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BLOCKCHAIN-ENABLED DIGITAL TWINS FOR ENHANCED LIFECYCLE MANAGEMENT IN BUILDING HANDOVER

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Abstract

Building handover is a critical stage in the building lifecycle, yet project information is often fragmented, difficult to verify, and hard to reuse in later operation and maintenance. Digital Twins (DTs) can improve lifecycle visibility, while BC can strengthen trust and traceability(Dounas et al., 2020). However, current studies rarely combine these with semantic knowledge representation. This work proposes a Blockchain-enabled semantic DT framework for building handover, using a five-layer architecture and a knowledge graph to structure building information. A lightweight prototype demonstrates trusted data admission and auditable event recording. The contribution is a practical and reproducible framework for improving lifecycle continuity beyond handover.

Introduction

Building handover is the point where responsibility moves from design and construction teams to owners, operators, and facility managers (Adu-Amankwa et al., 2023). At this stage, large amounts of information must be transferred, including room data, asset details, commissioning evidence, sensor information, and maintenance-related records. In practice, this transfer is often incomplete, inconsistent, or difficult to verify. As a result, valuable information is lost or underused after project delivery, which weakens later operation and maintenance (Boje et al., 2020).

DTs offer a way to organise and connect lifecycle information in a living digital environment (Opoku et al., 2021). Blockchain (BC) can complement DTs by providing tamper-evident records and stronger trust in shared data. Yet many current DT–BC studies focus mainly on data exchange or on-chain records, with limited attention to semantic structure (Dounas et al., 2023). Without semantic enrichment, handover information remains difficult to interpret across systems and lifecycle stages.

This poster proposes a BC-enabled semantic DT framework for building handover. The framework combines a knowledge graph based on BOT, BRICK, and SAREF with BC-supported governance to improve trusted information transfer at the handover stage. The system is organised into five layers: data acquisition, data transmission, semantic, BC, and application.

Framework overview

The framework shown as fig. 1 is designed to connect physical building information, semantic context, and trusted digital services across the handover process.

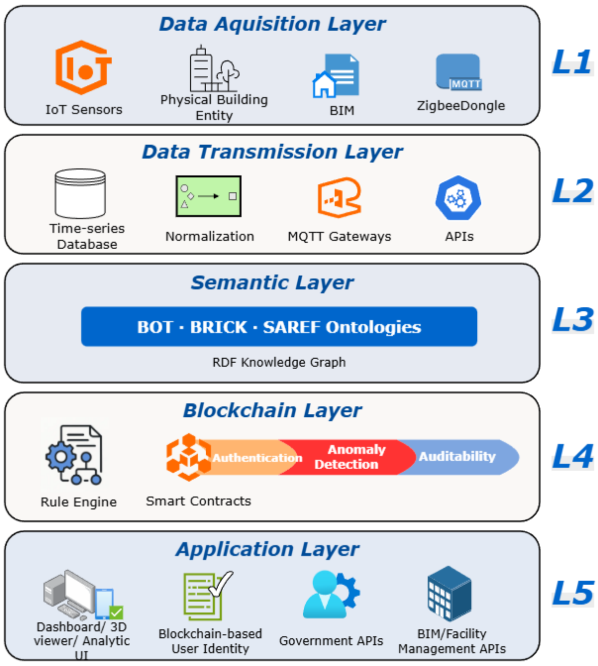

Figure 1: Methodology flowchart

The data acquisition layer gathers building and asset information from physical entities, BIM-related data, and IoT devices. The data transmission layer moves this information through standardised workflows and prepares it for processing. The semantic layer uses a knowledge graph to connect spaces, devices, and measured properties in a machine-readable form. The BC layer adds trust by verifying data sources and recording important lifecycle events. The application layer supports dashboards, analytics, and service integration for later building use. This structure allows data to move from fragmented project delivery information toward a more connected and trustworthy handover process.

Methodology

The proposed methodology integrates DT and BC through a structured three-stage workflow: data acquisition, BC access, and system enrichment, as illustrated in Fig. 2.

First, real-time data are collected from physical assets and IoT sensors, including temperature, energy, and occupancy. These data are transmitted, pre-processed, and partially handled at the edge to reduce latency and ensure a consistent format.

Second, the processed data enter the BC access stage, where key information is cryptographically hashed and anchored to the BC. Smart contracts are used to automate permissions, validation, and transaction logic, while an immutable ledger records critical events to ensure traceability and trust.

Finally, in the system enrichment stage, validated data are integrated into the Digital Twin model, enabling synchronised updates of building states. This enriched DT environment supports advanced analytics, simulation, and user-oriented visualisation. Through this workflow, the methodology ensures that building data are not only collected and processed efficiently but also verified and made trustworthy for lifecycle management.

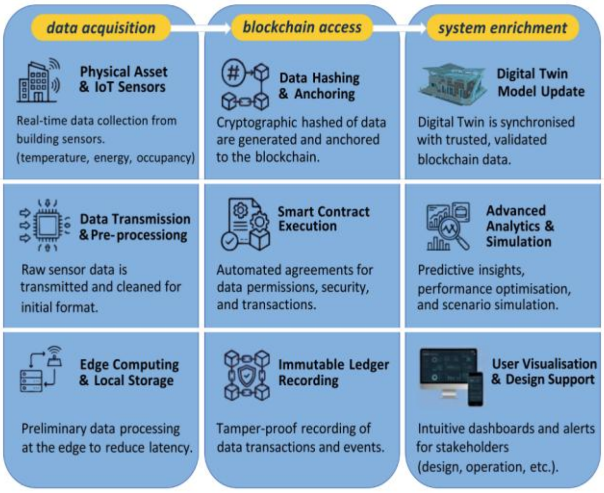

Figure 2: Methodology flowchart

Simulation and experiment

A lightweight prototype was developed in a containerised environment to demonstrate the feasibility of the framework. The prototype combines a knowledge graph, a time-series database, a workflow engine, and a local BC service. Rather than trying to represent all handover documents, the prototype focuses on one key principle: trusted entry of lifecycle information into the DT.

A semantic knowledge graph was prepared to represent rooms, devices, and measured properties. BC services were used to verify whether an information source was authorised before its data could enter the DT workflow.

Conclusion

This study presents a BC-enabled semantic DT framework for building handover. The proposed five-layer structure integrates semantic enrichment and BC-supported trust into one lightweight and reproducible system. The proof of concept shows that authorised information sources can be admitted while unknown sources can be blocked before entering the DT workflow.

The framework contributes a practical way to strengthen lifecycle continuity at handover by improving both interoperability and trust. Future work will extend the approach to richer handover data types, broader stakeholder workflows, and AI-supported lifecycle services.

References

Adu-Amankwa, N. A. N., Rahimian, F. P., Dawood, N., & Park, C. (2023). Digital Twins and BC technologies for building lifecycle management. Automation in Construction, 155, 105064.

Boje, C., Guerriero, A., Kubicki, S., & Rezgui, Y. (2020). Towards a semantic Construction Digital Twin: Directions for future research. Automation in Construction, 114. Scopus. https://doi.org/10.1016/j.autcon.2020.103179

Dounas, T., Jabi, W., & Lombardi, D. (2020). Smart contracts for decentralised building information modelling. https://rgu-repository.worktribe.com/output/968307

Dounas, T., Lombardi, D., Vele, J., & Prokop, Š. (2023). A CRYPTO-TWIN FRAMEWORK FOR THE AEC INDUSTRY - ENABLING DIGITAL TWINS WITH BLOCKCHAIN TECHNOLOGIES. Architecture and Planning Journal (APJ), 28. https://doi.org/10.54729/2789-8547.1215

Opoku, D., Perera, S., Osei-Kyei, R., & Rashidi, M. (2021). Digital twin application in the construction industry: A literature review. JOURNAL OF BUILDING ENGINEERING, 40. https://doi.org/10.1016/j.jobe.2021.102726