BEYOND ASSET SALES: THE EMERGENCE OF SERVICE AND AVAILABILITY-BASED REVENUE MODELS IN AEROSPACE

Abstract

The aerospace industry is undergoing a fundamental transformation in its revenue generation and cost management approaches. It is shifting from traditional capital expenditure (CAPEX)-driven models centered on asset ownership, purchase, and depreciation to operational expenditure (OPEX) frameworks emphasizing service delivery, performance, and availability. The "Power-by-the-Hour" (PBH) model, pioneered by Rolls-Royce in the 1960s for aircraft engine maintenance, exemplifies this shift. Under PBH, customers pay a fixed rate per engine flight hour (EFH), tying costs directly to usage, reliability, uptime, and performance rather than outright ownership.

This article explores the strategic cost management implications of PBH and similar availability-based contracts. It highlights their role in optimizing lifecycle value, mitigating financial risks for operators, incentivizing innovation among original equipment manufacturers (OEMs), and supporting sustainability goals. Through a review of literature, real-world case studies (including Rolls-Royce TotalCare, Pratt & Whitney EngineWise, and Safran services), comparative financial data, and analytical frameworks, the paper demonstrates how PBH reshapes cost structures, governance, risk allocation, and ESG (Environmental, Social, and Governance) compliance.

Key findings indicate that PBH enhances operational efficiency, promotes digital integration via tools like AI, IoT, and digital twins for predictive maintenance, and facilitates better ESG reporting by encouraging fuel-efficient operations and reduced emissions. However, challenges persist in sophisticated contract design, equitable risk-sharing, dependency on service providers, and adapting management accounting practices. Ultimately, PBH represents a paradigm shift in aerospace economics, positioning management accountants as strategic advisors who leverage lifecycle costing, performance metrics, and digital analytics to drive value in high-capital, long-lifecycle industries.

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INTRODUCTION

Historically, the aerospace sector has been capital-intensive, relying heavily on substantial upfront investments in aircraft, engines, infrastructure, and related assets. Traditional CAPEX models emphasized ownership, with costs dominated by acquisition, depreciation schedules, and asset management on the balance sheet. Airlines and operators bore the risks of unpredictable maintenance spikes, fuel volatility, and residual value fluctuations amid global economic instability, rising maintenance expenses, and demands for greater operational flexibility.

The emergence of OPEX-based models addresses these pressures by converting fixed capital outlays into variable, usage-linked costs. The "Power-by-the-Hour" (PBH) concept, introduced by Rolls-Royce in 1962 for the Viper engine on the de Havilland/Hawker Siddeley 125 business jet, marked a pivotal innovation. Instead of selling engines outright and handling separate maintenance, Rolls-Royce offered a comprehensive engine and accessory replacement service for a fixed cost per flying hour. This shifted maintenance risk from the operator to the OEM, making costs predictable and aligning incentives: the OEM earns revenue only when the engine is operational and producing "power."

Over decades, PBH has evolved beyond engines to encompass broader maintenance, repair, and overhaul (MRO) services, component support, and availability-based contracts across commercial aviation and defense. Programs like Rolls-Royce TotalCare, Pratt & Whitney's EngineWise, and GE's equivalents now integrate real-time data analytics, predictive maintenance, and global logistics networks.

This paper examines the strategic cost management ramifications of PBH. It analyzes how these models equilibrate financial sustainability, technological advancement, and risk distribution. By reviewing literature, presenting quantitative comparisons of CAPEX vs. OPEX structures, and detailing case studies, the article underscores PBH's contribution to lifecycle value optimization while addressing implementation complexities in contract governance and sustainability alignment. In an era of volatile fuel prices, supply chain disruptions, and ESG imperatives, PBH offers a resilient framework for aerospace economics.

REVIEW OF THE LITERATURE

Early adoption of PBH by Rolls-Royce demonstrated the feasibility of predictable costing and enhanced lifecycle value. By linking payments to actual utilization, operators gained cost certainty, while OEMs invested in reliability improvements to maximize long-term revenue.

The broader CAPEX vs. OPEX debate highlights trade-offs. Studies indicate that OPEX models significantly reduce initial capital requirements and improve cash flow and balance sheet health, though they increase reliance on service providers and introduce long-term dependency risks (Smith, 2018; Kumar & Rao, 2021). In high-capex industries like aerospace, shifting to OPEX can lower overall variability in costs but requires robust governance.

Digital transformation is central to PBH efficacy. Research emphasizes the role of AI, IoT sensors, and digital twins in enabling predictive maintenance, real-time engine health monitoring, and optimized scheduling. These technologies reduce unscheduled downtime and enhance the performance guarantees inherent in availability contracts (Johnson, 2022).

Sustainability dimensions are increasingly prominent. PBH incentivizes OEMs to develop and support more efficient engines and sustainable propulsion systems (e.g., lower fuel burn, hydrogen-compatible designs), contributing to reduced carbon footprints. Studies link service-based models to improved ESG compliance through efficiency gains and transparent reporting (Lee, 2023).

Risk allocation remains a critical challenge. Effective PBH contracts demand careful balancing of responsibilities between manufacturers (who assume maintenance and reliability risks) and operators (who retain utilization and operational risks). Poorly designed agreements can lead to disputes over uptime definitions, penalty clauses, or force majeure events (Brown, 2020).

Recent industry reports (Deloitte 2024; PwC 2025) affirm that service and aftermarket revenues now constitute a growing share of OEM profitability, often more stable than one-time asset sales. PBH aligns with broader trends toward servitization, where manufacturers transition from product sellers to solution providers.

OBJECTIVES

1. To analyze the implications of PBH for strategic cost management in the aerospace industry.
2. To compare service models based on CAPEX versus OPEX frameworks.
3. To evaluate PBH's contribution to lifecycle

value creation and ESG compliance.

4. To illustrate PBH applications in aerospace and defense through detailed case studies.
5. To provide actionable recommendations for management accountants operating within PBH frameworks.

METHODOLOGY

This study employs a mixed-methods approach. Qualitative analysis draws from academic papers, industry reports (e.g., Deloitte, PwC), regulatory guidelines, and corporate publications from Rolls-Royce, Pratt & Whitney, and Safran. Quantitative elements include financial metrics on lifecycle costs (LCC), total cost of ownership (TCO), and cost-per-flight-hour (CPFH) data aggregated from public sources, DOT Form 41 data, and illustrative industry benchmarks (2024–2026 context).

Case studies focus on PBH implementations by major OEMs. Comparative tables analyze CAPEX-heavy versus OPEX-heavy structures across acquisition, operation, maintenance, and disposal phases. An analytical framework integrates strategic cost management lenses: risk allocation, governance mechanisms, sustainability metrics, and digital enablement. Limitations include the proprietary nature of specific contract rates and variability due to utilization, route profiles, and fuel prices.

KEY CONCEPTS

CAPEX (Capital Expenditure):

- Asset ownership model with high upfront investment.
- Focus on balance sheet depreciation, interest, and residual value management.
- Suited to operators seeking full control but exposing them to maintenance volatility and technological obsolescence.

OPEX (Operational Expenditure):

- Service and availability-based model.
- Costs scale with usage (e.g., per flight hour under PBH).
- Delivers predictable cash flows, shared risks, and off-balance-sheet treatment, improving financial flexibility.

Power-by-the-Hour (PBH):

- Operators pay a fixed rate per engine flight hour or utilization metric.
- Emphasizes whole-lifecycle value, with the provider responsible for maintenance, spares, overhaul, uptime guarantees, and increasingly ESG performance.
- Converts unpredictable spikes (e.g., major shop visits costing millions) into smooth, budgeted OPEX.

HOW DO WE APPLY: LIFECYCLE COSTING (LCC) AND TOTAL COST OF OWNERSHIP (TCO)

Lifecycle Costing provides a comprehensive view:

LCC = C_acquisition + C_operation + C_maintenance + C_disposal

In traditional CAPEX models, acquisition dominates initial outlays (though only 10–20% of total LCC over 20–30+ years). PBH/OPEX optimizes operation and maintenance phases through predictability and incentives for reliability.

Table 1: Lifecycle Cost Breakdown for a Long-Range Commercial Aircraft (Approximate distribution over 20–30+ years)

Cost Category	% of Total LCC	Key Components	Typical Share within Category	Notes / Facts
Acquisition (CAPEX)	10–20%	Purchase price / Leasing, R&D, Production	Depreciation & Interest: 100%	Often only 8–16% of overall LCC; heavily discounted in practice

Operation & Support (OPEX)	70–85%	Fuel, Maintenance, Crew, Insurance, etc.	Dominant part	Fuel & Oil: 25–40% of DOC; Maintenance (Airframe + Engine): 12–18% of DOC (engines 40–60% of maintenance); Crew: 20–30% of DOC
Disposal / Retirement	1–5%	Decommissioning, recycling, residual value	Can be a credit	Positive residual value possible in ownership models

DOC (Direct Operating Costs) typically ~40–45% of Total Operating Costs. Operating & Support costs often reach 70–80% (up to 85%) of total LCC for long-range aircraft.

Table 2: CAPEX vs OPEX Comparison in Traditional vs Power-by-the-Hour Models

Aspect	**Traditional Asset Ownership (CAPEX-heavy)**	**Power-by-the-Hour / Availability-based (OPEX-heavy)**	**Key Advantage of OPEX Model**
Upfront Cost	High (full purchase)	Low / None (pay per flying hour)	Improves cash flow & balance sheet
Maintenance Cost Structure	Unpredictable spikes (shop visits costing $0.5M–$5M+)	Predictable fixed rate per hour	Reduces financial risk for airlines
Risk Allocation	Operator bears unscheduled maintenance risk	OEM bears most risk (reliability incentives)	OEM motivated for higher reliability and longer on-wing time
Total LCC Impact	Higher variability	Often 8–20% lower effective cost due to predictability & performance guarantees	Better long-term cost control
Ownership at End of Life	Operator owns asset (residual value potential)	Usually no ownership (pure service)	Lower residual risk for operator
Typical Example	Buy CFM56 or Trent engine outright	Rolls-Royce TotalCare or GE TrueEngine / Pratt & Whitney EngineWise	Airlines pay only when engine produces "power"

Engines typically represent ~15% of aircraft acquisition value but drive 35–40% (or more) of total maintenance costs. In PBH, a fixed rate per EFH bundles all maintenance, spares, and overhaul, smoothing costs. New-generation engines (e.g., LEAP, Trent XWB) offer longer shop visit intervals and better reliability, amplifying PBH benefits.

Table 3: Total Cost of Ownership (TCO) Breakdown for a Typical Long-Range Narrowbody Aircraft (e.g., A320neo / 737 MAX class, over 25 years)

Cost Category	**% of Total TCO**	**Approximate Value (illustrative)**	**Key Drivers & Notes**
Acquisition Cost (CAPEX)	12–18%	$45–70 million (net after discounts)	List price $110–130M; actual heavily discounted
Fuel Costs	35–45%	Highest variable	15–20% lower on new-gen vs. previous
Maintenance (Airframe + Engine)	15–22%	Engines: 35–40% of maintenance	Shop visits create spikes in traditional models

Crew & Training	12–18%	Pilot & cabin salaries	Reduced by fleet commonality
Financing / Leasing / Insurance	8–12%	Interest, hull & liability	Lower volatility in OPEX models
Other (Ground handling, Fees)	8–12%	Airport & navigation charges	-
Disposal / Residual Value	-2% to +5%	Credit or cost	Positive in ownership models

Key Insight: Fuel and maintenance often exceed 55–65% of TCO. Acquisition, though visible, is usually <20% of lifetime costs. New-gen narrowbodies deliver 10–18% lower TCO mainly via fuel efficiency and reliability.

Table 4: Cost per Flight Hour Breakdown – Narrowbody Aircraft (Illustrative 2025–2026, USD)

Cost Component	Approximate Cost per Flight Hour	% of Total DOC	Key Notes
Fuel	2,500 – 4,500	35–50%	Largest variable; 15–20% lower on neo/MAX
Maintenance (Airframe + Engine)	800 – 1,800	15–25%	Engines 40–60% of this
Crew (Flight Deck + Cabin)	1,000 – 1,800	15–25%	Varies by region
Ownership / Leasing / Depreciation	500 – 1,200	8–15%	Much lower or converted in PBH
Other (Insurance, Fees)	400 – 800	8–12%	-
Total DOC per Flight Hour	**6,000 – 10,000+**	**100%**	Varies by type, utilization, stage length, fuel price

Table 5: Cost per Flight Hour Comparison: Previous vs. New Generation Narrowbody

Aircraft Type	Total DOC per FH (approx. USD)	Fuel per FH (USD)	Maintenance per FH (USD)	Advantage of New Gen
A320ceo / 737 NG (Previous)	7,500 – 9,500	3,500 – 4,800	1,200 – 2,000	Baseline
A320neo / 737 MAX (New Gen)	6,200 – 8,200	2,800 – 4,000	900 – 1,600	10–18% lower overall TCO/CPFH

Differences driven primarily by 15–20% better fuel efficiency and improved engine reliability. Actuals depend on fuel price (~$4–5/gallon), stage length, and utilization (typically 2,500–3,500 FH/year).

Table 6: Engine Maintenance Cost per Flight Hour – Traditional vs. Power-by-the-Hour

Engine / Model	Traditional Maintenance (USD per EFH)	PBH Contract Rate (USD per EFH, illustrative)	Benefit of OPEX Model
CFM56-5B / -7B (Previous)	150 – 300+ (with spikes)	200 – 350 (fixed)	Predictable budgeting
LEAP-1A / 1B (New)	120 – 250 (early life)	250 – 400 (fixed, all-inclusive)	Better reliability, longer on-wing
Trent XWB / GE9X (Widebody)	300 – 600+	400 – 800+ (TotalCare style)	Risk transferred to OEM

PBH eliminates major shop visit spikes, converting them into stable hourly rates. Widebody operations show higher CPFH (~$18,000–19,000) due to fuel burn on long sectors.

Table 7: CAPEX and OPEX in Aerospace (Comparative)

Aspect	CAPEX (Ownership)	OPEX (PBH/Service Model)
Upfront Investment	High	Low
Cost Predictability	Low (variable MRO)	High (fixed per hour)
Risk Allocation	Owner bears most	Shared / shifted to provider
Lifecycle Value	Depreciation focus	Performance-based value
ESG Compliance	Limited incentives	Strong (efficiency-driven, transparent metrics)

Table 8: PBH Adoption in Aerospace Industry (Illustrative 2020–2025 Data)

Company	PBH Coverage (% of relevant portfolio)	Key Benefits Reported
Rolls-Royce (TotalCare)	~70% of engines	Predictable cash flows, reliability focus
Pratt & Whitney (EngineWise)	~60% of contracts	Reduced downtime via predictive analytics
Safran	~55% of MRO services	Enhanced ESG reporting, nacelle/component extension

CASE STUDIES

Case Study 1: Rolls-Royce TotalCare Rolls-Royce's flagship PBH program provides comprehensive engine support, including monitoring, maintenance, and overhaul for a fixed hourly rate. Benefits include reduced cost volatility for airlines, improved lifecycle value through OEM-driven reliability enhancements, and stronger customer relationships. Challenges arise in balancing risk during demand fluctuations (e.g., post-pandemic recovery or fuel price shocks). TotalCare has contributed significantly to Rolls-Royce's stable aftermarket revenues.

Case Study 2: Pratt & Whitney EngineWise EngineWise integrates digital twins and advanced diagnostics (ADEM system) into PBH-style contracts. It uses data analytics for predictive maintenance, minimizing unplanned events and supporting ESG goals through efficiency. The program enhances cost transparency and has been adopted by carriers like VivaAerobus and airBaltic for GTF engines, demonstrating digital enablement's value in OPEX models.

Case Study 3: Safran Nacelle Services and Component PBH Safran extends PBH beyond engines to nacelles and other systems, reducing airline CAPEX while aligning costs with operational availability. This supports broader service ecosystems and ESG reporting by optimizing component performance.

Case Study 4: JetSMART Airlines – AJW Group PBH Contract In this ultra-LCC example (initially signed around 2022, with ongoing relevance), AJW Group provides 10-year component PBH support for A320 CEO/NEO fleets across Chile, Peru, and Argentina. It includes inventory pooling, repairs, logistics, and on-site support, delivering cost predictability and high dispatch reliability without heavy spares investment—ideal for high-utilization, cost-sensitive operators in emerging markets. Similar deals with Air Transat and others highlight PBH's appeal for diverse fleet profiles.

Additional Context: Hypersonic Concepts (e.g., STRATOFLY MR3 vs. MR5) LCC analyses of advanced high-speed concepts show fuel and operations dominating costs (often >70% of DOC), underscoring the importance of efficiency-focused PBH-like models even for future platforms using hydrogen or advanced propulsion.

SUGGESTIONS / RECOMMENDATIONS

Aerospace stakeholders should adopt the following strategies:

1. **Hybrid Revenue Models:** Combine PBH with performance-based logistics (PBL) for balanced flexibility and accountability.
2. **Digital Integration:** Invest in AI-powered diagnostics, IoT, and digital twins to enhance predictive capabilities, reduce downtime, and improve cost transparency in PBH contracts.
3. **Strengthen ESG Frameworks:** Embed carbon efficiency, emissions metrics, and sustainability KPIs into service-level agreements (SLAs).
4. **Robust Risk-Sharing Contracts:** Develop clear legal frameworks defining uptime guarantees, penalties, risk matrices, and adaptation clauses for volatility.
5. **Enhance CMA Capabilities:** Train management accountants (CMAs) in lifecycle costing, availability-based pricing, digital analytics, and aerospace-specific regulations to support strategic decision-making.

Summary Recommendations Table

Area	Recommendation
Revenue Strategy	Shift toward flexible OPEX models like PBH while retaining hybrid options
Cost Management	Prioritize TCO and LCC over upfront acquisition focus
Technology Integration	Leverage AI, IoT, and digital twins for predictive maintenance
ESG & Sustainability	Integrate metrics into contracts for compliance and competitive advantage
Governance & Compliance	Align with industry norms for high-capex, long-term contracts
CMA Role	Evolve from cost controllers to strategic partners in contract design and optimization

CONCLUSION

The aerospace industry's transition from CAPEX-driven asset ownership to OPEX-based service and availability models, epitomized by Power-by-the-Hour, marks a profound evolution in strategic cost management. PBH delivers predictable finances, operational efficiency, risk transfer, and alignment with digital transformation and sustainability objectives. While challenges in contract complexity and risk governance remain, the model incentivizes OEM innovation and operator agility.

As availability-based contracts proliferate, management accountants must evolve into strategic enablers—mastering lifecycle analytics, ESG integration, and digital tools to unlock value. PBH is more than a pricing mechanism; it is a forward-looking blueprint for resilient, sustainable aerospace economics in an uncertain world. Future research should quantify long-term ESG impacts and explore PBH extensions into emerging segments like urban air mobility and hypersonic travel.

(Word count: approximately 3,000. Tables and content from the provided outline have been incorporated, expanded with contextual explanations, logical flow, and real-world grounding for coherence and depth while preserving all key data points and structures.) MA

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