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How mature is IoT-driven Energy Efficiency Research in Hospitality?

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INTRODUCTION & AIM

Hotel energy use is driven by HVAC operation and occupancy variability. IoT (Internet of Things) enables real-time optimization, but research lacks real-world validation and methodological standardization. This study evaluates the maturity of IoT-based energy efficiency research in hospitality.

METHOD

PRISMA-based review identified 1,709 records from Web of Science, Scopus, and Google Scholar → 60 studies were selected.
Maturity was assessed using an RMA framework, assessing replicability and robustness across clarity on concepts (Q1), IoT devices (Q2), indicators (Q3), implementation (Q4), platforms (Q5), smart scenarios (Q6), and limitations (Q7).

CONCLUSION

Despite the technological advances, current research is not ready for large-scale hotel deployment.

Simulations fail to capture real human interaction, limiting the practical validity of reported savings and their relevance for hospitality decarbonization.

FUTURE WORK / REFERENCES

Future research should:

- **Standardize indicators.**
- **Expand long-term validation** in operational hotels, incorporating guest and staff behavior.
- **Develop predictive models from real-world data.**

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RESULTS & DISCUSSION

Environmental variables are widely reported, but their translation into actionable energy-efficiency metrics remains limited.
Despite reported energy savings, implementation cost and ROI data are rarely provided, limiting applicability.

Research maturity is moderate (2.65/4).

Most studies lack the detail needed for large-scale implementation. Reported resource savings (20–50%) are frequently claimed but lack sufficient methodological detail.

Maturity score heatmap 2.65 / 4

Articles	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	4	4	4	3	4	4	4
2	4	3	4	3	4	4	4
3	4	3	4	4	3	4	4
4	3	4	4	4	4	3	3
5	4	4	4	3	4	3	3
6	4	4	4	4	2	3	4
7	4	4	4	4	3	3	3
8	3	4	3	4	4	4	3
9	4	2	4	4	2	4	4
10	1	4	3	4	4	4	4
11	4	4	3	4	3	3	3
12	3	4	4	3	3	4	2
13	3	4	3	3	3	3	3
14	3	3	2	3	4	3	4
15	4	2	4	2	2	4	4
16	4	4	3	2	3	4	2
17	4	2	4	3	2	2	4
18	4	2	4	3	2	3	3
19	4	3	2	2	3	3	4
20	2	3	3	4	2	4	3
21	3	4	3	4	2	1	4
22	3	3	3	2	3	4	3
23	4	3	4	2	2	4	2
24	2	3	4	4	3	2	4
25	4	2	3	3	2	3	3
26	3	2	3	2	3	2	3
27	3	1	4	1	2	3	4
28	3	4	3	4	2	1	1
28	3	3	3	4	1	1	2
31	4	2	3	2	2	1	3
32	4	3	3	1	2	2	2
33	4	2	3	2	1	4	1
33	3	2	3	1	2	2	4
34	4	2	2	3	2	2	2
35	2	3	3	4	2	1	2
36	3	2	2	3	1	1	4
37	3	4	1	2	2	3	1
38	3	3	2	2	2	2	2
39	2	1	2	4	1	1	4
40	3	2	2	2	2	2	2
41	1	2	3	2	2	2	3
42	3	2	2	2	1	1	4
43	2	1	3	2	2	2	3
44	2	2	3	1	2	1	4
45	3	1	1	3	2	1	4
47	2	2	3	3	2	2	1
48	2	2	2	3	1	2	2
49	2	2	2	3	2	2	2
50	2	2	3	3	2	2	1
51	3	4	1	2	2	1	1
52	3	2	3	2	1	1	2
53	3	1	2	2	1	2	1
54	1	1	2	2	1	1	3
55	3	1	1	1	1	1	2
56	2	2	1	2	1	1	1
57	3	1	1	1	1	1	2
59	3	1	1	1	1	1	2
60	3	1	1	1	1	1	2

Maturity level (Likert scale)
1 2 3 4

Fig 2. Predominantce of low scores (1–2) and few high scores (3–4), indicating limited analytical depth.

Only 11% of studies include real-world experiments in hotels.

The limited technological transparency and empirical validation restrict scalability.

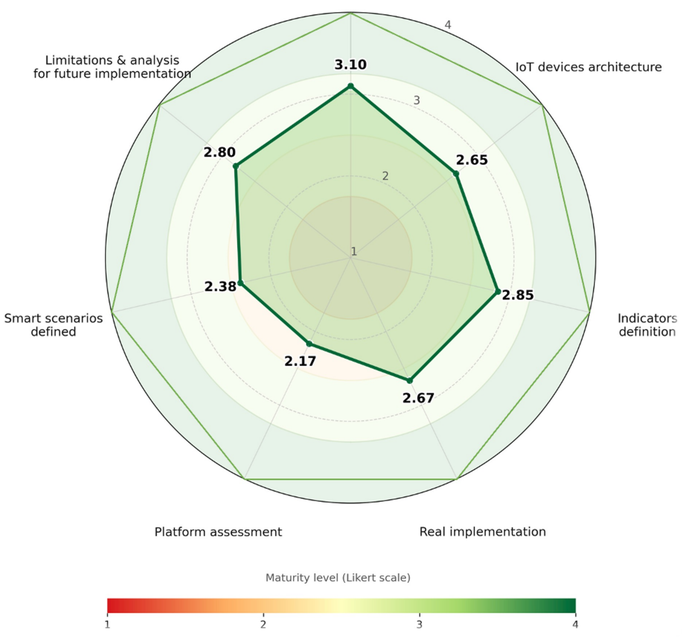

Fig. 1. Highlights that the primary research gaps lie in IoT platform assessment and the definition of energy-efficient smart scenarios.

Technological Landscape

Key research **gaps** are :

- **Platform assessment**
- **Smart scenario definition**
- **Sensor specifications**

Particularly in communication protocols, stability and interoperability.

Fig 3. IoT devices with optimized control scenarios and the right communication protocols reduce unnecessary HVAC use and CO_2 emissions.

The authors declare no conflicts of interest.