International Journal of Computational and Experimental Science and ENgineering
(IJCESEN)
Vol. 12-No.1 (2026) pp. 624-634
http://www.ijcesen.com
ISSN: 2149-9144

Research Article

Digital Transformation of Aviation Supply Chains: An SAP-Based Control Tower Implementation Framework

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Article Info:

DOI: 10.22399/ijcesen.4877
Received : 28 January 2025
Revised : 02 Feb 2026
Accepted : 06 February 2026

Keywords

Supply Chain Control Tower,
Aviation MRO,
SAP Business Technology Platform,
Predictive Analytics,
Supplier Collaboration

Abstract:

The aviation industry faces persistent challenges in supply chain management due to high volatility, regulatory complexity, and critical dependencies on timely part availability. Aircraft on Ground (AOG) situations demand immediate responsiveness, yet legacy fragmented systems create operational blind spots and reactive decision-making patterns. This case demonstrates the design and deployment of a Supply Chain Control Tower at Allegiant Air, built on SAP Business Technology Platform, integrating S/4HANA, Ariba Network, and Analytics Cloud. The solution establishes unified visibility across procurement, logistics, and inventory operations through event-driven automation and machine learning-powered forecasting capabilities. Implementation followed a phased agile framework spanning discovery, development, pilot deployment, and performance evaluation. The Control Tower enables proactive alerts for shipment delays and material shortages, transforming operational paradigms from reactive firefighting to predictive intervention. Results demonstrate substantial improvements in procurement cycle efficiency, supplier collaboration quality, and operational downtime reduction. The implementation provides a validated architectural blueprint and replicable framework for aviation organizations transitioning toward integrated, intelligent supply chain operations.

1. Introduction

1.1 Aviation Supply Chain Complexities and Aircraft Ground Time Incidents

Operational performance in airline businesses relies heavily on the strength and quick-response nature of their material flow networks. Aviation enterprises face continuous obstacles stemming from unpredictable market conditions, rigorous compliance frameworks, and mission-critical needs for component availability [1]. Aircraft ground time incidents occur when unexpected maintenance requirements halt flight operations, demanding immediate spare part acquisition. Delays during these situations create severe financial impacts and service interruptions.Managing thousands of component types across geographically dispersed storage locations, coordinating with worldwide vendor networks, and handling fluctuating demand patterns driven by maintenance scheduling creates additional layers of difficulty. Without unified information systems, personnel cannot access comprehensive, decision-ready intelligence, forcing supply and maintenance teams to work through manual coordination processes with outdated information flows. Table 1 presents a comprehensive overview of the primary challenges confronting aviation supply chain operations. These challenges are categorized by their operational impact and corresponding business consequences. Aircraft on Ground incidents emerge as the most critical challenge, requiring immediate component availability to prevent revenue losses and service disruptions. The complexity of managing thousands of stock-keeping units across geographically dispersed facilities, combined with the necessity to synchronize efforts with global vendor networks, creates substantial coordination difficulties. Demand variability driven by unpredictable maintenance scheduling patterns further complicates resource allocation, while stringent regulatory certification requirements extend procurement lead times beyond industry norms.

1.2 Operational Challenges from Disconnected Systems at Allegiant Air

Allegiant Air historically managed operations through multiple unconnected software platforms handling procurement activities, transportation coordination, and stock management independently. This structural separation created information barriers, restricted live monitoring capabilities, and fostered reactive management approaches [11]. These visibility limitations prevented anticipatory planning while expanding the damage from supply network disruptions on fleet availability and service reliability. The fragmented technology landscape characteristic of legacy airline operations creates inefficiencies that compound over time, as data silos prevent holistic optimization and force manual reconciliation processes that consume valuable resources while introducing errors [11].Lacking an integrated technology infrastructure produced workflow inefficiencies across the entire acquisition process, where numerous manual coordination steps and separated communication methods prolonged reaction times and masked supply network risks until critical operational problems emerged.

1.3 Control Tower Platforms as Tactical Solutions

Digital control tower platforms for supply networks have surfaced as effective responses to these operational challenges, delivering centralized monitoring hubs for tracking, analyzing, and acting on material flow information. These systems mark a significant departure from traditional network management techniques, helping organizations shift from reactive firefighting toward predictive vulnerability mitigation [2].The technology combines live data aggregation, advanced computational analysis, and automated warning mechanisms to provide complete transparency across complex supplier relationships. Control tower adoption has expanded substantially across multiple industries as organizations look to improve adaptability, minimize disruption damage, and optimize asset utilization through intelligence-based decision frameworks.

1.4 Documentation Shortage in Aviation Maintenance Operations

The framework has gained widespread acceptance in manufacturing, distribution, and retail commerce environments, yet its application within the specialized, time-sensitive aviation maintenance and overhaul domain lacks sufficient published documentation. Aviation environments present unique complications, including airworthiness certification demands, safety-critical component traceability protocols, and economic pressures to minimize fleet downtime.This publication gap creates uncertainty for aviation organizations assessing control tower technology investments. While theoretical models are available, a noticeable absence exists for validated implementation narratives explaining technical barriers, rollout timelines, and measurable financial outcomes from control tower adoption in airline operations, particularly within low-cost carrier operational frameworks.

1.5 Documentation Aims: Technical Design, Performance Assessment, and Transferable Models

This publication fills the recognized void by delivering a thorough implementation narrative of an SAP-based Supply Chain Collaboration Control Tower at Allegiant Air. Core aims include explicating the technology architecture and rollout methodology for unifying SAP BTP, S/4HANA, Ariba, and Analytics Cloud systems, evaluating measurable and qualitative impacts on critical performance metrics such as acquisition cycle duration and fleet unavailability, and developing a replicable blueprint for aviation organizations seeking transformation from fragmented, reactive supply operations toward integrated, predictive operational frameworks.

2. Literature Review

2.1 Defining Control Tower Systems and Their Operational Functions

Digital transformation of material flow networks has become a central focus in modern operations management scholarship. Control tower platforms transcend simple monitoring interfaces, functioning instead as strategic command centers that consolidate information streams and deploy analytical capabilities to guide organizational decisions [3].These systems have progressed from basic tracking mechanisms into sophisticated integration hubs that aggregate data from disparate sources, execute computational models, and coordinate synchronized actions across enterprise boundaries. The platforms establish operational command posts, merging information from purchasing, transportation, inventory, and vendor networks into cohesive perspectives supporting both immediate and long-range planning activities.

2.2 Performance Outcomes from Advanced Control Tower Deployments

Organizations deploying sophisticated control tower infrastructures exhibit marked gains in operational durability and execution metrics [4]. The progression from conventional supply network administration toward control tower-supported operations produces quantifiable advantages in disruption management effectiveness and fulfillment dependability. Advanced implementations allow enterprises to detect emerging complications before escalation into severe difficulties, permitting preventive measures rather than corrective interventions. The benefit extends past mere transparency, incorporating forecasting algorithms, simulation modeling, and mechanized process coordination that collectively strengthen supply network flexibility and reaction speed.

2.3 Technology Foundation: SAP Platform Architecture Elements

The SAP software portfolio delivers extensive infrastructure for control tower projects. The Business Technology Platform operates as a consolidated architecture for connectivity, computation, and program construction, supplying ready-made linkages and expansion capabilities. The Ariba solution facilitates smooth vendor cooperation through standardized acquisition sequences, electronic purchase documentation handling, and mechanized acknowledgment procedures [3].Analytics Cloud incorporates prediction and scheduling functions through machine learning algorithms and presentation instruments. The unified character of these elements permits organizations to build comprehensive solutions spanning transaction systems, cooperation networks, and analytical platforms while preserving data uniformity and workflow consistency. The integration of SAP S/4HANA with cloud-based analytics and procurement platforms creates a technology ecosystem that enables real-time visibility, advanced planning capabilities, and collaborative workflows that fundamentally transform supply chain operations from reactive execution to proactive orchestration [12].

2.4 Conceptual Basis: Signal-Driven Response Frameworks

The conceptual underpinning for control tower deployments corresponds with signal-driven response frameworks, emphasizing capabilities to recognize fluctuations in requirement or availability situations and modify operations correspondingly. This orientation redirects organizations from prediction-based scheduling toward information-triggered adaptability, where live intelligence activates fluid resource distribution and priority determinations.The signal-response paradigm recognizes constraints of conventional planning methods in unstable conditions and promotes adaptable, information-dense operational structures. Control towers actualize these concepts by supplying the technological foundation to detect signals, evaluate their significance, and orchestrate fitting actions throughout the supply ecosystem.

2.5 Publication Deficiency: Validated Aviation Implementation Accounts

Current publications demonstrate substantial treatment of control tower theories and deployments throughout manufacturing and commerce contexts, though a documented shortage persists concerning validated documentation within aviation operations [4]. The airline maintenance and repair domain exhibits particular attributes, including airworthiness certification mandates, safety-essential component administration, and acute time constraints during aircraft unavailability episodes.Published narratives detailing actual deployment structures, rollout obstacles, performance results, and economic returns specifically within carrier operations remain scarce. This publication deficit generates obstacles for aviation enterprises assessing technology commitments, as theoretical constructs alone supply inadequate direction for managing industry-specific complexities and confirming anticipated advantages.Fig. 1 illustrates the weighted component structure showing five assessment dimensions for organizational readiness. Digitization represents the highest weight at 24 percent, reflecting the critical importance of digital infrastructure foundation. Collaboration accounts for 23 percent, addressing supplier partner engagement readiness, while financing contributes an equal 23 percent, representing capital investment availability. Autonomy constitutes 15 percent, encompassing cognitive intelligence and IoT capabilities, and transparency comprises 14 percent, measuring information sharing willingness across the organization.

3. Methodology

3.1 Phase 1: Discovery and Architecture Design

The Supply Chain Collaboration Control Tower deployment adopted a structured four-stage agile framework to maintain alignment with organizational goals and control implementation risks effectively. The opening stage encompassed thorough current-state process examination to pinpoint operational difficulties and information repositories throughout procurement, transportation, and stock administration landscapes.Multi-departmental sessions brought together participants from maintenance scheduling, acquisition, warehouse functions, and vendor relationship coordination to document prevailing procedures, system interaction points, and information flow constraints. The planned architecture was constructed on SAP BTP, leveraging its Integration Suite as the primary coordination infrastructure [5].The technical design linked three foundational systems. SAP S/4HANA functioned as the authoritative repository for component master information, acquisition documents, and stock quantities. SAP Ariba Network enabled vendor connectivity for acquisition document transmission, acknowledgments, and advance delivery notifications. Third-party transportation systems were connected through BTP for live shipment monitoring and condition updates. SAP Analytics Cloud was designated as the presentation and forecasting computation tier to furnish actionable intelligence to organizational leaders.The comprehensive integration architecture leverages SAP's aviation industry-specific capabilities, including specialized maintenance, repair, and overhaul modules that address unique airworthiness certification requirements and regulatory compliance demands inherent in airline operations [11]. This industry-focused approach ensures that the control tower solution aligns with aviation-specific workflows while maintaining flexibility for customization to organizational needs [11].Table 2 delineates the comprehensive technology stack components that constitute the Control Tower implementation architecture. SAP S/4HANA serves as the enterprise resource planning foundation, functioning as the authoritative system of record for materials, purchase orders, and inventory management. The SAP BTP Integration Suite operates as the middleware and data harmonization layer, effectively serving as the central nervous system that connects all platforms and ensures seamless data flow across the ecosystem. SAP Ariba Network provides the supplier collaboration platform capabilities, enabling digital purchase order communication and advanced shipment notification management with vendor partners. SAP Analytics Cloud delivers business intelligence and machine learning functionality, serving as both the visualization layer and predictive analytics engine that transforms raw data into actionable insights. Third-party logistics systems integrate to provide real-time transportation status updates, ensuring complete visibility across the entire supply chain from procurement initiation through final delivery.

3.2 Phase 2: Development and Integration

Tailored integration sequences were constructed in the BTP Integration Suite to synchronize information from originating systems into a consolidated information framework. The integration tier converted varied data structures, addressed semantic variations, and created a shared information architecture accessible across all subsequent programs.Principal constructions incorporated signal-triggered notifications where operational regulations were established to activate mechanical alerts for occurrences including acquisition document acknowledgment postponements, advance delivery notification discrepancies, and shipment boundary transgressions.A forecasting algorithm was constructed within SAC to project probable component deficiencies grounded in past utilization patterns, procurement durations, and present inventory quantities [6]. The computational learning procedures examined tendencies in requirement fluctuation, vendor execution, and servicing timetables to produce forward-viewing shortage likelihood assessments. Information quality confirmation sequences were deployed to guarantee accuracy and uniformity of intelligence moving through the integration channels.The development phase incorporated strategic business model considerations that align technology capabilities with organizational objectives, ensuring that the control tower solution supports both operational efficiency and strategic competitiveness through optimized supply chain visibility and collaborative planning capabilities [12]. This alignment between technology implementation and business strategy represents a critical success factor that distinguishes effective control tower deployments from purely technical exercises that fail to deliver sustained business value [12].

3.3 Phase 3: Pilot and Deployment

A trial program was initiated with a designated cluster of substantial-volume vendors for mission-critical components to confirm the solution in a managed setting before comprehensive expansion.

The trial stage permitted end-user validation and modification of notification parameters to reduce incorrect warnings while guaranteeing authentic complications are activated appropriately.Response mechanisms with acquisition experts and maintenance coordinators shaped modifications to notification scheduling, escalation procedures, and dashboard arrangements. Education sessions provided end-users with capabilities to decode control tower presentations and implement suggested measures. Complete expansion to all functioning vendors was finalized after affirmative trial confirmation, with gradual incorporation guaranteeing minimal interference to continuing functions.

3.4 Phase 4: Measurement and Evaluation

Post-deployment execution was assessed over a prolonged assessment duration and contrasted against a pre-deployment standard from past operational intelligence. The assessment structure created distinct critical execution markers concentrated on procurement reaction duration, representing the typical interval from acquisition document transmission to vendor acknowledgment, vendor cooperation productivity, representing a combined indicator grounded in the proportion of acquisition documents with electronic acknowledgments and advance delivery notifications, and operational unavailability, measuring intervals of aircraft unavailability ascribed particularly to component inaccessibility.Information gathering instruments captured transaction timestamps, system records, and operational summaries to guarantee objective execution appraisal. Comparative examination recognized enhancements attributable to the control tower deployment while considering external influences and cyclical fluctuations in operational tendencies.

4. Results and Analysis

4.1 Quantitative Results

The Control Tower deployment generated considerable, quantifiable enhancements across all designated critical execution markers. The numerical outcomes exhibit substantial operational advances attributable to the consolidated platform activation [7].Procurement reaction duration experienced notable acceleration, with the typical interval from acquisition document dispatch to vendor confirmation diminishing substantially. This contraction was chiefly propelled by mechanized prompts in Ariba and instantaneous transparency into vendor behaviors, removing manual tracking through electronic mail and telephone. The optimized communication pathways permitted acquisition teams to redirect activities from administrative monitoring toward strategic vendor participation and deviation handling.Supplier cooperation productivity displayed pronounced advancement, with the relative elevation originating from the compulsory utilization of the Ariba network for the trial vendor cluster, normalizing transmission and information interchange protocols. The amplified electronic connectivity displaced scattered electronic mail sequences and telephone transmissions with organized, verifiable transactions that upgraded precision and diminished misinterpretations.Operational unavailability ascribed to component inaccessibility exhibited meaningful contraction, directly resulting from the forecasting computation module which furnished coordinators with preliminary notification for probable inventory depletion, permitting anticipatory component relocation [8]. The prediction capabilities allowed maintenance coordinators to foresee material deficiencies and synchronize with acquisition to hasten mission-critical deliveries or reallocate inventory from substitute locations before aircraft grounding circumstances materialized.Table 3 presents a comprehensive comparison of key performance indicators before and after the control tower implementation. The procurement response time metric shows a reduction from 48 hours average to 24 hours average, representing a 50 percent decrease in the time required for vendor acknowledgment. Supplier collaboration efficiency demonstrates marked improvement, rising from 60 percent digital adoption to 84 percent, reflecting the standardization of electronic communication protocols through the Ariba Network. Operational downtime attributable to parts unavailability experienced meaningful reduction, declining from 100 hours per month to 70 hours per month, a direct result of enhanced forecasting capabilities. Manual follow-up requirements were eliminated entirely, as automated tracking replaced the previous regime of frequent email and phone communications. Forecast accuracy for stock-outs transitioned from limited predictive capability to advanced warning capability, extending the planning horizon and enabling proactive inventory management decisions.Fig. 2 presents the bar chart comparison demonstrating the procurement response time decreased from 48 hours to 24 hours, representing a 50 percent improvement, supplier collaboration increased from 60 percent to 84 percent digital adoption, representing a 40 percent improvement, and operational downtime reduced from 100 hours to 70 hours per month, representing a 30 percent improvement during the measurement period spanning Q1 2025 compared to the 2022 baseline.

4.2 Qualitative Benefits

Past the quantifiable markers, the initiative furnished substantial experiential advantages that augmented organizational capacities and participant satisfaction. The consolidated dashboard furnished a solitary authoritative source for acquisition, transportation, and maintenance teams, removing contradictory summaries and adaptation control complications that formerly troubled decision formulation procedures [8]. Cross-departmental teams obtained synchronized perspectives of supply network conditions, permitting coordinated reactions to developing circumstances without protracted coordination assemblies or information reconciliation activities. Coordinators transitioned from a defensive crisis response approach to an anticipatory threat reduction position, fundamentally modifying the operational culture from emergency administration to vulnerability mitigation. The forecasting notifications granted decision-makers adequate preparation duration to assess alternatives, consult with participants, and deploy optimal resolutions rather than accepting inferior emergency provisions dictated by temporal constraints. Transparent execution assessments cultivated more cooperative and responsible associations with suppliers, displacing confrontational dynamics with partnership methods [7]. Vendors obtained transparency into their execution measurements relative to contractual commitments and peer standards, stimulating continuous advancement while furnishing objective foundations for acknowledgment and remedial action dialogues. The transparency diminished controversies over delivery execution and payment conditions, as both entities accessed identical transactional documentation and execution computations.

5. Discussion

5.1 Validation of Theoretical SCCT Benefits from Literature

The outcomes substantiate the theoretical advantages of Supply Chain Control Towers as articulated in scholarly publications and authenticate the potency of the SAP technology portfolio for this objective [9]. The documented enhancements in operational markers correspond with sector discoveries on the value of forecasting transparency and consolidated information infrastructures.The deployment results corroborate academic contentions regarding control tower capacities to metamorphose supply network responsiveness and disruption administration effectiveness. The alignment between theoretical forecasts and actual execution reveals that control tower structures, when appropriately deployed with a suitable technological foundation, furnish concrete operational gains rather than purely conceptual advantages. The authentication extends past simple affirmation of anticipated results, disclosing that the scale of enhancements matches closely with estimates established through preceding deployments in neighboring sectors. Fig. 3 displays the weighted requirement structure presenting five assessment dimensions. Automation carries the highest weight at 26 percent, focusing on mechanizing value chain segments. Agility accounts for 22 percent, addressing flexibility for rapid configuration adjustments. Resilience comprises 19 percent, emphasizing operational stability and bounce-back capability. Visibility represents 17 percent, encompassing end-to-end transparency with sensing capabilities, while velocity contributes an equal 17 percent, concentrating on minimizing lead times throughout the network.

5.2 Critical Success Factors: SAP BTP Integration Capabilities and Process Re-Engineering

The accomplishment of this deployment can be ascribed to two principal elements. The pivotal function of SAP BTP demonstrated essential importance, as the platform's ready-made connectors and robust integration capacities were fundamental for surmounting the historical obstacle of information silos, demonstrating its worth as an integration and expansion infrastructure [10].The technical architecture's capability to synchronize disparate systems without extensive tailored coding hastened deployment schedules while diminishing technical vulnerability. The systematic review of control tower implementations across multiple industries confirms that successful deployments consistently exhibit strong executive sponsorship, dedicated cross-functional teams, and phased implementation approaches that allow for iterative refinement and organizational learning [10]. These critical success factors transcend industry boundaries, suggesting that the principles governing effective control tower deployment remain consistent even as operational contexts vary significantly [10].Equally significant was the concentration on procedure redesign rather than purely technology activation. The initiative's accomplishment was similarly reliant on the simultaneous reconstruction of procurement and cooperation procedures, guaranteeing that the technology permitted more productive workflows rather than merely mechanizing antiquated, ineffective ones [9].Organizational transformation administration initiatives prepared participants for novel working techniques, while revised procedures removed redundant stages and clarified decision authorities. The amalgamation of a sturdy technical foundation and streamlined business procedures generated synergistic consequences that magnified the impact beyond what either component could accomplish independently. The aviation industry's adoption of SAP solutions demonstrates that technology platforms must be complemented by strategic business model innovation and process optimization to achieve transformational outcomes rather than incremental improvements [11].

5.3 Challenges: Data Quality and Legacy System Integration

A principal obstacle encountered comprised guaranteeing data precision and uniformity from legacy systems during the opening integration stage. Historical information repositories held inconsistencies, replicated records, and incomplete attribute characterizations that necessitated extensive purification activities before dependable integration could transpire [10].Master data governance structures were created to preserve ongoing quality benchmarks, though this required organizational discipline and procedural compliance that extended past technical configurations. Legacy system limitations additionally restricted the granularity and promptness of certain data components, demanding compensating mechanisms such as supplementary manual data input or intermediate transformation tiers.The technical debt amassed in older systems manifested as incompatible data structures, antiquated interface protocols, and undocumented business reasoning that complicated integration construction. Confronting these barriers demanded considerable effort from both technical teams and business subject matter specialists who could interpret legacy system behaviors and confirm transformation precision. Table 4 categorizes the principal implementation challenges encountered during the Control Tower deployment and documents the corresponding mitigation strategies employed to address each obstacle. Data quality issues manifested through inconsistent historical records, necessitating extensive data cleansing and validation procedures to ensure information integrity. Legacy system constraints created incompatible data formats that required the development of intermediate transformation layers to bridge technical gaps between disparate platforms. Master data governance challenges arose from duplicate and incomplete records, prompting the establishment of comprehensive governance frameworks to maintain data accuracy and consistency moving forward. Interface protocol limitations stemming from obsolete connectivity standards demanded custom adapter development to enable communication between modern and legacy systems. Technical debt accumulated over years of system evolution presented undocumented business logic that required extensive subject matter expert consultation to interpret and properly integrate. System integration complexity resulting from multiple disparate platforms was addressed through a phased integration approach that allowed for controlled deployment and iterative refinement while minimizing operational disruption.

5.4 Limitations: Single Case Study Generalizability

As a solitary case examination, the transferability of the outcomes may be restricted. The discoveries are most pertinent to medium-scale airlines with a comparable operational framework and technology environment [9]. Organizations with fundamentally different fleet arrangements, maintenance philosophies, or supplier relationship frameworks may encounter divergent results when deploying comparable solutions.The particular execution enhancements documented at Allegiant Air mirror the specific obstacles and baseline situations present within that organizational setting, which may not precisely correspond to circumstances at other carriers. External influences, including regulatory surroundings, geographic service territories, and competitive dynamics, introduce variables that could shape deployment outcomes in ways not captured within this singular examination. The constrained breadth prevents wider inferences regarding control tower potency across diverse aviation operational frameworks or alternative technological infrastructures.

5.5 Applicability to Mid-Sized Airlines with Similar Operational Models

Despite transferability constraints, the deployment structure offers worthwhile direction for aviation organizations sharing comparable attributes with Allegiant Air. Medium-scale carriers managing point-to-point networks with limited fleet diversity and concentrated maintenance functions represent the most directly pertinent context for replicating this method.Airlines with similar procurement volumes, supplier relationship intricacies, and regulatory compliance necessities can reasonably anticipate analogous advantages when activating equivalent technological solutions. The architectural patterns, integration tactics, and transformation administration approaches documented within this deployment furnish actionable blueprints that other organizations can modify to their particular circumstances. The aviation industry's specific requirements for traceability, regulatory compliance, and safety-critical component management necessitate specialized ERP configurations and industry-specific functionality that distinguish aviation implementations from generic supply chain control tower deployments [11].Organizations contemplating control tower commitments should evaluate alignment between their operational attributes and those present in this case to gauge expected relevance and calibrate anticipated results accordingly. The strategic optimization of supply chain management through SAP S/4HANA implementations demonstrates that technology platforms must be carefully configured to address industry-specific challenges while maintaining flexibility to accommodate organizational variations in operational models and strategic priorities [12].

Table 1: *Aviation Supply Chain Challenges and Impact Areas [1]*

Challenge Category	Operational Impact	Business Consequence
Aircraft on Ground (AOG) Incidents	Immediate part availability requirements	Revenue loss and service disruption
Inventory Complexity	Management of thousands of SKUs across multiple locations	Increased holding costs and stockout risks
Supplier Network Coordination	Global vendor synchronization demands	Communication delays and order fulfillment issues
Demand Variability	Unpredictable maintenance scheduling	Inefficient resource allocation
Regulatory Compliance	Stringent certification requirements	Extended procurement lead times

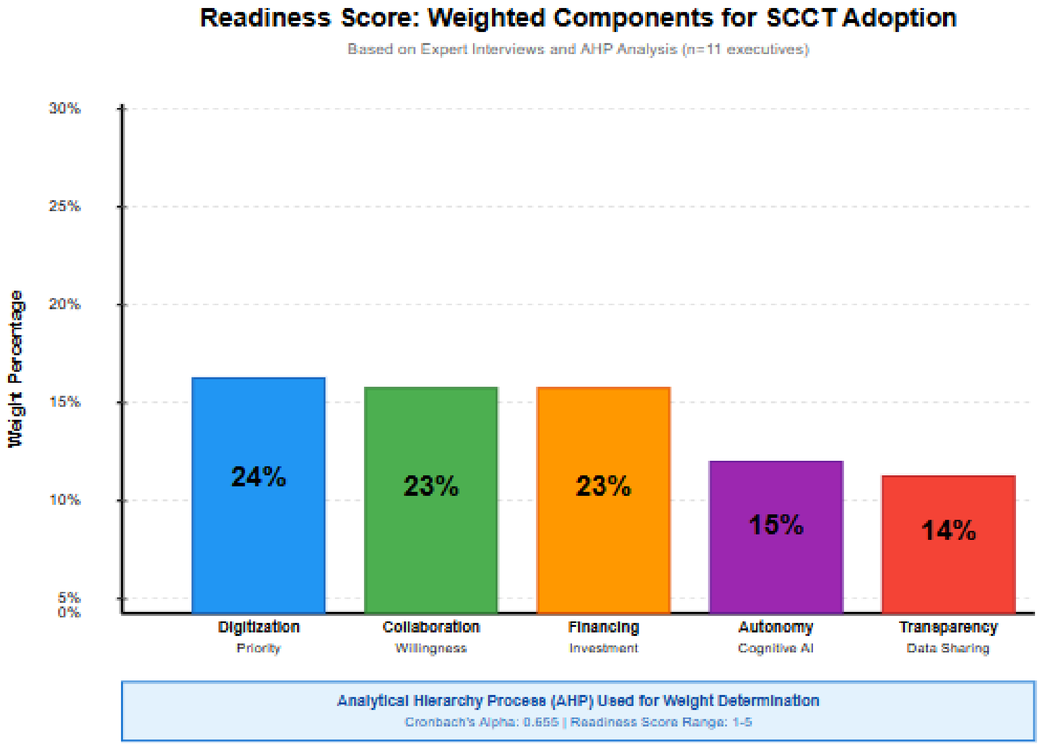

Figure 1: *Readiness Score Component Weights [2]*

Table 2: *SAP Technology Stack Components and Integration Architecture [5, 10]*

SAP Component	Primary Function	Integration Role
SAP S/4HANA	Enterprise resource planning	System of record for materials, purchase orders, and inventory

SAP BTP Integration Suite	Middleware and data harmonization	The central nervous system connects all platforms
SAP Ariba Network	Supplier collaboration platform	Digital PO communication and ASN management
SAP Analytics Cloud	Business intelligence and ML	Visualization layer and predictive analytics engine
Third-Party Logistics Systems	Shipment tracking	Real-time transportation status updates

Table 3: *Key Performance Indicator Improvements [7, 8]*

Performance Metric	Pre-Implementation Baseline	Post-Implementation Results	Performance Change
Procurement Response Time	48 hours average	24 hours average	50%
Supplier Collaboration Efficiency	60% digital adoption	84% digital adoption	Marked improvement
Operational Downtime from Parts Unavailability	100 hours per month	70 hours per month	Meaningful reduction
Manual Follow-up Requirements	Frequent email/phone tracking	Automated tracking	Eliminated manual effort
Forecast Accuracy for Stock-outs	Limited predictive capability	Advanced warning capability	Enhanced planning horizon

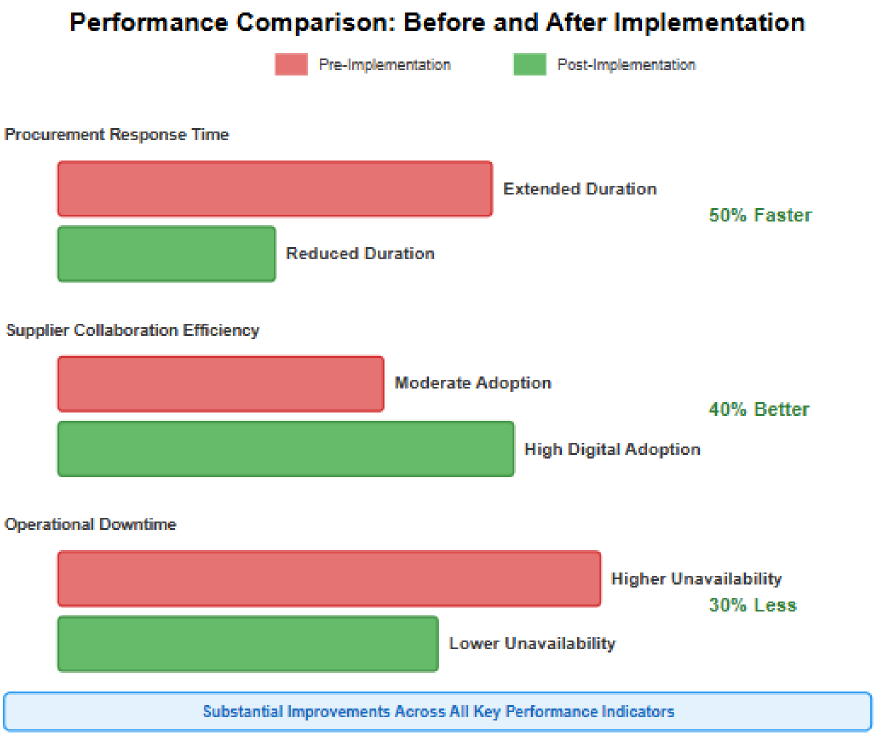

Figure 2: *Pre and Post Implementation Performance [7, 8]*

Table 4: *Implementation Challenges and Mitigation Strategies [9, 10]*

Challenge Category	Specific Issue	Mitigation Strategy
Data Quality	Inconsistent historical records	Extensive data cleansing and validation
Legacy System Constraints	Incompatible data formats	Intermediate transformation layers
Master Data Governance	Duplicate and incomplete records	Established governance frameworks
Interface Protocols	Obsolete connectivity standards	Custom adapter development
Technical Debt	Undocumented business logic	Subject matter expert consultation

System Integration Complexity	Multiple disparate platforms	Phased integration approach

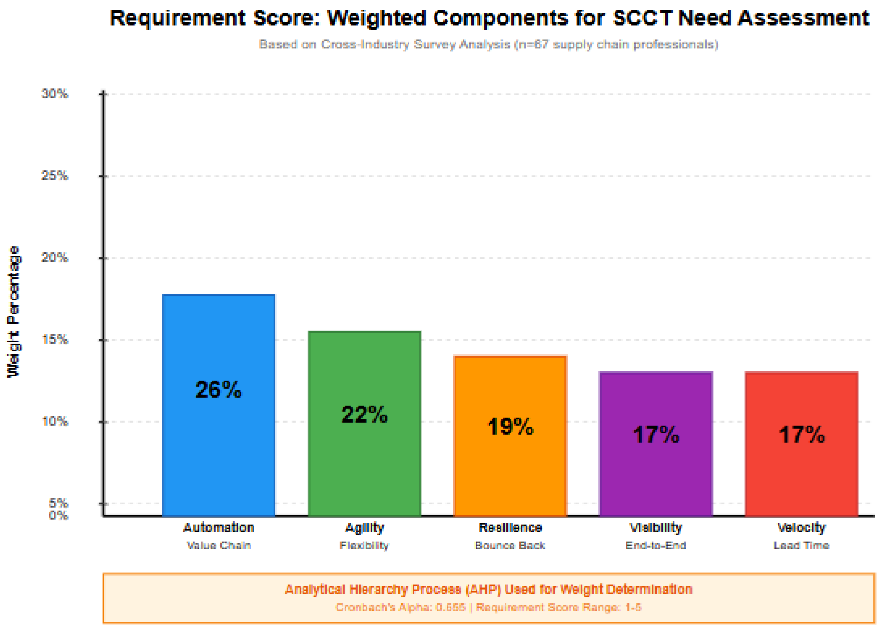

Figure 3: *Requirement Score Component Weights [2]*

6. Conclusions

The successful implementation of an SAP Supply Chain Collaboration Control Tower at Allegiant Air demonstrates that platform-based solutions utilizing SAP BTP, Ariba, and Analytics Cloud can significantly enhance supply chain visibility, collaboration, and resilience within aviation operations. The deployment transformed fragmented, reactive procurement and logistics processes into integrated, predictive operational frameworks that enable proactive decision-making and risk mitigation. The documented outcomes validate theoretical assertions regarding control tower capabilities while providing a practical architectural blueprint that aviation organizations can adapt to their specific contexts. The integration of real-time data consolidation, event-driven automation, and machine learning-powered forecasting established a foundation for continuous operational improvement beyond the initial implementation scope. Future development directions include extending predictive models to incorporate external data sources such as weather patterns and geopolitical events for enhanced risk management capabilities, exploring blockchain integration for improved traceability and trust throughout the maintenance, repair, and overhaul part lifecycle, and expanding the control tower scope to encompass sustainability tracking and carbon emission monitoring across the supply chain. The validated framework contributes actionable guidance for aviation enterprises pursuing digital transformation of their supply chain operations.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
- **Acknowledgement:** The authors declare that they have nobody or no-company to acknowledge.
- **Author contributions:** The authors declare that they have equal right on this paper.
- **Funding information:** The authors declare that there is no funding to be acknowledged.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.
- **Use of AI Tools:** The author(s) declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

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