Optimization of solid waste collections in Blantyre, Malawi

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MSc. Energy Science & Technology
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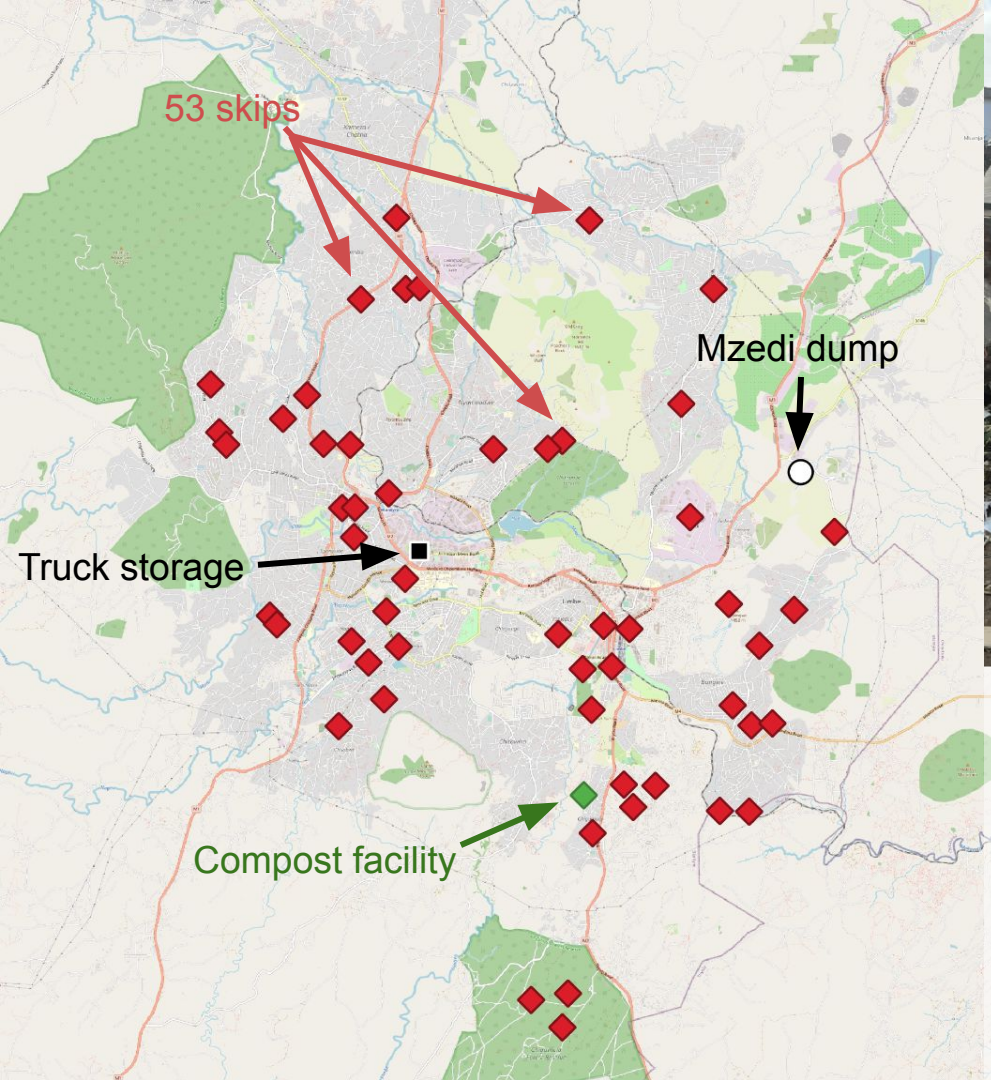
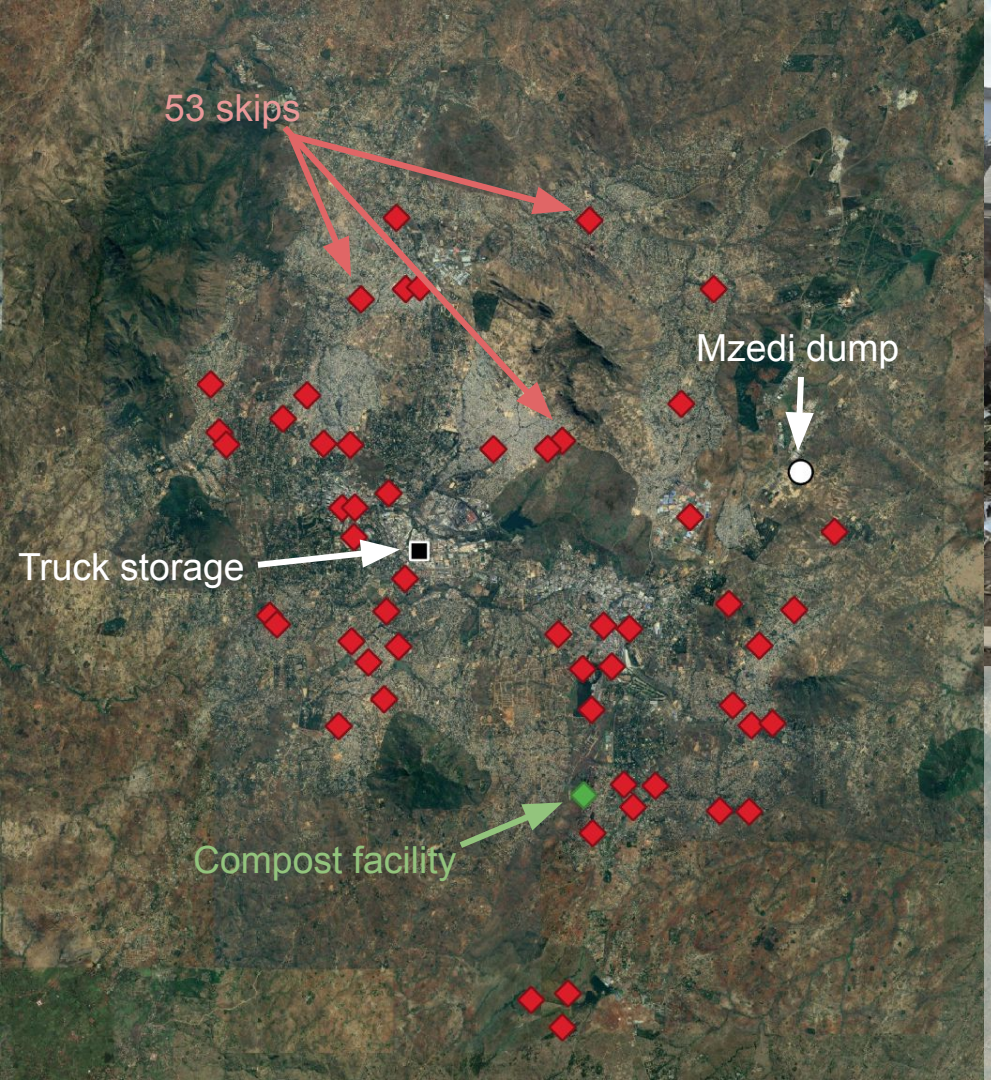


- ~800,000 population (large majority in informal)
- Community skips placed in public areas
- 2 trucks carrying the skips to Mzedi dump

- Frequently overflowing
- Irregular service
- Areas not served



- ~800,000 population
- Community skips placed in public areas
- 2 trucks carrying the skips to Mzedi dump

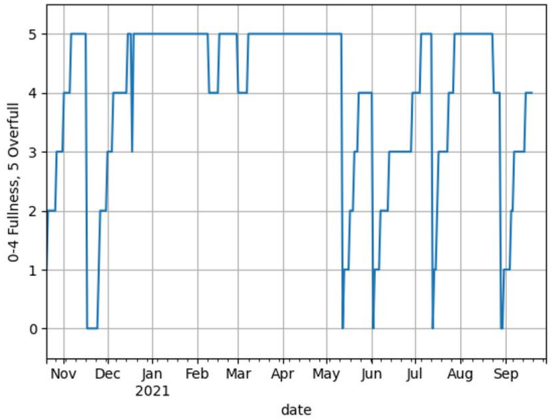
Consequences:

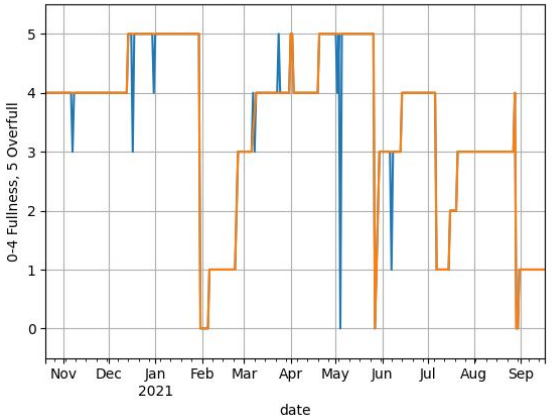
- Frequently overflowing
- Irregular service
- Areas not served

Research goals:

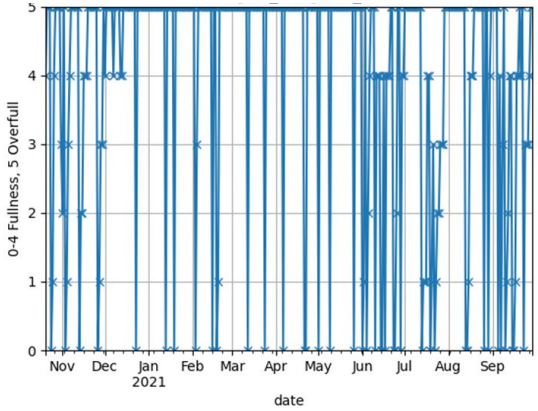
- Estimate the waste generation at the skips
- Optimize the solid waste collection schedules
- Compare scenarios based on OPEX and CAPEX

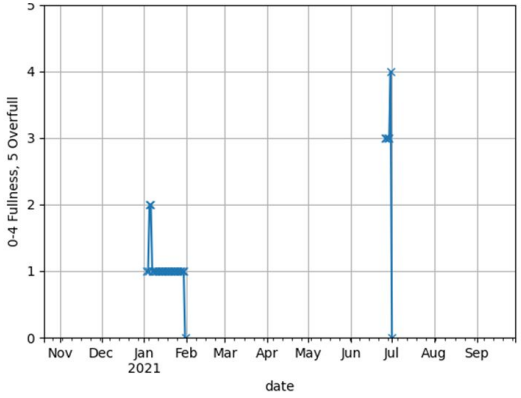
Informing the model | Filling measurements





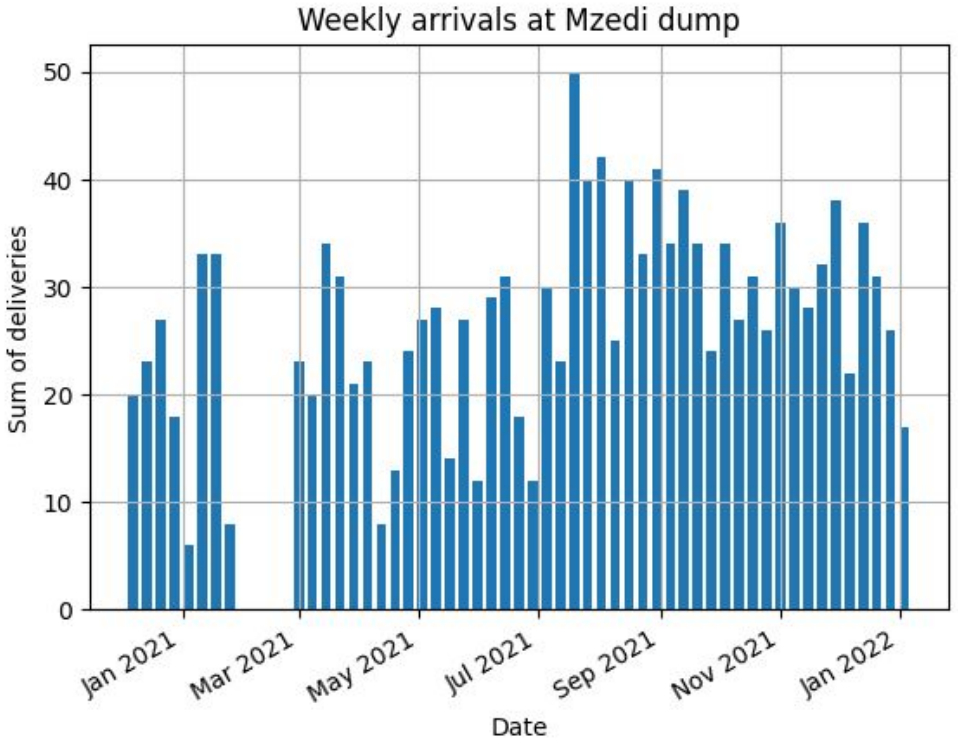
Produces useful estimates for ~10 skips



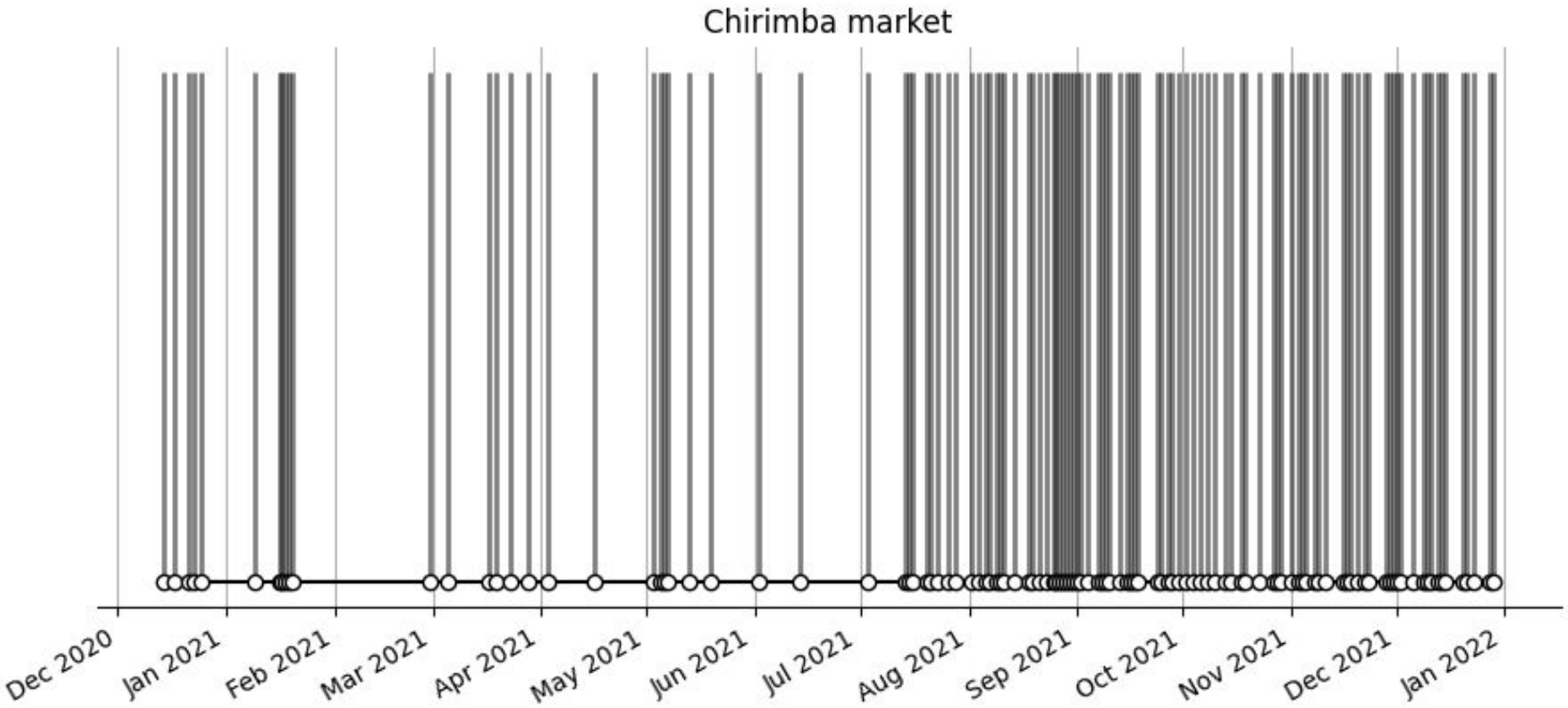


Informing the model | Mzedi dump logs (1)

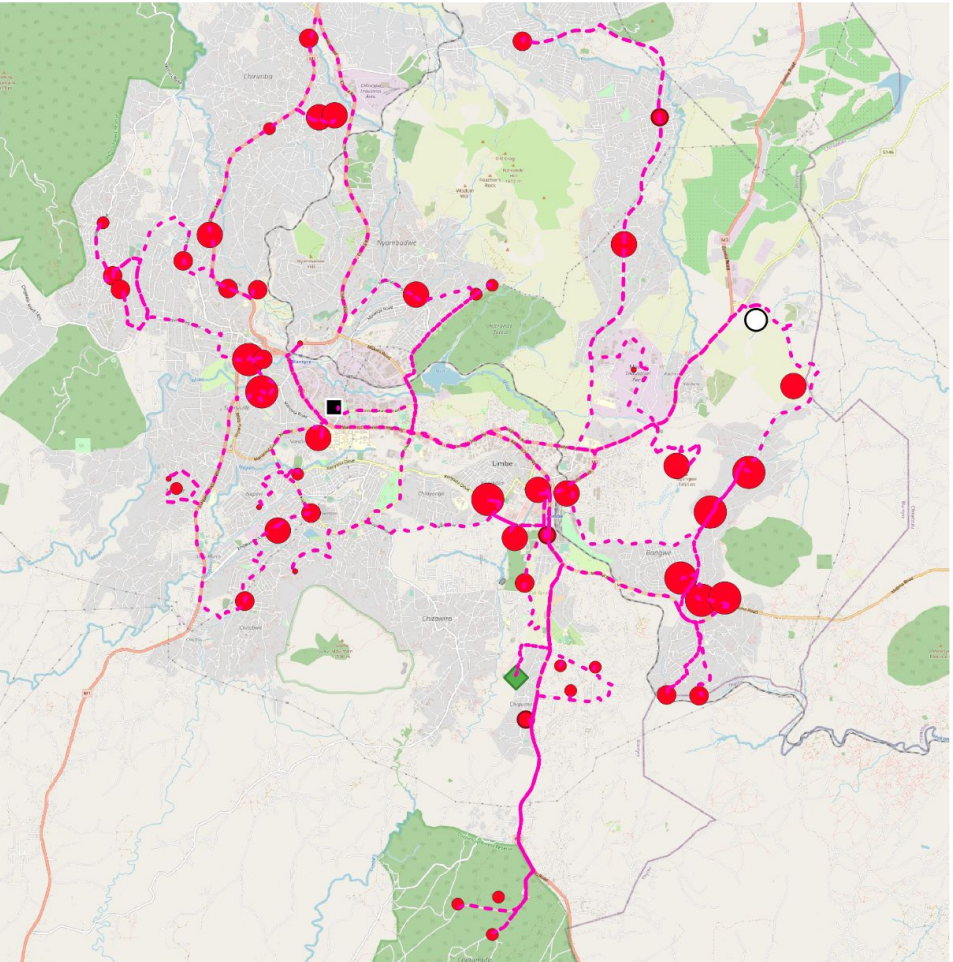
date	skip_origin
05/12/2020	Bangwe market
05/12/2020	Mbayani market
05/12/2020	Limbe market
05/12/2020	Blantyre flea market
05/12/2020	
05/12/2020	Bangwe ground
06/12/2020	
06/12/2020	Limbe market
06/12/2020	
06/12/2020	Thawale market
06/12/2020	Queens Guardian shelter
06/12/2020	Kachere market
07/12/2020	Chilobwe
07/12/2020	
07/12/2020	
07/12/2020	Chilobwe
07/12/2020	Zingwangwa mosque
07/12/2020	Thawale market
07/12/2020	Zingwangwa water board
07/12/2020	Soche market
07/12/2020	Blantyre flea market



Informing the model | Mzedi dump logs (2)



Data analysis results



- Estimated filling rates
  - Minimum service schedules
- Estimated road distances

Assumed operation

6 day operation
2 “periods” of 4hr per day

Constant speed of travel
Constant cost of travel
Cost of labor

Extra containers at the storage facility

Assumed operation

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2 “periods” of 4hr per day

Constant speed of travel
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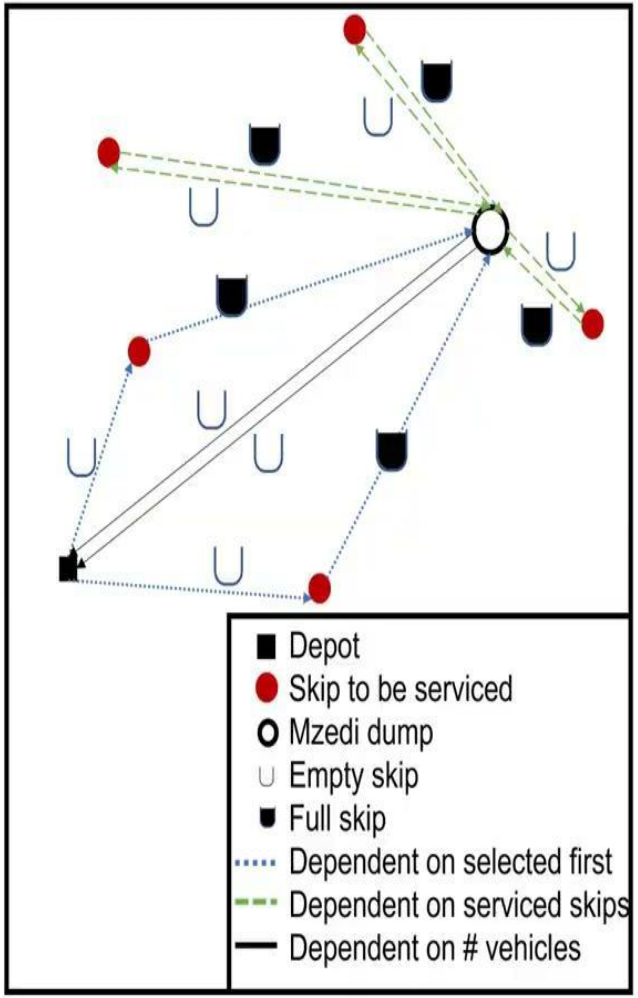
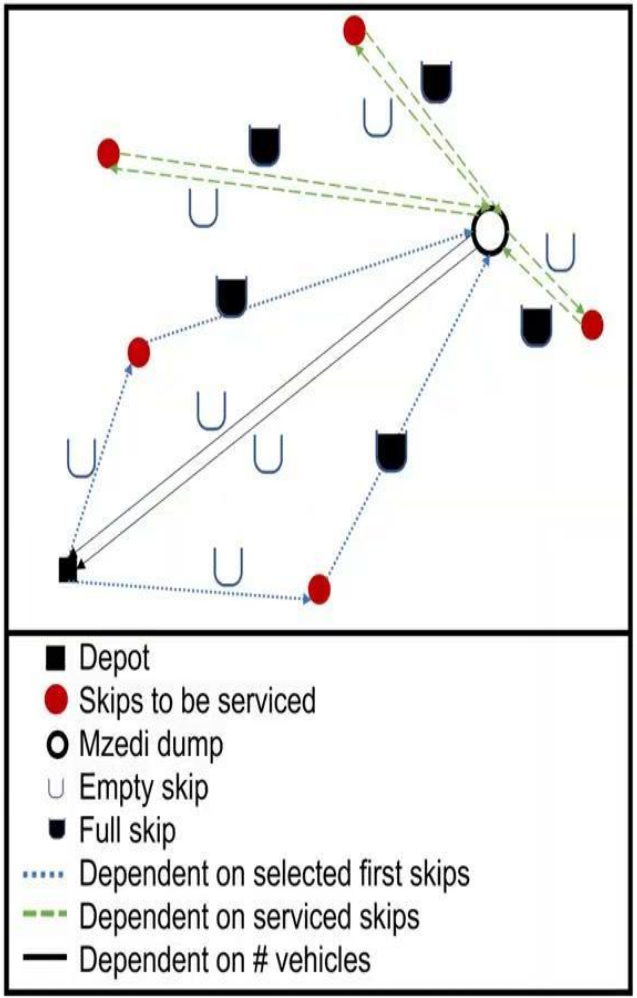
Extra containers at the storage facility





Decision variables

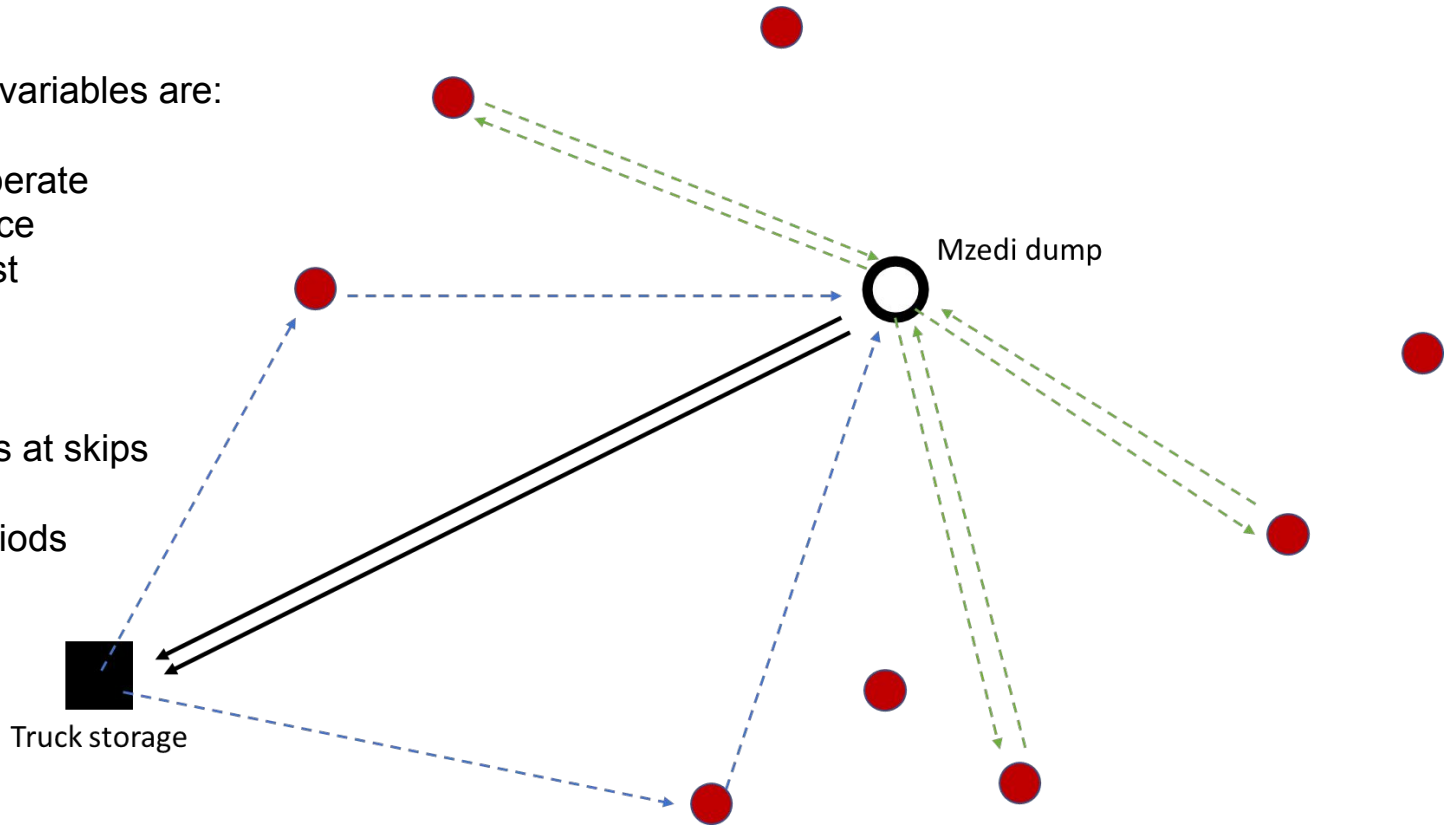
Each period, the decision variables are:

- How many trucks operate
- Which skips to service
- Which *n* skips go first

Additionally:

- Additional containers at skips

Optimised over the 12 periods in the week



Results (1)

The current system cannot operate without overflow!

What are the best changes to make?

Assuming we can only add max. one additional container to each skip location:

Total number of trucks	Number of containers added	Cost (mio. MWK/week)
3	5	1.39 → **~1390 CHF**
3	6	1.38
4	3	**1.49**
4	4	**1.49**
4 → only 3 used	5	1.38

Additional trucks and containers mostly affect feasibility, not efficiency.

Results (2)

The composting case

Composting facility closer to many skips than Mzedi dump

Running the optimization assuming all waste goes to composting facility:

MWK 1.298 Mio → **6.7% lower than base scenario**

Gives an indication of the advantage of composting as the system expands.

Current estimated cost of operation

- Mzedi arrival logs
- Distances & distance costs
- Assumed operation mode
- 2 trucks
- Labor costs

MWK 0.4225 Mio → **70% lower than base scenario, but with ~50% of skips overflowing**

Future work

- Study of solid waste collection in Blantyre
  - Waste quantification & characterization
  - Technical, economic & organizational analysis

- Development of implementable and appropriate operation decision support tools specifically for LMIC MSWM services
  - Collaborative development
  - Tools with minimal computing requirements

- Development of long-term planning decision support tools specifically for LMIC MSWM services
  - Groundwork of research on planning has already been laid
  - Some tools under development at EAWAG

Thank you! Any questions?

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Results | Example schedules for individual skips

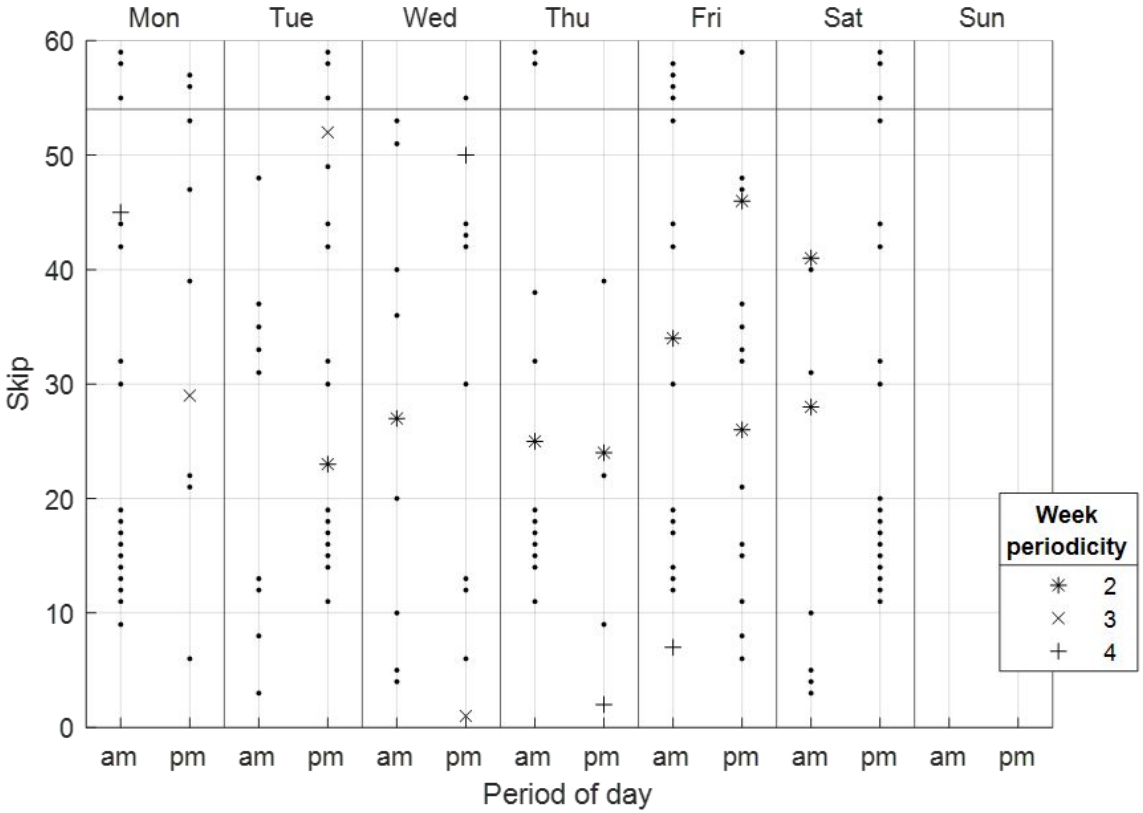
Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm

Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm

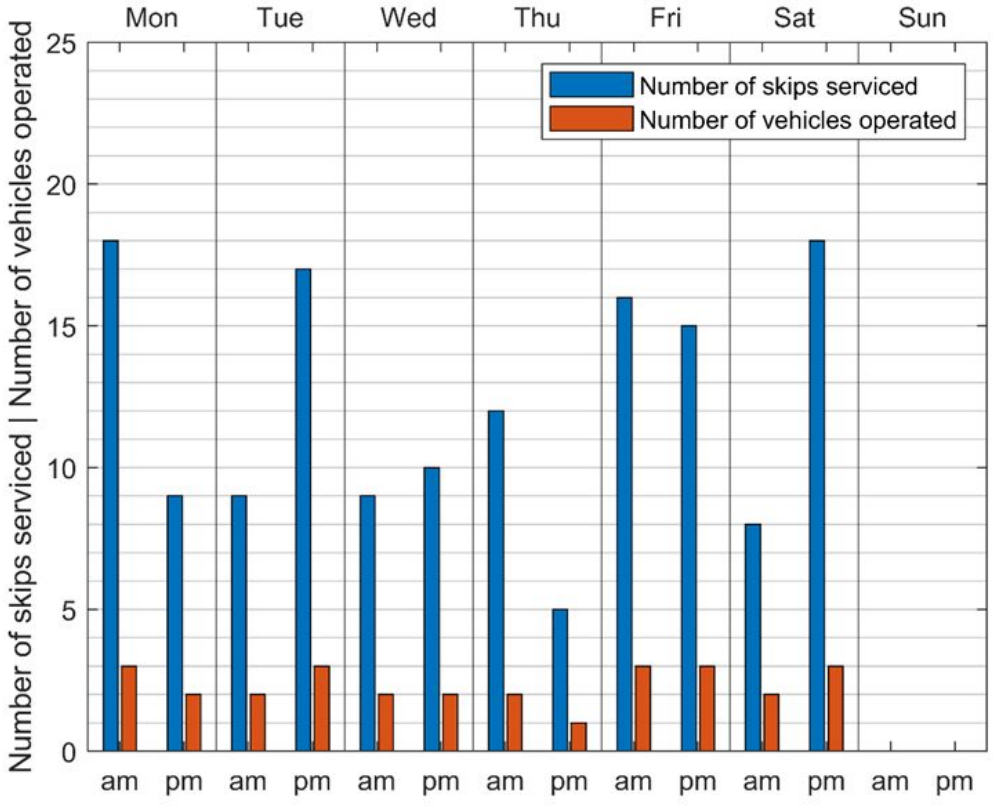
Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm

Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm

Results | Example weekly schedule for entire system



Results | Summary weekly of operations



~160 skips emptied

Results | Summary of weekly costs