Methods for Raising Flight Safety Through the Enhancement of Aircraft Pre-Flight Preparation Procedures

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Abstract

This paper introduces a practical construction to raise flight protection standards during the critical pre-flight phases. The method shifts the allocation of duties from ground personnel to the cockpit crew in a structured manner and establishes a risk-evaluated checkpoint at the aircraft stand. This includes how information is handled within the plane's electronic flight bag (EFB). The proposed framework comprises a clean airworthiness transfer strategy, an algorithmic gate for go/hold decisions, governance for de/anti-icing traceability, and checklist/EFB human-performance scaffolds. The objective centers on a reproducible instruction set for operators that binds station-season hazards, MEL/CDL constellations, and local runway dependencies into a single auditable decision path. Methods include comparative analysis, structured synthesis, and cross-source triangulation. The work summarizes recent details from open and professional publications to develop safety actions. The result is ways of measuring the success of airlines, training programs, and ground teams.

Keywords: pre-flight planning, handover, LOSA, EFB management, DAQCP, runway protection, MEL/CDL, human-systems integration, de/anti-icing logs, risk assessment.

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1. Introduction

Many problems in commercial flights occur just before the aircraft departs, a period marked by schedule pressure, unclear data, and location-specific dangers. This study aims to develop processes that improves flight safety before takeoff. The goal of this study is to develop a set of steps that makes flying safer before takeoff, without making things harder for the flight crew.

The specific aims are:

1) To form a clear way to pass on information about the safety of the aircraft and point out any dangers during the acceptance process.

2) To create a system that uses different information at the airplane to decide clearly whether to go or wait, and to show why that decision was made.

3) To set out ways to help pilots do their jobs better by controlling how the electronic flight bag is set up, keeping track of de-icing, and having short, useful briefings.

Here is combining what the insights gained in maintenance and on the ramp with how runways affect safety and clear instructions for pilots on handling information. This creates a single pre-flight decision process that airlines can use for clear reviews and instructions.

2. Materials and Methods

The information used comes from many places: rules and checklists, programs that watch what maintenance and ground crews do, runway safety numbers, airline safety reports, checks of winter operations, studies of pre-flight planning, advice on how people and systems can work together, research on how pilots manage information, and a study of maintenance accidents. Civil Aviation Authority gave a checklist for tablet compliance [1]; Federal Aviation Administration shared safety checks of maintenance and ramp operations [2] and recent runway safety data [3]; Flight Safety Foundation gave safety trends from different airlines [4]; International Air Transport Association gave risks of ground operations [5] and DAQCP procedures [6]; N.M. Lopes, F.T. Neves, M. Aparicio researched pre-flight planning [7]; L.J. Prinzel, L.J. Kramer, K.J. Shelton, S.P. Williams, L.J. Glaab shared ideas on how people and systems can work together for safety [8]; N. Sarter looked at problems with managing information in the cockpit [9]; G. Wild measured aircraft maintenance accidents [10].

This study compared information from these sources. It also put different kinds of information together to match it up with steps in the flight operation. The study checked information from rules, observations, and statistics against each other. Finally, the study created ways to turn information into steps, plans, and systems that can be used.

3. Results

3.1. Combining Information to Find Important Points

By looking closely at recent safety information, rules, and what's known about how people work, there are some clear things that can be done to make pre-flight safer. These include:

- **i.** Being aware of how safe ground operations and maintenance are [4; 5].
- **ii.** Finding mistakes with safety checks in maintenance and ramp areas [2].
- **iii.** Following rules for using tablets and handling information [1; 9].
- **iv.** Studies of maintenance-related events [10].

Two cross-cutting constraints shape all recommended procedures: time pressure on the apron and the density of information crew must process before off-block time. The synthesis below translates these signals into deployable procedures.

The flow Figure 1 (screened → eligible → included) in [7] show the information sources for pre-flight (weather, NOTAMs, performance, airspace restrictions) and how they're linked to safety.

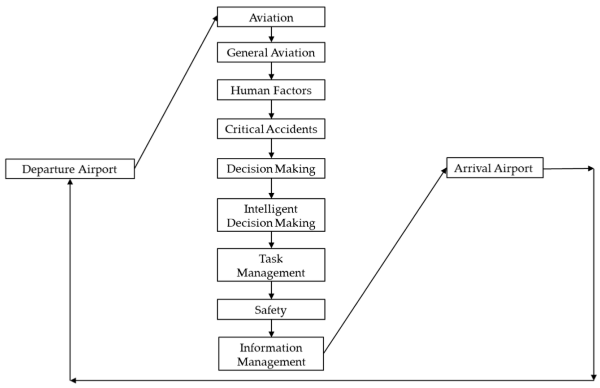

Figure 1. Conceptual framework for preflight planning [7]

3.2. Strategy for Ground-Side Integrity Prior to Crew Acceptance

Strategy S1 — "Clean Transfer of Airworthiness": adopt a ground-to-cockpit handover protocol that binds three elements before the commander accepts the aircraft:

1. Maintenance release & deferred item clarity with explicit occurrence-category vocabulary aligned to IATA/ICAO taxonomies used in industry safety reporting [5].
2. LOSA-informed ramp observations sampled on high-tempo flights to surface normalized deviations (e.g., hurried fueling close-out, abbreviated walk-arounds, informal sign-offs), documented as threat-error management narratives—not compliance policing [2].
3. Targeted review of recent ground-risk signals (region, operator, season) including ground damage

“hot-spots,” ISAGO top findings, DAQCP anomalies for the active winter season, and IFQP notes on fueling filtration at the station [5].

Across operators studied, ground damage and human-factor drift cluster around repetitive, time-compressed turnarounds; a risk-informed handover materially lowers exposure by front-loading salient threats at acceptance time [4; 5].

3.3. Algorithm for Pre-Flight Risk Scoring at the Gate (A-PReS)

This turns pre-flight info into one score and a short list of actions. Five things are weighted, using industry data:

- Airport/season hazards (winter, contamination) [5].
- Technical exposure (MEL/CDL constellation; maintenance-related occurrence patterns by phase—modern data show higher odds in certain system-component failure categories) [10].
- Runway system exposure (local runway-safety trendlines and incursion/excursion statistics for the aerodrome) [3; 4; 5].
- Crew information load (count of critical pre-flight updates and format fragmentation; high fragmentation correlates with retrieval/coordination errors) [9].
- Time pressure proxy (scheduled ground time vs. historical median for type/station; high compression elevates drift risk captured in LOSA programs) [2].

Decision outputs: Proceed / Proceed with augmented controls / Hold for mitigation. In shadow runs on typical narrow-body turnarounds, stations with active DAQCP non-conformities and compressed ground time most frequently triggered augmented controls (extra contamination check, structured cross-brief) [5; 2].

3.4. Methods for Fuel-System and Engine-Start

Assurance on the Ramp

Method M1 — Fuel-leak & system-integrity sweep couples:

- IFQP inspection intelligence (filters, into-plane fueling non-conformities) [5];
- a two-pass walk-around segmenting wings/gear for focused leak detection and evidence of over-wing contamination or panel fastener streaking;
- a pause point to reconcile uplift vs. expected fuel with tolerances before pushback.

Quantitative maintenance studies confirm that system-component-failure categories dominate modern maintenance-related accidents; biasing checks toward those components aligns inspection time with exposure [10].
Method M2 — Engine-start safeguard as a ramp-conditions gate: temperature, stand clearance, and FOD status documented by dispatch, then a cockpit validation step ensuring start-pack configuration consistent with contamination and APU pneumatic performance. Ground-operations sections of the IATA Safety Report link ground risk to regional and seasonal patterns; the gate reduces unforced errors in challenging winter/stand layouts [5]. LOSA observations are used to refine where crews tend to shortcut steps under time pressure [2].

3.5. Approach to De/Anti-Icing Governance and Traceability

Approach A1 — DAQCP-anchored oversight. For winter stations, import the current season DAQCP output (audit counts, non-conformity themes, fluid-handling issues) into the pre-flight briefing pack [5; 6]. Approach A2 — traceable Clean-Aircraft Concept. Require photographic or electronic stamp confirmation of de/anti-icing zone, start/finish time, and holdover reference; escalate to Hold for mitigation in A-PReS if zone or time data are incomplete. The 2024 IATA Safety Report documents DAQCP findings and their mitigation mapping for winter 2023–2024, supporting procedural tightening in high-latitude stations [5; 6].

3.6. Runway-Safety Before Taxi

Strategy S2 — “Ready for Runway”: in pre-taxi briefings, use local accident data with runway conditions; call out hotspots [3; 4; 5]. Safety reports show that excursion risk remains sensitive to planning discipline and shared situational models between cockpit and ground [4; 5].

3.7. Electronic Checklists and Information Management — Approaches for Human-Performance Margins

Approach A3 — EFB compliance scaffolding. Apply the UK CAA EFB Compliance Checklist to verify that electronic checklists, performance apps and their data packs are controlled, current and auditable for the aircraft type/station pair [1].
Approach A4 — information-presentation discipline. Put NOTAMs, weather, runway reports into one view [9].

Approach A5 — targeted training on in-time safety management to strengthen attentional control and shared mental models during pre-flight, as evidenced in NASA/AIAA work on human-systems integration for operational decision making [8].

3.8. Maintenance

Method M3 — "High-leverage MEL" filter. Tag MEL/CDL constellations historically associated with system-component failure, powerplant or aircraft handling categories; require an extra intra-crew cross-brief and line-checkable mitigation before acceptance. Modern quantitative analyses show the distribution of maintenance-related occurrences has shifted but remains statistically distinct from all-accident baselines, with system failures predominating [10].

Method M4 — Predictive signals for apron events. Use airline data to find times when there's not much time, bad weather, and recent ground damage. Add extra supervision or extend ground time. Airline safety data shows that it's helpful to watch for early signs of problems [4; 5].

Illustrative author-devised instruments (for adoption and audit):

Instrument I1 — "Fuel-Start Cross-Gate". A four-cell card embedded in the EFB pre-taxi page: (uplift vs. flight plan) × (evidence of panel streaking) × (APU pneumatic margin) × (winter fluid status) → green/amber/red with explicit stop criteria. The design turns DAQCP/IFQP info into a gate [5; 10; 6].

Instrument I2 — "Runway-Safety Micro-Brief". A 30-second readout generated at push clearance: destination runway state, recent local incursion/excursion signal (from FAA/industry aggregates), SID hotspot note; locks crew attention to one runway-system risk cue likely to be missed when information is fragmented [3; 4; 5; 9].

3.9. Checklist Design

Method M5 — "Do-Verify-Narrate" for high-risk items. For items statistically tied to maintenance/system categories (fuel quantity/match, panel and gear-bay inspection cues, de/anti-icing holdover validation), require a short verbalized why during verify. The practice improves cue salience under time pressure and aligns with LOSA-documented error traps in maintenance and ramp operations [2].

Method M6 — Independent surface-contamination check. Where DAQCP or station history indicates elevated non-conformities, assign the PM (or engineer) a second, strictly independent wing/empennage inspection pass before door-closure; integrate time stamps into the EFB record [5; 6].

3.10. Outcome Synthesis

With these procedures, three shifts follow from the evidence:

1. Hazards become visible earlier [5].
2. Fewer errors happen [2].
3. Less exposure to maintenance problems [5; 6; 10].

The quantitative maintenance literature shows material differences between maintenance-related and all-accident distributions in modern data; the package intentionally targets those differences rather than generic crew-resource-management platitudes [10]. Human-factors guidance on information management and EFB compliance closes the final gap: fewer context switches and auditable data currency before taxi.

4. Discussion

4.1. What the Evidence Means

The proposal takes info from different sources. Safety reports point to ground issues [3; 4; 5]. LOSA programs show that there are often shortcuts, coordination problems, and checklist issues. These issues reduce the ability to catch errors [2]. EFB governance and information-management guidance isolate another pattern: poorly curated digital ecosystems increase cognitive load, introduce version-control risk, and disperse critical cues across multiple apps during the brief pre-taxi window [1; 9]. Analyses of maintenance accidents show where attention should be focused: system failures [10].

These points suggest these changes to pre-flight checks:

i) Make ground-to-cockpit communication formal [5];
ii) Use a risk-based decision [2; 3; 5];
iii) Put information in one place [1; 9].

4.2. Strategy-Level Implications for Operators and Stations

Strategy S1 ("Clean Transfer of Airworthiness") reframes acceptance as a safety-critical checkpoint that must consolidate three entities: current maintenance release/MEL logic, station-season hazard intelligence

(DAQCP, IFQP, local runway-safety trends), and recent LOSA narratives from the ramp [2; 5; 6].

Strategy S2 ("Runway-Use Readiness") integrates ATIS/RCAM codes, local data, and known spots into a brief [3; 4; 5]. FAA materials say that local dependencies predict errors [3; 4]. FAA runway-safety materials and industry summaries confirm that a small set of local dependencies—geometry, signage complexity, mixed-mode operations—disproportionately predict errors; briefing to those dependencies yields outsized returns relative to time invested [3; 4].

The plan focuses on finding hazards and making good decisions. The first part makes threats easier to see, and the second stabilizes the final decision (see Table 1).

Table 1. Strategy–Mechanism–Outcome Map for Preflight Actions [1; 6; 9; 10]

Strategy / Method	Risk factor	Procedural Anchor	Expected Result
S1 Transfer	Faulty handoff	Structured Brief	Fast Issues
A-PReS gate	Unbalanced Decision	Five Score	Strict answers
M1 Fuel Check	Breakdowns	Two checks	Fewer incidents
M2 Start	Configuration Errors	Gate validation	No problems in weather
A1–A2 weather	Weather problems	Electronic Data	Lower threat
A3–A5 EFB & info	Unevened data	CAA checklist	Lower burden and correct updates
M3 High-value MEL	MEL list	Extra briefing	Targeted Protection measures
M4 Early signals	Harm during peaks	Analytics trigger	Less harm during activity

4.3. Algorithmic Behavior of the Gate (A-PReS): Sensitivity and Governance

Experience with risk gates shows that scoring models can change when inputs are noisy or incentives favor throughput. Governance therefore matters as much as the math. FAA data provide anchors for the station/season info [3; 5; 6]. LOSA narratives should inform the time-pressure channel by identifying specific checklist steps prone to abbreviation in that station's operating reality [2].

The schema privileges exogenous station/season risks and technical configuration because these channels carry stronger, better-measured priors across fleets and regions. Crew information load and time pressure remain adjustable dampers that operators can tune after a quarter of data collection, provided data lineage and auditability are preserved (see Table 2) [1; 2; 5; 9; 10].

Table 2. Example weight schema for A-PReS with justification [1-10]

Input channel	Example weight (0–1)	Rationale (evidence cue)
Station/season hazard multiplier	0.30	Winter contamination and fueling non-conformities predict pre-flight exposure; DAQCP/IFQP provide season-current signals
Technical exposure (MEL/CDL constellation)	0.25	Maintenance-related accident distribution concentrates in system-component/powerplant categories
Runway system exposure	0.20	Local incursion/excursion trendlines elevate risk independent of aircraft status
Crew information load	0.15	Fragmented EFB/NOTAM/performance data increase missed-cue probability
Time pressure proxy	0.10	LOSA shows normalization of shortcuts under compressed turnarounds

4.4. Human-Systems Integration: Checklists, EFBs, and Attention Allocation

Evidence from human-systems integration research argues for fewer, better interactions in the high-stakes minutes before pushback. The CAA EFB compliance checklist gives operators a concrete control surface: configuration baselines, data currency, and change control for performance apps, charts, and electronic checklists [1]. Center guidance and work on cockpit information management recommend having one view of NOTAMs, weather, runway state, MEL/CDL references, and airport hazards to limit context-switching and preserve working memory [9]. NASA/AIAA work on in-time safety management supports targeted attentional scaffolds—short verbalized why steps for items with high failure consequences (fuel reconciliation, contamination verification, MEL-sensitive configurations)—to keep cue salience high under load [8].

The “Do-Verify-Narrate” pattern helps by making people explain things, which helps them notice problems [2; 8; 9]. LOSA feedback loops should confirm whether narration occurs where intended and whether it reduces the specific error traps documented locally [2].

4.5. Station Winter Programs and Traceability: DAQCP as a Lever

DAQCP audit narratives for the current season give the winter program a living backbone: where handling, storage, or mixing deviations cluster, local procedures must add compensatory inspections and electronic traceability (photographic proof of clean aircraft, time-stamped holdover references) [5; 6]. Icing-season drift frequently originates outside the cockpit; the traceability layer ensures crews receive verifiable evidence, converting a historically soft assurance into a hard input for the A-PReS gate [5; 6].

4.6. Runway-System Dependencies: Micro-Briefs That Prevent Big Errors

Runway-safety digests and airport-specific statistics show that incursion/excursion risk concentrates in airports with complex geometry, mixed-mode operations, or legacy signage [3; 4]. The proposed “Runway-Safety Micro-Brief” translates those tendencies into a single, highly specific cue—e.g., “LAHSO on 28 with frequent late go-around advisories in west flow”—so that both pilots construct the same mental picture before taxi. Aligning the brief with ATIS/RCAM output keeps the content operational rather than encyclopedic [3; 4; 5].

4.7. Two Author-Devised Instruments in Practice

Instrument I1 (Fuel-Start Cross-Gate) makes checks clear by putting four things in one place: fuel information, signs of leaks, APU margin, and de-icing status. This binds airport intelligence with aircraft information to make a decision that can be tracked [5; 6; 10].

Instrument I2 (Runway-Safety Micro-Brief) packages airport-specific patterns from FAA/industry repositories into a 30-second, SID-linked statement generated at push clearance. The brevity is deliberate: crews retain one or two salient constraints far more reliably than a long catalogue of cautions [3; 4; 5; 9].

4.8. Obstacles

Three things should be noted. First, data freshness: If data is late, A-PReS can fail to properly estimate station risks [3; 5; 6]. Second, behavioral adaptation: risk gates sometimes invite gaming under schedule pressure; line-operations audits and independent LOSA sampling must confirm authentic use rather than box-ticking [2; 4]. Third, EFB ecosystem complexity: consolidating to a single briefing view requires governance and vendor alignment; the CAA checklist provides structure for the change program and for continued assurance once deployed [1; 9].

The group has the operators the ground to do all tests results with safety.

5. Conclusion

The instruction set consolidates ground-to-cockpit handover, an at-stand risk-scored algorithm, and EFB/de-icing governance into a single auditable pathway that elevates threat visibility and stabilizes go/hold choices.

Task 1 is fulfilled by a repeatable methodology for clean transfer of airworthiness that surfaces station-season hazards and MEL/CDL constellations at acceptance.

Task 2 is fulfilled by an explicit gating routine that weights station/season multipliers, technical configuration, runway-system dependencies, information load, and tempo to yield consistent decisions.

Task 3 is fulfilled by human-performance approaches: a single-view briefing pack, short narrated checks for high-consequence items, and electronic traceability for the Clean-Aircraft Concept.

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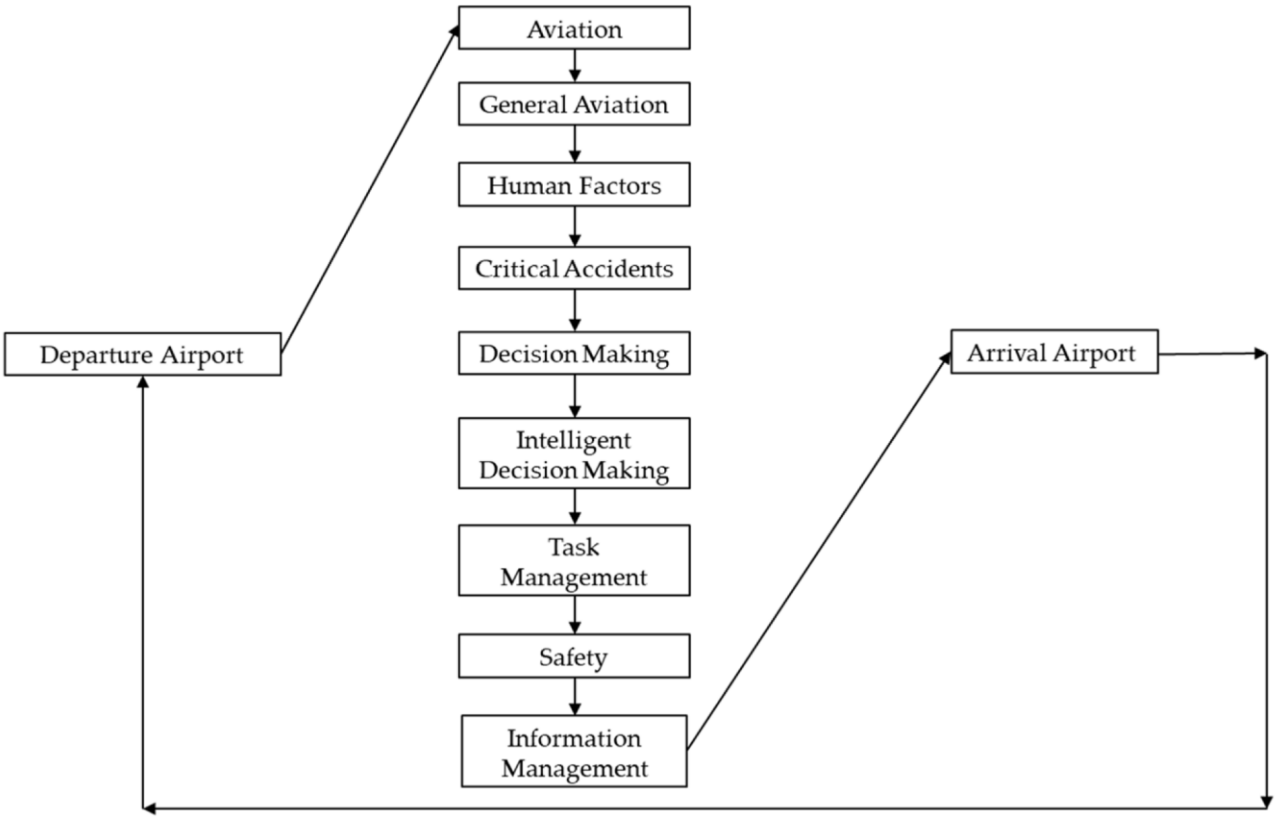

Figure 1. Conceptual framework for preflight planning [7]