TABLE IV. AVERAGE PERCENTAGE OF FLIGHTS WITHIN THE UDPP MEASURE THAT HAVE A CHANGE FROM THE BASELINE SLOT

Flights within UDPP Measure	% Flights with Change	% of Flights with Priority	%Flights with Change >=|5| minutes	%Flights with Change >=|15| minutes	%Flights with Change >=|30| minutes
302	27%	10%	15%	8%	5%

The results show that on average only 8% of the flights within the UDPP Measure show a large change from the baseline slot allocated by the FPFS algorithm, of which 0.1% are non-participating users according to TABLE III.

b) Human Performance

Human Performance (HP) was assessed in terms of system acceptability, workload, situational awareness and trust.

All assessments of the impact on HP exceeded the minimum requirements, showing positive impacts. Participants provided feedback that the UDPP features are clear, acceptable and that the users have a high level of trust in the UDPP features. The workload was considered to be tolerable and acceptable and situational awareness achieved very high ratings.

c) Operational Feasibility

The participants provided their expert opinion on the usability and acceptability of each specific UDPP features, shown in Figure 6. Majority of the responses agree that each function is acceptable and usable. Semi-Automated Margins received only positive responses suggesting that it is the most acceptable solution in an operational sense.

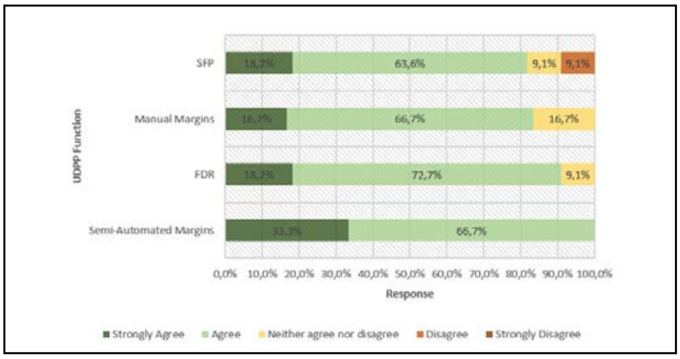

Figure 6: User Acceptance of each UDPP feature

2) Airport Performance and Integration

During the exercise, the APOC triggered UDPP at the start of each run and the participants using the stand allocation process were not aware of the actions performed by AUs on their flights with UDPP. The participants could only see variability in the traffic, not knowing which was due to UDPP. For airports, the effects of UDPP should be negligible as there is already a lot of noise and disruption in actual operations: UDPP would be a small part of the larger noise.

The performance of the airport was measured by the total delay at the airport. The results of the analysis show that UDPP reduced delay for arrivals. In some cases, off-block delay was increased although to the benefit of an increased departure flow, decreased risk of cancellations and increase in passenger connectivity, or to airlines "sacrificing" flights in order to minimise the impact of delay.

Verbal exchanges of information from airports about the stand changes to certain flights were disclosed to airlines and they checked these changes against their priorities. Observations of these verbal exchanges showed that the airports did not touch any flights of importance to the airlines, therefore the stand changes did not degrade the benefits for airlines and passengers. The common goal of both stakeholders is to ensure passenger connectivity and UDPP is expected to provide these benefits.

Airport participants agreed that integrating UDPP improves pro-active CDM with AUs and that further exchange about priorities would be beneficial. Participants noted that the workload of the stand planner seemed to increase, although still at a tolerable level.

Finally, Airports and AUs agreed that UDPP would be an advantage for operations, as airports and NM would receive less requests from airlines and less last minute changes, therefore, creating a more stable plan.

3) ECAC-wide performance assessment

A performance assessment was performed extrapolating the results ECAC-wide. It assumes that a UDPP Measure could be triggered every year 120 times at each of the 15 airports identified as problematic, and that only the major airline of that airport will perform UDPP actions. Therefore, assuming that UDPP Measures could occur 1,800 times a year within the ECAC network. These assumptions have been taken from expert judgement and the analysis of the current slot swapping, arrival regulations and the results from the validation exercise.

The extrapolation used 40% as the amount of additional costs due to delay recovered for participating airlines. 40% is the average cost savings per airline type from the validation exercise, equating to €50K cost recovery per UDPP Measure.

These assumptions calculating that €90M ECAC wide could be saved with 1,800 UDPP Measures per year each saving €50K were used as inputs into the Cost Benefit Analysis that took a conservative hypothesis on the deployment date. Figure 7 shows the results with a positive return of investment within only 6 to 7 years. These results, however, do not take into consideration the network effects of UDPP.

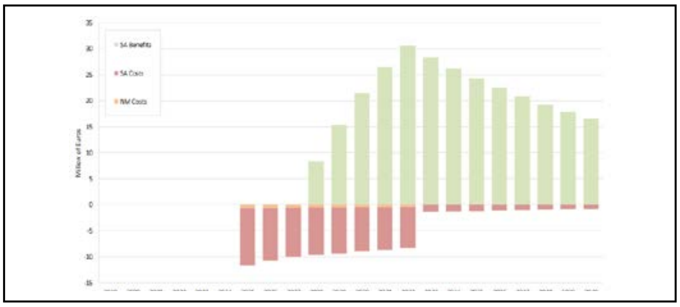

Figure 7: Annual investments and benefits for Network Management and Scheduled Aviation

4) *Limitations of Validation Results*

The validation results of the feasibility and performance of UDPP are promising, despite the following limitations:

- The measurements were assessed at only one airport, whereas there are more than 400 airports in ECAC.
- Only one-day's traffic was assessed. Constraints at airports differ from day-to-day and season-to-season.
- Participants did not have all tools and options available, such as airframe swapping, which may have exaggerated the use and benefits of UDPP.
- The cost-delay model did not include all constraints that produce costs and aid decision making for the allocation of UDPP prioritisations, such as crew duty time.

V. Conclusions and Future Work

For AUs, each UDPP feature is useable, desirable, feasible and acceptable in operations, although airlines would need support from automation for the allocation of priorities/margins to flights when there are a lot of flights. Performance results show that, whilst respecting equity, more flexibility brings more cost efficiency for AUs with 40 % reduction on average of the additional cost of delays, and increases the number of successful connections for passengers. In particular, users with fewer constraints to consider in the decision making (MVUs) were able to recover the most costs; LVUs were able to use UDPP with the current features, although not consistently.

For airports, although looking at stand allocation covered a limited range of the Total Airport Management, the initial results looked acceptable to APOC participants. Furthermore, airlines and passengers are airports' clients and UDPP is expected to provide benefits to both clients. The common goal of the AUs and airports is to ensure passenger connectivity, and from that perspective UDPP benefits would contribute to the airport Quality of Service.

The paper suggests that the SESAR performance framework for measuring the impacts of UDPP on flexibility and equity is not fully mature; further metrics for flexibility should include the rate of acceptance for UDPP prioritisations, as well as the rate of opportunities to use UDPP in ATM. With passengers as the clients of air transport, passenger experience metrics should be included into the performance framework.

UDPP for airport constraints has completed V2 maturity according to the E-OCVM [4] from the perspective of AU operational feasibility and will transition to V3.

UDPP aims to reduce the impact of delays, not the delay itself. The validation results of the feasibility and performance benefits of UDPP are promising. Future research will assess the impacts of multiple UDPP Measures on the network stability through Fast Time Simulations, and address the integration of UDPP into Network Management Collaborative processes with local and regional ATM actors at airports and with NM in contexts closer-to-operations.

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