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AIR TRAFFIC CONTROLLER ASSESSMENT OF THE FREE ROUTE AIRSPACE IMPLEMENTATION WITHIN ZAGREB AREA CONTROL CENTRE

ABSTRACT

Current tools in air traffic control are not sufficient to support the advanced conflict detection that has arisen from implementation of free route airspace. Free route airspace has proven to be more efficient for airline companies, but the effects on air traffic controllers have not yet been tested in full. It is attempted to solve that problem in this paper and to see what kind of impact free route airspace has on the air traffic controllers. It is concluded that with the implementation of specific free route airspace (SEAFRA), traffic complexity is increased and that controllers have a hard time detecting conflict in advance since there are no more old "hotspots" to concentrate on. Hence, the whole airspace is considered as a hotspot. At the end of the paper, several steps have been proposed for future work and for solving some of the issues that the air traffic controllers have emphasized.

KEY WORDS

Free route airspace; air traffic controller; traffic complexity; conflict detection; workload;

1. INTRODUCTION

In accordance with contributing to the achievement of the Single European Sky ATM Research (SESAR) objectives, Free Route Airspace (FRA) started the path of development in 2008. European Union, through the Commission Implementing Regulation (EU) No 716/2014 commenced the ambitious plan of implementing FRA by 2021 in a majority of European airspace [1] and gave the FRA concept definition: "A specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) waypoints, without reference to the ATS route network, subject to airspace availability. Within this airspace, flight remains subject to air traffic control." [2–4]. An example of points used in FRA is given in Figure 1 where FRA (I) represents intermediate point, FRA (A) arrival connecting point and FRA (E/X) entry or exit point. These new points have significant meaning to the Air Traffic Controllers (ATCOs) and the preponderant role for carrying out the traffic within FRA falls on them, therefore it is important to pay attention to their performance.

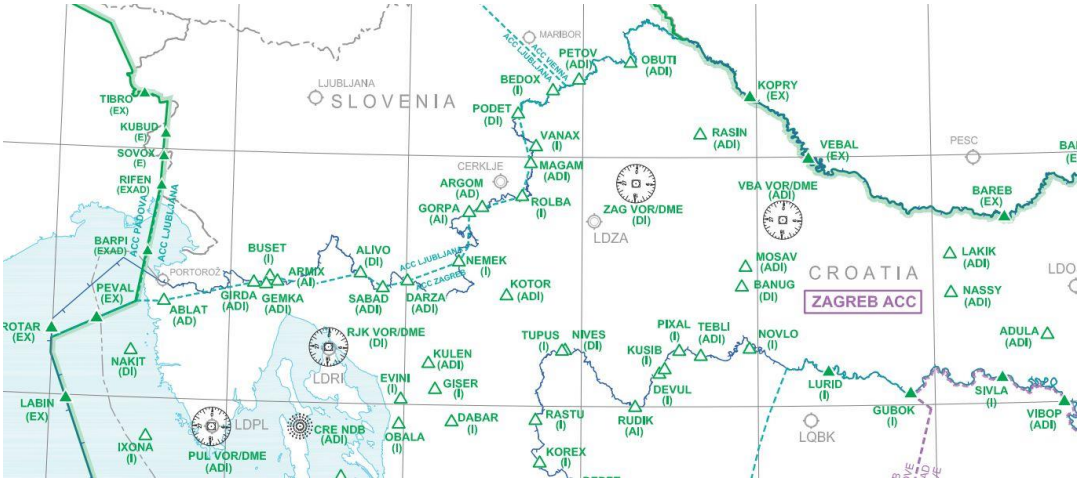

Figure 1. Example of FRA points [5]

FRA presents a means of enhancing airspace performance in capacity, efficiency and environment [2]. The proliferation of average daily flights in EUROCONTROL area emphasizes the important role of airspace capacity. STATFOR observations showed an increase of 2.4% traffic in 2016 compared to data from 2015 (Figure 2) [6]. Further average annual growth from 2015 to 2023 is forecast to be 1.9% and in 2023 number of flights is expected to be 14% higher than in 2016 [6]. The latter year showed a decline of service quality that started three years before. The time of arrival within 15 minutes of the scheduled time was in 80.5% fights and compared to 2015 a decrease of 1.6% was noted. Departure delay increased from 10.2 minutes to 11.2 minutes per departure. The main reason for delays were reactionary delays that were caused by previous flight legs. Turn around delay is the next main reason for overall delays caused by operators such as airlines and airports although their share in delay shows a decline by 1% compared to 2015 [6].

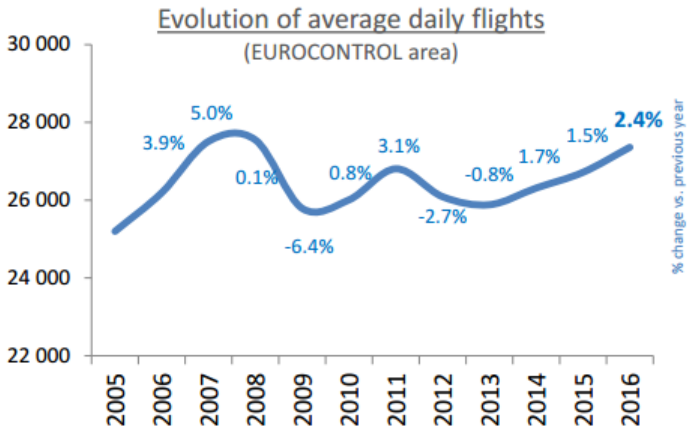

Figure 2. Evolution of average daily flights [6]

The growth of the number of aircraft has an inevitable connection with emissions, costs and fuel burn. Enlarging the area of FRA directly influences the environment. The flight efficiency benefits brought by FRA are clearly presented in STATFORs analysis of trajectories. Comparison of flight plan trajectories and actual trajectories (Figure 3) distinguishes the States with full FRA implementation (red circle) and States who have implemented FRA partial or with no implementation (blue square). The latter States have flight efficiency of 1.6% points less than the full FRA implementation States and 1% points higher gap between actual and planned operation. The predictability, which is important for utilization of capacity and resources, is improved by leading the actual operations closer to the planned ones [6].

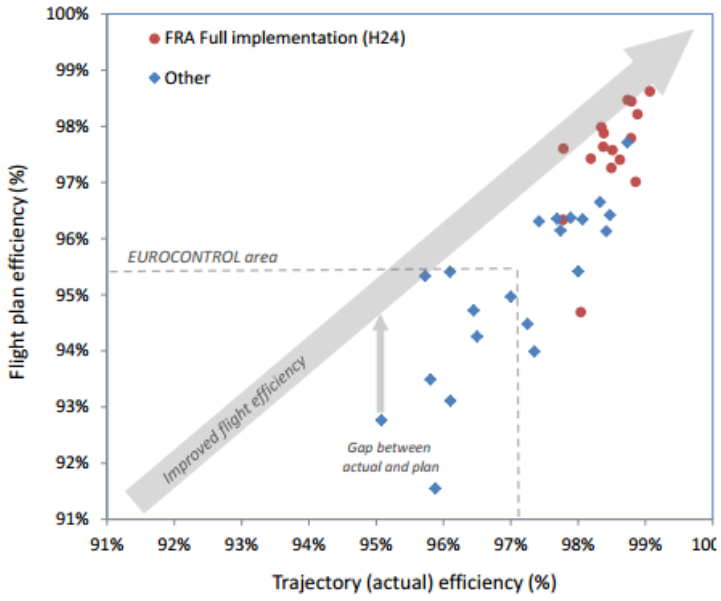

Figure 3. Flight efficiency by State [6]

In order to achieve FRA all over Europe, cross-border implementation of FRA is or shortly will be done in larger parts of Europe: Croatia – Serbia – Bosnia and Herzegovina and Montenegro (SEAFRA); Romania – Hungary – Bulgaria (SEENFRA); Malta – Italy; Estonia – Latvia – Finland – Sweden – Denmark – Norway (NEFRA) and Austria - Slovenia (SAXFRA). It is expected that their work will improve natural harmonization of airspace design, operating procedures and rules with the addition to network flexibility [6]. Before the summer of 2018, the European airspace is expected to take shape as shown in Figure 4 [7].

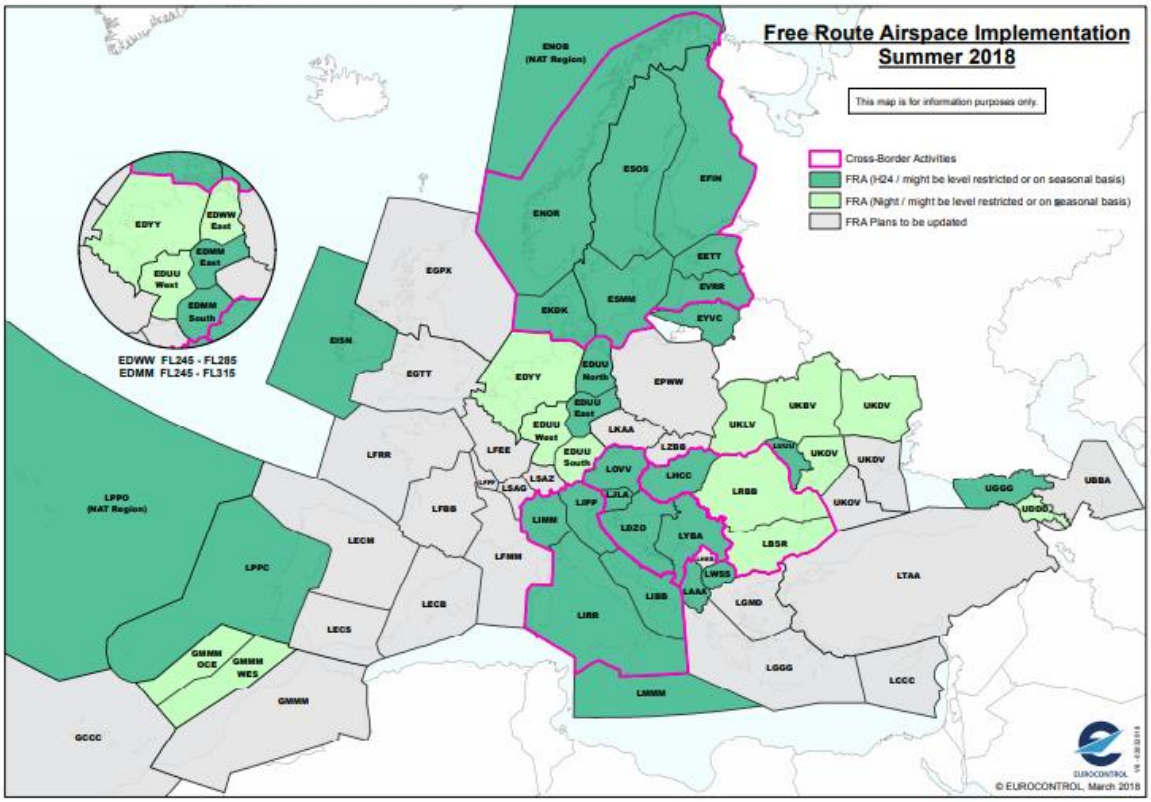

Figure 4. Project plan for the implementation of FRA [7]

SEAFRA is one of the cross boarders FRA implemented and well on in operation. The airspace covers the area of four countries: Croatia, Serbia, Bosnia and Herzegovina and Montenegro being the first one in Europe by such a high number of states included. Three ANSPs: CCL (Croatia Control Ltd), SMATSA (Serbia and Montenegro Air Traffic Services SMATSA LLC), and BHANSA (Bosnia and Herzegovina Air Navigation Services Agency) are offering their costumers flight planning without the boarder's constriction but instead entry, exit and intermediate points into the whole airspace. SEAFRA operates 24 hours a day and has become a good milestone for the SECSI FRA [8].

In February 2018, South East Common Sky Initiative (SECSI) FRA was organized by joining Croatia – Serbia – Bosnia and Herzegovina and Montenegro (SEAFRA) and Austria - Slovenia (SAXFRA) (Figure 5). SECSI is brought to strengthen the South East Axis which has an important role in connecting the Central and South Europe. It gives more routing options and city pair connections. The estimation of potential saving per day are about 1.940 NM in flight distance, a reduction in fuel consumption of 8,000 kg, a reduction in CO2 emissions of 25,500kg and 285 minutes in flight time [9]. Therefore, the savings for airline operators are obvious and the profit for passengers lies in shorter duration of fight. SECSI FRA was one of the most ambitious projects in Europe regarding the airspace. It is an example of how two large already functioning FRA connect to one in order to achieve the common European FRA scheduled for 2022 [9,10].

Figure 5. South East Common Sky Initiative Free Route Airspace (SECSI FRA) [9]

2. AIR TRAFFIC CONTROLLERS ASSESSMENT

For the purpose of this research, an anonymous survey was conducted on the 34 ATCOs within Zagreb Area Control Centre (Zagreb ACC) of the Croatia Control ltd. The survey was conducted one year after the implementation of SEAFRA during the summer season to help analyzing the new experience that came with the FRA traffic and how it influenced the ATCOs' work. From all the 34 participants, 26.5% had between 6 to 10 years experience in providing air traffic control service, the second most represented work experience was between 16 to 20 years with the 17.6%, Figure 6, left

chart. Exactly 50% of ATCOs stated that they have been working 12 months within the FRA environment and only 14.7% had experienced it for one month, Figure 6, right chat.

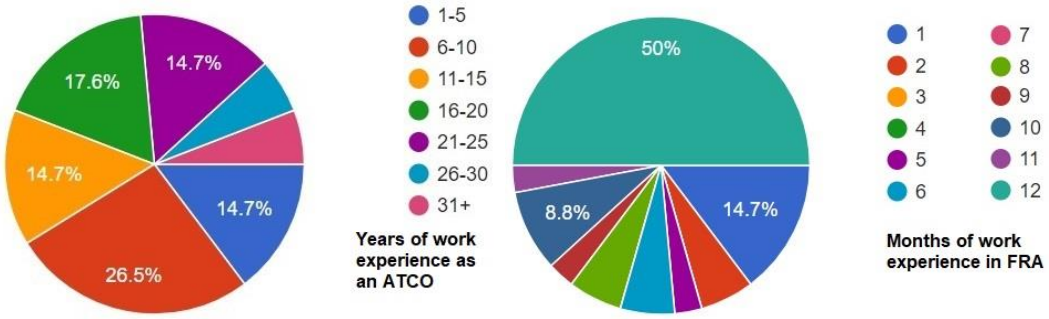

Figure 6. Survey of years of experience as an air traffic controller (LEFT CHART), and period of work experience in FRA (RIGHT CHART)

When asked about the overall knowledge about the implementation of FRA in Europe, ATCOs responded very well, more than 70% were very well knowledgeable about FRA implementation in Europe, Figure 7, upper chart. But the interesting thing to notice is opposing opinions on the idea whether FRA is really necessary to be implemented, there were no high scores in answers for the need to implement nor for the need not to implement, the highest score was the middle one with 35.3%, Figure 7, lower chart.

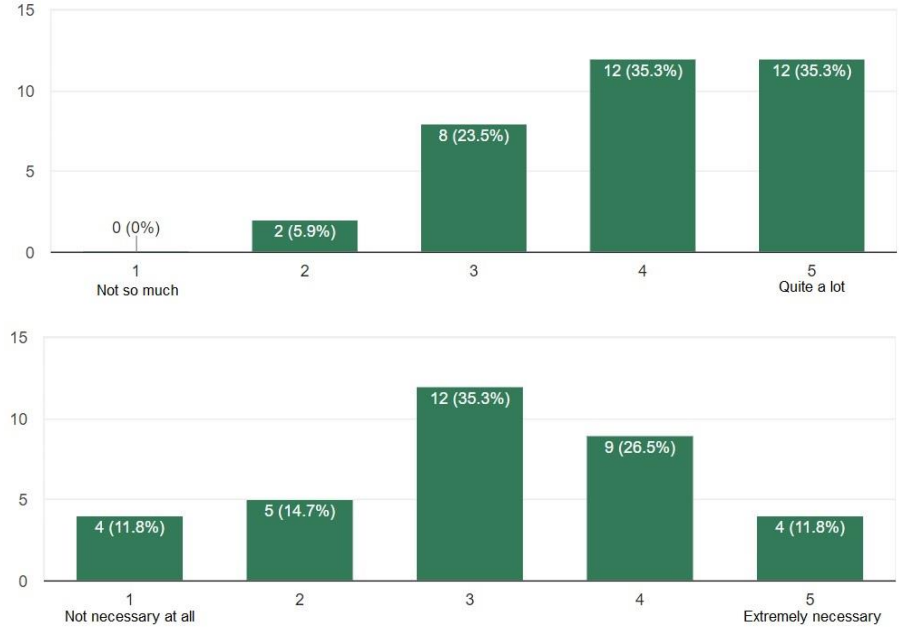

Figure 7. Survey of how much ATCOs know about the implementation of Free Route Airspace in Europe (UPPER CHART), and what is the necessity of FRA implementation (LOWER CHART)

Main reasons for implementing FRA was well recognized among the tested ATCOs. More than 90% stated that reduced fuel consumption was one of the reasons and more than 85% stated that the main reasons are reduced flight distance and reduced flight time. Also, interesting to notice is that the low scores were received in the categories of reduced traffic complexity, reduced number of conflicts and reduced controller's workload. That could be a problem in the future ATC work since the traffic is only going to increase over the years [6]. On a side note here, there was an option for participants to enter other reasons for the implementation of FRA and they could be categorized into two types of answers. Environmental factor and emissions with 11.8% and 5.9% for the "Implementation rule", Figure 8.

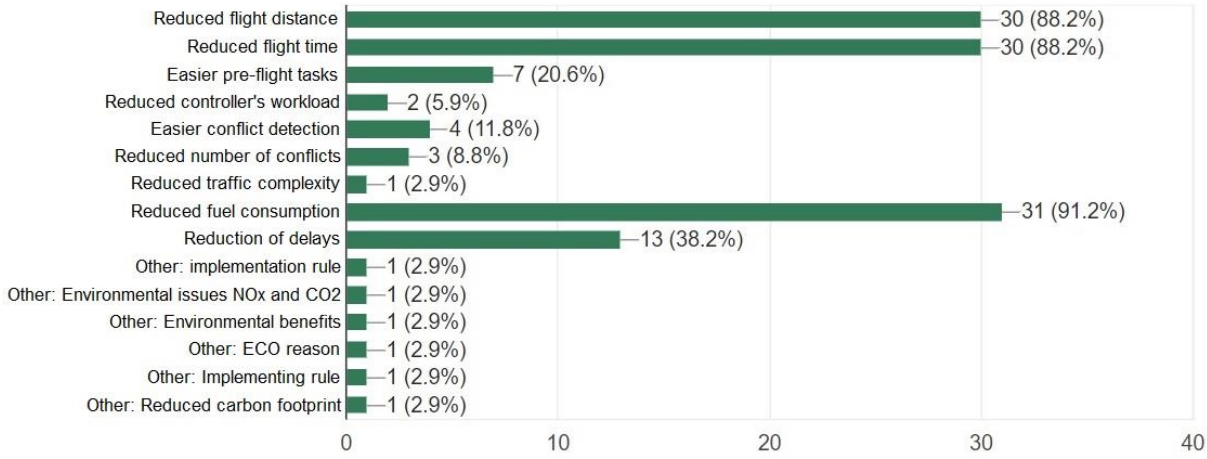

Figure 8. Survey that shows what are the main reasons for FRA implementation

More than 60% of ATCOs stated that their work experience in FRA compared to the standard fixed routes changed a lot, Figure 9, upper chart. And when asked about a specific category and the level of change there were some interesting answers as well. For example, conflict detection received astonishingly high marks in drastic changes and in changed a lot answers, overall, more than 75% and more than 60% received the same marks for traffic complexity and situational awareness, Figure 9, lower chart.

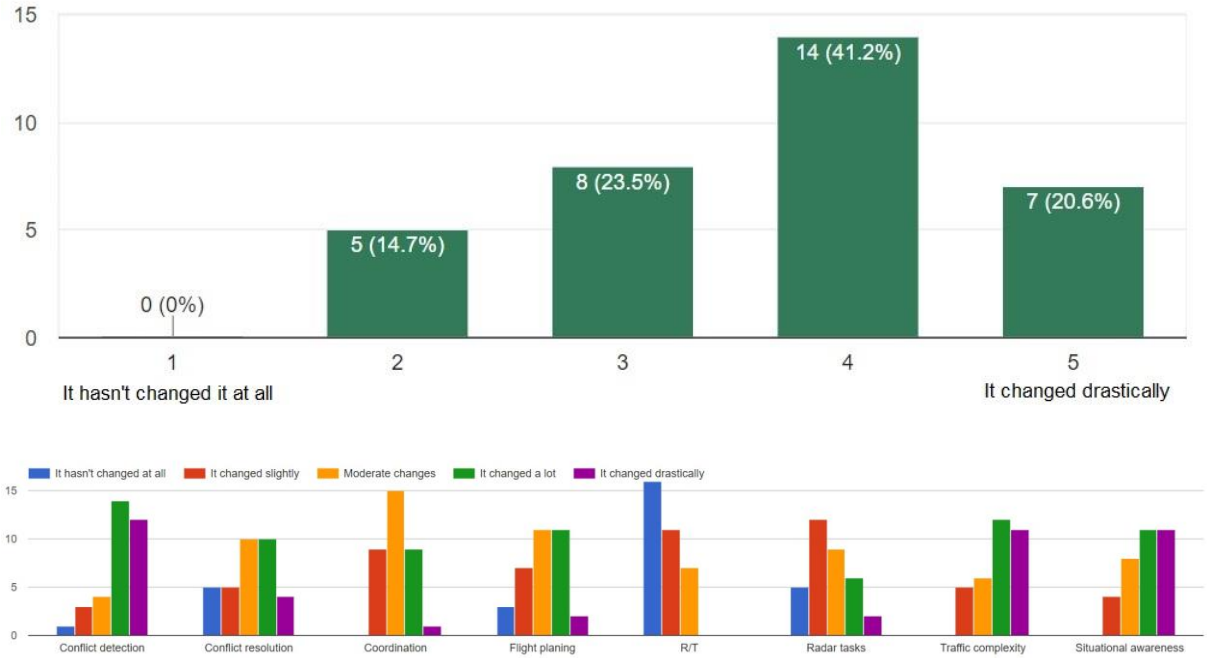

Figure 9. Survey of how much has FRA changed ATCOs work experience compared to the standard fixed routes (UPPER CHART), and the ATCOs experience that has changed with FRA implementation (LOWER CHART)

Continuing on the change of the work within FRA, the next logical inquiry was to see how did the workload changed with the new FRA environment. Surprisingly, high marks received an increased workload with the new FRA environment, more than 70%, Figure 10, upper chart. Related to the specific workload tasks, yet again it can be noticed that conflict detection, traffic complexity and situational awareness are extremely high. For conflict detection, ATCOs answered more than 60%

increase with a high workload and more than 70% for the traffic complexity and situational awareness, Figure 10, lower chart.

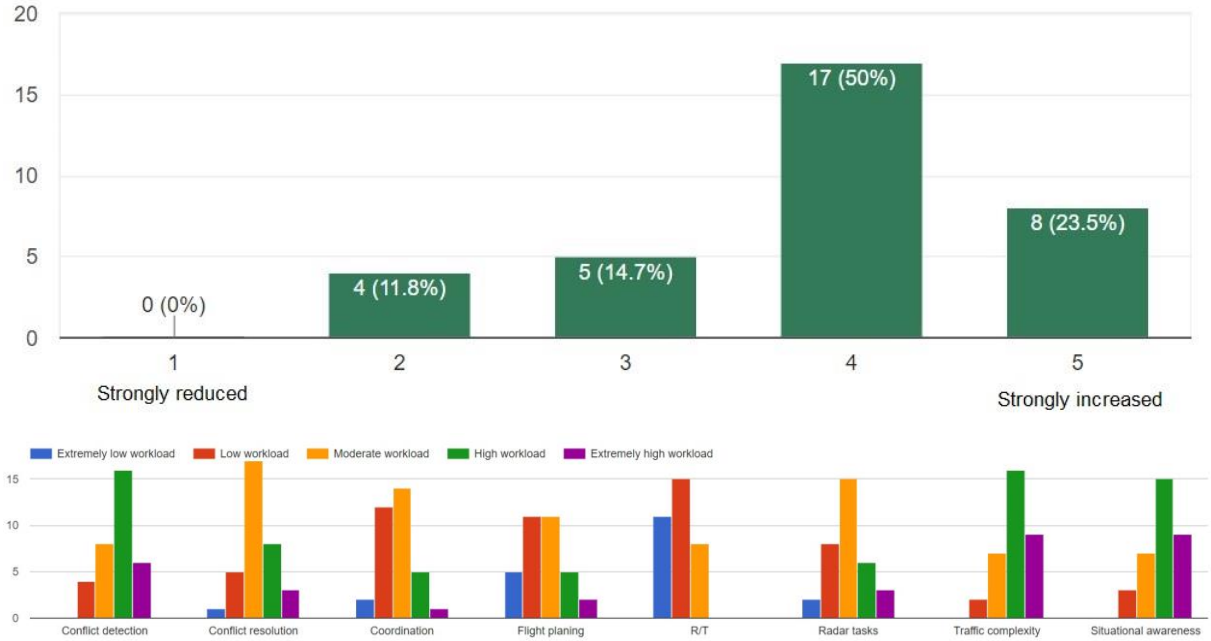

Figure 10. Survey of ATCOs workload with FRA implementation (UPPER CHART), and the level of workload for the given ATCO categories with FRA implementation (LOWER CHART)

Compared to the conventional "fixed" ATS routes, more than 40% of ATCOs stated that they can handle the same amount of traffic within the FRA environment, but 35% of them stated that they can handle more traffic than before, unlike some that said that they can handle less, which makes for 20% of the candidates, Figure 11.

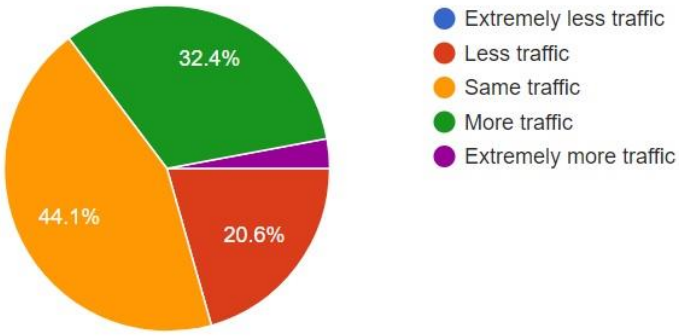

Figure 11. Survey of traffic management within FRA compared to the conventional fixed routes

But regardless of the amount of traffic they can handle, the surprisingly high percentage of answers was received for complexity estimation: air traffic within FRA is more complex than before, approximately 80% of the ATCOs think that the air traffic is more complex compared to the conventional "fixed" ATS routes, Figure12, left chart. And alongside that, 70% stated they need more advanced tools for conflict detection when working within the FRA environment, Figure 12, right chart.

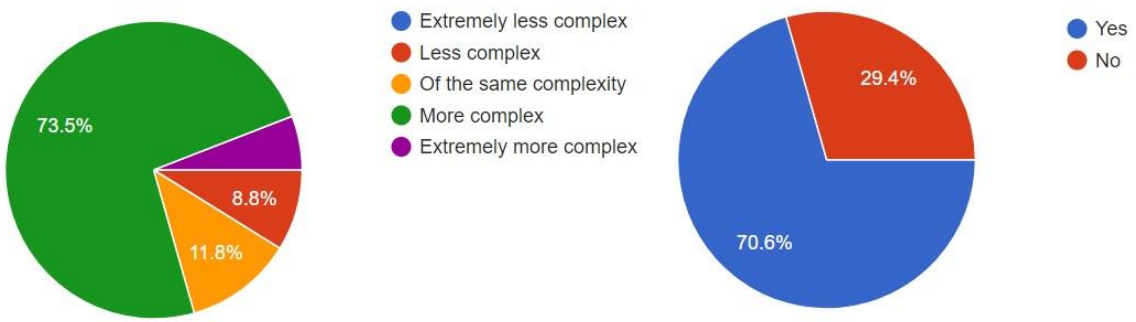

Figure 12. Complexity comparison of conventional ATS routes to the ones within FRA (LEFT CHART), and the need for more advanced tools for conflict detection when working within FRA environment (RIGHT CHART)

Based on the answers on each particular ATC tool it can be concluded that existing tools are sufficient for their work and that there should be some sort of a new tool that could help ATCOs detect conflict in advance. Also, it could be seen that CARD (Conflict and Risk Detection) tool needs more changes, with 50% of ATCOs requesting its improvement, Figure 13. While STCA (Short Term Conflict Alert), QDM (Range and Bearing tool), Probe (tool for checking the conflicts if the flight route is changed), Level band highlight (filtering the flight levels), Flight leg embellishment (tool for checking the conflicts along the flight route), DAPs (feeding information from the aircraft FMS system) and SEP (Separation tool) all have high percentages in marks that the tool does not require any changes or slight changes are required. Some other studies also indicate the need for new ATC tools when dealing within FRA environment [11].

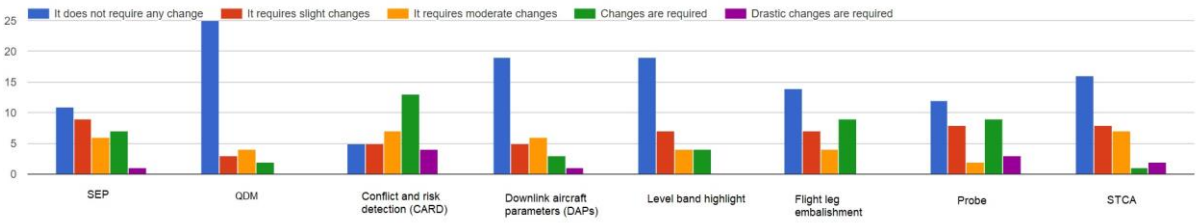

Figure 13. Survey of to what degree do the ATCO tools need to be changed

3. DISCUSSION

The results have shown that with SEAFRA there has been an increased change in traffic complexity, conflict detection and situational awareness for the tested ATCOs. Increase in change has been followed by the increase in workload for the same categories; traffic complexity, conflict detection and situational awareness. Some other similar papers showed that other ATCOs also had some problems with the implementation of the FRA [12]. At the end of the survey, controllers were asked to state any additional comments regarding their experience as a FRA controller in SEAFRA environment:

- “FRA was a major change in ATC because no one knew what impact there would be on the existing traffic patterns. As a result, we got more workload because ATCOs have to vector everything, and new conflict "hot spots" have arised. The flight level allocation scheme is almost nonexistent compared to before, and we still don't know if this is going to be a good or bad thing (controlling-wise), of course, the airlines are happy because of lesser fuel consumption. ATCs are now working more complex traffic for the same unit rate.”
- “Much simpler and cheaper for airline carriers, a lot harder and more complex for the ATCs.”
- “Flight plan management has gone to hell with complexity.”

- "Strongly positive - better track correlation with FPL trajectory received by OLDI message enabling early conflict detection, reduced r/t transmissions and sector occupancy, reduction of bunching hot spots in one sector (ZAG, PUL, DBK) - traffic is better distributed through sector volumes, change of ATC paradigm - controllers control traffic in volumes by help of trajectory prediction tools and not by flows, routes or points, attracts more users, better service to operators, compliance to PCP implementing rule, has benefits on all SES main pillars - safety, cost efficiency, capacity and environment."
- "Negative aspect - complicated cross-border procedures - should be resolved in the next implementation."
- "ADDITIONAL REMARK - this is a cross-border FRA implementation, not just Croatia FRA (B&H, Serbia, Montenegro & Croatia). It is to be extended next year with two more countries, Slovenia and Austria (current SAXFRA) forming the SECSI FRA initiative."
- "Implementation of the FRA is one of the major technological mistakes in Zagreb ACC. It raised the level of complexity, reduced profits and capacity. Adversely affects the safety of air navigation as the final product of our company."
- "I think it's a positive change which will be highlighted with years and experience of working in it."
- "The biggest problem with the introduction of the FRA is that there are no more standard places where you can expect conflicts, but it can be literally anywhere in the airspace. It happens that, for example, two different companies have the same take-off and landing aerodrome but completely different routes. Regardless of the FRA, some air carriers still plan their flights so that the routes are not direct, so you wonder then whether the "direct" route is really the cheapest, ecological, etc. Generally speaking, I think it was to be expected that the concept of direct routes would become a reality, however, the traffic complexity increases and by increasing its complexity, the capacity of air traffic controllers in the sector is decreasing."
- "Much more complex. Sector capacity remained the same or they are increased. Impossibility of conflict resolution by direct routes, because the aircraft are already heading directly and it requires a large number of aircraft to be resolved by turning the heading. Increased coordination with neighboring units."
- "Too big of a change in a short time that, with the increased air traffic, in some cases complicates things, and I do not see big benefits for us or for companies."
- "It became harder to detect traffic flows, i.e. traffic flows are now dispersed throughout the map. That resulted in the loss of the familiar hotspots and the creation of the new ones. Also, now it's more difficult to incorporate an aircraft into a new flow because there's more converging traffic instead of a "single line" flow. Converging conflicts take more time and workload to resolve than other kinds."
- "I am convinced that, in the case of the FRA, it goes hand in hand to the carriers (economically) under the pretence of ecology (emission of harmful gases and oxygen burning by shortening the flight duration), while at the same time ATC's job is becoming more complicated. There are no established conflict points but are all around the AOR depending on the flight plan, too many routes are on the same FL, head on etc. All this adds to the workload and the low awareness, which simultaneously reduces the capacity of the sector. More and more in aviation it is about money and profits, and unfortunately in this and in a number of other changes, the safety of air navigation is undermined."

From the ATCOs discussion, we can see that there are diverse comments. Some believe that FRA is good and that ATCOs only need time to adapt, while others believe it is a safety issue and that traffic complexity has increased alongside with harder conflict detection and undermined situational awareness.

4. CONCLUSION

In this paper, we have presented the opinions of 34 ATCOs from Zagreb ACC that are actively working on free route airspace and since the finish of this paper now on the new SECSI FRA airspace. It can be concluded from their answers that traffic complexity, situational awareness and conflict detection has increased and that the workload for those categories has also increased. But although there has been an increase in conflict detection, ATCOs also stated they had no problem whatsoever in conflict resolution. In fact, precisely 50% of them stated that conflict resolution is at a moderate level. Also, they stated they can handle the same or even more traffic than before, although more than 70% of them told that traffic routes are more complex than before. So, it is safe to say that they can still manage new traffic situation that has arisen from the implementation of FRA.

Finally, for future work, it would be good to see how ATCOs would evaluate work in the new SECSI FRA environment and to compare the results from two surveys. Such a new research could give us information if ATCOs only needed time to adapt to FRA environment or the situation has worsened. Since the main problems were conflict detection and the need for more advanced ATC tools, we believe that with the applicable forecast traffic complexity model, these negative comments would vanish.

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