

EBOOK

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AIRLINE OPERATIONS

Four stages to achieving operational consistency with AI-assisted decision-making

How a success-based Experience Bank helps overcome “the subjectivity crisis” to make today’s best outcomes tomorrow’s normal

Improving operational performance through AI-assisted decision-making

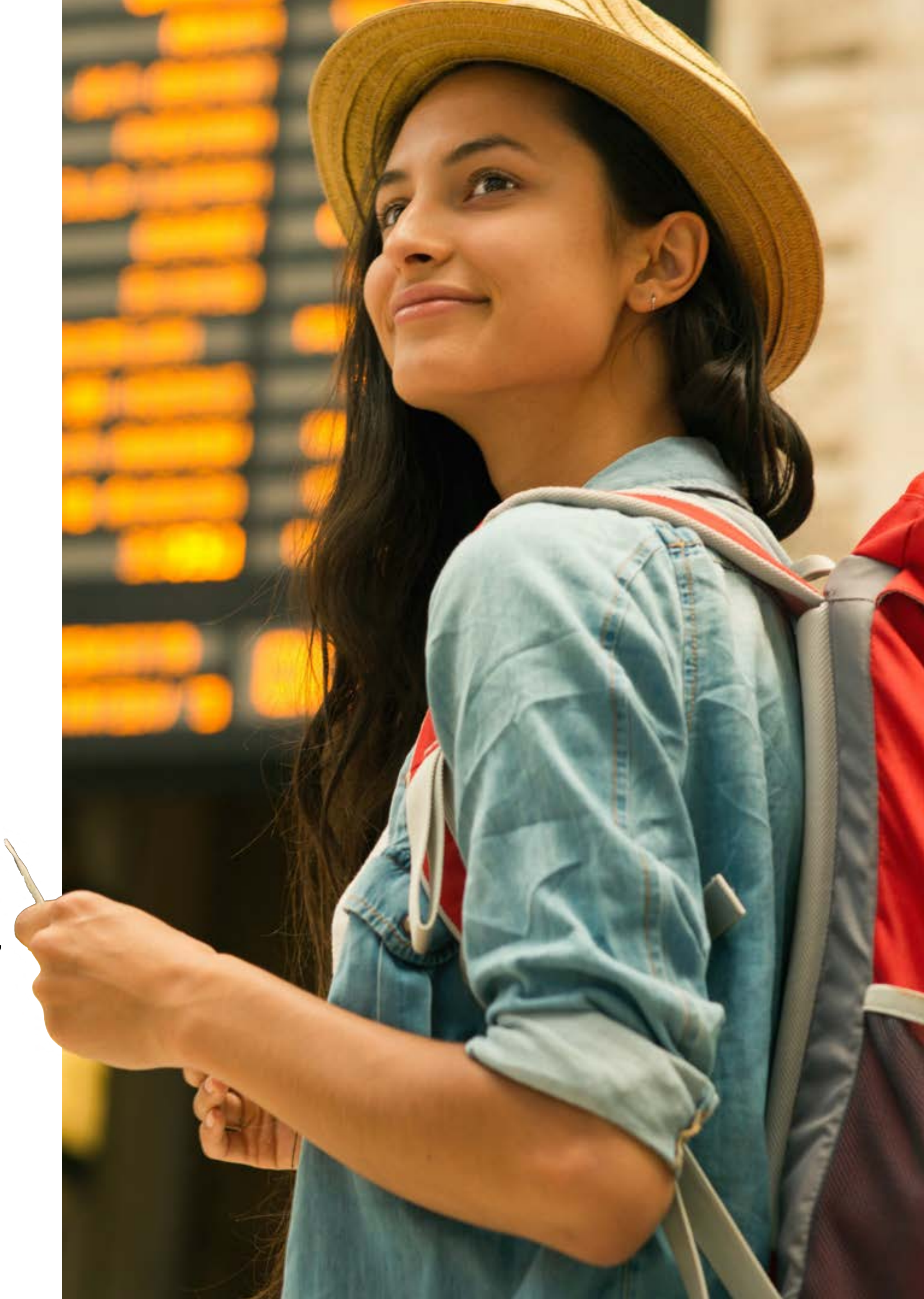
Delays and disruptions are among the most persistent challenges facing the airline industry, creating ripple effects that impact efficiency, customer satisfaction, and profitability. The significant financial, logistical, and reputational costs associated with irregular operations underscore the need for smarter solutions.

While travel demand grows, operational performance remains vulnerable to unpredictable factors like geopolitical shifts, aircraft delivery delays, infrastructure limitations, and regulatory frameworks. To overcome these challenges, airlines must optimize existing assets and empower their teams to make better decisions faster and consistently.

Skilled professionals are the backbone of airline operations teams, yet their decision-making is often constrained by time pressures, incomplete information, and human judgment's inherent

subjectivity. Overcoming the “subjectivity crisis” is crucial to improving operational performance, from planning to disruption management. Making the right choices with consistently high-quality outcomes relies on proactive decision support that integrates past learnings across different operational scenarios.

Enter AI-assisted decision-making. By embedding AI into daily operations, airlines can consistently capture and apply best practices, ensuring teams – from the most experienced to the newest members – can achieve optimal results even in the most challenging scenarios. AI-assisted decision-making unlocks consistent, high-quality outcomes that improve operational performance, increase employee satisfaction, and deliver better customer experiences.



The subjectivity crisis

In the high-stakes environment of an airline operations room, a single wrong or suboptimal decision can set off a domino effect, impacting crewing, scheduling, and customer and employee experiences for days or even weeks.

Speed

What happens when the right decision is taken too late?

Accuracy

Has every operational and commercial impact been considered?

Compliance

Does this decision align with company and regulatory requirements?

Customer

What's the impact on internal KPIs and the customer experience?

Aftermath

How will this decision affect operations tomorrow or in the future?

Crew

Can this decision lead to fatigue, dissatisfaction, or staffing shortages?

Even the most experienced professionals struggle to make the best decisions unaided, under constant pressure, and in rapidly changing conditions. Today, the quality of decisions and their outcomes depend on the team's experience and skill on the day, the information they have at hand, and many other intrinsic and external variables.

This is the subjectivity crisis: an overreliance on human decision-making whose quality and consistency are shaped by individual expertise,

experience, and psychological and physical state, constrained by time, complexity, incomplete information, and pressure.

But what if the experience, knowledge, and judgment that drive the best outcomes could be captured, shared, and standardized across the organization? What if "best" could become the norm, enabling consistent, high-quality decisions every time?



“Airline operations staff are the backbone of aviation—their expertise is indispensable. Ensuring operational consistency is key to resilience, requiring decisions free from cognitive biases or experience gaps. Empowering experts with the right tools is essential to achieving this!”

Decision-making challenges in the operations room

Why are decisions so variable in their outcomes across similar operational scenarios? Because of the subjectivity crisis and the lack of tools to capture, share, and apply best practices.

Key factors affecting decision-making in Operations Control Centers include:

01

Subjectivity

Decision-making quality depends on the person making it, the team around them, and other intrinsic and external variables.

02

Human error

Fatigue, stress, and pressure can lead to mistakes, even among seasoned professionals.

03

New joiner onboarding

Training new hires requires significant time and resources, distracting senior staff from critical tasks during challenging scenarios.

04

Overwork

Experienced team members often juggle operations management and mentoring responsibilities, increasing stress and the likelihood of errors.

05

Knowledge gaps

High-pressure, fast-paced environments offer limited opportunities to capture and transfer knowledge formally or informally.

06

Lack of retrospective learning

Limited time, resources, and knowledge capture inhibit retrospective evaluation for future applications.

07

Legacy documentation

Even when manual records are kept, staff typically bypass poorly organized information or do not know what historical data points to apply.

08

Complexity and pressure

Dynamic, interdependent operational factors and situations make it difficult for humans to assimilate and act on all the variables rapidly enough.

“Your most knowledgeable and experienced people cannot be everywhere at once. Somehow, you need to make their insights universally available.”

The impacts of highly human-dependent operations

Subjectivity, inconsistency, and undue human intervention in decision-making processes increase the time lost to delays, cancellations, and even routine operations. This can quickly lead to increased stress, burnout, and absenteeism in high-pressure environments.

Current stopgap measures, like mentoring programs and experience-based training (EBT), are insufficient. These approaches rely on individual expertise and availability, which are circumstantial, given dynamic operating conditions, and aren't scalable. Furthermore, workforce shortages and increasingly demanding customers force seasoned staff to prioritize operational continuity over training junior staff.

With each delay minute costing \$100.80, according to Airlines for America, airlines simply can't afford operational inefficiencies. Automated, predictive, and learning-based solutions will drive the next era of operational efficiency, optimization, and overall performance.

Operational consistency through real-time decision enhancement

AI-powered tools can support operations teams with optimized, experience-based, real-time insights that balance operational, commercial, and customer objectives. Key requirements for effective decision enhancement include:

- Capturing and processing decision-making criteria, reasoning, and outcomes from past scenarios and simulations.
- Offering optimized solutions that integrate cross-departmental data, rules, and constraints.
- Incorporating learnings from historical events to improve decision quality.
- Providing transparent, explainable recommendations that staff can trust and compare against objectives.
- Ensuring actionable solutions that facilitate swift and accurate decisions on the spot.

By integrating these capabilities, airlines can enable their teams to make faster, more consistent decisions, improving operational efficiency and reducing delays. However, these success-based solutions aren't achieved through process transformations or resource improvements alone.





Myth busting: Perceptions driving resistance to change

While areas like crew scheduling have embraced advanced technology, pre-operations planning and day-of-ops management remain primarily manual. Why?

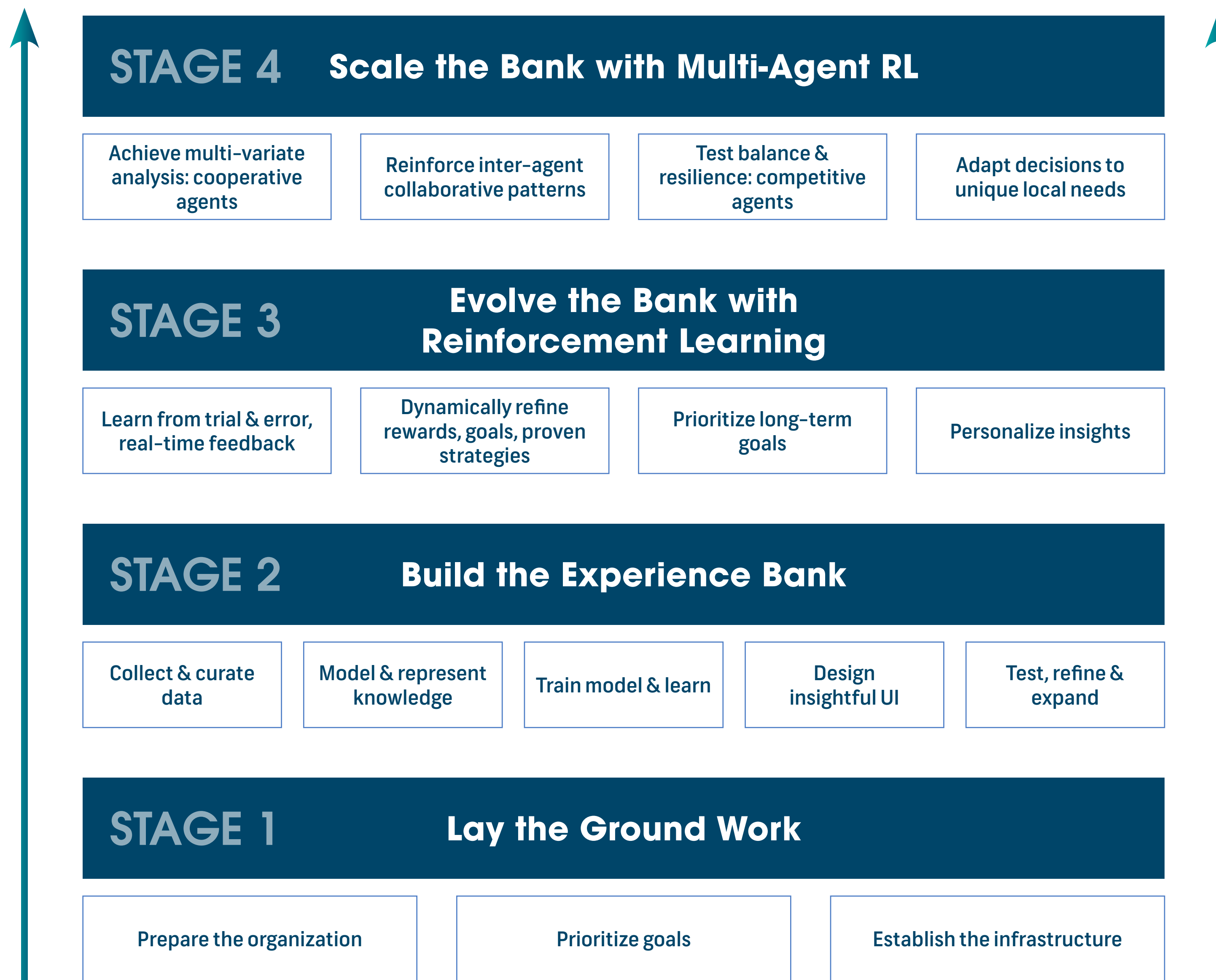
The multiple, interdependent processes and factors involved are considered too complex for technology to handle. Concerns about data availability, rapid responsiveness, and a historical reliance on subjective, siloed practices further reinforce the belief that day-of-ops is more art than science. Past failures with re-optimization tools based on historical snapshots, limited explainability of solutions, and an inability to address interconnected operational challenges have also fueled mistrust in technology.

Achieving operational consistency requires advanced optimization technologies that integrate historical data, predictive insights, and tailored solutions to support adaptive, interconnected decision-making across operational stakeholders and stages.

Four stages to achieving operational consistency through digitization

To build trust in AI-assisted decision-making, solutions must integrate high-quality data with insights into how it was used, why, and the outcomes it produced. Success hinges on two core elements: access to quality data and the ability to leverage it effectively.

At the center of this transformation lies an Experience Bank that captures daily decisions, analyzes their outcomes to identify best practices, and integrates them into recommended solutions. Applying and adapting learnings continuously refines stored knowledge, accelerating decision-making and driving consistent, high-quality outcomes across operational scenarios and individual experience levels.



STAGE 1

Lay the groundwork

Prepare the organization for transformation:

AI adoption in airline operations demands a comprehensive change management strategy. Transitioning from a legacy of human expertise to technology-assisted decision-making requires engaging stakeholders early to address concerns and demonstrate the technology's role as a support system, not a replacement. AI should be framed as:

- A **virtual mentor** guiding staff, enhancing safety, and enabling veterans to focus on strategic priorities.
- A **decision enhancer** improving consistency, speed, and quality of decisions while allowing expert overrides when needed.

Encourage collaboration on platform design, reward openness to change, and share early adopter success stories to build trust and enthusiasm. The transformation process should be gradual and include the necessary timeframe to embed the change into the organizational culture.



A woman with glasses is smiling while working on a laptop. The image has a blue overlay and a yellow text box. There are also some decorative icons like gears and speech bubbles.

“It’s crucial to build confidence in the platform as a tool to complement, not replace, human experts. Decision enrichment platforms augment senior staff and raise the consistency, quality, and speed of decision-making across the entire operations organization.”

Attempting to transform across all operational phases and scenarios, especially given the controversial nature of such a transformation, would be a critical misstep, likely leading to the project's failure. Instead, adopt an agile approach to ensure adaptability and success.

Prioritize goals and use cases:

Break down the broader goal into focused priorities. Target phases reliant on qualitative expertise and those with the highest operational and commercial impact, such as disruption management.

Once an operational area and flow are identified, start with high-impact sub-problems. For instance, if prioritizing disruption management, analyze potential ramifications, optimize departures and arrivals, and reassign crew and tails for recovery. Once the model is rolled out and achieves wider adoption, scale to more challenges like pairing reconstruction, fatigue reinstatement, or logistics rearrangement.

Ensure data and infrastructure readiness:

Success hinges on robust data and infrastructure. Key steps include:

Data centralization

Identify and normalize essential datasets (aircraft, crew, passengers, airports, etc.) for specific use cases into a centralized and unified repository. Ensure reliable APIs for real-time data access are in place where centralization isn't possible.

Seamless integration

Develop bi-directional interfaces with operational systems (reservations, ATC, ground, baggage, etc.) to ensure seamless communication and real-time data availability.

Airlines can successfully implement AI to transform operations and achieve consistent, high-quality decision-making by prioritizing use cases and aligning organizational and infrastructural readiness.

Transaction history

Provide high-quality, expert transaction history to enable AI to learn effectively. Poor data quality can severely hinder progress.

High-performance computing

Allocate secure and powerful computing resources to handle complex computations. Reliability, redundancy, and integrability are critical.

Many AI projects fail because of an inadequate data framework necessary for their success. A recent survey conducted by IBS Software revealed that 47% of participants identified the lack of centralized data to support intelligent digital platforms as a significant barrier to the faster adoption of advanced technologies like AI.

STAGE 2

Build the Experience Bank

An AI-driven Experience Bank is a powerful system that captures and stores the decision-making expertise of users – particularly those who consistently make optimal choices – building a robust repository of best practices. The system uses machine learning to identify patterns and correlations that define successful decision-making processes by recording the context, variables, and outcomes of decisions across diverse scenarios. This enables the Experience Bank to suggest or automate best-practice decisions, effectively replicating the expertise of top performers. Decoupling decision-making from veteran intervention ensures consistency, enhances operational efficiency, and empowers less experienced staff to deliver higher-quality results.



Key benefits of an Experience Bank:

Consistency across users

Decisions are based on collective knowledge over time rather than subjective intuition on the day, standardizing outcomes.

Faster onboarding

New staff can align with the performance of seasoned professionals faster.

Enhanced efficiency

AI provides actionable insights, improving decision speed and accuracy.

Getting going

01

Data collection and curation

- **Map key decision points:** Identify expert judgment that yielded effective outcomes and collect historical data, including contextual information, decision inputs, actions, and outcomes. Past data can be structured (e.g., transaction logs) or unstructured (e.g., handwritten reports).
- **Annotate and label data:** Distinguish successful, suboptimal, and neutral decision outcomes to train the model.

02

Experience modeling and knowledge representation

- **Define experience profiles:** Use collected data to create decision-making profiles, like decision trees, highlighting effective vs. ineffective pathways.
- **Feature engineering:** Extract key characteristics or signals (e.g., quantitative measures like time to action or qualitative ones like decision rationale) that drive successful outcomes.
- **Develop ontologies and rules:** Build a knowledge base or ontology to formalize relationships between decisions, outcomes, and context.

03

Machine Learning and AI modeling

- **Train decision models:** Leverage ML to analyze historical data and predict outcomes based on patterns from top performers.
- **Reinforcement Learning:** Enable AI to adapt and improve as new data enriches the experience bank, enhancing accuracy over time.
- **Feedback loops:** Incorporate real-time user feedback to refine recommendations and strengthen the experience database.

“Start small, test thoroughly, and roll out in phases to ensure AI maturity and effectiveness without disrupting operations.”

04

User interface and decision support integration

- **Create insightful interfaces:** Design intuitive interfaces to display AI recommendations, emphasizing the rationale based on past outcomes.
- **Embed in decision tools:** Integrate the AI experience bank into existing systems for real-time, data-driven guidance across all user levels.

05

Testing, validation, and continuous improvement

- **Test and validate:** Continuously compare AI recommendations with actual outcomes to ensure accuracy. Use pilots for performance evaluation.
- **Refine and expand:** Update models with new data, add features and periodically review experience profiles to meet changing needs.

Building an AI Experience Bank is an iterative process that relies on robust data management and continuous model training. This approach enables the Experience Bank to evolve into a dynamic, reliable resource that consistently supports high-quality decision-making across the organization.

Continuous refinement is key—fuel AI agents with quality data, expert input, and regular audits to ensure they meet evolving KPIs and drive operational success.

SNOWSTORM AT THE AIRLINE HUB

Access Experience Bank

- History of flight delays, crew availability, pax connection options, airport resource capacity, etc
- History of actions adopted by users to solve problems
- History of impacts of actions on resource availability and key KPIs

Predict & Explain best solutions

- Which flights to delay, cancel, divert etc?
- What airports and aircrafts to choose?
- Plan airport resources to meet demand of schedule changes e.g. de-icing equipment distribution.
- How to ensure crew availability – which reserve crew to assign?
- Predicting re-accommodations prioritizing passenger experiences

Challenges of creating an experience bank:

- **Static decision patterns:** Reliance on historical data can lead to inflexible responses in dynamic scenarios. For instance, in rapidly changing environments such as fluctuating passenger demand or during a weather disruption, the bank might lack strategies tailored to unique conditions, resulting in less effective responses.
- **Generalization:** Performance may suffer when data-trained models are applied to new environments with insufficient data. For example, if the bank was trained on data from one airport hub, it may not perform well in a different hub operating under different conditions.
- **Maintenance demands:** Continuous, human-supervised updates are needed to ensure relevance and accuracy.
- **Reduced personalization:** AI systems may struggle to adapt to unique user preferences or behaviors.

While building an Experience Bank is the first step to improving decision-making accuracy and consistency, the model needs to learn to adapt to changing scenarios and variables, ensuring AI evolves to address gaps in historical data.



STAGE 3

Evolve the Experience Bank with Reinforcement Learning

Reinforcement Learning (RL) enhances an Experience Bank by enabling dynamic adaptation and continuous improvement through feedback. By learning through trial and error, RL transforms the Experience Bank into a more responsive and effective decision-making tool. Integrating the Experience Bank with RL optimizes processes by offering historical insights and improving efficiency in exploration, policy evaluation, and decision-making.

Synergies between RL and an Experience Bank:

Replay buffer

The Experience Bank serves as a repository of diverse historical interactions, allowing RL to sample data, improve convergence, and reduce overfitting.

Guided exploration

Insights from the Experience Bank reduce exploration times by focusing on previously effective strategies.

Hybrid decision-making

AI provides actionable insights, improving decision speed and accuracy.

Reward shaping

Historical outcomes drive more precise rewards and penalties, refining RL policy evaluation and performance.



How RL enhances the Experience Bank:

01

Learning from trial and error

- **Adapting to dynamic environments:** RL enables the bank to adjust to changing conditions by learning from real-time feedback and adapting its recommendation strategy based on rewards or penalties.
- **Scenario simulation:** RL explores strategies in simulated environments, uncovering optimal decision patterns that aren't evident from historical data alone.

02

Continuous feedback integration

- **Real-time refinement:** Feedback from actions improves the system, reinforcing successful strategies and discouraging ineffective ones.
- **Personalized insights:** RL tailors recommendations to individual preferences or contexts, enhancing relevance and user satisfaction.

03

Consistency and objectivity

- **Bias reduction:** RL minimizes human biases by basing decisions on empirical feedback rather than intuition.
- **Standardized guidance:** By continuously refining a core set of optimal decision strategies, RL ensures that the Experience Bank delivers consistent, high-quality recommendations across users and departments.



04

Long-term optimization

- **Sustained rewards:** Unlike rule-based or short-term learning strategies, RL can prioritize long-term goals, like customer loyalty, over immediate sales gains.
- **Exploration vs. exploitation:** RL balances testing new decision strategies with leveraging proven ones to refine decision outcomes continuously.

05

Autonomous evolution

- **Alignment with growth:** RL adapts to changing organizational priorities, focusing on updated reward structures and goals.
- **Resilience in complexity:** RL builds flexibility and robustness in unpredictable environments, evolving continuously with new experiences.

Challenges of a single-agent RL model

- **Scalability:** A single-agent model struggles with complex tasks that require distributed decision-making and interdependent objectives, limiting its ability to scale effectively.
- **Context sensitivity:** It may not adapt well to localized decisions or nuanced environments (e.g., different airport hubs) due to a lack of flexibility in handling specialized operations.
- **Single point of failure:** Centralized reliance on one agent risks system-wide disruptions if errors occur, making the model vulnerable in dynamic, unpredictable environments.
- **Balancing conflicting goals:** Managing trade-offs in dynamic settings can be inefficient, with a single agent struggling to balance diverse objectives and adapt strategies, compared to multi-agent systems that specialize and collaborate for better performance.

By integrating RL, the Experience Bank evolves into an adaptive, proactive system that refines decision-making consistency, supports long-term organizational goals, and remains resilient in changing conditions. While a single RL agent lays the groundwork for the Experience Bank's steady improvement, adopting a Multi-Agent architecture helps scale those learnings and recommendations to address specific challenges in complex, multi-stakeholder environments.



STAGE 4

Scale the Experience Bank with a Multi-Agent RL architecture

Integrating a Multi-Agent Reinforcement Learning (MARL) model into an AI Experience Bank enables collaborative and competitive decision-making among multiple specialized agents. This process accelerates and scales insight generation in the Experience Bank, optimizing complex airline operations like crew scheduling, ground handling, and customer service.

MARL benefits

01 Cooperative agents for interdependent operations

- **Multi-variate analysis:** Agents representing specific operational areas (e.g., flight scheduling, crew availability, and ground operations) coordinate real-time adjustments to align flight timings and crew availability optimally. These proactive, interconnected recommendations are particularly useful during disruptions to accelerate recovery and minimize knock-on effects.
- **Resource allocation:** Dynamic resource management (e.g., gates, fuel trucks, maintenance teams) ensures efficiency based on predicted and current demands.



02 Competitive agents to test resilience

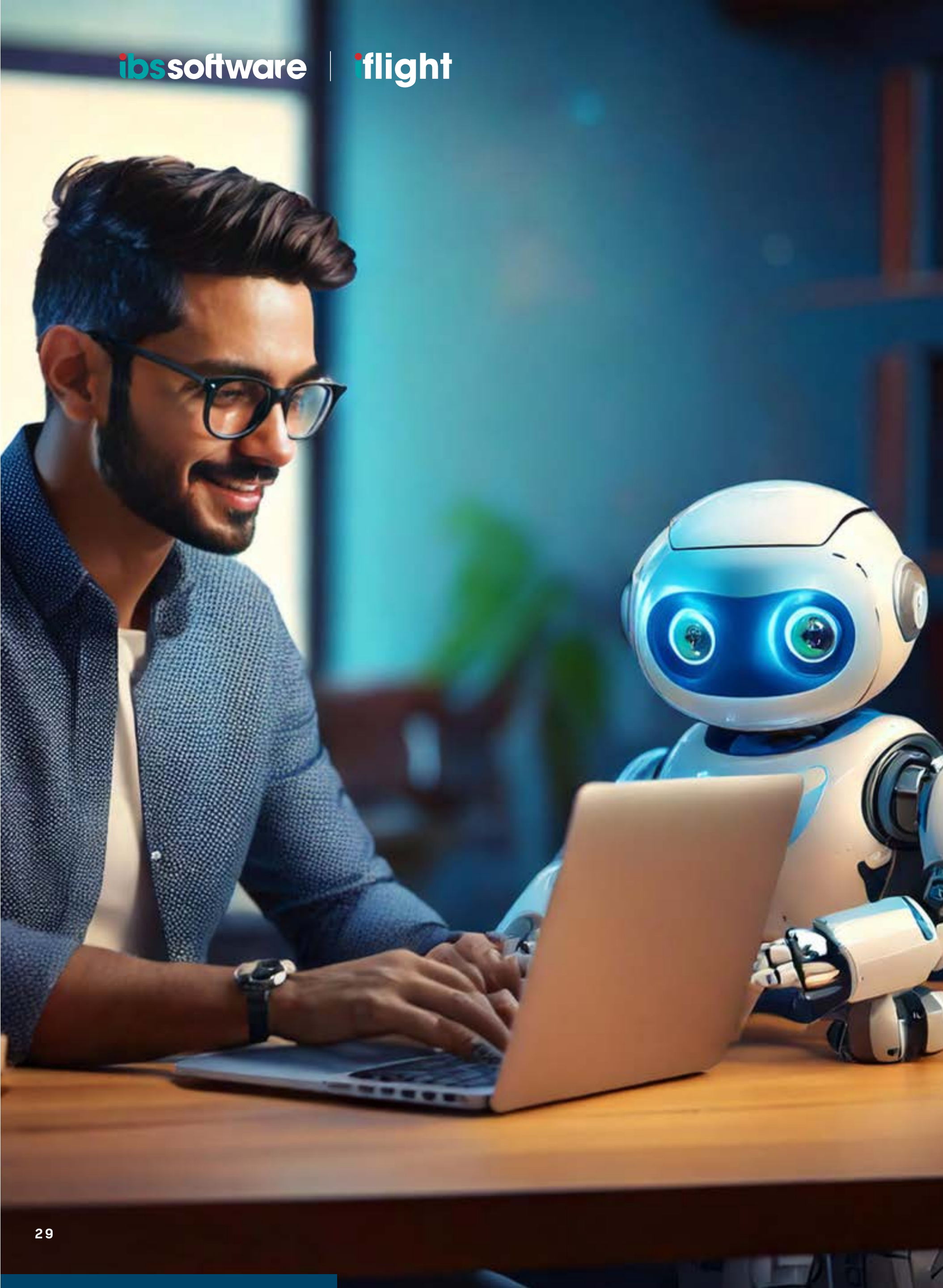
- **Simulating conflicts:** Agents with opposing goals (e.g., cost minimization vs. on-time performance) uncover balanced, robust decision strategies for real-world complexities.
- **Stress testing:** Simulations of extreme scenarios (e.g., severe weather or surges in demand) refine the Experience Bank's decision policies and build operational resilience.

03 Distributed decision-making for real-time adaptation

- **Decentralized operations control:** Local agents make autonomous decisions (e.g., handling flight delays) while coordinating with other agents for overall operational efficiency.
- **Disruption management:** Agents cooperate with each other to manage rerouting, rebooking, and resource reallocation to mitigate ripple effects during disruptions.

04 Cross-functional optimization

- **Inter-agent coordination:** Agents analyze dependencies (e.g., maintenance schedules influencing departures) to improve cross-departmental alignment and planning.
- **Reinforced patterns:** Successful collaboration patterns (e.g., reducing delays through synchronized crew and flight scheduling) are reinforced for consistent optimization.



05 Scalability and customization

- **Hub-specific strategies:** Agents adapt decision-making to meet the unique challenges of specific hubs, ensuring optimized operations based on local needs (e.g., gate availability, peak-time congestion).
- **Route optimization:** Agents tailor decisions for specific routes, like enhancing policies for connecting times or crew rest for long-haul flights, improving network efficiency.

06 Data-driven insights and continuous learning

- **Strategic refinement:** The Experience Bank receives data on how different strategies perform in varied scenarios over time to refine strategic policies, such as fleet allocation, staff scheduling, or contingency planning.
- **Evolving policies:** Feedback continuously refines agents' strategies, ensuring the Experience Bank identifies the best strategies for tackling new challenges.

Challenges

- **Resistance to change:** A primary challenge is the fear of replacement by advanced technology, leading to resistance against process and technology transformations.
- **Data quality and availability:** Airlines are still working towards centralizing and standardizing data across departments, limiting the quality and availability of AI training inputs. Furthermore, fragmented systems often result in missing or inaccessible logs, leading to incomplete transaction histories that undermine the robustness of training data.
- **Integration complexity and costs:** The operational landscape features diverse systems with varying technological maturity. Integrating and normalizing data between them requires investment.
- **Trust deficit:** AI's nascency in airline operations makes it difficult for users to trust its decisions, especially when the rationale behind those decisions isn't clear. Fears around stability, security, and privacy must also be addressed.
- **Patience at infancy:** The Experience Bank needs time to learn and refine its recommendations to match veteran expertise. This requires patience and sustained investment in time and resources. Once mature, the benefits will be exponential.

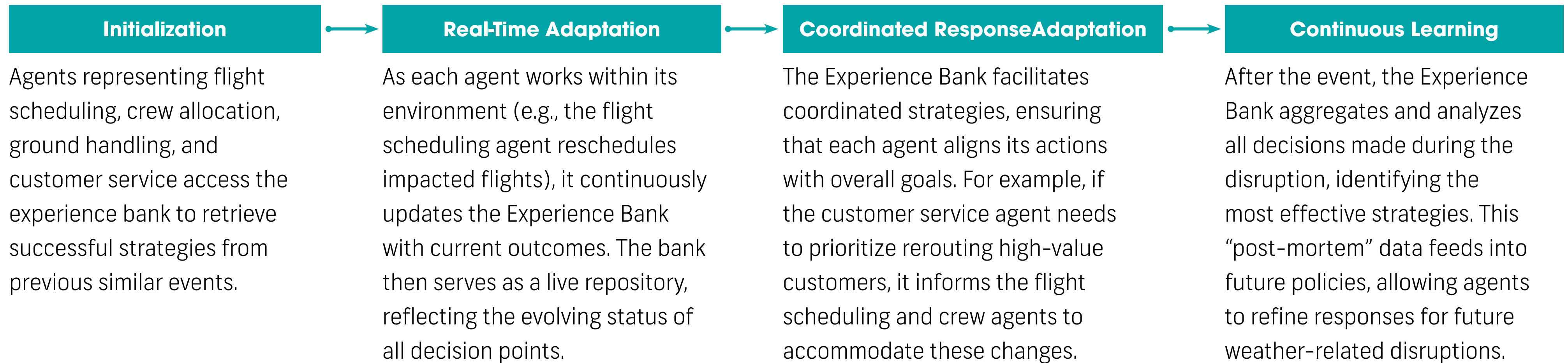
By leveraging MARL, airlines can enable autonomous, scalable, and adaptive decision-making across operations. This approach fosters resilience, optimizes coordination, and drives continuous improvement, ensuring better outcomes even in complex and dynamic environments. By addressing its adoption challenges through education, robust data management, transparent AI frameworks, and incremental implementation, airlines can pave the way to a new era of operational optimization.



The incremental growth and effectiveness of the model are intricately linked to the quality of data and the expertise of those who train it.

INTEGRATED DISRUPTION MANAGEMENT DURING SEVERE WEATHER

A severe weather event impacts multiple airline hubs simultaneously. An integrated MARL-supported Experience Bank enables the airline to orchestrate a dynamic, coordinated response:



Outcome

This integrated approach allows airlines to respond to disruptions dynamically, minimizing passenger inconvenience, optimizing resource utilization, and building resilience for future challenges. By continuously learning and improving, the system evolves into a proactive tool for disruption management.

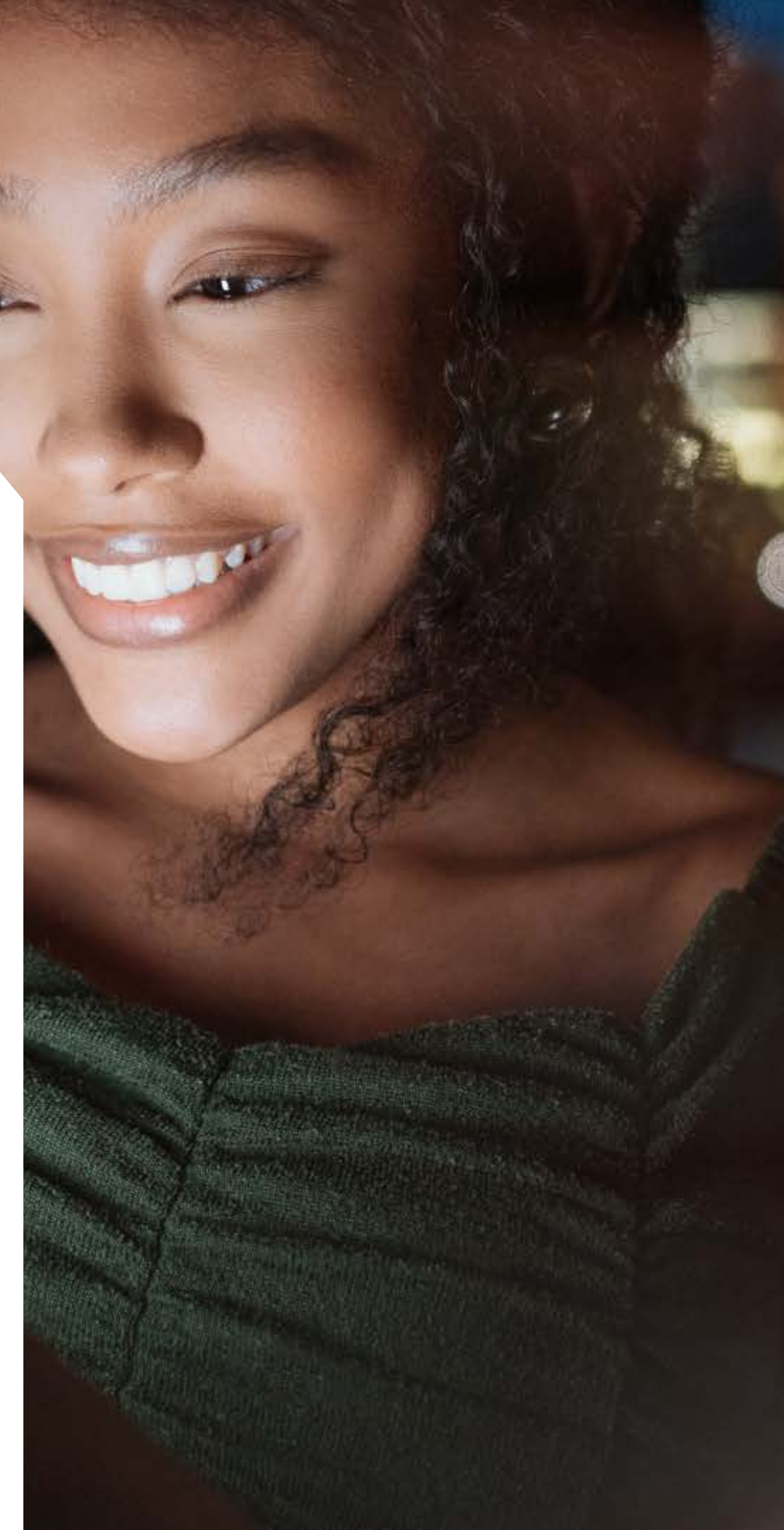
Enhancing operational performance and resilience with AI-assisted decisions

Integrating an Experience Bank with Multi-Agent Reinforcement Learning offers transformative benefits for airlines, enabling them to align operational efficiency with dynamic operating conditions. Adopting AI-assisted decisions minimizes disruptions, fosters interdepartmental coordination, and streamlines decision-making processes by consistently applying best practices across diverse scenarios.

AI is a powerful tool to support and accelerate decisions, ensuring that employees – from seasoned veterans to new hires – are empowered with actionable insights and proven strategies. This reduces overload on a shrinking pool of highly experienced professionals and speeds up the onboarding process for new talent, equipping them to make informed decisions faster.

Continuous data flows and experimentation between the Experience Bank and MARL-enabled systems create an intelligent, continuously evolving ecosystem. The Experience Bank aggregates historical successes, while MARL agents apply these insights in real-time to address current challenges and uncover new efficiencies. Together, these systems create a feedback loop that drives smarter, faster, compliant, and more coordinated decisions.

Internally, these technologies enhance decision-making across hubs and operational scenarios, reducing the cognitive load on operations professionals and fostering a culture of continuous improvement. By embracing AI-assisted tools, airlines can empower their workforce from planning to disruption management, elevate operational standards, and ensure readiness to navigate future complexities with confidence and resilience.



About IBS and iFlight

IBS Software is a leading provider of mission-critical SaaS solutions to the global travel industry.

iFlight is the only single-source and cloud-native platform for seamless airline operations and crew management.

Instant visibility

Centralized data enables instant visibility on flight, crew, and hub operations - all through a common platform - offering unrivaled performance management. Accurate, real-time, and holistic situational awareness breaks down silos, driving proactive stakeholder collaboration for fast and efficient operations. Beyond cold KPIs, iFlight boosts crew satisfaction and quality of life through crew-friendly and empowered planning, pairing, rostering, and optimization.

Industry-leading architecture

Leading airlines worldwide rely on iFlight for best-in-class planning, management, tracking, optimization, and recovery across the operational spectrum. Developed and continuously updated with the latest cloud architectures, frameworks, and protocols, iFlight's modular SaaS platform accelerates deployment while reducing the total cost of ownership.

Proactive learning and response

AI-driven tools and optimizers provide a helping hand and streamline recovery by recommending viable, compliant, and cost-aware solutions—proactively for any scenario. In parallel, ingrained ML ensures the system learns from the decisions made, so you're always ahead in strategic decision-making with automated recommendations.

Discover iFlight's rich capabilities and features

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