

Abstract

What if a Marine squadron commander could predict aircraft failures before deployment, optimize spare-part inventories before shortages occur, and select the right aircraft for the mission based on real-time sustainment forecasts? The U.S. Marine Corps H-1 fleet currently relies on fragmented data systems, reactive maintenance practices, and fleet-wide averages that obscure the unique condition of individual aircraft. This research explores how bureau-number-specific digital twins, powered by predictive analytics and AI-enabled logistics, can transform sustainment from a reactive process into a strategic readiness advantage. Using existing aviation maintenance and readiness data, the study proposes a Minimum Viable Digital Twin framework that integrates aircraft health, maintenance, and supply-chain information to forecast failures, improve mission-capable rates, and strengthen performance-based logistics decisions. The findings outline a practical pathway toward intelligent sustainment ecosystems that could reshape not only H-1 readiness, but the future of Department of Defense aviation logistics as a whole.

Methods



Note. Image generated using OpenAI ChatGPT (2026) with the initial prompt: Create a highly professional, defense-industry-quality infographic poster in a 3:4 portrait format titled: "DIGITAL TWINS & PREDICTIVE SUSTAINMENT FOR THE H-1" Subtitle: "Unified Data Architecture Enabling Aircraft-Specific Predictive Maintenance and Supply Forecasting" The graphic should visually communicate a conceptual framework, not a software architecture diagram.

- Employed a qualitative, exploratory research design to assess the feasibility of BUNO-specific digital twins for Marine Corps H-1 sustainment.
- Conducted document and policy analysis of DoDI 5000 guidance, digital engineering strategies, PMA-276 documentation, and DoD sustainment reports.
- Performed comparative analysis of digital twin, predictive maintenance, and digital engineering efforts across defense aviation programs
- Conducted semi-structured interviews with H-1, H-60, NAVAIR, and NAVSUP subject-matter experts to validate findings and assess operational feasibility.
- Synthesized findings into a proposed digital twin-enabled sustainment architecture and phased implementation strategy.

Results & Impact

- Current H-1 sustainment decisions rely on fragmented data systems, fleet-wide averages, and reactive maintenance practices that limit readiness and forecasting accuracy.
- SMEs consistently identified data integration, predictive maintenance capability, and logistics alignment as the primary barriers to predictive sustainment.
- Digital twin outputs could improve aircraft selection, maintenance prioritization, failure prediction, inventory forecasting, and long-lead procurement planning.

Future Research

- Refine the proposed unified data architecture, including data normalization, reconciliation, governance, and visualization requirements.
- Develop Naval Aviation standards for digital twin data structures, interoperability, and system integration across platforms.
- Evaluate applicability of the framework across other Naval Aviation legacy platforms to establish a scalable enterprise digital sustainment model.