Msc Van Huong Ngo 2025, 13:4
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology

An Open Access Journal

A Technical Analysis Of Software For Managing Fuel Consumption, Range, And Endurance In Modern Aviation

[1] Msc Van Huong Ngo, [2] Msc Trong Son Phan, [3] Msc The Son Nguyen, [4] Msc Le Phan, [5] Msc Van Tuyen Nguyen

Abstract- Amid rising fuel costs and mounting environmental pressures, the aviation industry faces the dual challenge of reducing operational expenditures while meeting stringent carbon reduction mandates. As fuel remains the largest single cost component and a major source of emissions, software systems for managing fuel consumption, range, and endurance have become indispensable. This paper provides a technical analysis of the principles, control methods, and strengths and limitations of such systems. To illustrate these concepts in practice, the paper presents an in-depth case study of Viettel's SkyBook, an Electronic Flight Bag (EFB) developed in Vietnam. By examining its architecture, functionalities, strategic advantages, and challenges, the study demonstrates how localized innovation can support global standards in aviation. The analysis concludes by emphasizing the role of software-driven optimization as a strategic driver of safety, cost-efficiency, and sustainability in modern aviation.

Keywords- Aviation industry,Rising fuel costs,Environmental pressures,Carbon reduction mandates,Fuel management systems.

I. INTRODUCTION

Fuel management has long been central to aviation operations. Traditionally, pilots and operators relied on paper manuals, look-up charts, and personal experience to calculate fuel requirements, endurance, and range. Although effective in simpler operational contexts, such approaches have become increasingly inadequate in today's complex environment. Aircraft now generate vast amounts of operational data, and airlines face intense economic and environmental pressures.

In response, advanced software platforms have emerged that integrate real-time data streams, predictive algorithms, and optimization tools. These systems extend beyond simple fuel calculations, forming part of a wider digital ecosystem that supports both operational decisions and long-term strategic planning. This paper first outlines the theoretical and operational underpinnings of fuel management software, then analyzes their benefits and limitations, and finally presents Viettel SkyBook as a case study that highlights the potential of localized technological innovation in aviation.

II. PROBLEM STATEMENT

Fuel consumption errors are not only costly but potentially hazardous. Even minor miscalculations can lead to excessive expenditures or, in worst-case scenarios, fuel exhaustion in-flight. At the same time, international regulatory bodies such as ICAO and IATA have tightened environmental requirements, demanding that airlines demonstrate measurable reductions in carbon emissions.

Operating under razor-thin margins, airlines cannot afford inefficiencies in fuel management. The challenge, therefore, extends beyond ensuring adequate fuel for flight completion: it lies in systematically optimizing every aspect of consumption. This imperative drives the development of integrated software systems capable of consolidating data, modeling performance, and providing actionable insights in real time.

III. METHODOLOGIES FOR CONTROL AND OPTIMIZATION

Modern aviation fuel management and optimization systems represent a significant advancement over traditional methods, moving away from single-source data to a comprehensive, integrated approach. The foundational step in this process is Data Acquisition and Integration. These sophisticated software solutions do not rely on a single system but instead draw from a variety of heterogeneous inputs to create a cohesive and dynamic model. Data is continuously streamed from on-board Engine Monitoring Systems (EMS), which provide critical, real-time metrics such as fuel flow rates, thrust output, and exhaust gas temperature. This information is combined with data from Flight Management Systems (FMS), which deliver essential details on the aircraft's current payload, altitude, speed, and center of gravity. Finally, Meteorological Sensors contribute real-time atmospheric conditions, including wind speed and direction, temperature, and pressure. The seamless integration of these diverse data streams is crucial, as it allows the system to create a holistic, dynamic model that accurately reflects the complex interplay between weight, lift, drag, weather, and engine performance throughout the entire flight.

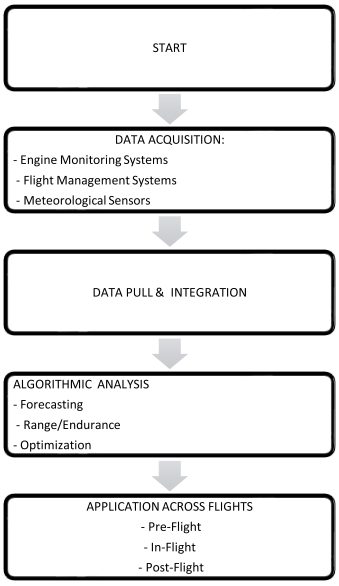

Figure 1. Flowchart of fuel consumption, range and flight time calculation algorithm

Once this consolidated data is available, it is processed through a suite of sophisticated Algorithmic Analysis and Predictive Modeling techniques. The integrated model enables Fuel Burn Forecasting, where real-time fuel consumption is rigorously compared with both a theoretical baseline and historical flight patterns to identify any anomalies or deviations. Advanced computational models, leveraging principles like the Breguet range equation, are used to generate precise Range and Endurance Calculations, providing pilots and ground control with accurate estimates of remaining flight time and distance. The most impactful aspect of this stage is Real-Time Optimization. The system analyzes the current flight parameters against the dynamic environmental conditions and can propose subtle, proactive adjustments to the aircraft's altitude or speed. By exploiting favorable atmospheric conditions, such as a tailwind, these minor adjustments can significantly reduce fuel burn without impacting the flight schedule, leading to considerable operational savings.

The application of fuel management software spans the entire operational cycle of a flight. In the Pre-Flight phase, the system runs scenario simulations to support flight planners in determining the most optimal cruise profiles before takeoff. During the In-Flight phase, continuous monitoring of fuel consumption and performance allows the system to issue immediate alerts if abnormal consumption is detected, giving the crew time to address potential issues. After the flight is complete, the Post-Flight phase is where the system's data reports are analyzed. This analysis allows operators to review the performance of both the aircraft and the flight crew, providing valuable feedback that can be used to refine and improve long-term operational strategies. This continuous process demonstrates that these systems provide not only immediate, in-the-moment support but also establish a crucial feedback loop for continuous operational refinement and excellence.

While the advantages of these systems are clear, their implementation is not without challenges. The primary benefits include substantial Cost Reduction through optimized fuel consumption, enhanced Environmental Compliance by supporting carbon reduction commitments, and improved Safety Enhancement by providing accurate fuel predictions

that mitigate the risk of shortages. Furthermore, the aggregated data provides invaluable Strategic Insight for identifying long-term trends and improving operational practices. However, these benefits must be weighed against several Limitations. The High Implementation Costs for infrastructure and licensing can be a significant barrier to entry for smaller airlines. There are also considerable Training Demands for pilots and operations personnel who must adapt to new workflows and procedures. The system's effectiveness is entirely dependent on the Data Reliability from its various sensors, and Integration Challenges may arise when attempting to sync the software with older, legacy systems. Despite these hurdles, the widespread adoption of such systems underscores their undeniable value to the modern aviation industry.

IV. ADVANTAGES AND LIMITATIONS OF FUEL MANAGEMENT SOFTWARE

Advantages

- Cost Reduction: Optimized consumption can save airlines millions annually.
- Environmental Compliance: Reduced burn supports carbon reduction commitments.
- Safety Enhancement: Accurate real-time predictions mitigate risks of fuel shortage.
- Strategic Insight: Aggregated data help operators identify trends and refine practices.

Limitations

- High Implementation Costs: Infrastructure and licensing require substantial investment.
- Training Demands: Pilots and operations personnel must adapt to new workflows.
- Data Reliability: System accuracy depends on the integrity of sensors and communications.
- Integration Challenges: Legacy systems may resist seamless synchronization.
- Despite these limitations, the widespread adoption of such systems reflects their undeniable value to modern aviation.

V. CASE STUDY: VIETTEL SKYBOOK

Overview

To illustrate the practical application of these principles, this paper examines Viettel SkyBook, an EFB developed by Viettel Software in Vietnam. Awarded the Sao Khue Prize in 2025, SkyBook exemplifies how localized innovation can align with global aviation standards while addressing regional needs. It replaces bulky paper documentation with a comprehensive digital platform and integrates seamlessly with airline operational systems, thereby positioning itself not only as a digital tool but as a strategic enabler of transformation.

System Architecture and Functionalities

SkyBook is structured as a modular, interconnected platform, with functionalities spanning:

- Digital Briefing and Document Management: Provides updated operational manuals and integrates real-time METAR, TAF, and NOTAMs.
- Journey Logging: Automates recording of block-off, block-on, fuel uplifts, delays, and irregularities, creating an auditable log.
- Performance Calculations: Automates computations of weight, balance, maximum takeoff weight, and takeoff/landing performance metrics.
- Integration and Data Flow: Connects cockpit systems with Operations Control Centers (OCC), safety systems, and maintenance databases.
- Alerts and Notifications: Highlights critical conditions such as restricted airspace or weather minima, reducing pilot workload.
- Connectivity and Synchronization: Supports Wi-Fi, 3G/4G/5G, with offline functionality for resilience.

Strategic Advantages.

SkyBook offers multiple benefits:

- Operational Efficiency: Streamlines workflows, reduces turnaround time, and decreases paperwork.
- Error Reduction: Automation minimizes risks of manual miscalculation.
- Safety Assurance: Provides reliable and up-to-date information in critical phases of flight.

- Regulatory Compliance: Supports adherence to ICAO and IATA digital recordkeeping standards.
- Localization: Tailored for Vietnamese regulations and language, offering cost efficiency compared with imported systems.
- Digital Sovereignty: Contributes to national independence in aviation digital infrastructure.

Limitations and Challenges

Nonetheless, SkyBook faces challenges that mirror those of EFB systems worldwide:

- Dependence on accurate sensor data.
    - Training requirements for pilots and ground staff.Integration difficulties with older systems.
- Continuous certification demands for Class 2/3 EFB compliance.

Table 1. Consolidates SkyBook's main features

Feature	Description
Digital Briefing	Real-time, alert-prioritized briefing with integrated weather and NOTAMs
Journey Logging	Automated log of timings, fuel, and events synced with ground systems
Performance Tools	Automated weight, balance, and takeoff/landing calculations
Integration	Seamless data exchange with OCC, SMS, maintenance, and APIs
Alerts& Notifications	Interactive warnings for critical conditions
Connectivity	Wi-Fi, 3G/4G/5G support with offline capability
Customization	Modular design tailored to operator requirements

VI. CONCLUSION

From simple manual aids to integral operational systems, fuel management software has become a cornerstone of modern aviation. By harnessing big data, predictive modeling, and artificial intelligence, these systems empower airlines and military operators to lower costs, increase safety, and enhance sustainability.

The case of Viettel SkyBook demonstrates that local innovation can achieve global relevance, offering both technological sophistication and contextual adaptation. By enabling digital transformation and reinforcing national capabilities, SkyBook represents a strategic platform for Vietnam's aviation industry.

Looking ahead, the deeper integration of EFB systems with air traffic management and AI-driven optimization will accelerate the transition toward a safer, more efficient, and environmentally sustainable aviation sector worldwide.

REFERENCES

1. Breguet, L. (1920). Calculations of Aircraft Range and Endurance. Aeronautical Press.
2. Daniel P. Raymer. Aircraft Design: A Conceptual Approach. AIAA Education Series – 2012.
3. EUROCONTROL, Base of Aircraft Data (BADA) User Manual, Eurocontrol Experimental Centre – 2009.
4. International Civil Aviation Organization (ICAO). (2023). Environmental Protection and Fuel Efficiency in Aviation. ICAO Publications.
5. OpenAirlines. (2024). SkyBreathe Analytics Overview. Retrieved from https://www.openairlines.com.
6. GE Digital. (2024). Fuel Insight Overview. Retrieved from https://www.ge.com/digital.
7. Viettel Software. (2025). SkyBook Product Information. Retrieved from https://viettelsoftware.com.

Author's details

1 Van Huong Ngo Faculty of Aircraft – Engines, Air Force Officer's College, Khanh Hoa, Viet Nam, Vanhuongkq@gmail.com

2 MSc Trong Son Phan, Faculty of Aircraft – Engines, Air Force Officer's College, Khanh Hoa, Viet Nam, trongson21@gmail.com

3 MSc The Son Nguyen, Faculty of Aircraft – Engines, Air Force Officer's College, Khanh Hoa, Viet Nam, theson20041993@email.com

4 MSc Le Phan, Faculty of Aircraft – Engines, Air Force Officer's College, Khanh Hoa, Viet Nam, lephan1093@gmail.com

5 MSc Van Tuyen Nguyen, Faculty of Aircraft – Engines, Air Force Officer's College, Khanh Hoa, Viet Nam, chantroixanh6868@gmail.com