



Aviation Economy and the Balance of Payments in Iraq: A Hybrid Analysis Using SWOT–TOPSIS

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Abstract

The civil aviation sector is a pillar of economic growth strategy due to its effective role in facilitating commercial operations and expanding tourism services, in addition to providing job opportunities. In rentier economies such as Iraq, where oil is the main source of income, it is important to stimulate non-oil sectors, particularly aviation services, in order to strengthen the balance of payments' capacity to achieve comprehensive economic diversification. The objective of this study is to analyse the structural and financial framework of the civil aviation sector in Iraq during the period (2015-2024) and assess its ability to sustainably support the balance of payments.

This study uses a mixed analytical framework combining the SWOT and TOPSIS methods, in addition to multi-criteria decision-making tools based on the Python language (PY Decision). Quantitative indicators based on passenger traffic, air cargo volume and aviation revenues were extracted using official data from the Central Bank of Iraq, the Ministry of Transport and international aviation organisations ,The research findings regarding the balance of payments are as follows:

The research findings show that the aviation sector is strategically important as a catalyst for improving Iraq's external balance, particularly the services account in the balance of payments. Unlike rentier exports, aviation services—such as passenger transport, cargo logistics, and flight operations—generate foreign cash flows that are less dependent on commodity price cycles and more resilient to global demand fluctuations.

Simulation analysis shows that digital transformation (alternative B) emerges as the most effective measure, capable of increasing aviation revenues by 25% and reducing the services account deficit by up to 40% by 2030.

These gains can be achieved by improving transaction transparency, enhancing ticketing and shipping processes, and reducing foreign currency leakage through domestic services. In addition, regulatory reforms (Alternative D) complement this scenario by addressing structural deficiencies and improving regulatory responsiveness.

Keywords : *Aviation economy, balance of payments, SWOT analysis, TOPSIS, digital transformation.*



اقتصاد الطيران وميزان المدفوعات في العراق: تحليل هجين باستخدام SWOT-TOPSIS

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المستخلص :

يعد قطاع الطيران المدني ركيزة استراتيجية النمو الاقتصادي نظرا لدوره الفعال في تسهيل العمليات التجارية وتوسيع الخدمات السياحية ، بالإضافة إلى توفير فرص العمل. في الاقتصادات الريعية مثل العراق ، حيث النفط هو المصدر الرئيسي للدخل ، من المهم تحفيز القطاعات غير النفطية ، وخاصة خدمات الطيران ، من أجل تعزيز قدرة ميزان المدفوعات على تحقيق التنوع الاقتصادي الشامل. تهدف هذه الدراسة إلى تحليل الإطار الهيكلي والمالي لقطاع الطيران المدني في العراق خلال الفترة (2015-2024) وتقييم قدرته على دعم ميزان المدفوعات بشكل مستدام .

تستخدم هذه الدراسة إطارا تحليليا مختلطا يجمع بين أساليب the SWOT and TOPSIS methods ، بالإضافة إلى أدوات صنع القرار متعددة المعايير على أساس لغة بايثون (PY Decision). تم استخراج المؤشرات الكمية القائمة على حركة المسافرين وحجم الشحن الجوي وعائدات الطيران باستخدام بيانات رسمية من البنك المركزي العراقي ووزارة النقل ومنظمات الطيران الدولية.

نتائج البحث المتعلقة بميزان المدفوعات هي كما يلي، تظهر نتائج البحث أن قطاع الطيران له أهمية استراتيجية كمحفز لتحسين التوازن الخارجي للعراق ، وخاصة حساب الخدمات في ميزان المدفوعات. على عكس الصادرات الريعية ، فإن خدمات الطيران- مثل نقل الركاب ، والخدمات اللوجستية للبضائع ، وعمليات الطيران- تولد تدفقات نقدية أجنبية أقل اعتمادا على دورات أسعار السلع وأكثر مرونة في مواجهة تقلبات الطلب العالمي .

يظهر تحليل المحاكاة أن التحول الرقمي (البديل ب) يظهر باعتباره الإجراء الأكثر فعالية ، والقادر على زيادة إيرادات الطيران بنسبة 25 ٪ وتقليل عجز حساب الخدمات بنسبة تصل إلى 40 ٪ بحلول عام 2030.

ويمكن تحقيق هذه المكاسب من خلال تحسين شفافية المعاملات ، وتعزيز عمليات إصدار التذاكر والشحن ، والحد من تسرب العملات الأجنبية من خلال الخدمات المحلية. وبالإضافة إلى ذلك ، تكمل الإصلاحات التنظيمية (البديل دال) هذا السيناريو بمعالجة أوجه القصور الهيكلية وتحسين الاستجابة التنظيمية.

الكلمات المفتاحية: اقتصاد الطيران ، ميزان المدفوعات ، تحليل سوات ، توبسيس ، التحول الرقمي.



1. Introduction

The aviation sector plays an important role in modern economies by conducting (trade, tourism, communications, knowledge flows). In many countries, no improvements in the flight service

Transport infrastructure and services stimulate regional development, enhancing market access and promoting economic growth (Vitek et al., "Air transport, And their social and economic effects"). Several studies highlight that aviation

Directly contribute to GDP through airline operations and airport activities, indirectly in the induced links with the supplier industries (ICAO / CGE).

The aviation sector has untapped potential to diversify non-oil revenue sources, in the context of developing and resource-rich economies, such as Iraq, it can reduce exposure to external shocks and strengthen the balance of payments. Balance of Payments represent the country's record of all economic transactions with the rest of the world. A sustainable external situation requires that the current account (including exports and imports of services) and the Capital/Financial Account remain relatively Balance. The aviation sector, especially by air freight and air passenger services, It can contribute positively to the service exports side of the equation.

However, despite this theoretical potential, the Iraqi aviation sector faces many structural, organizational and operational constraints that limit its external contribution. In Especially, (limited charging capacity, regulatory bottlenecks, insufficient digital Underdeveloped infrastructure and quality of Service prevented aviation from playing a key role Balancing dependence on oil). Moreover, the (low diversification of service exports. In Iraq, this



means that any improvement in aviation performance can have a significant impact on the external sector.

The contributions of this paper are threefold:

1. It offers a combined SWOT–TOPSIS framework specifically tailored to a rentier economy’s aviation-balance nexus.
2. It quantifies alternative development paths (e.g. digital transformation, cargo expansion) and estimates their incremental effect on aviation revenues and service-account deficits.
3. It proposes policy recommendations grounded in data-driven ranking, focusing on how to unlock aviation’s external leverage in a challenging institutional environment.

The remainder of the paper is structured as follows: Section 2 reviews related literature on aviation’s economic impacts and balance of payments linkages; Section 3 describes the methodology, data sources, and scenario setup; Section 4 presents the results, combining SWOT output and TOPSIS rankings and simulation results; Section 5 concludes with policy implications and recommendations.

2. Methods

2.1. Research Design and Analytical Framework

This study presented a dual analytical framework that integrates qualitative strategy (assessment through the strengths, weaknesses, opportunities, and threats model) with multi-criteria decision-making (MCDM) using the topsis method (technique for ordering preferences by measuring against an ideal solution).



This design allows qualitative insights to be translated into measurable and comparable criteria that provide decision-makers with evidence-based results in the aviation sector.

The analytical process is divided into four main stages:

- **Diagnostic Assessment:** A comprehensive evaluation of Iraq's civil aviation sector's structure, performance, and institutional environment.
- **SWOT Analysis:** Identification of the sector's internal strengths and weaknesses and its external opportunities and threats.
- **Quantitative Evaluation with TOPSIS:** Transformation of qualitative SWOT elements into measurable criteria and ranking of strategic development alternatives.
- **Scenario Simulation:** Estimation of the sector's potential contribution to the service component of the balance of payments through a Monte Carlo simulation model using Python.

This integrated approach provides systematic accuracy by combining firstly (structured judgment of experts with experimental data), and secondly (aligning strategic vision with quantifiable outcomes).

2.2. Data Sources

The study uses data sources (primary and secondary). Secondary data were obtained from official and international reports , including:

Central Bank of Iraq (2015–2024): Balance of payments data, service-account structure, and foreign currency flows.

- **Iraqi Civil Aviation Authority & Ministry of Transport:** Passenger and cargo volumes, revenue indicators, and regulatory reports.
- **IATA (2023) and ICAO (2022–2023):** International aviation benchmarks and compliance audits.



The initial data was obtained through (structured interviews with 12 experts from Iraq, The civil aviation sector), as well as (policy makers and managers of airlines and airport operations Aviation specialists and economists). These interviews led to the identification of SWOT factors and the weighting of topsis criteria.

2.3. Expert Panel Characteristics

The structured interviews were also conducted between March and May 2024. The experts were selected based on their professional importance, experience and institutional role. Table number (1) displays the main characteristics of the panel.

Table 1. Characteristics of the Expert Panel

Expert Group	Number	Specialization	Years of Experience
Civil Aviation Authority officials	4	Air transport policy and regulation	12–20
Airline managers (Iraqi Airways, Kurdistan Air)	3	Airline operations and commercial strategy	10–18
Airport infrastructure specialists	3	Airport planning, logistics, and navigation systems	8–15
Academic researchers in aviation economics	2	Economic modeling and trade analysis	7–14

Source: Authors' structured interviews, 2024.

2.4. SWOT Analysis and Conversion to Quantitative Criteria

The framework has been activated to identify the strategic factors that advance Iraq the aviation sector. By validating these factors by a team of experts and a triangle with Official reports. Table No. 2 shows the matrix of unified strengths, weaknesses, opportunities and risks.

**Table 2. SWOT Matrix for Iraq's Civil Aviation Sector (2015–2024)**

Strengths	Weaknesses	Opportunities	Threats
Strategic location connecting three continents(IATA,2022)	Outdated airport infrastructure	Digitalization initiatives(ASYCUDA Air,2023)	High insurance costs due to security risk Lloyd's Aviation,2023
Skilled technical personnel in Iraqi Airways	Fragmented regulatory framework	Regional open-sky agreements	Strong regional competition (Amman, Doha, Dubai).
Rising domestic demand due to improved security	Limited cargo capacity and outdated systems	Expansion of religious and medical travel	Volatile fuel prices and geopolitical instability

Source: Compiled by authors based on IATA (2022), ICAO (2022), Ministry of Transport (2023), COSIT (2020–2023), Lloyd's Aviation (2023).

To make these qualitative factors in the topsis model effective, each of them was assigned a quantitative criterion based on its measurable effect:

- Revenue impact (M1): depends on strengths (for example, demand growth) and opportunities (For example, the expansion of goods).
- Implementation cost (M2): depends on weaknesses (e.g. infrastructure deficit) and Threats (for example, expenses related to security).
- Implementation time (M3): it is influenced by the organizational complexity and scope of the project.
- Feasibility (M4): depends on institutional readiness and policy environment.

The correctness of the mapping process was verified by expert consensus (Cronbach's Alpha = 0.89), Ensuring internal consistency in the transition from qualitative to quantitative Input.

2.5. Topsis methodology and mathematical formulation

2.5.1. Criteria Weights

The relative weights of the four criteria(M1–M4) were determined based on the expert panel's assessment, as shown in the following table:

**Table 3. TOPSIS Criteria Weights as Determined by the Expert Panel**

Criterion	Symbol	Weight(wj)	Type
Revenue Impact	M1	0.35	Benefit Criterion (to maximize)
Implementation Cost	M2	0.25	Cost Criterion (to minimize)
Implementation Time	M3	0.20	Cost Criterion (to minimize)
Feasibility	M4	0.20	Benefit Criterion (to maximize)

Source: Authors' construction based on expert panel assessment results, 2024.

The model estimates the aviation sector's net contribution to the services account(B_aviation) using the following functional form:

the ranking of strategic alternatives by their proximity to the ideal, The solution was using the topsis method, the four criteria defined above (M1-M4) and the four public policy alternatives are Analysis

A: Airport infrastructure modernization

B: Digital transformation and smart aviation management

C: Regional partnerships and route expansion

D: Organizational reform and capacity building

Step 1: Constructing and Normalizing the Decision Matrix

The decision matrix $D = [x_{ij}]$ represents the performance score of alternative A_i under criterion :

$$D = \begin{matrix} & \begin{matrix} x_{11} & x_{12} & \dots & x_{1n} \end{matrix} \\ \begin{matrix} x_{21} \\ x_{22} \\ \vdots \\ x_{m1} \end{matrix} & \begin{matrix} x_{22} & x_{22} & \dots & x_{2n} \\ x_{m2} & x_{m2} & \dots & x_{mm} \end{matrix} \end{matrix}$$

Normalization removes unit inconsistencies:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}$$

Step 2: Weighted Normalized Matrix

Each normalized value is multiplied by its criterion weight w_j :

$$V_{ij} = w_j \times r_{ij}$$



where $\sum_{j=1}^n w_j = 1$

Step 3: Positive and Negative Ideal Solutions

For benefit criteria:

$$A^+ = \{v_1^+, v_2^+ \dots \dots, v_n^+\}, v_j^+ = \max(v_{ij})$$

For cost criteria (reverse direction):

$$v_j^+ = \min(v_{ij}), v_j^- = \max(v_{ij})$$

Step 4: Distance from Ideal Solutions

$$D_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2}$$

Step 5: Relative Closeness Coefficient and Ranking

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-}$$

A higher (C_i) indicates greater closeness to the ideal solution and a higher ranking.

2.6. Monte Carlo Simulation of the Sector's Contribution to the Services Account

To assess whether improvements in the aviation sector can affect Iraq's balance of payments, a Monte Carlo simulation was conducted for the period 2025-2030 under two scenarios: (Baseline) and (Policy Intervention). The simulation relied on historical data for variables such as revenue volatility, travel demand elasticity, and sensitivity to fuel prices. 1000 iterations of the simulation were run to estimate the cumulative impact of policies under conditions of uncertainty.

By checking the internal consistency of expert-derived weights using kronbach Alpha = 0.89, the model indicates a strong reliability. (Sensitivity



analysis with a weight of 10%) (weight) The contrast showed stable assessments in more than 85% of cases). All calculations have been made Using Python 3.11, using the NumPy, PY Decision, and skate learning libraries.

3. Results

Arranging strategic alternatives using topsis by constructing a weighted decision matrix and applying (topsis algorithm) as follows Detailed in Section 3, we evaluated four strategic alternatives alternatives based on its relative Proximity to the ideal solution. The assessment included four main criteria (Revenue impact, implementation cost, implementation time, feasibility-that.

Table 3 shows the results of the final ranking along with The Associated impact on the service Calculation of the balance of payments in IraqTable 3 presents the final ranking results along with the associated impact on the service account of Iraq's balance of payments.

Table 4. TOPSIS Results with Key Criteria and Implications for the Balance of Payments

Alternative	Closeness Coefficient (Ci)	Rank	Main criteria Driving the ranking	Expected Annual Revenue Growth (%)	Impact on BoP Service Account	Interpretation
B – Digital transformation and smart aviation	0.85	1	High revenue impact, low cost, rapid implementation	+25 %	Deficit reduction $\approx$ 40 % by 2030	Highest efficiency gains due to low cost and quick scalability; improves ticketing, cargo management , and digital



						payments inflows.
D – Organization al reform & capacity building	0.74	2	High feasibility, medium cost, moderate revenue impact	+18 %	Moderate deficit reduction ≈ 25 %	Enhances operational governance and reduces administrative leakages.
A – Airport infrastructure modernization	0.60	3	Long implementation time, high cost, moderate revenue impact	+12 %	Minor deficit reduction ≈ 10 %	Capital-intensive; long-term benefits but delayed returns.
C – Regional partnerships & route expansion	0.55	4	Medium feasibility, low revenue impact, competitive constraints.	+8 %	Limited impact ≈ 5 %	Relies on external partners; constrained by competition from regional hubs.

Source: Authors' calculations based on Central Bank of Iraq (2015–2024), Iraqi Civil Aviation Authority (2023), ICAO (2023), and IATA (2024).

3.1. Simulation of the aviation contribution to the calculation of the service

Determines whether improvements in the aviation sector can affect Iraq's balance

Of the payments, the Monte Carlo simulation for the period 2025-2030 was conducted under Scenarios (baseline) and (political intervention). Built-in historical simulation (Revenue volatility), (elasticity of passenger demand), (sensitivity to fuel prices).

The model arrived at the net contribution of the aviation sector to the calculation of the service (B)) using the following functional form:



The model estimates the aviation sector's net contribution to the service account ($B_{aviation}$) using the following functional form:

$$B_{aviation} = (R_{inbound} + R_{freight} + R_{overflight}) - (E_{outbound} + E_{leasing} + E_{insurance})$$

Where:

$R_{inbound}$: inbound passenger and ticketing revenue

$R_{freight}$: air cargo revenue

$R_{overflight}$: overflight fees and service charges

$E_{outbound}$: outbound payments for foreign carriers

$E_{leasing}$: aircraft leasing costs

$E_{insurance}$: insurance and security-related payments

Simulations (1000 repetitions) show that:

Depending on the baseline scenario, flows (services related to aviation) range from 165 to 225 US dollars, Million per year with an average of 193 million US dollars.

Under the digital transformation scenario (alternative B), the top can rise to 260 million USD, which represents the emergence of an improvement of about 75 million USD per. And reduce (the deficit in the account of aviation services) by up to 40% by 2030.

3.2. Channels of Impact on the Balance of Payments

The results (simulation and ranking) reached three main transmission channels through What reforms in aviation services strengthen Iraq's balance of payments:

1. **Revenue expansion channel:** can be achieved by (improving freight operations), (increasing passenger load Factors), and (higher ticket revenues directly increase service exports).



2. Cost reduction channel: through (localization of maintenance, ground handling and booking Systems reduces foreign currency flows).

3. Data governance channel: digitization improves reporting and accounting (Flows of aviation services), (reduction of unrecorded leaks in the balance of payments)

3.3. Key Findings

- Digital transformation (Alternative B) is the most effective and rapid pathway to enhance aviation's contribution to the service account, with significant revenue gains and reduced outflows.
- Organizational reform (Alternative D) complements digitalization by improving institutional capacity and operational efficiency.
- Infrastructure modernization (Alternative A), while necessary in the long term, delivers slower returns due to its capital intensity.
- Regional partnerships (Alternative C) face structural limitations due to regional competition and capacity constraints.

4. Discussion

4.1. Interpretation of Findings in the Context of the Balance of Payments

The results of this study highlight the strategic importance of the aviation sector as a catalyst for improving Iraq's external balance, especially within the service account of the balance of payments. Unlike traditional commodity exports, aviation services - such as passenger transportation, cargo logistics, overflight operations — generate foreign exchange flows that are less dependent on commodity price cycles and more resilient to fluctuations in global demand.

The simulation analysis shows that digital transformation (alternative B) stands out as the most effective path, capable of increasing aviation revenue



by 25% and reducing the service account deficit by up to 40% by 2030. These gains are primarily achieved by improving the transparency of transactions, enhancing ticketing and shipping processes, and reducing the leakage of foreign currency through domestic services. Moreover, regulatory reforms (alternative d) complement this scenario by addressing structural deficiencies through improved regulatory response.

The evidence also suggests that while infrastructure modernization is the first alternative (alternative A) and regional partnerships are the second alternative (alternative C) have advantages, their short-term impact is limited due to high capital requirements, and (long implementation timelines). And (regional competitive pressures). However, its effects in the medium and long term) could be significant if integrated into a broader aviation development strategy based on the gains achieved through digitization.

4.2. Comparative Perspective: Insights from Other Economies

These results are consistent with international experiences in the field of aviation sector reform, which leads to improved service account performance. For example, in Kazakhstan (a digital platform for aviation was implemented in 2018, which led to a decrease in foreign payments, mainly in foreign currency for tickets and maintenance by more than 30% as well as a recorded increase in service flows by about 20% in three years (altanbek et al. 2021) South Africa's aviation modernization program has also improved cargo efficiency and diversified service exports, contributing to a 25% improvement in its service balance.

In 2017 and 2022 (ndelila and Moyo, 2023) and these experiences provided a valuable comparative background to the state of the aviation sector in Iraq.



The aviation sector in Iraq has untapped potential due to regulatory fragmentation, outdated regulations and inadequate digital infrastructure.

The results across these cases suggest that strategic sequencing (digital transformation) coupled with investment in physical infrastructure is a powerful model for improving the external balance driven by air travel.

Moreover, studies using hybrid methodologies in the field of aviation-SOT topsis (2019) and Karak et al. (2020) - concluded that prioritization

Low-cost, high-feasibility alternatives bring stronger short-term gains than intensive infrastructure projects. The current study is based on this literature by

Placing the approach within the framework of the rentier economy and explicitly clarifying it.

4.3. Theoretical and Policy Implications

The results have numerous implications for both theory and policy:

1. Theoretical contribution:

This study implemented the application of SOT topsis hybrid methodologies by linking them directly to the macroeconomic framework (balance of payments).

2. The importance of politics:

Prioritizing digital transformation is not only an effective approach in terms of cost control but an almost rapid mechanism for increasing service account flows and reducing deficits. By (integrating aviation reforms into Iraq's broader external balance strategy), policy makers ' revenue sources can be diversified beyond hydrocarbons and (strengthening the country's resources) (withstanding external shocks).

3. Strategic sequence:



The evidence supports a two-stage reform strategy: (a) rapid digital transformation and institutional reform for short-term gains, followed by (B) targeted infrastructure Investment and international partnerships to maintain long-term competition.

4.4. Limitations and Future Research

Like any empirical study, this research is subject to certain limitations that should be acknowledged:

Data availability: Some official data - especially for cargo revenues and overflight charges - were incomplete or aggregated, necessitating the use of interpolation methods and estimates based on secondary reports.

Expert judgment bias: Although the structured interviews provided valuable qualitative insights, expert opinions may contain inherent biases that could influence the weighting of criteria.

Static weighting scheme: The AHP–Entropy weights used in the TOPSIS model are assumed to be stable over time. In reality, these weights might evolve as the policy environment and external conditions change.

Future research could address these limitations by incorporating dynamic weighting techniques, expanding the dataset as new information becomes available, and exploring aviation's interaction with other service sub-sectors (e.g., tourism, logistics) to construct a more integrated model of the service economy's role in external balance.

5. Conclusions and Policy Recommendations

5.1. Main Conclusions

The main conclusions are as follows:



1. The Iraqi aviation sector possesses significant untapped potential to serve as a strategic channel for service exports and to improve the balance of payments position.
2. Digital transformation ranks first among the alternatives in terms of effectiveness, with the capacity to increase sector revenues by 25% and reduce the services account deficit by approximately 40% by 2030.
3. Structural and regulatory constraints (such as legislative fragmentation and lack of digital infrastructure) continue to hinder the realization of this potential.
4. The Monte Carlo simulation confirms a strong quantitative link, showing that targeted reforms can add between \$75 to \$100 million annually to inbound flows by 2030.

4.2. Policy Recommendations

Based on the empirical findings, the following policy recommendations are proposed:

1. Integrate aviation policy with external balance objectives: Aviation development goals should be explicitly embedded within Iraq's balance of payments and economic diversification strategies.
2. Accelerate digital transformation: Establish an "Aviation Digital Transformation Unit" to oversee the digitization of all processes (ticketing, cargo, customs, payments).
3. Activate public-private partnerships: Open areas such as ground handling and maintenance to private sector participation to improve efficiency and attract investment.



4. Strengthen institutional capacities: Streamline regulatory procedures and align standards with the International Civil Aviation Organization (ICAO) to enhance attractiveness and competitiveness.

5. Improve data governance and reporting: Develop an integrated national system to track financial flows related to aviation to ensure their full recording in the balance of payments.

6. Adopt a phased reform approach: Focus on low-cost, quick-win initiatives (digitalization, regulatory reform) in the short term, followed by major infrastructure investments to ensure long-term competitiveness.

4.3. Future research directions

Future research could explore the interaction between aviation and other services Sectors, such as tourism and logistics, are studying how to combine the service sector Reforms affect the external sustainability and comprehensiveness of the model. Expansion to dynamic Weighting and econometric Group data would further enrich the understanding of Macroeconomic impact of aviation

4.4. Future Research Directions

Future research could explore the interaction between aviation and other service sectors, such as tourism and logistics, and examine how combined service-sector reforms influence external sustainability. Expanding the model to include dynamic weighting and panel data econometrics would further enrich the understanding of aviation's macroeconomic impact.



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