Simulation of Aircraft Landing and Takeoff on Single Runway of Mumbai Airport

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Objective

- To replicate the landing and takeoff of aircrafts on a single runway 09/27 of Mumbai Airport.
- To understand and identify the occupancy of runway in high intensity runway operation (HIRO).
- To understand and analyse average number of aircrafts in landing queue and takeoff queue.
- To understand and analyse average waiting time in landing queue and take off queue.

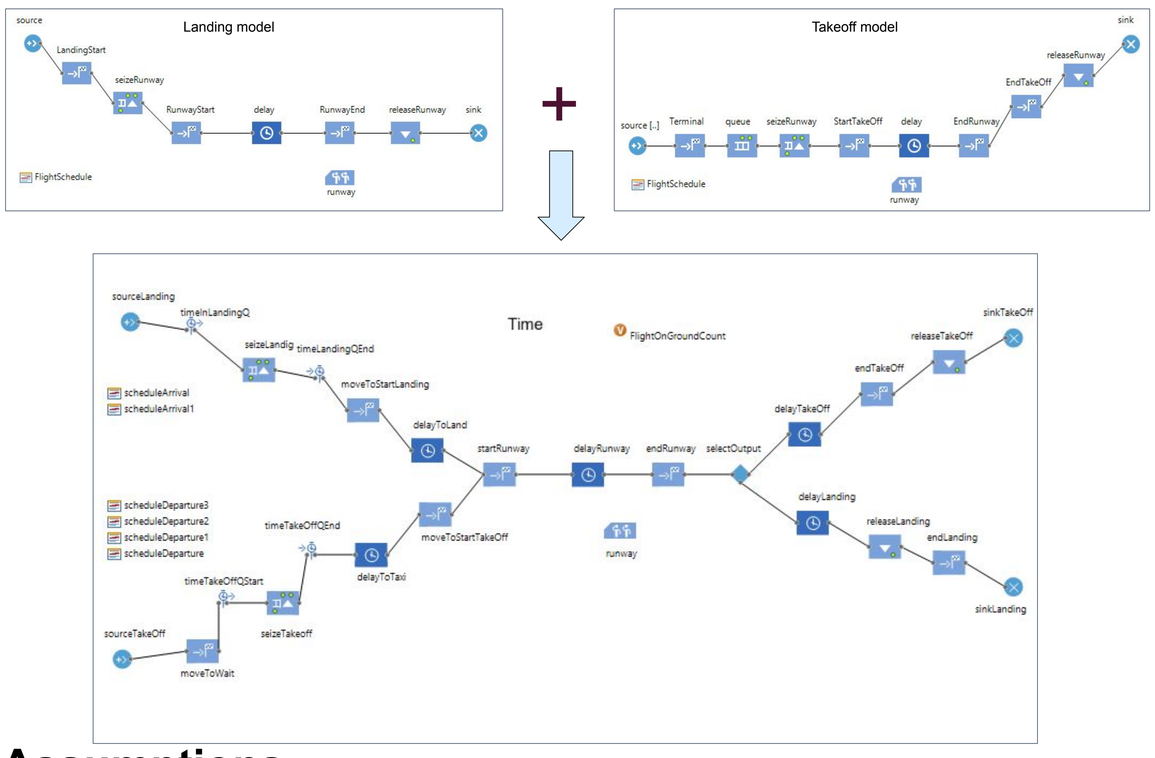
Materials and method

- **Data Description**
  Fight Era (Website): Actual arrival and departure schedule of flights.
  Collected manually.
- Google map image of Mumbai airport
- Operations in Aircraft landing and Takeoff
- Tool used**: Anylogic**

Approach

Step 1: Identified the operations in takeoff and landing on runway.
Step 2: Runway use time is found using average speed (240 Kmph) on the runway and runway length (3 Km).
Step 3: Prepared a raw model of takeoff and landing operations.
Step 4: Combined both raw models to get the overall model of runway operation simulation.
Step 5: For base scenario flight schedule of arrival and takeoff from 6:00 am to 8:45 am is considered.
Step 6: Four different scenarios are proposed for further analysis of result.

Simulation model



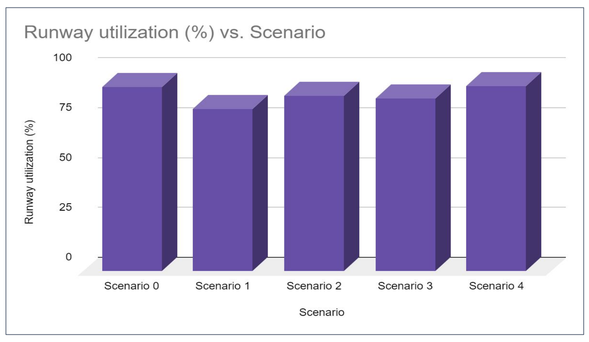
Assumptions

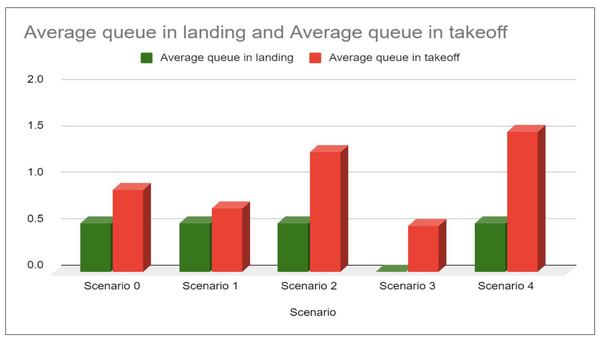
- 6:00 am to 8:45 am flight schedule is considered.
- Landing flights are given priority over the take off flight.
- Runway use time of each flight is Uni(40,60).
- Delay before each runway uses is Uni(10,15) and Uni(5,10) for takeoff and for landing respectively.
- Delay after each runway uses is Uni(15,20) and Uni(30,40) for takeoff and for landing respectively.
- Model time is in minutes and runway uses time is in second.
- Initial number of flights on ground is 68.

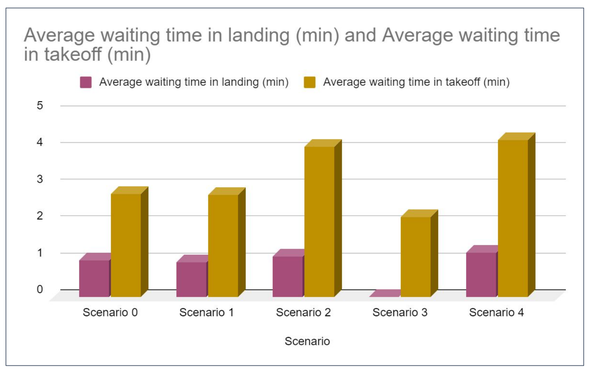
Results

- 10 replications for each scenario were considered and the average results are shown in table 1.
- Scenario 0 is the base case in which the scheduled departure and arrival of flights is considered.
- In scenario 1, schedule arrival and 2 flights per 5 mins for departure are considered.
- In scenario 2, schedule arrival and 2, 2, 3 flights in each 5, 10, 15 mins for departure are considered.
- In scenario 3, 1 flight per 5 min for arrival and 2 flights per 5 min for departure are considered.
- In scenario 4, schedule arrival and 3, 2, 3 flights in each 5, 10 , 15 mins are considered.

Scenario	Landing description	Takeoff description	Number of flight		Runway utilization (%)	Average queue in landing	Average queue in takeoff	Average waiting time in landing (min)	Average waiting time in takeoff (min)
			Take off	Landing					
Scenario 0	Schedule	Schedule	65	35	92.42	0.5224	0.8809	1.007	2.815
Scenario 1	Schedule	2 / 5 min	59	36	81.34	0.5246	0.6871	0.953	2.791
Scenario 2	Schedule	2,2,3 / 5,10,15 min	67	35	88.06	0.528	1.292	1.112	4.085
Scenario 3	1 / 5 min	2 / 5 min	62	32	86.82	0	0.5	0	2.17
Scenario 4	Schedule	3,2,3 / 5,10,5 min	72	35	92.69	0.526	1.5116	1.212	4.266







- In morning peak hours landing queue of flights is comparatively smaller than takeoff queue as landing is given priority over takeoff which can be seen from the above barchart.
- The runway utilization is minimum in scenario 1 (81.34%).
- In morning peak hours number of flights on ground keeps decreasing as more flights are departing than arriving.
- Maximum number of flights on ground in each scenario is 68.

Conclusion

- Successfully simulated the runway operations for scheduled flights from 6:00 am to 8:45 am time window.
- Among the proposed scenarios, scenario 1 performs best as it has less average queue in takeoff and slightly less waiting time in both landing and takeoff than the base scenario.
- Other scenarios have higher waiting time and queue length.
- If landing schedule can be changed then scenario 3 outperforms than others in terms of all parameters.

Guided by

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References

[1] Rogovs, S., Nikitina, V., & Gerdts, M. (2022). A novel mixed-integer programming approach for the aircraft landing problem. *Frontiers in Future Transportation*, *3*, 968957.
[2] Initiatives by Ministry of Civil Aviation yielding results at Mumbai airport, Air traffic situation has shown improvement, Delays in flight arrivals