city development and carbon neutrality (Ziozias et al., 2023).



This article gives a comprehensive review of AI applications in BSE in Hong Kong. Its objectives are to map the institutional and policy ecosystem enabling AI adoption in BSE; study the main application domains and their empirical basis; assess the evidence of performance improvements; identify challenges, limitations and gaps in research; and set out a research agenda to steer future studies. The article uses a variety of sources, including government reports, industry publications, academic papers, and pilot project documentation. A major limitation of this review is the limited number of peer-reviewed empirical studies, particularly those with strong experimental or quasi-experimental designs. Much of the evidence comes from pilot projects and industry case reports which, while informative, are often not open to independent verification or methodological critique.

II. The Institutional and Policy Ecosystem

One of the unique institutional ecosystems that facilitates the use of AI in Hong Kong BSE is the key role of the Electrical and Mechanical Services Department (EMSD) in coordination and innovation. EMSD has clearly articulated its strategic commitment to accelerating the adoption of innovative technologies (EMSD, 2025). It is fully committed to accelerating the adoption of innovative technologies – including IoT and AI in building services systems. Its commitment has led to a series of initiatives.

A. The E&M AI Lab PracticeNotes

In 2024, the EMSD (2024) established the E&M AI Lab, a program co-developed by the EMSD, government departments and industry stakeholders. The Lab is a platform for research and promotion of applications of AI in E&M systems. A notable output is the publication of two Practice Notes on AI-ready Building Informatics, one on data quality and one on semantic modelling. These Practice Notes are designed to advance best practice and encourage progress across the industry. The focus on data quality and semantic modelling shows an understanding that the effectiveness of AI fundamentally depends on the availability, integrity and structured representation of building data (Du et al., 2024).

B. Global challenge in establishing E&M Facilities with AI

The EMSD (2025a) has also worked with the Guangdong Association for Science and Technology to organise the Global AI Challenge on Building E&M Facilities. It drew more than 200 teams from 26 countries and regions and became a major international platform for exchange of innovation. The Challenge offered two competition categories – “Build Your AI Model” and “Innovative Proposal for Construction and Engineering”. Running in parallel, the Building and Construction AI Conference themed ‘Transforming Construction with AI - Paving the Way to Smart Cities’ featured industry speakers sharing their expertise on intelligent building E&M transformation and sustainable technology application. The Challenge aims to nurture AI talent and promote the practical implementation of innovative technologies. The EMSD said it has “facilitated the practical implementation of numerous innovative technologies, injecting new momentum into the high-quality growth of the industry”.

C. Policy Address Pledges

The Hong Kong Government (2025; 2026) Policy Addresses have reiterated the government’s commitment to leverage AI in the construction sector. AI was listed as a core industry in the 2025 Policy Address, with the commitment to “advance AI development to enhance Hong Kong’s competitiveness and accelerate smart city development”. The 2026 Policy Address also outlined other applications, such as the EMSD to use AI and drones for defect detection to facilitate maintenance and the expansion of the Mechanical and Electrical Services Operating Fund to cover AI applications in works management in respect of site supervision, contract management and procurement assistance.



Such policy commitments may signal institutional support for the ongoing institutionalisation of AI in BSE.

D. Data architecture

The data infrastructure is a fundamental part of the ecosystem. EMSD said it has linked data of E&M equipment in about 400 government buildings to a central digital monitoring center, saying: Currently, it has linked data of E&M equipment in about 400 government buildings to its central digital monitoring center. AI and big data analysis (Rahmani et al., 2021) will be used to enhance operational efficiency and environmental performance. This aggregated data at scale is the raw material for training and deploying AI models. But it also raises questions about data standardisation, privacy and security that are not fully addressed in the documentation.

III. Principal Application Domains

In Hong Kong, the focus of AI applications is in four areas: energy optimisation, fault detection and diagnosis, predictive maintenance and management enabled by digital twins (Yitmen et al., 2025). Each domain has its own technological characteristics, evidence bases, and implementation challenges.

A. AI-Driven Energy Optimisation

Energy optimisation is the most mature and well documented AI application domain in Hong Kong BSE. The focus is on the optimisation of the chiller plant, as cooling represents the dominant share of building energy consumption.

(a) ChillStream® and EMSD Chiller Optimisation -- The EMSD's ChillStream® system is the flagship government-led AI energy optimisation initiative. It is billed as a AI-based chiller plant optimisation system (Chiu et al., 2024) that predicts cooling demand and automatically adjusts settings to continuously optimise energy performance. It was developed in-house by EMSD and released in 2024. ChillStream® can save up to 5% energy at its current level of deployment. The system has been installed in a chiller plant serving a clinical laboratory building in Hong Kong. A trial run was carried out in a multistory clinical laboratory building with a chiller plant of 7,200 kW cooling capacity. The EMSD reports that the system uses streaming analytics for chiller plant energy optimisation, a scalable approach.

(b) Private Sector Chillers Optimisation -- The private sector deployments have reported more significant savings. At the same time, at the landmark property of Three Garden Road in Central which combines the 47-storey Champion Tower and 37-storey ICBC Tower (1.6 million square feet), an AI-driven solution developed by Jardine Engineering Digital Insights (JEDI) optimised a 7,150 RT chiller plant. The project achieved a 6.1% reduction in energy use (435,000 kWh per year), almost 287,000 kg reduction in carbon emissions and full payback in six months. The AI solution connects to the building management system and uses Model Predictive Control and Reinforcement Learning (Lin, McPhee & Azad, 2020) to monitor in real time and detect potential problems early. The project shows that AI-enabled optimisation can generate environmental and financial gains in a commercially attractive timeframe.

(c) AI Load Prediction for Cooling -- Effective chiller optimisation requires accurate prediction of the cooling load. A new AI model developed by the School of Data Science at Lingnan University can forecast hourly cooling load demands up to one month in advance, allowing substantial energy savings without compromising occupant comfort. The model was tested in a commercial building in Hong Kong, and in the Das Intellitech Building, Shenzhen. This work was the Gold Award winner in the Global AI Challenge for Building E&M Facilities 2025. Related work has proposed hybrid global and sub-domain approaches for hourly cooling load forecasting, tested on 18 months of real-world data in a commercial building in Hong Kong, showing large improvements over state-of-the-art techniques such as LSTM, LightGBM and Informer.



(d) Hospital Authority Deployment -- The Hospital Authority is a significant case of AI energy optimisation in a complex 24/7 operational environment. The Hospital Authority operates 43 public hospitals with a total gross floor area of over 3 million square feet, which requires a substantial amount of energy. HVAC systems account for nearly 50% of hospital energy use. Since 2016 the Hospital Authority has been replacing air-conditioning units with more energy-efficient models. In recent years it has also introduced AI-controlled central air-conditioning systems, which use big data and machine learning to predict cooling demand at different times, and automatically adjust the operating parameters of the central air-conditioning units according to the actual environment. It is now being used in two hospitals and Hospital Authority headquarters, with an estimated annual saving of almost 750,000 kWh. The Hospital Authority's (2026) implementation is a great example of the need to tailor AI energy optimisation to the unique operational needs of healthcare facilities, where reliability and occupant comfort cannot be compromised.

B. Fault Detection and Diagnosis (FDD)

Fault detection and diagnosis (Leite et al., 2024) is an important function in building energy systems, because undetected faults can lead to performance degradation, increased energy consumption and occupant discomfort. The EMSD has created an AI system for FDD in hospital HVAC systems that 'uses data from building management system, operating parameters and maintenance records to monitor the component condition of the heating, ventilation and air-conditioning systems in hospitals for early identification and alert of potential anomalies'.

One notable development is the agentic platform for end-to-end FDD developed by Kinevo Limited in collaboration with EMSD and piloted in a government office block in Hong Kong. The platform consists of three elements: a building data model connected to the BMS, a knowledge base of O&M procedures adapted to the site, and a search agent based on LLM. Given an operator query, the agent interprets the runtime context, retrieves appropriate equipment and sensor information, invokes data and procedure execution tools, and returns traceable diagnosis results and recommended actions via a user-facing interface. The platform's feasibility was shown in a preliminary case study of a traceable FDD workflow on a water-cooled chiller compressor oil temperature alarm. The platform is designed to address a major limitation of existing FDD approaches which are often stand-alone analytical modules with limited connection to live building management systems and site-specific procedures.

C. Predictive Maintenance

Predictive maintenance involves the use of AI to analyse data (Ucar, Karakose & Kırımça, 2024) about the condition of equipment to predict failures before they happen, and schedule maintenance at the optimum time, reducing unplanned downtime. The EMSD has installed IoT sensors on the major components of 60 lifts to collect operational data for predictive maintenance, including buildings such as Queensway Government Offices, Cheung Sha Wan Government Offices and Harbour Building. The EMSD's AI Real-time Lift Door Inspection System won a silver medal in the International Exhibition of Inventions of Geneva.

In the private sector, Hongkong Land (2025) launched Hong Kong's first AI-powered Integrated Facility Management Control Tower (IFMCT) in 2025. The platform integrates over 20 independent building systems on a single platform and offers predictive maintenance, automates 66% of work orders, accelerates documentation retrieval by 80% and minimises maintenance effort by 16%. NTT Com Asia's OCEAN Intelligence™ platform, deployed in over 100 buildings in Hong Kong, is said to be transforming facility operations from passive management to data-driven decision-making. It is said the platform can reduce maintenance work input by up to 50% and maintenance downtime by 75%. But they are striking figures of the industry, which would be better verified independently.

D. Digital Twin-Based Management



Digital twin technology (Botín-Sanabria et al., 2022) produces virtual representations of physical buildings that are updated in real-time with sensor data, allowing simulation, prediction and optimisation. The Hong Kong Polytechnic University has created a digital twin system for smarter, greener government and corporate buildings. The system “creates high-precision digital models of buildings and uses IoT sensors to monitor real-time data including temperature, pressure and power consumption. It can “accurately predict equipment failures and automatically optimise air-conditioning start-stop times, water temperature settings”, combining artificial intelligence (AI) analysis with physical engineering models. The research team’s AI-powered digital twin platform for smart energy management won the Gold Medal at the International Exhibition of Inventions Geneva 2025 and has been successfully implemented in a high-rise government office building in Hong Kong. The system can cut daily energy use by as much as 40%.

Hongkong Land IFMCT has 4D digital twin visualisation to improve operational awareness and decision-making. A study, based on data from a Hong Kong hotel, has examined how digital twin applications have evolved from “Fixed Mode” to “Energy Optimisation Solution (EOS) Mode” and then to a “AI-driven autonomous system”, since the hotel’s real-world deployment in 2013. The longitudinal view is insightful but the move toward full autonomy brings concerns about human supervision and responsibility that deserve more research.

IV. Evidence Synthesis

The evidence of AI’s effectiveness in Hong Kong BSE is promising, although there are several limitations that are worth noting.

(a) Quantified benefits -- The available evidence reports a range of benefits: 5% energy savings from EMSD’s ChillStream®; 6.1% energy savings and six-month payback at Three Garden Road; up to 40% daily energy reduction from the PolyU digital twin; 66% automation of work orders and 16% reduction in maintenance effort from Hongkong Land’s IFMCT; 50% reduction in maintenance work and 75% reduction in downtime from NTT’s OCEAN Intelligence™; and an estimated 750,000 kWh annual saving from the Hospital Authority’s AI air-conditioning system. These numbers indicate that standard artificial intelligence can provide significant savings in energy, maintenance and operations.

(b) Quality of evidence -- But the evidence base is patchy. Much of this is derived from industry press releases, government reports and pilot project documentation, rather than from peer-reviewed empirical studies. There are few academic studies available, such as the work from Lingnan University on cooling load prediction and the hybrid forecasting method validated on 18 months of real-world data, but the peer-reviewed literature on AI in Hong Kong BSE is still limited. The agentic FDD platform paper (describing a pilot deployment) is a short conference paper and not a full journal paper with a comprehensive evaluation. This fragmentation and reliance on grey literature reduces the conclusions that can be drawn.

(c) Contextual Factors – The distinctive features of the Hong Kong context shape AI applicability. High-rise, high-density buildings generate complex BSE systems, with complex interactions among components. The subtropical climate means that there are cooling demands all year round and hence chiller optimisation is particularly important. The extent of government ownership of the building stock (roughly 400 government buildings linked to the central monitoring center) offers opportunities for coordinated deployment and data sharing that may not be present in jurisdictions with more fragmented ownership. However, the large share of privately owned buildings and the heterogeneity in modern buildings, systems and management arrangements, make scaling up AI solutions challenging.

(d) Comparison with international evidence -- The Hong Kong evidence is broadly consistent with international evidence on AI in building services, which report energy savings typically in the range of 5–20% for HVAC optimisation, variable results for predictive maintenance depending on equipment criticality and data quality, and growing adoption of digital twin technologies. But the differences in building stocks, climate, regulations, and evaluation methodologies make direct comparison difficult.



The Hong Kong case is interesting in terms of the strong role of government-led innovation through the EMSD, which is contrasted with some other jurisdictions' more market-driven adoption patterns.

IV. Challenges and Limitations

There are several obstacles and constraints that constrain the realisation of AI's potential in Hong Kong BSE.

(a) Data quality and interoperability. -- AI effectiveness is fundamentally dependent on data. The issues are acknowledged as serious impediments in the Practice Notes on AI-ready Building Informatics by EMSD, which highlight data quality and semantic modelling. Data produced by building systems is typically in proprietary formats with inconsistent naming and incomplete metadata and variable sampling rates. Semantic modelling (SM) is the production of structured, machine-readable representations of building data. It is a crucial step in allowing artificial intelligence (AI) systems to understand and integrate data from multiple sources. It is not apparent from the documentation available how much these challenges have been addressed in current deployments.

(b) Integration with legacy systems -- Many buildings in Hong Kong, especially older buildings, are using legacy BSE systems that are not designed for digital integration. The addition of AI capabilities to these systems involves not just technical solutions, but also careful management of risk, disruption and cost. The Hongkong Land IFMCT is an example that integrates over 20 standalone building systems. This shows that integration is possible, but the effort and investment is huge. The problem is particularly acute for the many buildings operated by smaller organisations with limited technical capacity.

(c) Evaluation and verification -- There is no standard framework for evaluating AI solutions, which makes it difficult to compare them and measure their real effectiveness. Industry-reported savings are self-reported and do not control for confounding factors such as weather, occupancy, or concurrent equipment upgrades. Independent, methodologically rigorous evaluations with controlled or quasi-experimental designs would be a benefit to the field.

(d) Human factors -- Artificial intelligence systems do not exist in a vacuum. The power of these tools lies in the hands of the building operators, engineers and managers who use them. Kinevo's agentic FDD platform directly addresses this by providing 'traceable diagnosis results and recommended actions' to a user-facing interface, but the bigger question of how AI changes the nature of building services work (and what skills and competencies are needed to work effectively with AI) remains largely unexplored. The EMSD's focus on nurturing AI talent through the Global AI Challenge reflects awareness of this problem, but there is a dearth of systematic research on human-AI collaboration in BSE.

(e) Cost and scalability -- While the Three Garden Road pilot recovered all costs within six months, the initial costs of deploying AI, including sensors, data infrastructure, software licenses, and integration services, may be prohibitive for many building owners, particularly in the private sector and for smaller buildings. Scaling successful pilots up to system-wide deployment is a major challenge.

(f) Cybersecurity and privacy -- AI systems' collection and analysis of building data raise cybersecurity and privacy concerns. Such concerns are also recognised at the policy level, as the 2026 Policy Address announced a "Cybersecurity Defence Plan" and the creation of a cybersecurity threat intelligence analysis and alert system. However, the specific implications for AI-enabled BSE systems have not been widely investigated in the available literature.

VI. Future Directions and Research Agenda

The review identifies several priorities for future research and development.

(a) Longitudinal performance assessment -- Most of the available evidence is based on pilot deployments or initial implementations. Longitudinal studies to track the performance of standard artificial intelligence systems over time, including seasonal effects, equipment degradation and



changes in building use. Such studies would provide stronger estimates of sustained benefits and contribute to maintenance and upgrade strategies.

(b) Standardised evaluation frameworks -- The field would benefit from standard metrics and methodologies for evaluating AI in BSE, including agreed definitions of energy savings (e.g. weather normalised, occupancy adjusted), maintenance metrics and return on investment calculations. The Practice Notes of the EMSD are a good starting point but their adoption and refinement through empirical application should be a priority.

(c) Scalability and interoperability research -- Research is needed into the technical, organisational and economic factors that determine whether successful pilots can be scaled to larger portfolios. Key enablers will probably be interoperability standards, open APIs and modular architecture. Hongkong Land's experience in integrating more than 20 standalone systems is a useful case for studying scalability challenges and solutions.

(d) Human factors and workforce development -- As AI is integrated more deeply into BSE operations, understanding the changing roles of building operators and engineers is critical. Research into human-AI collaboration, decision-making with AI recommendations and the skills and training needed for effective AI-assisted building management would be useful. EMSD's talent development initiatives could provide a platform for such research.

(e) Comparative studies -- A comparative study of AI applications in different building types (office, hospital, educational, residential), ownership models (government, private, mixed) and climate zones would help to identify contextual factors that moderate AI effectiveness. The Hospital Authority's experience with AI air-conditioning control in healthcare settings is an especially interesting benchmark compared with commercial office deployments.

(f) Integration with grid & district systems -- With the increased move toward carbon neutrality in Hong Kong, integration of building-level AI with district energy systems, renewable generation and grid demand response will play an increasing role. Research on interfaces between building BSE AI and energy systems at larger scales is needed.

(g) Ethical and governance considerations -- The use of AI for building services raises issues of accountability, transparency and the appropriate level of oversight by humans. Careful consideration is needed for the governance framework for AI decision making, especially for safety-critical systems such as fire services and lifts. Research on regulatory structures, liability and ethical guidelines for AI in BSE would be useful.

VII. Conclusion

Artificial intelligence is reshaping building services engineering in Hong Kong, with uses such as energy optimisation, fault detection and diagnosis, predictive maintenance, and digital twin-enabled management. The institutional ecosystem of the EMSD's E&M AI Lab and the Global AI Challenge is robust enough to promote innovation and knowledge sharing. The evidence so far suggests that standard artificial intelligence can deliver material benefits including 5-6.1% energy savings in chiller optimisation, up to 40% daily energy savings in digital twin deployments and significant maintenance efficiency gains. However, the evidence base is fragmented, drawn from grey literature and pilot-scale deployments and is not sufficiently methodologically rigorous to allow for confident generalisation.

Moving from promising pilots to system-wide adoption requires overcoming challenges related to data quality, interoperability, evaluation, human factors, scalability, and governance. A research agenda focusing on longitudinal assessment, standardised evaluation, scalability, human-AI collaboration, comparative analysis and ethical governance will help to consolidate and advance the field. Hong Kong's experience provides useful lessons for other high-density, high-rise cities that want to harness AI for building efficiency and sustainability, but the realisation of this potential requires continued investment in both technology and the research needed to understand how to apply it effectively.



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