VALE

Simulation Driven Impact Estimation on the Mining Industry

Photo : 9Dstudio

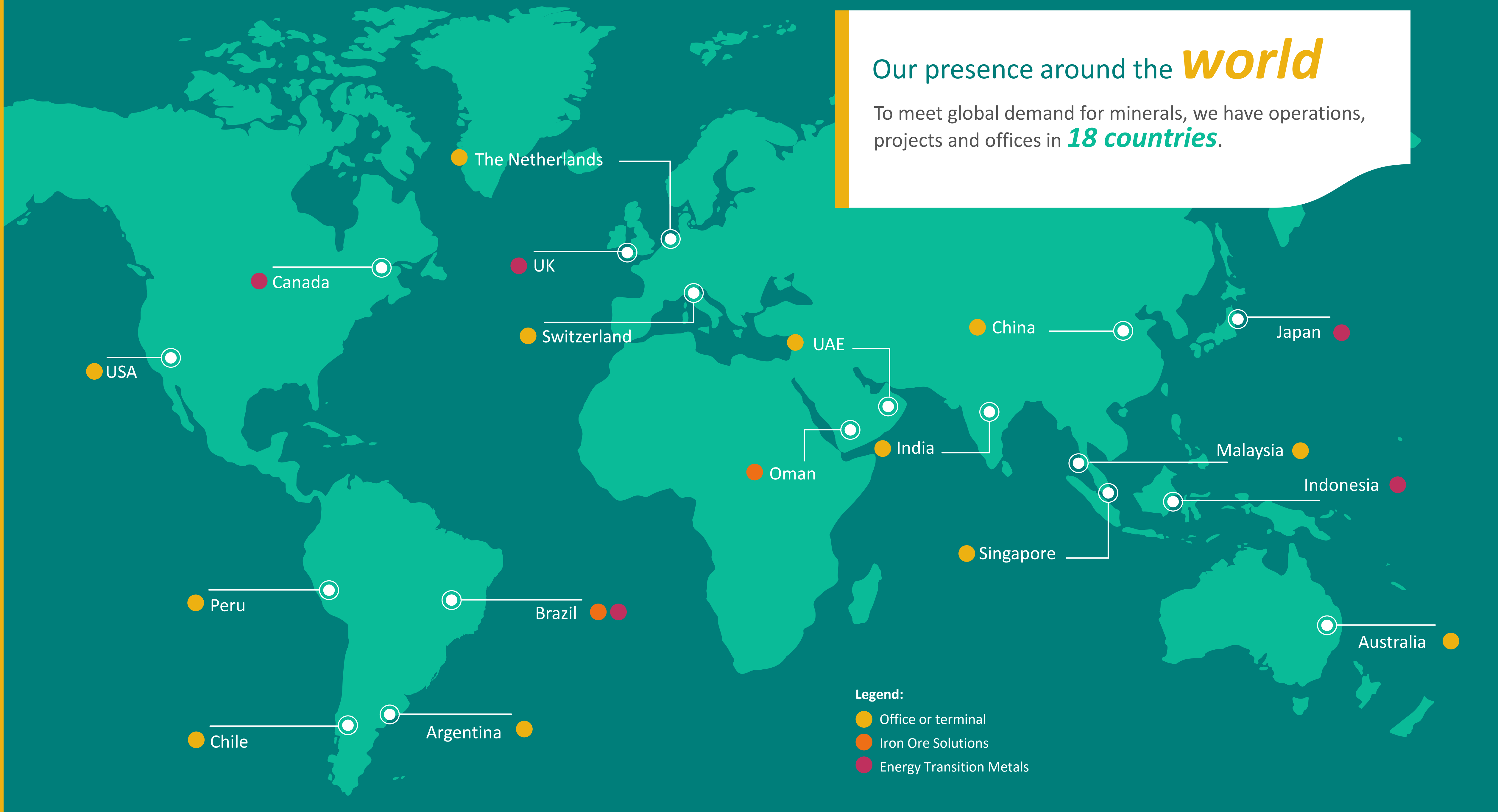
Our *business*

We are among the world's largest producers of ***iron ore*** and ***nickel***. We are also a major ***copper*** producer and have ***gold, silver and cobalt*** operations.

Bruna Brito and Luciano Grázzia in Congonhas, Minas Gerais, Brazil
Photo: Leo Lopes

Our presence around the *world*

To meet global demand for minerals, we have operations, projects and offices in ***18 countries***.



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1. Problems Overview

Problem 1

- S11D is one of the biggest projects in the history of Iron Ore mining
- To increase the capacity of waste crushing, a new operational model was proposed
- The new operation will have interference with existing operations; the size of impact must be estimated

Problem 2

- In order to increase the usage of the existing logistic network (railways and ports), there is a demand to evaluate additional train loading at Serra Leste rail loop
- The new operation would load material that have a different origin than the existing operations
- Expanding current one-way road to a two-way road requires extensive earthworks

2. Why AnyLogic?

- Discrete-event simulation software package
- Several useful libraries available – fluid / bulk product handling, road traffic, process modelling
- GIS integrated
- Agent-based modeling makes extension of existing library or new libraries easy
- Agent-reuse on different case scenarios

3. Interaction between Haul Truck and small Vehicle traffic

3.1. Problem Overview

- S11D is one of the biggest projects in the history of Iron Ore mining
- The mine operates with in-pit conveyor crushing and trucking on a mixed model
- Open pit mines have two main haulage materials: Run-Of-Mine (ROM) and Waste
- ROM is fed to the processing plants in order to become product
- Waste is material that must be removed and has to be dumped on the Waste Piles

3.1. Problem Overview

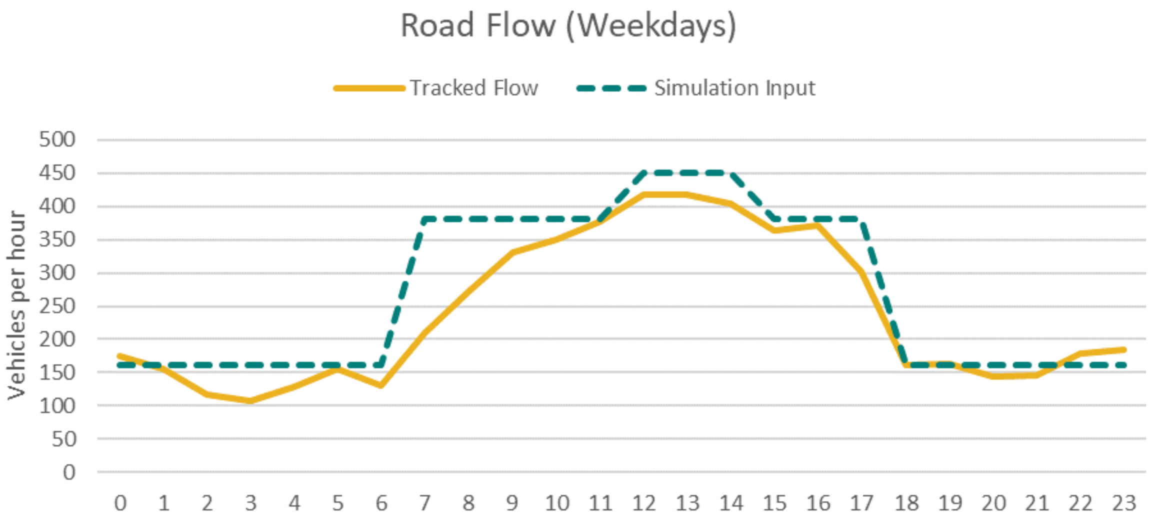
- In order to increase waste crushing capacity, a new suitable area was being considered

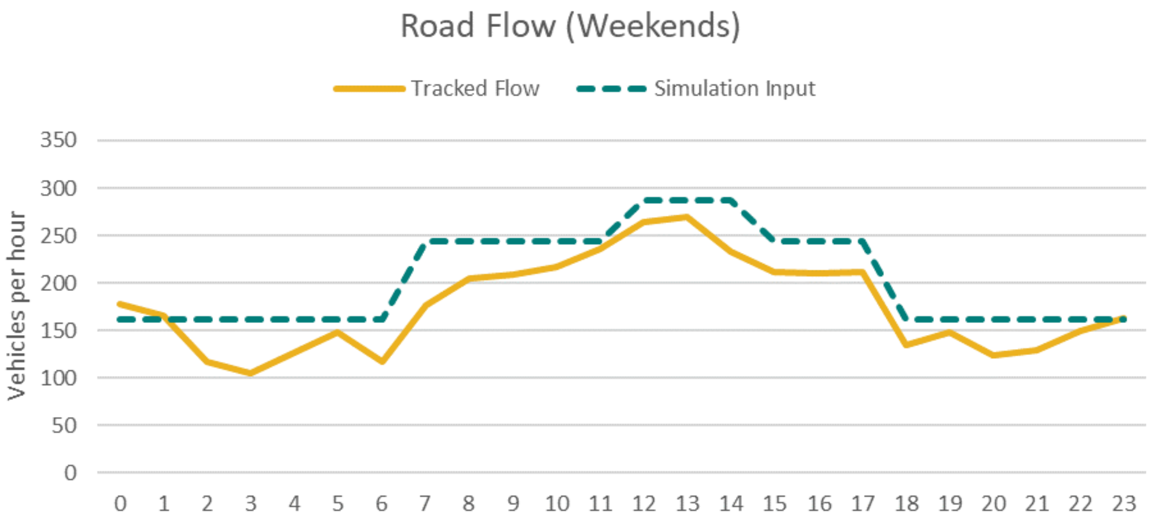
- However, simultaneous traffic from haul trucks and road vehicles is forbidden

- The study aims to evaluate the impact of automatic road gate barriers on the existing vehicle traffic

3.2. Data Gathering

- The existing road traffic is composed of buses, small cars and road trucks that transport people, waste and materials
- Vehicles entering or leaving the mine are tracked due to access control
- Vehicles transporting waste are tracked for production purposes
- Field data collection was performed to find the difference between tracked and total traffic on each direction
- The real world data was converted into a scheduled rate for the model





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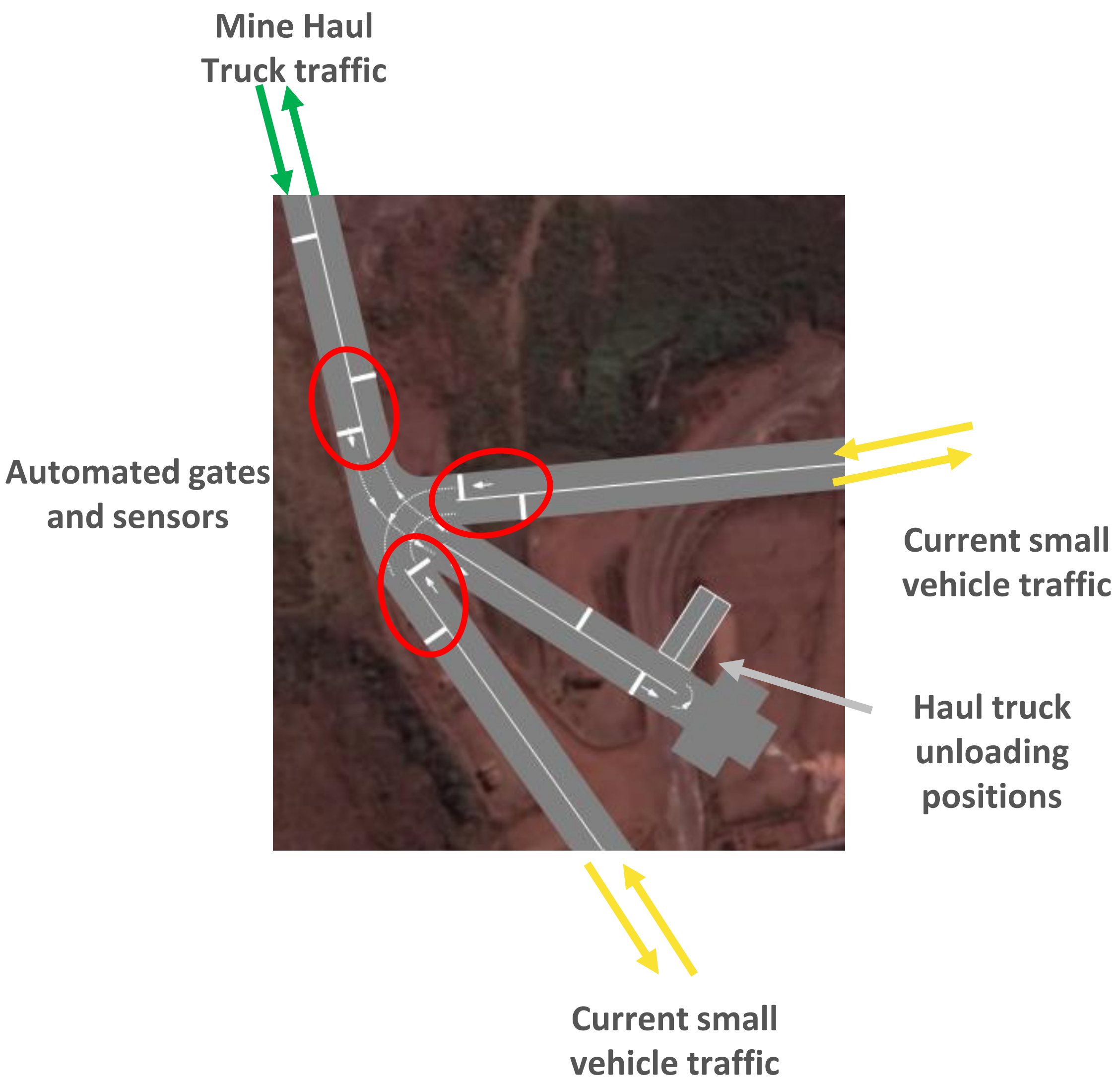
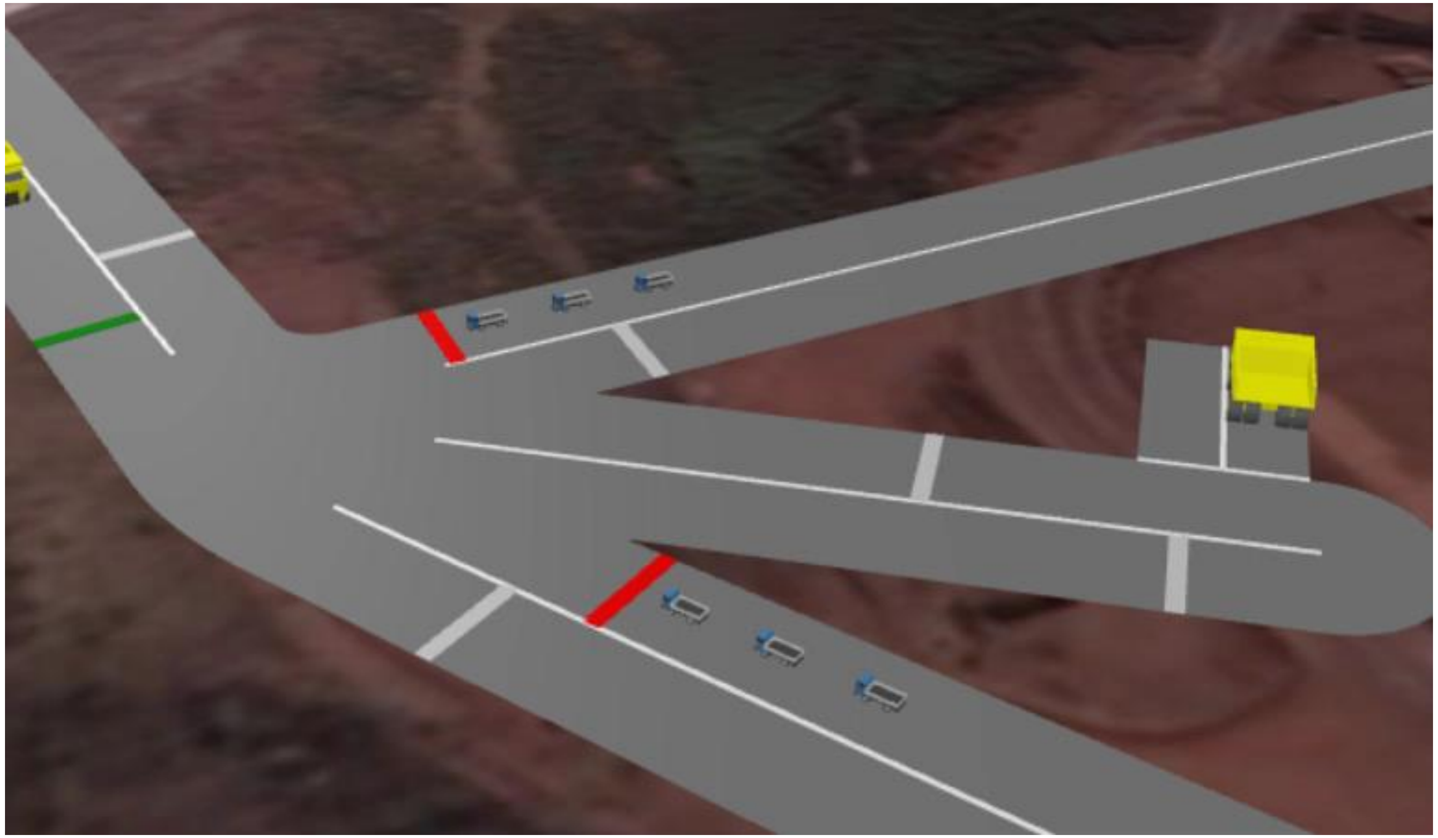
3.3. Modeling



- Development of an Agent for management of interference areas
- The agent controls entrance and exits of vehicles on the controlled area
- Entrance is controlled by setting the TrafficLight on each StopLine before entering the restricted area
- There is one additional agent that comprises ParkingLot with delay for the unloading with control of empty positions and queueing
- The arrival of both Haul Trucks and Small Vehicle is defined by schedules

3.3. Modeling



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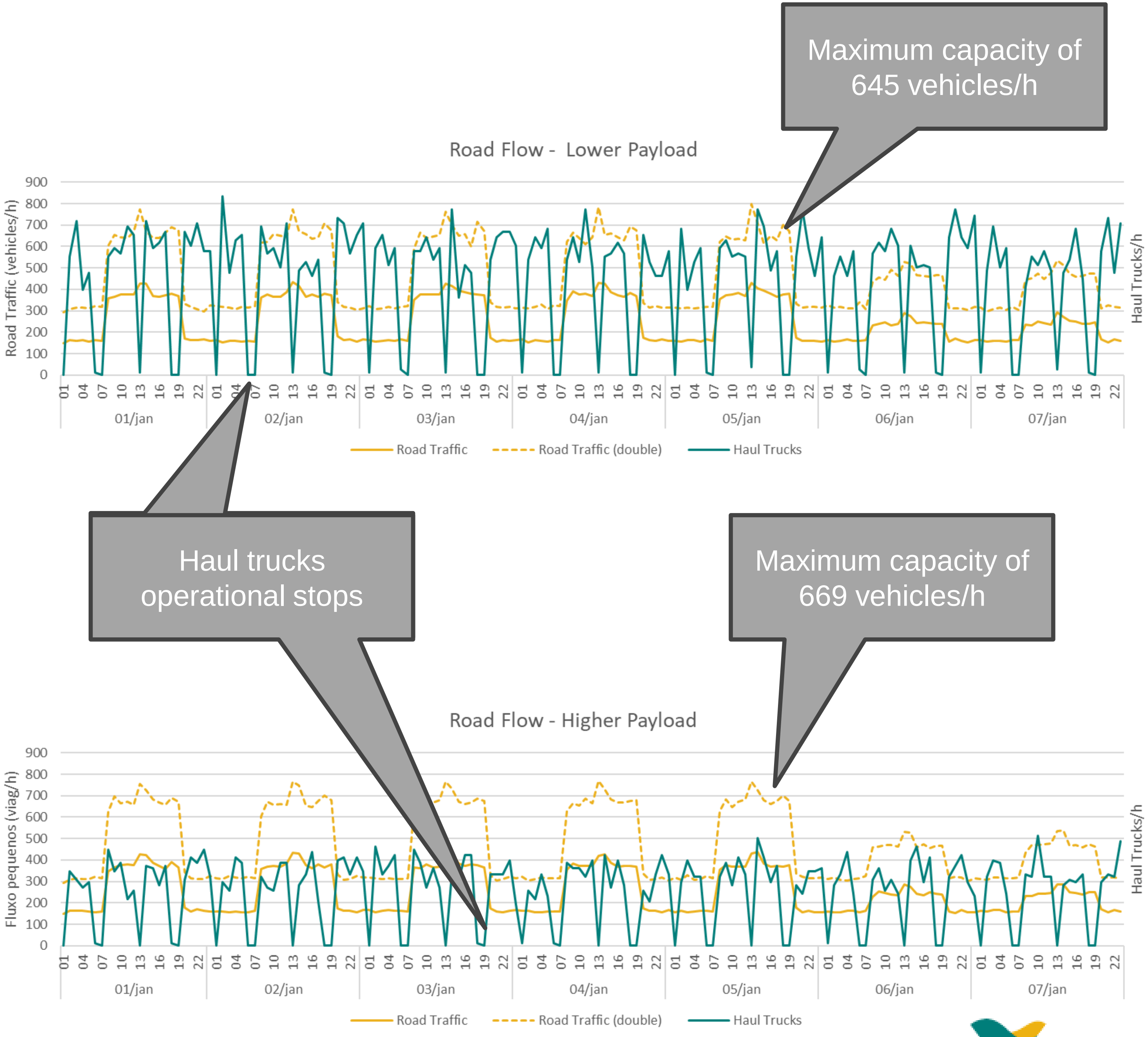
3.4. Results

- Traffic was simulated during one week, with 10 replications

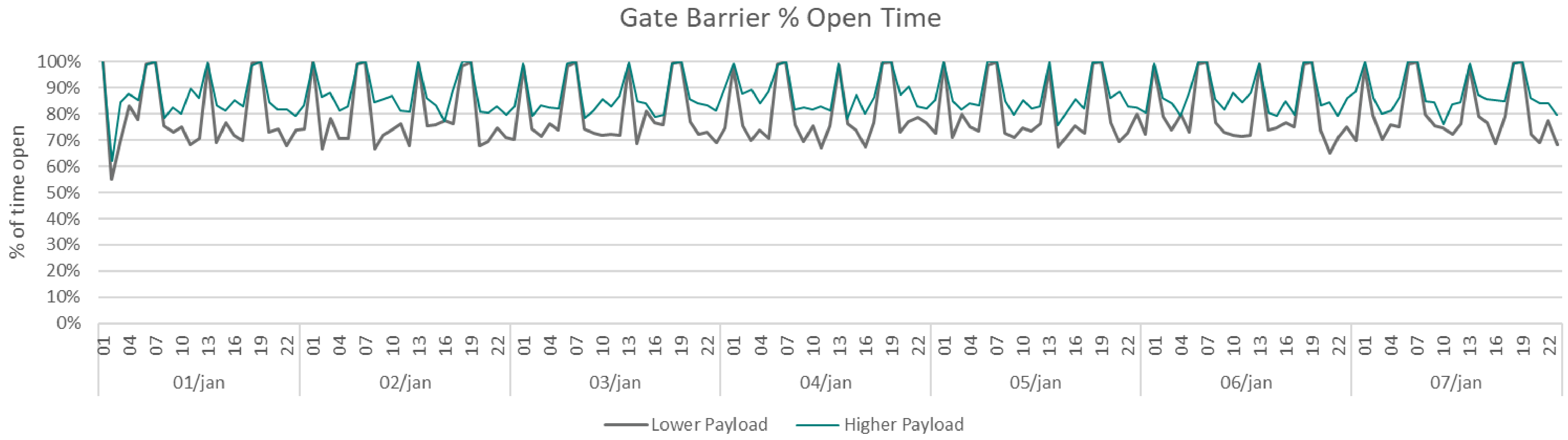
- Different models of Haul Truck were evaluated

- Higher capacity Haul Trucks lead to less trips and less time blocking road traffic

- To estimate the maximum capacity of the gate barrier, scenarios with double the required road traffic were also evaluated



3.4. Results

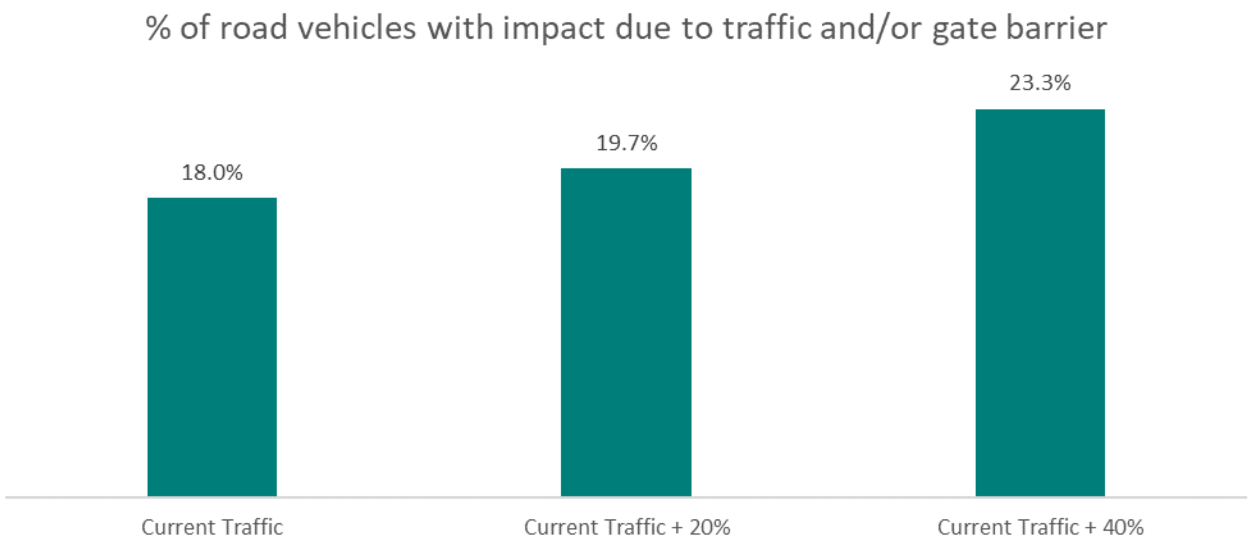


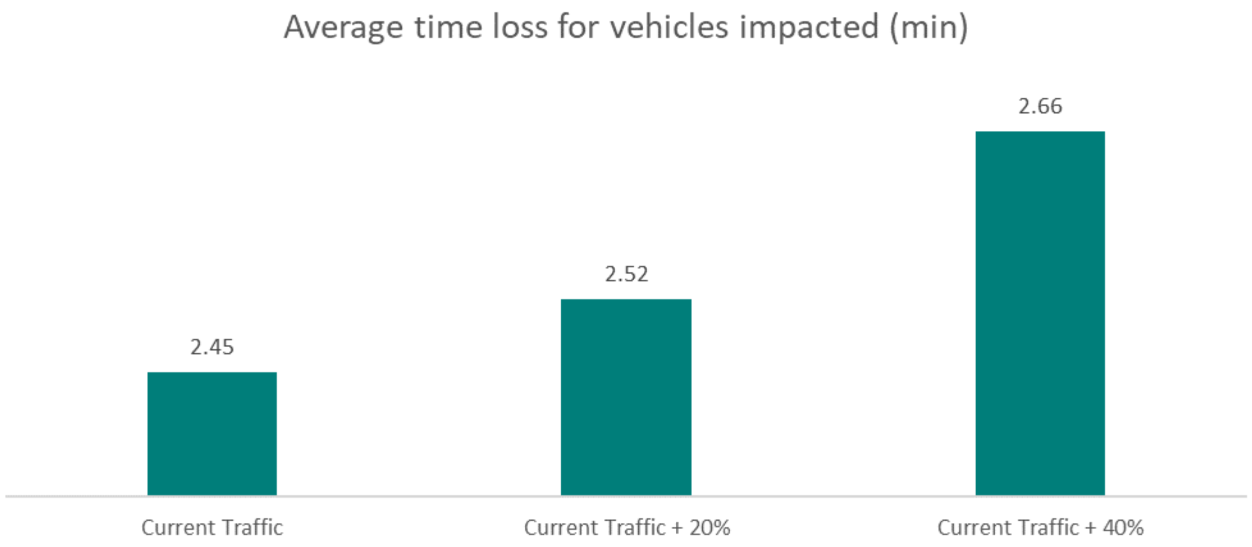
	Lower Payload	Higher Payload
% time of barrier open	73.4%	83.3%
Average Open time (min)	10.2	15.0
Average Closed time (min)	4.2	4.0
Maximum Closed time (min)	5.3	4.5

3.4. Results

- To assess time impacts on road traffic and existing operations, a queue / traffic analysis was detailed for the higher payload truck

- Additional road traffic demand of +20% and +40% was also evaluated due to future projects





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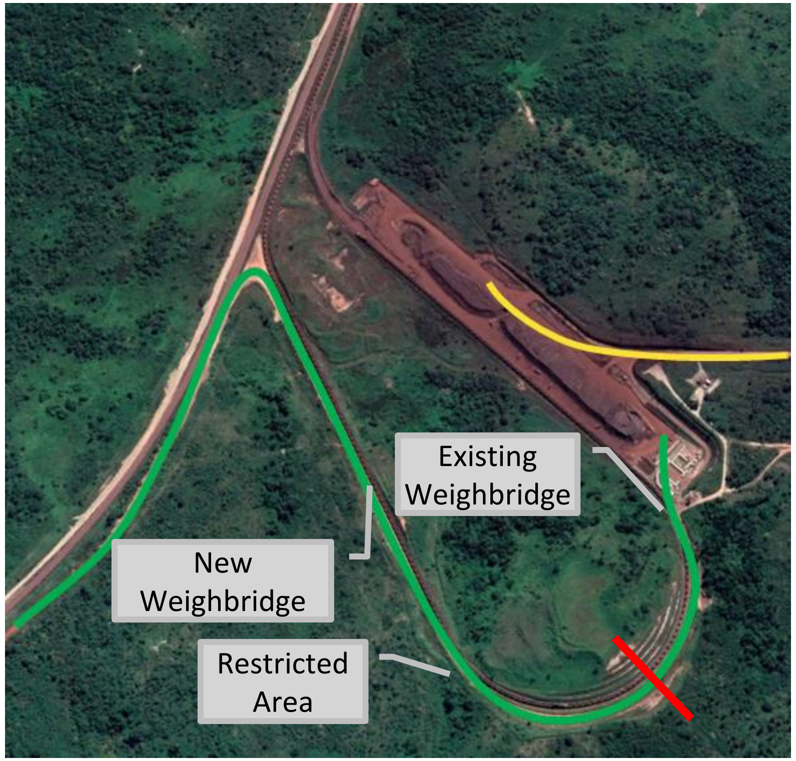
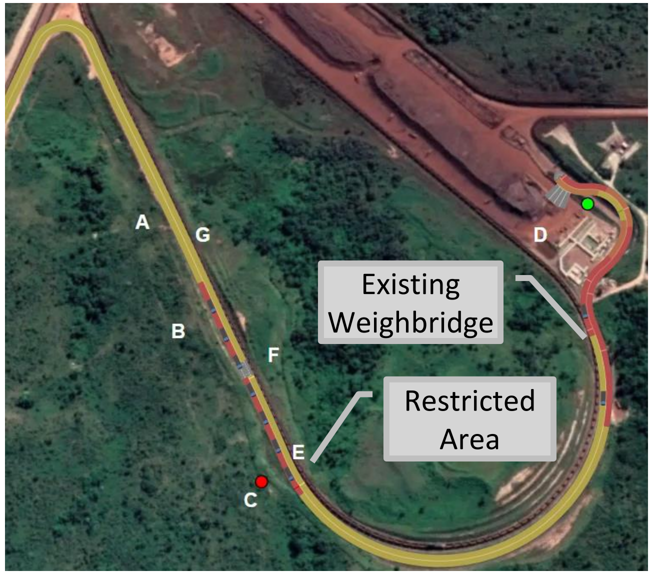
4. Weight station capacity

4.1. Problem Overview



- In order to increase the usage of the existing logistic network (railways and ports), there is a demand to evaluate additional train loading at Serra Leste rail loop
- The new operation would load material that have a different origin than the existing operations
- Expanding current one-way road to a two-way road requires extensive earthworks
- There is currently an entrance with a weight bridge, however it sits inside the restricted area
- With the new operation, there will be an increase in demand and the capacity of the current structure. Additionally, two new structures should be evaluated for future expansion

4.2. Modeling



- There are 4 simultaneous dumping positions
- Restricted area was controlled via the agent developed previously
- Restricted area control was done using TrafficLight of the StopLines
- Every inbound loaded truck must be weighted
- Outbound empty truck would ideally be weighted at every trip
- If additional capacity is required, it is possible to use previous empty truck weighted if it was recent enough; modeled as chance of requiring weight on empty trucks

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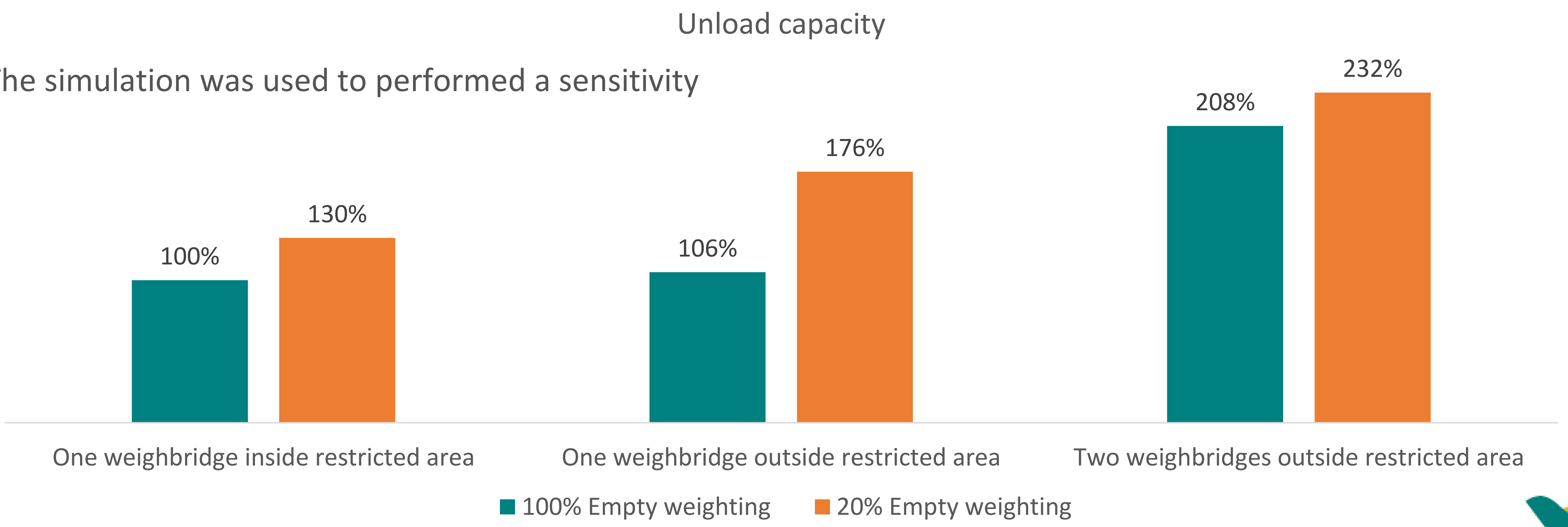
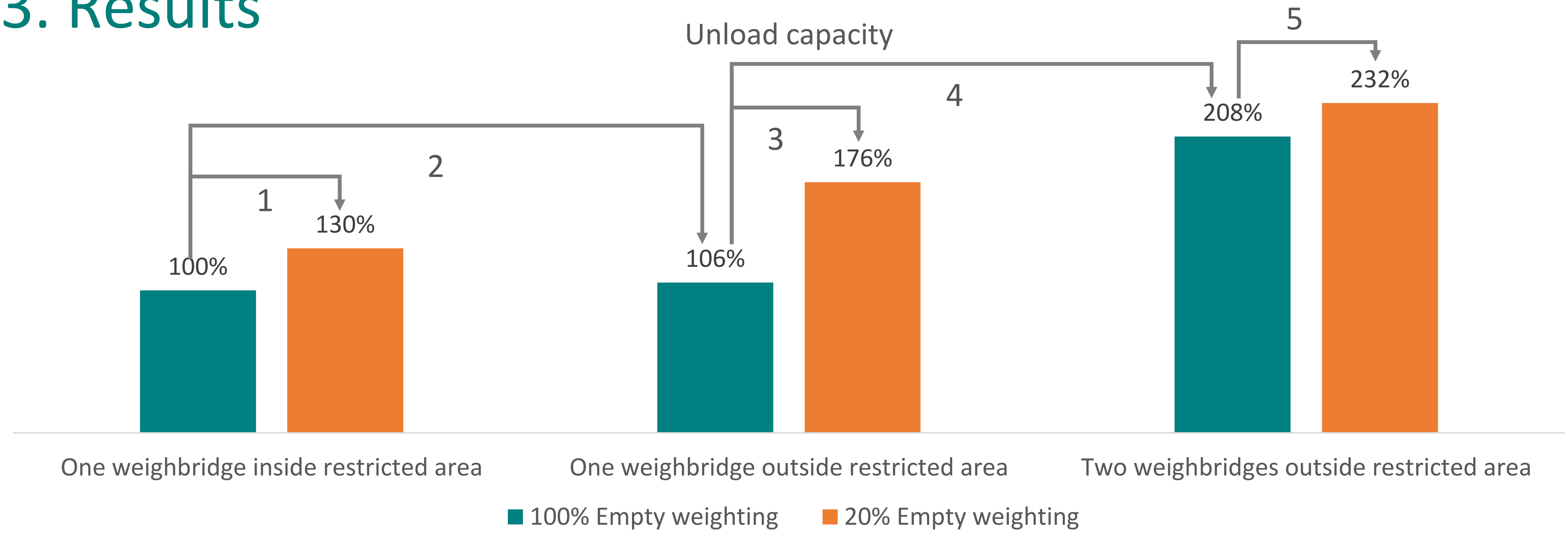
4.3. Results

- The simulation were run in each of the three different scenarios
  - Existing weighbridge inside restricted area
  - One new weighbridge outside of the restricted area
  - Two new weightbridges outsides of the restricted area
- The simulation was used to performed a sensitivity analysis to the arrival rate of trucks (9 levels) and required empty truck weighting (5 levels), for a total of 135 runs (each with 10 replications)
- The worst case scenario was considered 100% of unloading capacity



4.3. Results



1. Reducing empty weighting from 100% to 20% shows small increase in capacity for the existing bridge
2. Moving the weighbridge outside of the restricted area shows small improvement
3. For the weighbridge outside of the area, reducing empty weighting increases capacity significantly
4. Two weighbridges outside of the area have about double the capacity of the single bridge at 100% weighting
5. Reducing empty weighting with two weighbridges shows small improvements

Questions?

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