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EDITORIAL

Reviews and Responses for Uncovering Hidden Inefficiencies in the Route Availability Document

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Reviewers: Rainer Koelle, Raúl Sáez, and Christian Verdonk Gallego

Editor: Martin Strohmeier

1. Original paper

The DOI for the original paper is https://doi.org/10.59490/joas.2024.7892

2. Review - round 1

2.1 Reviewer 1

Thanks for giving me the opportunity to review this paper. Congrats to the authors for a decent piece of work!

The paper studies potential inefficiencies stemming from the wider ATFM process by integrating strategic and recurring tactical interventions in form of constraints/operational requirements into the Route Availability Document. This is showcased on the example of a subset of European aerodrome pair connections, i.e. flights from Zurich (LSZH) to the London multi-aerodrome system covering London Heathrow (EGLL), London Gatwick (EGKK), and London City (EGLC).

The argument focusses on the level of adherence to flight plans – motivated by a recent 'All together now' initiative. Flights plans are contrasted to the actual flown/observed trajectories for the selected flights. The extracted data are analysed with a set of statistical tests supporting to reject respective hypotheses analysing the flight time/distance based on the level of adherence with the flight plan.

A valid set of observations for the LSZH-London multi-airport system are derived. A brief discussion of the generalisation of the approach and similarly short conclusion wrap up the paper.

It is worth to stress the findings – albeit within the scope of the study – more prominently; definitely these should also go in the conclusions.

Overall the paper is well written in an engaging style. The text is augmented with useful figures and tables. There is scope to add (or break out some of the figures/tables) to drive home some of the observations made.

I added various comments in the enclosed documents. They can be considered 'complaining' on a 'high note'. I find the paper publishable in its current form and do not insist on augmenting / integrating any of the comments. From a purist point of view, review your abstract: the last sentence might not be fully correct or proposes something that the paper does not "fully" deliver.

Overview The paper studies potential inefficiencies stemming from the wider ATFM process by integrating strategic and recurring tactical interventions in form of constraints/operational requirements into the Route Availability Document. This is showcased on the example of a subset of European aerodrome pair connections, i.e. flights from Zurich (LSZH) to the London multi-aerodrome system covering London Heathrow (EGLL), London Gatwick (EGKK), and London City (EGLC).

The argument focusses on the level of adherence to flight plans – motivated by a recent 'All together now' initiative. Flights plans are contrasted to the actual flown/observed trajectories for the selected flights. The extracted data are analysed with a set of statistical tests supporting to reject respective hypotheses analysing the flight time/distance based on the level of adherence with the flight plan.

A valid set of observations for the LSZH-London multi-airport system are derived. A brief discussion of the generalisation of the approach and similarly short conclusion wrap up the paper.

It is worth to stress the findings – albeit within the scope of the study – more prominently.

Overall the paper is well written in an engaging style. The text is augmented with useful figures and tables. There is scope to add (or break out some of the figures/tables) to drive home some of the observations made.

A job well done.

[enclosed comments]

Comments on Sections

The following comments may provide fruit for thought to augment the respective sections in the paper.

Introduction The introduction provides an overview of the problem space/topic. It zooms in on the complexity of RAD restrictions and the associated challenges to handle the amount of constraints, and motivates the use-case (aka 'narrow scope' of the paper – which is not necessarily bad).

The section flows well and is nicely constructed to guide the reader from a problem statement to the scope of the paper. It might be worth to remove one of the other para break, e.g. line break in l.26 does not really separate completely different ideas. This removes a bit the mechanical 'short para' cadence (idea/topic sentence, reference – line break – next idea . . .). I think a teaser – why this work is relevant – could help to kick-off the discussion. Since the paper is about inefficiencies from the RAD [process/complexity/number], it will be good to place this into perspective with a higher goal statement, e.g. increasing operational efficiency to reduce fuel burn, etc.

l. 41-57 introduces the case-study. How about pushing this into section 2? This avoids listing waypoints that 'surprise' the uninitiated reader and Figure 1 could be placed better with the surrounding text introducing these points. These and listed RAD conditions break a bit the flow of the introduction.

l.64 – It might be worth to mention that such deviations are not exclusively an aircrew triggered action. ATCOs might offer a direct routing to a point further downstream or vector for sequencing/separation or to enable an unrestricted climb.

Case Study

Re above – the l.41-57 might nicely fit here defining the problem space. This would then drive the needed / extracted data for analysis purposes.

l.71f – The scoping is a bit abrupt. It might be worth spending a line on why "this" time horizon (May 23 – Sept 24)[I know that you later speak about pre-'All together now' – but this is not clear

here]. What makes picking 3 operators (of a set of x) more 'statistically consistent'? How big is this majority? It is a valid to point out differences between (cost-index driven) operations of different groups of airspace users. However, fall Swiss, British Airways, and EasyJet in the same groups? What is the spread of aircraft types operated by these 'economic agents'.

Maybe it is my curiosity – think about mentioning the reasons for about 15% of unmatched flights. Since. l.85 speaks about outliers, a reader might be on the wrong track here.

l.90/91 – this reads a bit like only LSZH-EGLL allows for the 'meaningful' statistical analysis. Obviously – as witnessed later in the paper – you take all flights into account. I think the argument should be that departing Zurich to the multi-airport system London has no direct operational bearing on the departure segment (all flights sort of fly 'direction London') and the 4855 departures (in the given time horizon) cover about x% of all outbounds to London == reason for selecting your – statistical analytics – approach.

l.93 – I am not a big fan of the term 'suspected'. Possibly a more suspicion- or expectation-free formulation could be: The goal of this study was to analyse the adherence to RAD restrictions during day-to-day operations.

l.96 – Since Fig. 2 and Table 2 demonstrate the (non-)compliance with the filed departure routing, the applied threshold/mechanism to determine fly-over/fly-by would be worth a mentioning here.

l.104-106 – re above – you would have paved the way forward for considering the outbound flow and provide the necessity here. Just think about finding a better word than "circumvention" – this deflates your valid approach. There is no issue with going with the statistical test. However, you can make a similar claim by using a more geographical oriented approach (and supporting numbers), i.e., in l.38 the investigation "… of geographical inefficiencies …" is earmarked.

l.115ff – This is an useful attempt to provide more narrative to the outcome of the statistical test. L.118 suggests it is a simple analysis. I assume these are the totals over the complete sample horizon. To drive home the point the paper wants to make – as a minimum – it would be useful to break out the patterns or colour the fractions in Fig. 3 a/b to show pre-'All together now' and 'All together now'. While it may still not be 'statistically valid/significant', Fig. 3c shows more 'flying as filed' in terms of density. Fig. 3c shows something else – there is a striking non-adherence for the xmas23-spring24 period. The paper later specifies this to 23. Nov – 29. March. Thus, I would argue that there are some – maybe not expected – patterns popping up in contradiction to the statement in l. 120f.

Fig. 3 – In light of the paper, think about presenting this information regarding the percentage of flights in your sample on these days.

Sub-section 2.3 - Nothing wrong with flight time/distance. For future studies think about introducing a 'gate'. Implicitly, you argued that the flights to the multi-airport system London. Thus, they are comparable to a point along that path (e.g., channel, entry into UK airspace, London TMA).

l.134f – How about putting a table with the possibly groupings here and motivate the 'small group' exclusion / share of aircraft types?

Analysis and discussion (l.138-162) – It is fair to assume that the dataset and operations chosen impact the flight time/distance based analysis as the London TMA operations ripple into both measures. Fig 3. Gives an idea about the skewness of the distributions. Thus, this could be an entry point to think about the inter-quartile range or 20th-80th/10th-90th percentile to get the notion of "expected"/mostly observed travel times/distances. The bit that would be worth reflecting on a bit more: via REKLA means obvious a flight path extension in a west-north-westerly heading account-

ing for an additional mileage/time of x. This follows nicely from Fig. 2. Thus, what is the penalty given an expected travel time/distance by adding the 'extra REKLA' portion.

l.160f – comprises a relevant explanation for the observed additional time/distance in the London TMA. This is heavily influenced (c.f. previous comment) by the operational concept (i.e., runway pressure). This grants more flexibility to the ATCO to control (and maximise) the arrival sequence closer to the destination airport.

l.167-170 – this is one of the key outcomes of your observations. For example, couple this back to what was commented above: add a teaser/goal statement to your introduction to frame the benefit of your work.

Application of the Methods to Large-Scale Analysis

This elaborates on the generalisation of the approach to the European network. It stresses the sample size of traffic and speaks about "defined thresholds" and "low rate of [flight plan] adherence". l.177f speaks about the quest to "[d]etermining appropriate thresholds …": It would be super useful to reiterate the thresholds used in this study, and possibly add a thought on whether these reflect reasonable thresholds to start with.

A series of challenges are listed. There is an interesting thought regarding the change of airspace structure vs time horizon. Similar to 'All together now' which can be labelled an operational procedure constraint, airspace structure changes should fall into another class of class of constraints impacting the operational procedures. Thus, would it not be worth to also make use of this approach to judge on the efficiency of such changes?

Conclusions

The conclusions are relatively brief – nothing wrong with this: short and sweet and to the point. However, they focus mainly on i.) what the paper has shown. I miss a bit ii.) strength and weaknesses of the approach, iii.) potential application – also the paper speaks about LSZH-London airport system, there are a few observations in the paper that should go here 'again' (also in light of the abstract suggesting "… potential RAD modifications …", and iv.) a bit more thoughts on future work outside the reference that there is benefit in doing this on a large-scale basis.

Writing Style, Authorship

The paper is well written. The authors use an engaging writing style.

I lean towards British English (BE) from a day-to-day job perspective and in accordance with ICAO. Anyway, the paper used US spelling consistently throughout the paper – which is acceptable.

Fig. 3, Fig. 5 – I am not a big fan of the background colouring in these figures. The general visualisation recommendation to deliberately think about the ink-whitespace ratio holds and helps to justify not using the default themes.

One point to keep an eye on is that the paper regularly 'focusses' on LSZH-EGLL in a prominent way using respective verbiage. This could pose the question, why flights to the other London aerodromes were considered at all. I think there is a valid argument in the paper to look at the "flow" to London. Flights bound to Heathrow are, thus, the more prominent subsample in terms of numbers (but also supporting business case for operations).

2.2 Reviewer 2

The authors investigate flight inefficiencies due to the restrictions/constraints imposed by the Route Availability Document (RAD). They also propose some ways in which the RAD could be modified

in order to avoid such inefficiencies. Furthermore, the authors briefly analyze the effects of EUROCONTROL's All together Now 2024 initiative.

Overall, the paper is well structured and clear. However, the authors should clarify/improve some minor aspects:

1) In general, performing a flight is more a matter of opportunity than of the specific flight route being flown or the airline submitting the flight plan, as discussed in this paper (presented in the ATM Seminar 2015): https://drive.google.com/file/d/1B4z3rsgLxClsuIvklUIkeggjtJwSvuew/view. I recommend the authors to extend their literature review by briefly discussing this matter in their paper, and link it with the RAD effects on the planned trajectories. Other references related to this topic would be welcomed as well.

Depending on the situation, ATCOs might be able to give shortcuts to flights, which will mean that aircraft will not adhere to the filed flight plan. Even though that from a pure efficiency point of view following these shortcuts would always be beneficial, depending on the day of operation and amount of traffic this will not be always possible. Therefore, the filed flight plans will usually represent longer routes and, thus, less efficient routes. Then, at a tactical level, it will be the ATCOs' task to make the flown trajectories more efficient.

2) In line with Comment 1, are the authors completely sure that the filed flight plans are only not efficient due to the RAD restrictions or there could be something else affecting the airline's submitted flight plans?

3) The authors mention at the end of the Introduction the "following section" and Section 4. However, they do not mention Section 3. I recommend the authors to mention all sections in this part.

4) The font size of the plots axis and legend should be increased to improve readibility.

2.3 Reviewer 3

I find this paper to be very well written, highly relevant to the conference where it was presented, and well aligned with the scope of the journal. The authors demonstrate excellent knowledge of ATFCM procedures, and the study is both timely and pertinent for assessing the usefulness of the EUROCONTROL "Network All Together Now 2024". However, it should be noted that drawing generalised conclusions from a single city-pair analysis is challenging and may not capture the full complexity of the issue.

The reference to the PRR is a highly pertinent. I would recommend the authors to see the difference for the KER for actual and filed flight plans, and it is in an indicative that what was observed in this study is something quite general.

Regarding the discussion on why flights appear to have a significantly greater impact when arriving in London Heathorw, it would be beneficial to investigate the specific arrival congestion patterns at EGLL during the study period. Heathrow's operational goal on maximising runway throughput may produce side effects: heightened departure congestion could lead to aircraft following the SID procedure with rigorous adherence in origin may be coupled with increased arrival congestion, might result in prolonged holding times in the stack. At the end, everyone wants to arrive at London at peak times.

I would also encourage the authors—either in this study or in a future extension—to examine the time difference between filed flight plans and actual flight durations. Focusing on this metric enables the calculation of two key indicators: the bias and the variance in prediction. These correspond to PRD1 and PRD2, respectively, in the DES Performance Framework, and are highly relevant measures for

evaluating predictability. Obtaining PRD1 and PRD2 at a European level, disaggregated by city pair, would greatly enhance the quality of inputs for initiatives such as the Network All Together Now.

In conclusion, this is a well-articulated and timely paper. I congratulate the authors on their contribution and look forward to seeing how this research may evolve, particularly through a broader analytical scope incorporating multiple city pairs and predictive performance indicators.

3. Response - round 1

3.1 Response to reviewer 1

Comments on Sections

The following comments may provide fruit for thought to augment the respective sections in the paper.

Introduction

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l. 41-57 introduces the case-study. How about pushing this into section 2? This avoids listing waypoints that 'surprise' the uninitiated reader and Figure 1 could be placed better with the surrounding text introducing these points. These and listed RAD conditions break a bit the flow of the introduction.

l.64 – It might be worth to mention that such deviations are not exclusively an aircrew triggered action. ATCOs might offer a direct routing to a point further downstream or vector for sequencing/separation or to enable an unrestricted climb.

Response

We incorporated some of the suggetions to help readability, such as moving the list of waypoints and RAD conditions into section 2.

Case Study

Re above – the l.41-57 might nicely fit here defining the problem space. This would then drive the needed / extracted data for analysis purposes.

l.71f – The scoping is a bit abrupt. It might be worth spending a line on why "this" time horizon (May 23 – Sept 24)[I know that you later speak about pre-'All together now' – but this is not clear here]. What makes picking 3 operators (of a set of x) more 'statistically consistent'? How big is this majority? It is a valid to point out differences between (cost-index driven) operations of different groups of airspace users. However, fall Swiss, British Airways, and EasyJet in the same groups? What is the spread of aircraft types operated by these 'economic agents'.

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Response

We agree, but we don't have any suggestions on where these thresholds should be. This should be defined with different stakeholders and experts and should be based on more that just a single case study. One could argue that a non-adherence of above 90% would clearly above the threshold, but what about 20%? We don't think we are in a position to make this call.

Conclusions

The conclusions are relatively brief – nothing wrong with this: short and sweet and to the point. However, they focus mainly on i.) what the paper has shown. I miss a bit ii.) strength and weaknesses of the approach, iii.) potential application – also the paper speaks about LSZH-London airport system, there are a few observations in the paper that should go here 'again' (also in light of the abstract suggesting "… potential RAD modifications …", and iv.) a bit more thoughts on future work outside the reference that there is benefit in doing this on a large-scale basis.

Response

We agree and expanded the conclusions accordingly

Writing Style, Authorship The paper is well written. The authors use an engaging writing style.

I lean towards British English (BE) from a day-to-day job perspective and in accordance with ICAO. Anyway, the paper used US spelling consistently throughout the paper – which is acceptable.

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Response

We feel that these suggestions are somewhat subjective and decided not to change the writing style or the background of the figures.

3.2 Response to reviewer 2

The authors investigate flight inefficiencies due to the restrictions/constraints imposed by the Route Availability Document (RAD). They also propose some ways in which the RAD could be modified in order to avoid such inefficiencies. Furthermore, the authors briefly analyze the effects of EUROCONTROL's All together Now 2024 initiative.

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Response

We belife that the suggested literature is not relevant for this paper. The reviewer's suggestion looks into how airlines' choice of routing is affected by navigation charges. We don't consider how airlines arrive at a certain routing, but instead assume the routing as a given and compare what is filed to what is flown. In the case study, 92% of the filed flights for the city pairs filed via the initial waypoints. Why the different operators choose to do so is out of the scope.

Depending on the situation, ATCOs might be able to give shortcuts to flights, which will mean that aircraft will not adhere to the filed flight plan. Even though that from a pure efficiency point of view following these shortcuts would always be beneficial, depending on the day of operation and amount of traffic this will not be always possible. Therefore, the filed flight plans will usually represent longer routes and, thus, less efficient routes. Then, at a tactical level, it will be the ATCOs' task to make the flown trajectories more efficient.

Response

This point is discussed towards the end of Sec. 1

2) In line with Comment 1, are the authors completely sure that the filed flight plans are only not efficient due to the RAD restrictions or there could be something else affecting the airline's submitted flight plans?

Response

There might be a whole host of considerations that went into the decision to take a specific route for a given city-pair. But the paper "only" looks into the difference between what is filed and what is flown.

3) The authors mention at the end of the Introduction the "following section" and Section 4. However, they do not mention Section 3. I recommend the authors to mention all sections in this part.

Response

Good point, corrected.

4) The font size of the plots axis and legend should be increased to improve readibility.

Response

Good point, corrected.

3.3 Response to reviewer 3

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Response

We agree that the single city-pair does not generalize, but it shows what the method is capable of.

The reference to the PRR is a highly pertinent. I would recommend the authors to see the difference for the KER for actual and filed flight plans, and it is in an indicative that what was observed in this study is something quite general.

Response

Apologies, but we don’t understand the comment.

Regarding the discussion on why flights appear to have a significantly greater impact when arriving in London Heathorw, it would be beneficial to investigate the specific arrival congestion patterns at EGLL during the study period. Heathrow’s operational goal on maximising runway throughput may produce side effects: heightened departure congestion could lead to aircraft following the SID procedure with rigorous adherence in origin may be coupled with increased arrival congestion, might result in prolonged holding times in the stack. At the end, everyone wants to arrive at London at peak times.

Response

That is correct, but too far outside of the scope of the paper.

I would also encourage the authors—either in this study or in a future extension—to examine the time

difference between filed flight plans and actual flight durations. Focusing on this metric enables the calculation of two key indicators: the bias and the variance in prediction. These correspond to PRD1 and PRD2, respectively, in the DES Performance Framework, and are highly relevant measures for evaluating predictability. Obtaining PRD1 and PRD2 at a European level, disaggregated by city pair, would greatly enhance the quality of inputs for initiatives such as the Network All Together Now.

Response

We agree and would be happy to include this in future work

In conclusion, this is a well-articulated and timely paper. I congratulate the authors on their contribution and look forward to seeing how this research may evolve, particularly through a broader analytical scope incorporating multiple city pairs and predictive performance indicators.