

# Groovenauts and Mitsubishi Estate: Creating Sustainable Cities through Waste Collection Optimization

## A Case Story

*"Utilizing quantum annealing, the route for collecting waste, currently requiring a distance of about 2,300 km, was optimized and reduced to just 1,000 km. As a result, CO2 emissions would be reduced by approximately 57%, and the number of vehicles reduced by approximately 59%."*

*From: [Using Artificial Intelligence \(AI\) and Quantum Computers for Optimized Waste Collection and Transport Verified in Reduction of CO2 Emissions](#)*



IMAGE: EXAMPLE OF WASTE COLLECTION FOR MULTIPLE BUILDINGS



IMAGE: COLLECTION ROUTE OPTIMIZATION



### Building the Smart Cities of the Future

Groovenauts, Inc. has been one of Japan's preeminent quantum pioneers since 2011. The software company developed a cloud service called MAGELLAN BLOCKS in 2016 that enables companies across industries to use AI to solve hard business problems. In early 2019, they announced a new commercial service integrating D-Wave's quantum computing capabilities into MAGELLAN BLOCKS. The combination of technologies gave users a quantum-hybrid solution for tackling business problems, without requiring specialized physics or programming knowledge.

Right away, Groovenauts put their new service to the test in partnership with Mitsubishi Estate Co., Ltd., who manages and develops office buildings in major cities across Japan. The project goal was to optimize the collection and transportation of waste in the Marunouchi area of Tokyo, a special urban regeneration area.

In addition to increasing operational efficiency, the team hoped to devise a plan that would lead to a reduction in CO2 emissions as part of a larger goal to make cities smarter, safer, healthier, more welcoming places for people to live.

Together, the companies designated 26 sites owned by Mitsubishi Estate that would serve as the starting point for Groovenauts' data collection and projection efforts. Their detailed research included the number of tenant companies and employees in each building, waste collection regulations, vehicle specifications for transport, and the amounts, collection routes, required labor time and collection frequency for each type of waste produced by each building.

This was combined with weather data provided by MAGELLAN BLOCKS (such as temperature, humidity, and precipitation), district event information, and other data that can affect prediction factors to create a model forecasting the amount of each type of waste that would be generated over a period of several months.



The results obtained from the AI prediction were used with quantum annealing to simulate a combination of routes requiring the fewest vehicles, and which was composed of the shortest distances, while reliably maintaining waste collection. Constraints such as load capacity of vehicles, the access and positioning of loading-unloading areas of buildings and disposal sites, and required collection times were considered for all buildings.

Item	Current	Optimized	Difference
Total Route Distance	2,296.2 km	1004.2 km	▲1,292.0 km
Number of Trucks	75	31	▲44
Total Work Time	8,650.9 mins.	5,372.2 mins.	▲3,278.7 mins.

By utilizing the machine learning / deep learning and D-Wave quantum computing technology provided with MAGELLAN BLOCKS, the amount of waste generated was able to be predicted with an extremely high level of accuracy (about 94%), and based on that prediction, the optimal route was able to be determined from amongst a vast set of possibilities. The route enabled a 57% reduction in CO2 emissions, a 59% percent reduction in the number of vehicles needed to perform the work, and a 38% reduction in the total work time.

Building on their exciting findings, Groovenauts and Mitsubishi Estate are currently conducting Proof of Value for actual operations based on the data from this simulation. In addition to contributing to sustainability, they hope to reduce long work hours and labor shortages with the various waste treatment companies servicing different buildings. In the future, both companies will continue to promote “City as a Service” as a model for cities, and will continue to work towards improving urban services and ultimately realizing a “smart” city utilizing advanced technologies.



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