The Next Frontier in HTA? Reviewing the Integration of Artificial Intelligence and Discrete Event Simulation for Resource Modelling

HTA324

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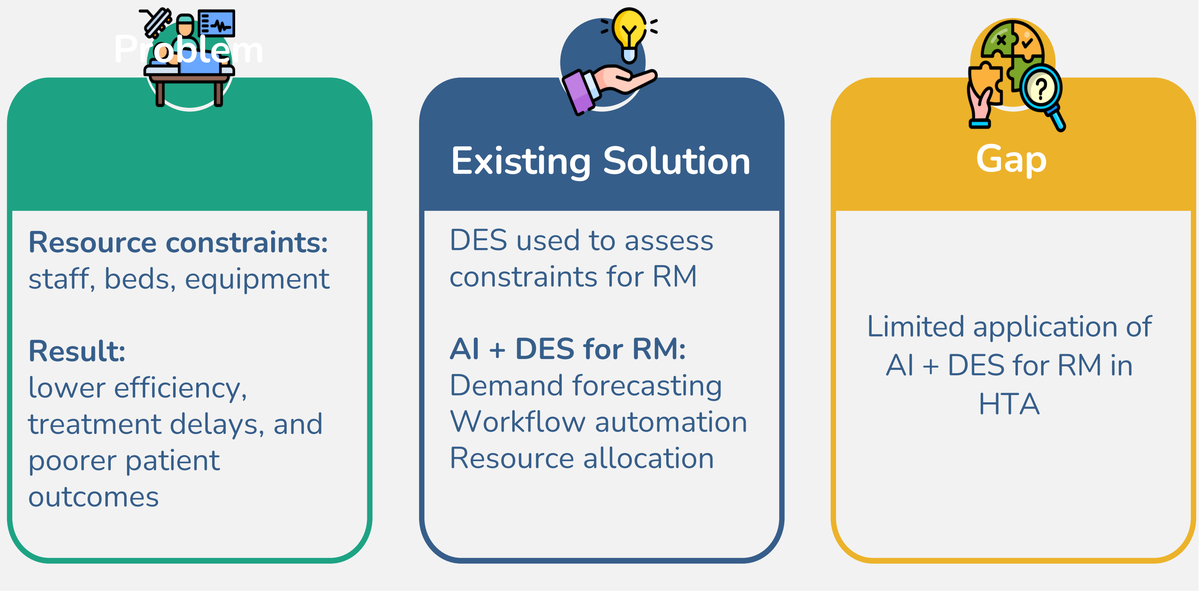
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Context: Healthcare systems often face physical resource constraints (e.g., staff, beds) that reduce efficiency, delay care, and worsen outcomes. Resource modelling (RM) provides a structured way to measure the effects of such constraints. This is typically conducted using discrete-event simulation (DES). Artificial intelligence (AI), particularly machine learning, can support DES based RM by improving forecasting, automating workflows, and optimizing resources. While these methods are common in operational research (OR), their use in health technology assessment (HTA) remains limited. **(Figure 1)**

Objective: To explore, using a targeted literature review, how integrating AI with DES can enhance RM in healthcare, optimize resource allocation, and strengthen evidence for HTA.

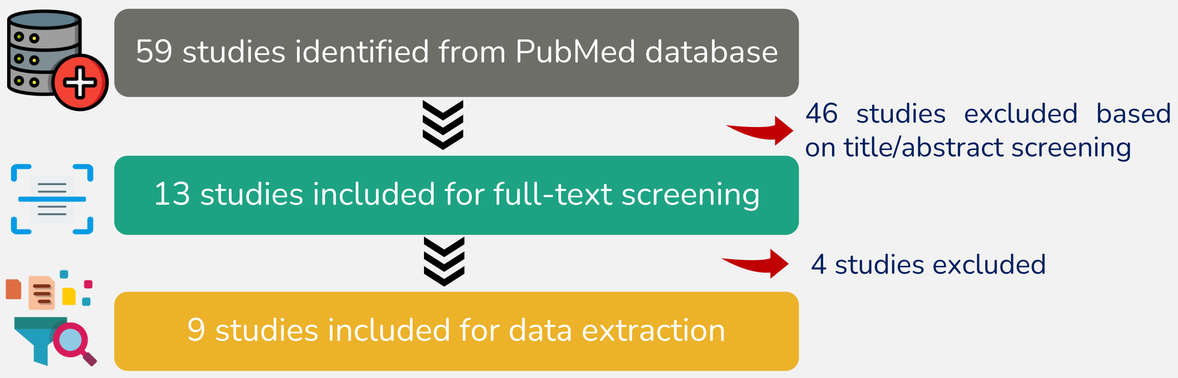
Figure 1: Problem and research gap



METHODS

- A targeted literature review was conducted in PubMed for the period June 2020 to June 2025. The initial search focused on studies applying AI-integrated DES for RM within HTA. No publications were identified in this scope.
- The review was then broadened to include AI+DES applications in the wider healthcare context, particularly studies related to RM in OR. **(Figure 2)**

Figure 2: PRISMA flow diagram



RESULTS

- ✓ Of 59 studies screened, 13 were included, with 9 providing extractable data. AI+DES was applied across all studies for RM, most often using clustering and predictive modeling.
- ✓ Resources were modeled as single-use items, such as syringes and plasters, or reusable assets, including nurses and ambulances. **(Figure 3)**

Figure 3: Extracted studies at glance

Domain	Findings
Impacts Reported*	• Improved scheduling (5 studies) • Optimized patient flow (4 studies) • Reduced delays (5 studies) • Better resource use (3 studies)
Outcomes*	• Reduced waiting times (5 studies) • Improved resource allocation (3 studies) • Optimized patient workflow (4 studies) • ML/AI utility evaluation (1 study)
Data Sources	• Real-world hospital data (5 studies) • Literature reviews (2 studies) • Assumptions/expert opinion (2 studies)
Variability Assessment	• Scenario testing via DES • Stochastic optimization • Workflow simulations

*Some studies reported multiple impacts or outcomes.

AI → Scalable discrete event simulation (DES) → Efficient resource modelling (RM) → Strengthening HTA evidence

Integrating AI with DES strengthens realism by modeling bottlenecks, capacity constraints, and dynamic resource flows, offering clear benefits for healthcare RM. However, its use in HTA remains limited, calling for greater validation and uptake.

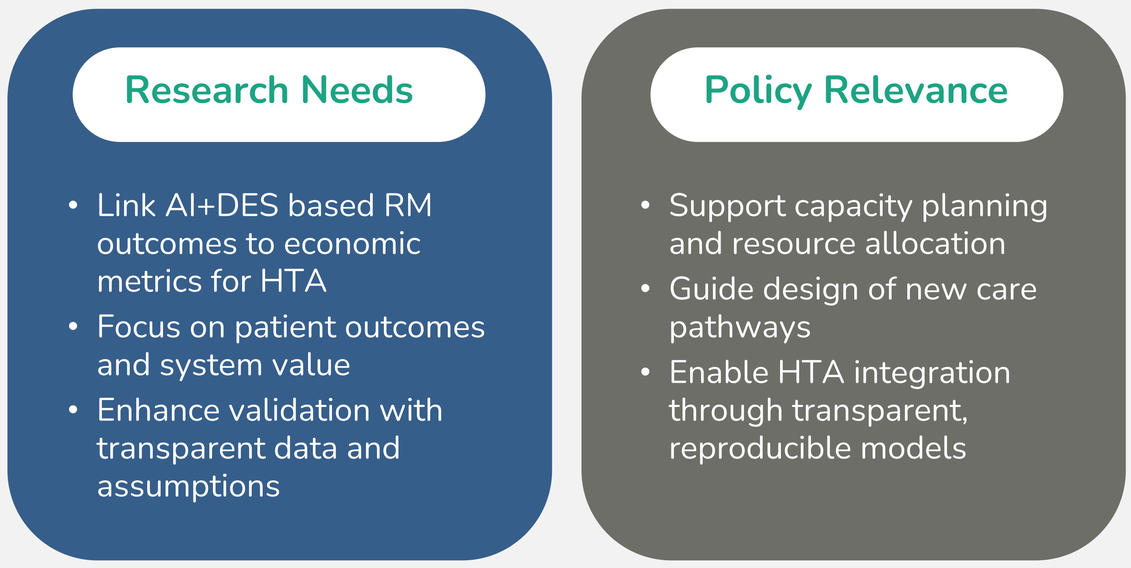
Figure 4: Enhancing RM with AI + DES: key impacts

Resource Allocation	Improves use of ICU beds, ventilators, imaging slots, and personnel under constrained conditions.
Scheduling Efficiency	Optimizes appointments, balances staff workloads, and reduces delays across services.
Workflow Simulation	Uses predictive modeling with DES to test and redesign care pathways before real-world implementation.
Patient Prioritization	Integrates risk scores and clinical data to triage patients and streamline care delivery.

DISCUSSION

- **Operational Potential:** AI+DES enhances RM by optimizing scheduling, streamlining workflows, and prioritizing patients based on clinical need. It increases model adaptability in complex healthcare settings and enables real-time scenario testing.
- **Barriers:** AI often functions as a "black box," making outputs hard to interpret. Clinicians and decision-makers may hesitate to trust results. Many studies report limited validation and lack detail on real-world implementation.
- **Research Gaps:** Use of AI+DES for RM in HTA remains limited. Transparent documentation of assumptions and parameters is often missing. External validation against real-world data is rare, reducing confidence in applicability. **(Figure 5)**

Figure 5: Impact of AI-enhanced RM on HTA



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REFERENCES

1. Boresta et al. (2024). Health Care Mgt Sci. 27(3), 415–435.
2. Grøntved et al. (2024). Int J Med Informatics. 189, 105527.
3. Hadid et al. (2022). Int J Environ Res Public Health, 19(23), 15539.
4. Lin et al. (2025). J Am College Radiol. 22(3), 297–306.
5. Ortiz-Barrios et al. (2023). J Business Res. 160, 113806.
6. Ortiz-Barrios et al. (2024). Int J Emergency Med. 17(1), 45.
7. Ponsiglione et al. (2024). Progress in Biomed Engineering. 6(2), 022001
8. Salleh et al. (2017). PharmacoEconomics. 35(9), 937–949
9. Syed Salleh (2019). Doctoral Dissertation, University of Sheffield.
10. Thokala et al. (2015). PharmacoEconomics. 33(3), 193–203.
11. Wornow et al. (2023). J Biomed Informatics. 139, 104319.
12. Marshall et al. (2015). Med Decision Making. 18(2), 147–160.

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