Effects of weather, delays, and technical disruptions on passenger satisfaction

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As Innovative Air Mobility (IAM) systems move towards reality, a need arises to focus not only on operational metrics but also on passenger-centric service quality. Passenger satisfaction influences user adoption, operational efficiency, and long-term success of any transportation system, boosting its environmental impacts and helping the country's economic development. When passengers embark with positive satisfaction, it encourages the use of multimodal systems. In that way, the transportation system is seen as reliable and convenient, heading toward broader acceptance. The satisfaction feedback from the passengers also helps the transport providers refine schedules, infrastructure, and digital services for the betterment of the system.

While existing frameworks evaluate vertiport performance, they lack the resolution to capture the diverse perceptions of individual passengers undergoing delays and disruptions. In this brief abstract, we aim to present a satisfaction model that bridges this gap by combining operational simulation with behavioral sensitivity by simulating vertiport scenarios under varying environmental and technical disruptions, delays and cancellations due to miscellaneous factors.

In this work, we introduce a metric-based satisfaction level of the passengers using the vertiport facilities. Our work is based on the HorizonUAM project [1-2] from the German Aerospace Center (DLR). Within this, our abstract addresses the effect of vertiport operations, weather conditions, and associated eVTOL cancellations and delays on passenger satisfaction. The level of passenger satisfaction is determined by developing a hybrid passenger satisfaction model that integrates dynamically weighted sensitivities, disruption penalties, and tolerance-based emotional classifications. In a vertiport simulation environment, an agent-specific satisfaction score was generated by considering the aforementioned factors.

The vertiport operations are frequently subject to non-nominal events, such as operational disruptions (missed vertiport slots /cascading delays), specific environmental conditions (particularly wind intensity and snowstorms), infrastructural failures (blocked gates / pad unavailability), or other vehicle related issues (technical faults/cancellations). These disruptions affect not only system-level performance but also have varying impacts on the passenger experience. While frameworks like Vertidrome Airside Level of Service (VALoS) [3] provide a threshold-based method for assessing operational acceptability (e.g., average delay, punctuality, cancellations), they are inherently binary and system-oriented. VALoS classifies each day or simulation run as either "acceptable" or "non-acceptable," based on global metrics, and lacks importance at the individual passenger level. As in Figure 1, passengers would prefer a smooth and ideal travel over severe delays and cancellations.

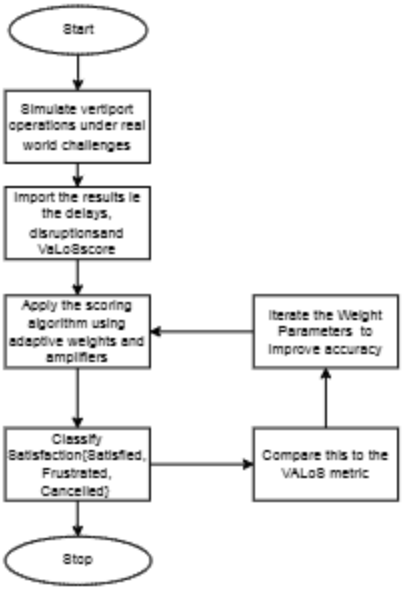


Figure 1 Framework for passenger satisfaction model

The core of our approach lies in a scoring algorithm that deducts penalties from a basis score based on the disruption data. Two types of penalties are applied, first one is the independent penalties for each disruption (e.g., delay minutes, missed slot, snowstorm), and the other are the amplifier penalties applied when disruptions that are known to interact negatively from a passenger's perspective (e.g., delay, cancellation, or snowstorm). The final satisfaction score is then evaluated against the agent's personal tolerance threshold to determine their emotional state. If the score ≥ tolerance, then the passenger is satisfied, if score < tolerance the passenger is frustrated. To validate the accuracy of our model, we compare the classifications to benchmark outputs derived from the VALoS framework.

Finally, the framework conducts a weight calibration mechanism. Using a feedback loop, we iteratively rectify the penalty weights and amplifier coefficients to minimize the mismatch between our predicted agent states and the VALoS benchmark. The result is a calibrated, validated, and personalized satisfaction model that transforms coarse system-level disruptions into nuanced, stakeholder-aware evaluations.

To add more accuracy to the algorithm, the ground truth must come from real data sources. Therefore, as a part of the future work, we further research into satisfaction data from public transport platforms such as railways (Deutsche Bahn), airports, trams and buses in Germany.

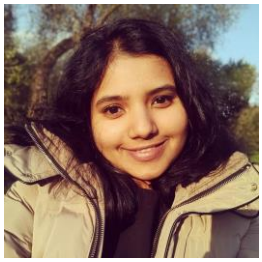
[1] Schuchardt, B. I., Becker, D., Becker, R.-G., End, A., Gerz, T., Meller, F., Metz, I. C., Niklaß, M., Pak, H., Schier-Morgenthal, S., et al., "Urban Air Mobility Research at the DLR German Aerospace Center– Getting the HorizonUAM Project Started," AIAA Aviation 2021 Forum, 2021, p. 3197.

[2] Schweiger, K., König, A., Metz, I. C., Naser, F., Swaid, M., Abdellaoui, R., and Schuchardt, B. I., "HorizonUAM: Operational Challenges and Necessary Frameworks to Ensure Safe and Efficient Vertidrome Operations,"CEAS Aeronautical Journal, 2024, pp. 1–16.

[3] Schweiger, K., and Knabe, F., "Vertidrome Airside Level of Service: Performance-based evaluation of vertiport airside operations," Drones, Vol. 7, No. 11, 2023, p. 671.

Biography

Nirupama Vinayakumar Nair



Nirupama completed her masters in Embedded systems engineering from the University of Freiburg and is currently working at DLR Institute of Flight guidance as a researcher. Her research includes Vertiport placements and operations