

Yuan Xiaoying

DBA Program Doctoral Student

Al-Farabi Kazakh National University

Kazakhstan, Almaty

Scientific Advisors:

1. Asanova Daniya, DBA, PhD, Professor

2. Olga Koshkina, c.e.s., assistant Professor

SMART BUILDINGS AND ESG COMPLIANCE: A CASE STUDY OF CHINESE HIGH-RISE DEVELOPMENTS

Abstract: *China's green building sector has become the world's largest, with the Chinese mainland ranking first globally in LEED certifications for the ninth consecutive year and its smart building market projected to more than double from \$96.3 billion in 2025 to \$206.4 billion by 2031. This article examines how smart building technologies support Environmental, Social, and Governance (ESG) compliance in Chinese high-rise developments, using Shanghai Tower as an illustrative case. The analysis finds that environmental gains from smart systems are well documented and substantial, with reported energy and water savings of 15–50% depending on intervention type, while social and governance dimensions remain comparatively underdeveloped, constrained by a “triple institutional dilemma” of carbon lock-in, human-capital alienation, and ambiguous governance structures in China's construction sector. The article concludes that smart building technology is necessary but not sufficient for full ESG compliance, and that governance frameworks — not sensors — are the binding constraint on China's high-rise sustainability transition.*

Keywords: *ESG compliance, smart buildings, green building certification, high-rise developments, building automation, sustainable construction, China, dual carbon strategy*

1. Introduction and Literature Review

China's green building sector has expanded rapidly under policy support: the 14th Five-Year Plan (2021–2025) pushed prefabricated construction toward 30% of new starts, and the 2022 General Code for Building Energy Conservation set residential energy-savings targets of 65–75% by climate zone (Yu et al., 2024). The Chinese mainland has topped global LEED rankings for nine consecutive years, with 1,860 projects covering over 25 million square meters certified in 2024 alone (China Daily, 2025), while its smart building market was valued at \$96.3 billion in 2025 and is forecast to reach \$206.4 billion by 2031 (Mordor Intelligence, 2026). Whether this constitutes full ESG compliance is contested: Labib (2025) maps smart building technology against all three ESG pillars, finding strong environmental gains but underdeveloped social and governance contributions, while Tan and Dai (2025) identify a “triple institutional dilemma” — carbon lock-in, human-capital alienation, ambiguous governance — specific to Chinese construction. Few studies examine all three pillars within one Chinese high-rise case; this article addresses that gap.

2. Methodology

This is a qualitative case-based literature review: a review of China's green building policy (2016–2025) and certification data, a single-case illustration using Shanghai Tower — a documented LEED Platinum supertall with quantified performance data — and a mapping of smart building technologies against the Environmental, Social, and Governance pillars (Labib, 2025). Because environmental-performance literature is quantitatively richer than social/governance literature for Chinese construction, that asymmetry is treated explicitly below.

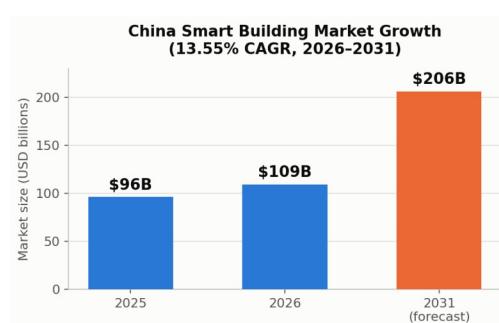


Figure 1. China's smart building market is projected to more than double by 2031 (Mordor Intelligence, 2026).

3. Results and Discussion

3.1 Case Illustration: Shanghai Tower

Shanghai Tower, at 632 meters China's tallest building, illustrates smart-technology-enabled environmental performance in a supertall high-rise: LEED Platinum certification, a 21% energy reduction against baseline, and a 45% reduction in lifecycle operating costs across over 500,000 square meters of mixed-use space (Tetra Tech, n.d.). Its systems combine wind turbines, geothermal exchange, ice thermal storage, combined heat and power, and intelligent automation — an integrated stack, consistent with the finding that the largest gains come from combining systems rather than deploying them in isolation.

3.2 Environmental Performance: The Strongest Pillar

Table 1 and Figure 2 map specific technologies onto the three ESG pillars. Environmental gains are the best-documented: MPC HVAC systems report 15–30%+ energy savings, occupancy-based lighting up to 35%, smart irrigation 20–50%+ water savings, and integrated HVAC-lighting-blinds strategies up to 23% total savings (Labib, 2025). At the national level, Shanghai's Changning District achieved 20% average energy savings across 32 retrofitted buildings (Yu et al., 2024), showing building-level gains scale to district retrofits. These technologies also support automated Scope 1–2 emissions tracking against GRI, SASB, and TCFD frameworks.

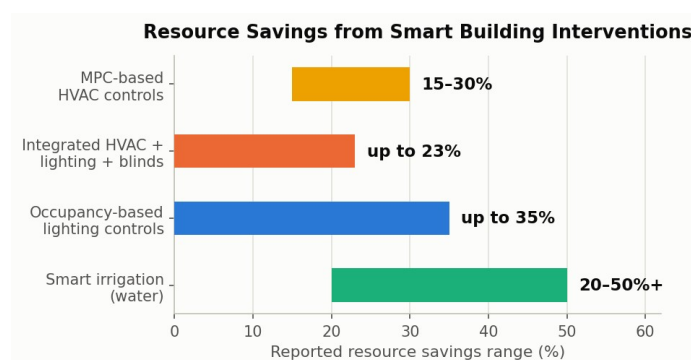


Figure 2. Reported resource savings ranges by smart building intervention type (Labib, 2025).

Table 1. Mapping smart building technologies to ESG pillars.

Pillar	Smart Building Technology	Reported Effect	Aligned Standard
E	MPC HVAC, smart metering, occupancy lighting	15–35% energy/water savings; Scope 1–2 tracking	GRI, SASB, TCFD
S	IAQ sensors, demand-controlled ventilation, accessibility automation	Improved occupant health, comfort, cognitive function	WELL, Fitwel, RESET Air
G	Data governance, OT/IT cybersecurity, audit trails	Transparent, auditable ESG disclosure	NIST CSF, ISO 27001

3.3 Social and Governance: The Underdeveloped Pillars

Social and governance contributions lag behind. The same sensors that improve indoor air quality and comfort also raise surveillance, data-misuse, and algorithmic-bias risks rarely quantified alongside energy savings (Labib, 2025). On governance, Tan and Dai (2025) find China's construction sector responsible for 44.8% of national energy consumption and 48.3% of energy-related carbon emissions, with fragmented responsibility and inconsistent disclosure undermining compliance; among China's top 500 enterprises, only 77.3% of construction firms published ESG reports in 2024. This asymmetry — strong E, weak S and G — mirrors Labib's (2025) global pattern, suggesting a structural rather than China-specific gap.

3.4 Reconciling the Pattern: Governance as the Binding Constraint

Together, these findings suggest smart technology is necessary but not sufficient for ESG compliance: environmental performance scales with technology investment, but social and governance performance depend on organizational and regulatory choices that sensors alone do not make. Labib's (2025) call to “prioritize governance before deploying technology” aligns with Tan and Dai's (2025) finding that China's ESG dilemma is institutional rather than technological — implying investment should be paired with data-governance frameworks, workforce protections, and standardized disclosure.

4. Conclusion

This article has examined how smart building technologies support ESG compliance in Chinese high-rise developments, using Shanghai Tower alongside

national policy and market data. Environmental performance is the clear strength — documented savings of 15–50%, nine consecutive years of LEED leadership, and a market set to more than double by 2031 — while social and governance performance remain underdeveloped, constrained by data-privacy risks, fragmented responsibility, and disclosure that still lags adoption. Governance, not sensor technology, is the binding constraint on full ESG compliance; developers and policymakers — including those in Kazakhstan evaluating Chinese technology transfer — should weight governance and disclosure alongside energy performance, rather than treating adoption alone as evidence of compliance.

References

1. Yu H., Wen B., Zahidi I., Fai C. M., Madsen D. Ø. China's green building revolution: Path to sustainable urban futures // Results in Engineering. 2024. Vol. 23, art. 102430. DOI: 10.1016/j.rineng.2024.102430.
2. Tan X., Dai Y. The practical dilemma and relief of ESG compliance under the “dual carbon” strategy in China // Sustainability. 2025. Vol. 17, No. 24, art. 11136. MDPI.
3. Labib R. Mapping the contributions of smart buildings to ESG goals // Sustainable Cities and Society: Advances. 2025. DOI: 10.1016/j.scsadv.2025.100009.
4. China Daily. Nation's efforts in green buildings garner praise. 2025. URL: chinadaily.com.cn.
5. Mordor Intelligence. China smart building market — Companies, industry trends & size. 2026. URL: mordorintelligence.com.
6. Tetra Tech. Revolutionizing sustainability in Shanghai: Achieving LEED Platinum in a supertall building. URL: tetratech.com.