ROBUST MAXIMUM COVERAGE FACILITY LOCATION PROBLEM WITH DRONES

Paper 20-05491

Darshan R. Chauhan, Avinash Unnikrishnan,
Miguel Figliozzi, Stephen D. Boyles

at

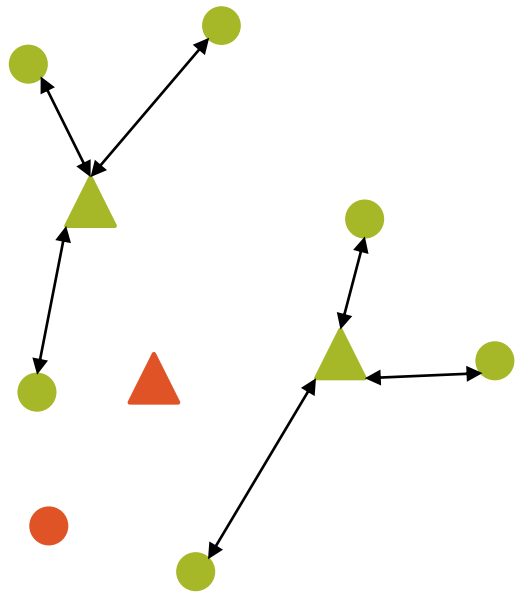
The 99th Annual Meeting of the Transportation Research Board

January 13, 2020

Usage of Drones

Sources: https://www.droneblog.com/2017/07/25/how-drones-can-improve-disaster-response-and-relief/, https://www.gpsworld.com/canada-awards-drone-airspace-management-contract-to-kongsberg-geospatial/, https://www.thomasnet.com/insights/drone-use-in-agriculture-is-soaring-to-new-heights/, https://csengineermag.com/u-s-transportation-secretary-elaine-l-chao-announces-faa-certification-of-commercial-package-delivery-for-drones/

Problem Characteristics

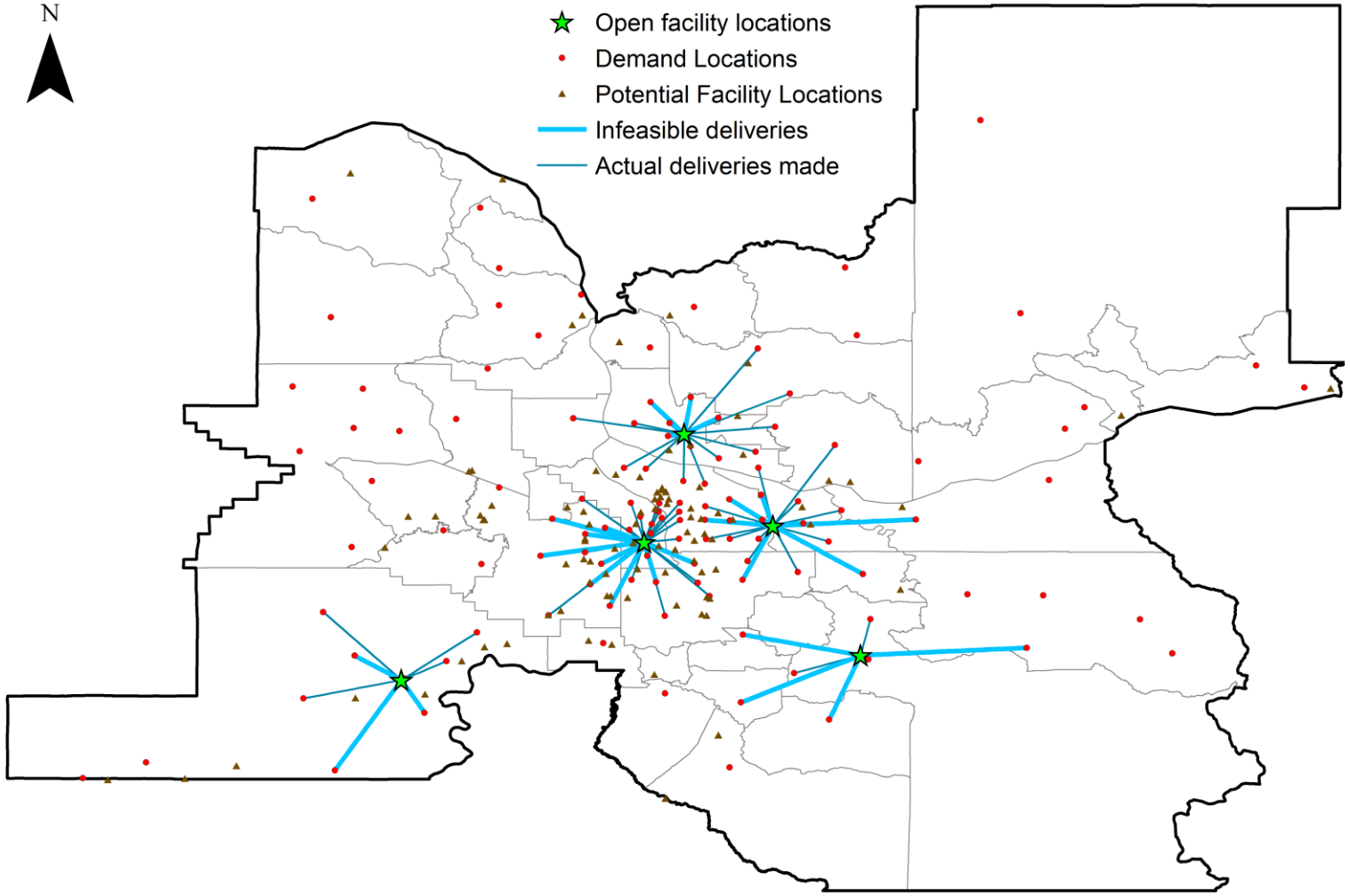


- Goal: Maximize coverage
- Questions:
  - Locating facilities
  - Assigning drones to open facilities
  - Delivery assignments for each drone
- Constraints:
  - Number of facilities that can be open and number of drones available
  - Capacity constraints for facilities
  - Battery capacity constraint for drones
  - One-to-one delivery by drones

Problem Considerations

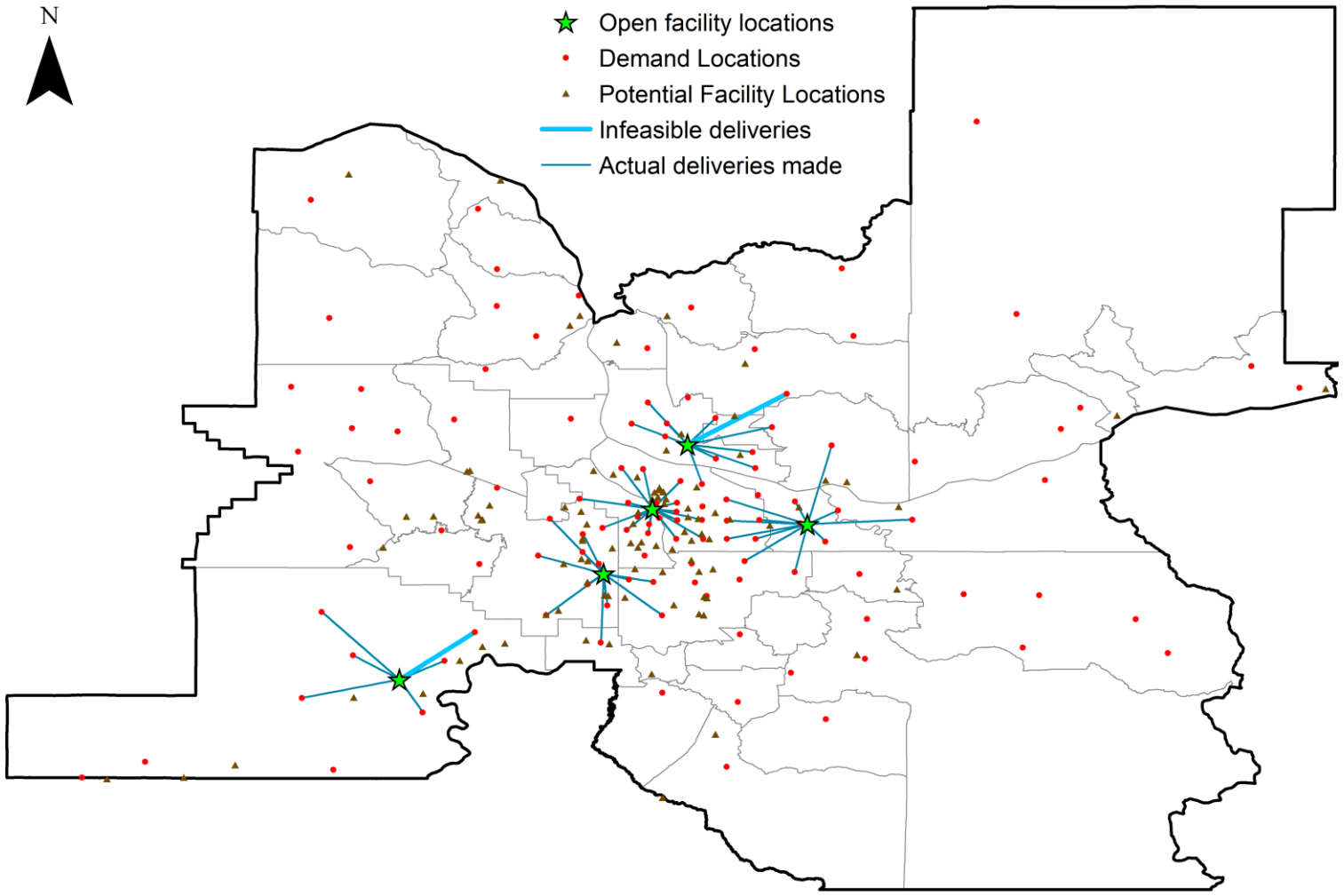
- Key contributions:
  - Uncertainty in energy consumption during deliveries
  - Uncertainty in available battery energy level for each drone
- Robust Optimization is used to model uncertainties
- Solution Approaches:
  - Exact solution using an MIP solver
  - Robust Three Stage Heuristic (R3SH) taking advantage of the principles of decomposition and fast local search

Results



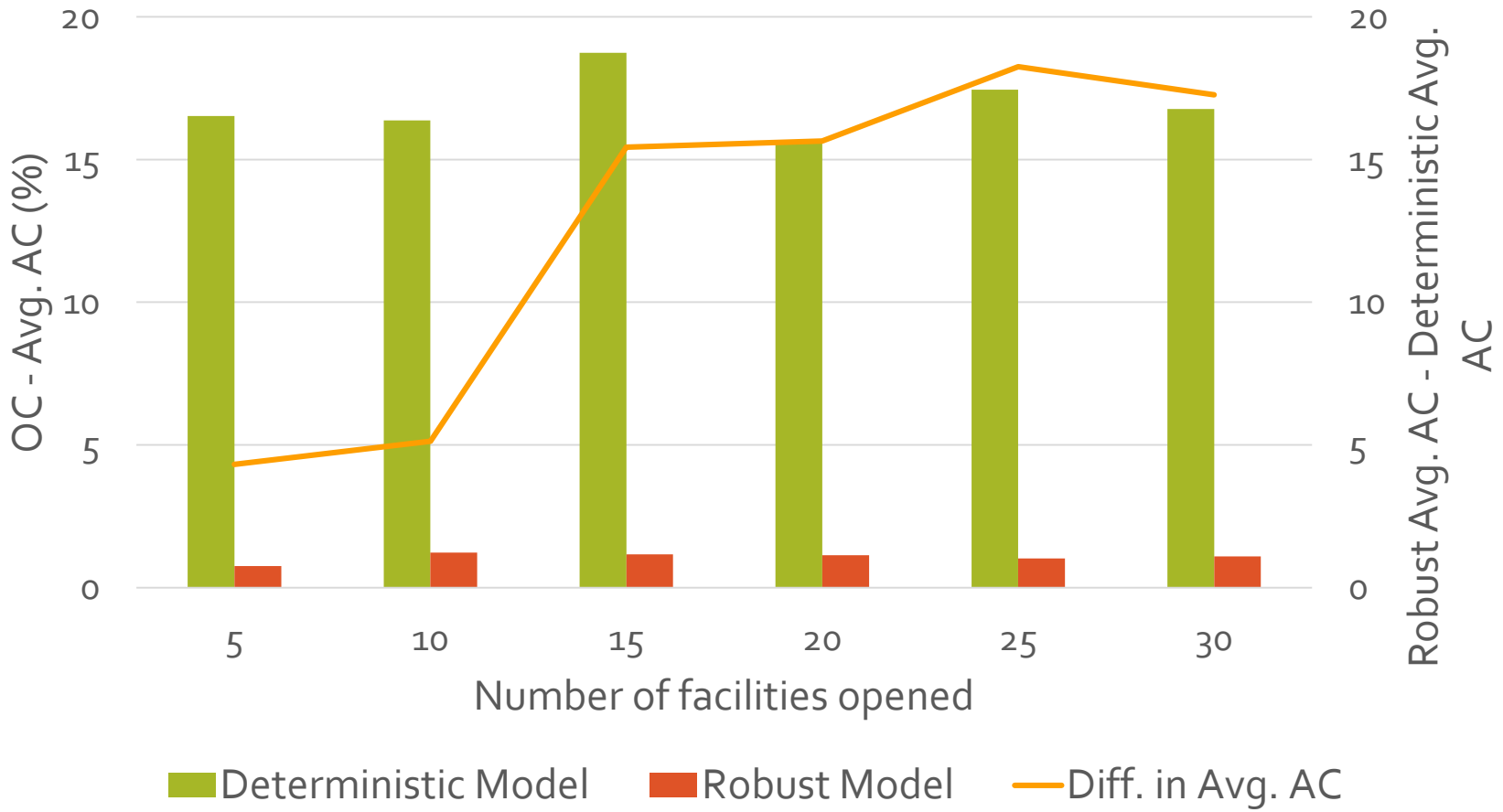
Deterministic Model (No uncertainties considered)

Results



Robust Model (all uncertainties considered)

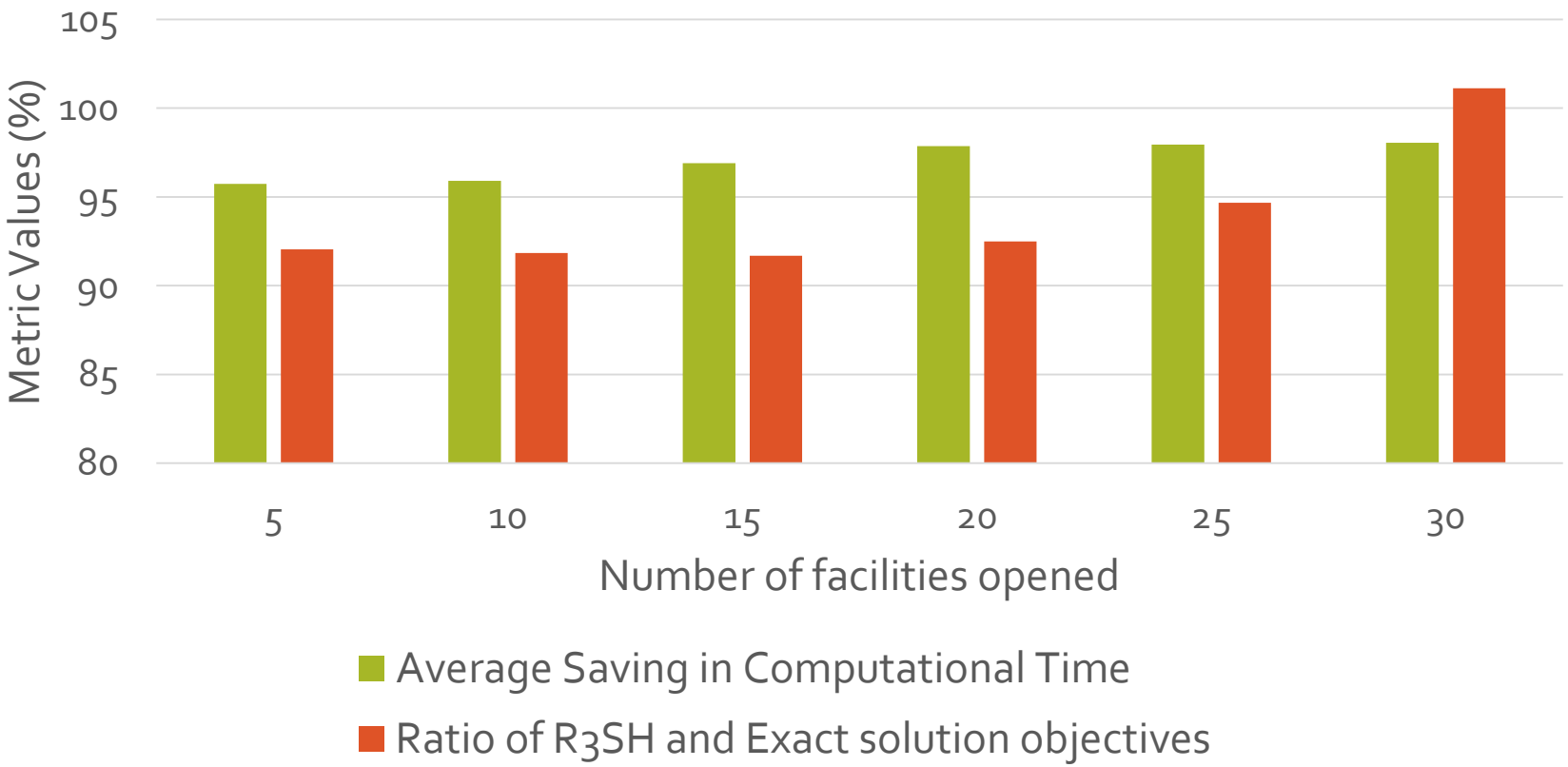
Value of adding robustness



OC : Coverage obtained after solving the model

Avg. AC : Average Actual Coverage through Monte Carlo Simulations

Computational Efficiency



R3SH : Robust Three Stage Heuristic

Conclusions

- The proposed R3SH achieves 93% of coverage obtained through MIP solver on average with 97% reduction in median computational time
- Robust model provides a more realistic estimate of the coverage
- Robust model also provides with more reliable drone delivery assignments

Acknowledgements

- National Science Foundation, USA (CMMI-1562109/1562291, CMMI-1254921, CMMI-1636154)
- Data-Supported Transportation Operations and Planning Center
- Center for Advanced Multimodal Mobility Solutions and Education
- Freight Mobility Research Institute

Thank you!

Contact:

Darshan R. Chauhan

Ph.D. Student

Portland State University

drc9@pdx.edu