Horizontal Flight (in)Efficiency: A review of benefits, challenges and implementation considerations

Matej Soldo Jocić[1], Zvonimir Rezo[2], Sanja Steiner[1]

[1] Faculty of Transport and Traffic Sciences, University of Zagreb, Croatia
[2]Institute of Transport and Communications, Zagreb, Croatia

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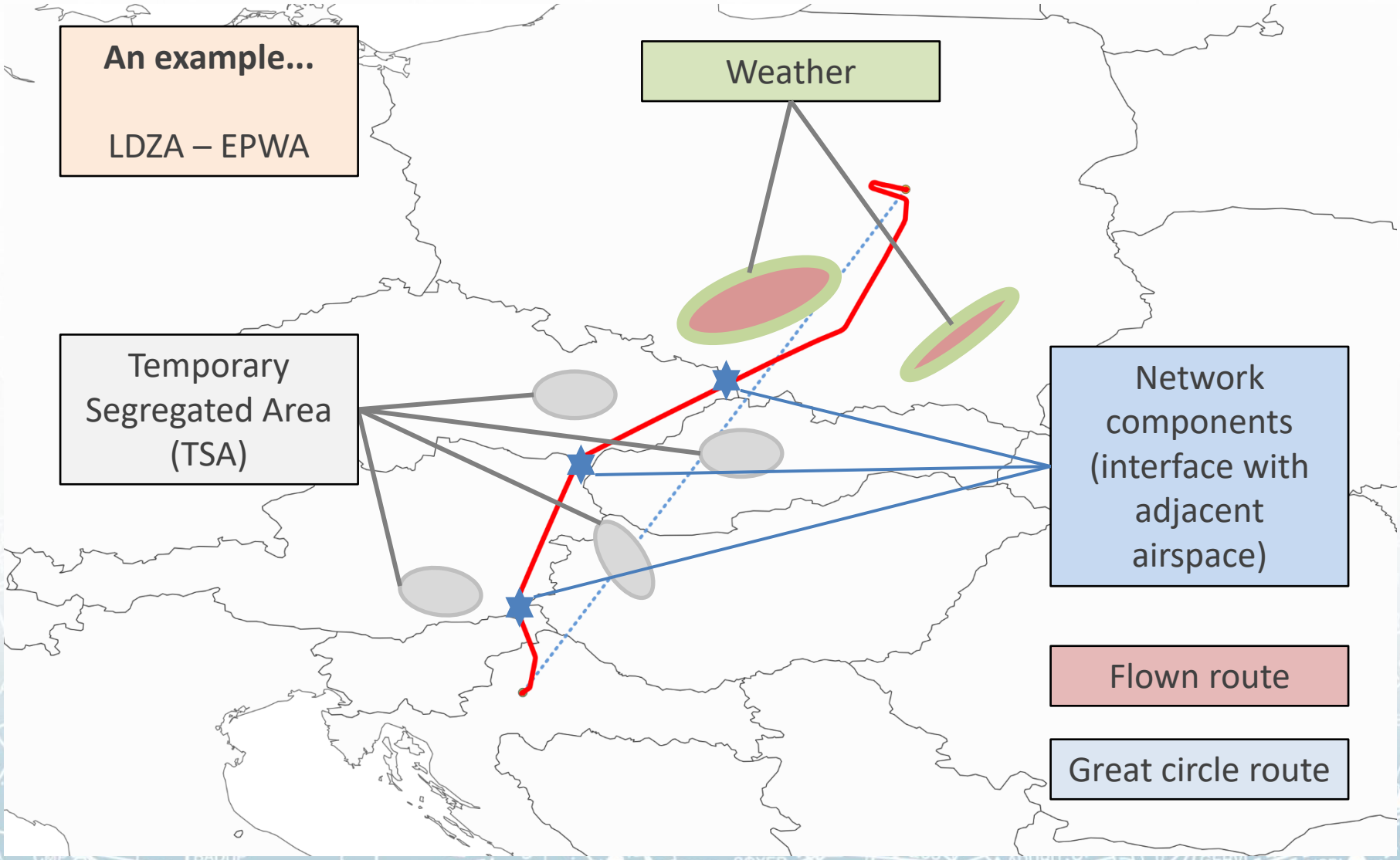
Agenda

I. Introduction
II. Methodological Framework
III. Findings
IV. Discussion
V. Conclusion

I. Introduction

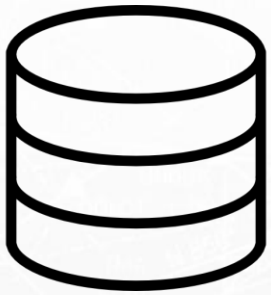
- **Why Horizontal Flight Efficiency (HFE) matters:**
  - Key Air Traffic Management (ATM) metric (ICAO KPI04/KPI05, EU SES)
  - Impacts fuel use, emissions, and operational costs…
- **Challenges:**
  - Flights rarely follow shortest possible route
  - Influenced by technical, natural, geopolitical or social factors
- **Aim:**
  - Systematic review of the current knowledge of HFE




An example...
LDZA – EPWA
Weather
Temporary Segregated Area (TSA)
Network components (interface with adjacent airspace)
Flown route
Great circle route

II. Methodological Framework

- PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)



Web of Science & Scopus



until 05 February 2025

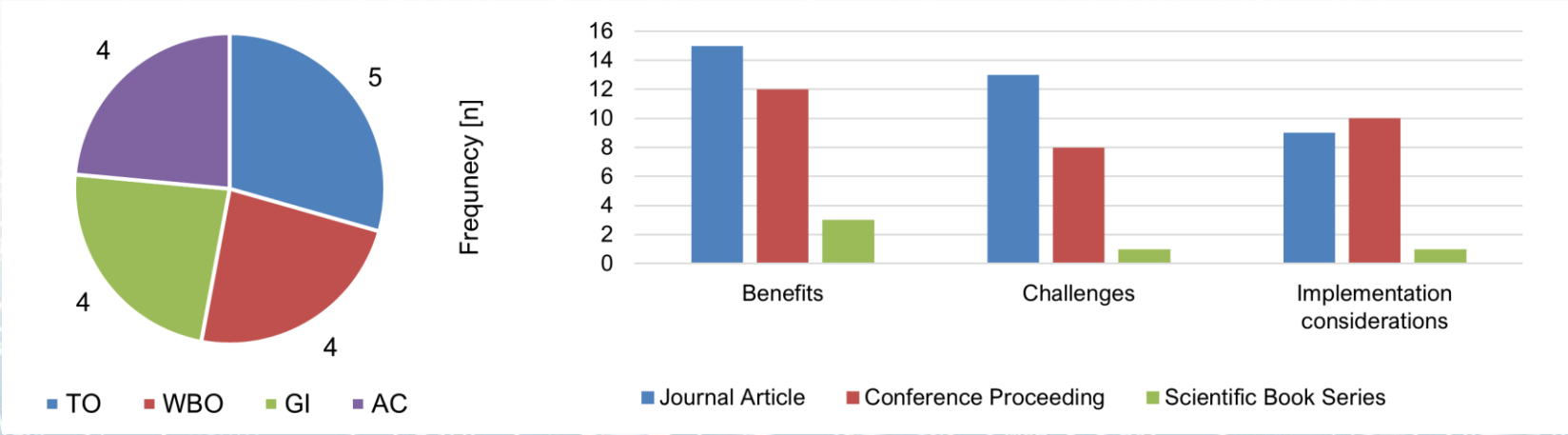


“horizontal flight efficiency”, “flight detour”, “flight trajectory”

- **Initial Records:** 1402 → **Final Set:** 17 selected studies
- Focused on peer-reviewed sources from 2014–2024, in English.

III. Findings

- **Four categories**:
  - Trajectory Optimization – General & Cost-Based **(TO)**
  - Wind-Aware & Weather-Based Optimization **(WBO)**
  - Airspace Constraints and Operational Challenges **(AC)**
  - Airspace Closures and Geopolitical Impacts **(GI)**



IV. Discussion: Benefits

- **Fuel savings** (reported in 9 studies)
- **Cost reductions** (reported in 6 studies)
- **Travel time reductions** (reported in 3 studies)
- Examples:
  - Wind-optimal routing → **5–54 min time savings**
  - **Cost reduction** up to 16.3% via optimized algorithms
  - Dynamic weather models → **efficient rerouting**







IV. Discussion: Challenges

- **Computational Complexity**:
  - Nonlinear, multidimensional optimization problems
  - Need for heuristic and metaheuristic approaches
- **Wind & Weather Uncertainty**
- **Geopolitical Constraints**:
  - Rerouting, CO_2 increase
- **Limited application of 4D trajectory optimization** (below 1500 ft not covered)

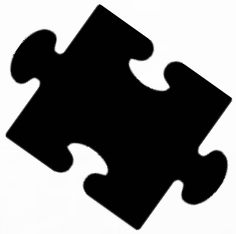






IV. Discussion: Implementation considerations

- Need for **integrated models** for horizontal + vertical optimization
- Consider **aircraft-specific factors** (cost index, perf. model, trip length)
- Integration of **conflict-assistance tools** into ATM systems
- Include takeoff and landing phases in **optimization**
- Align operational decisions with environmental goals







V. Conclusion

- HFE optimization offers clear **environmental and economic benefits**
- **But….**
- Holistic strategies must integrate:
  - Advanced optimization methods
  - Real-world operational constraints
  - Stakeholder collaboration
- **Future research**: develop hollistic 4D optimization models, integrate weather, integrate conflict tools...







Thank you for your attention!

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Matej Soldo Jocić, Faculty of Transport and Traffic Sciences, University of Zagreb, Croatia, email: matejsoldojocic@gmail.com

Zvonimir Rezo, Institute of Transport and Communications, Zagreb, Croatia, email: zvonimir.rezo@ipv-zg.hr

Sanja Steiner, Faculty of Transport and Traffic Sciences, University of Zagreb, Croatia, email: ssteiner@fpz.unizg.hr