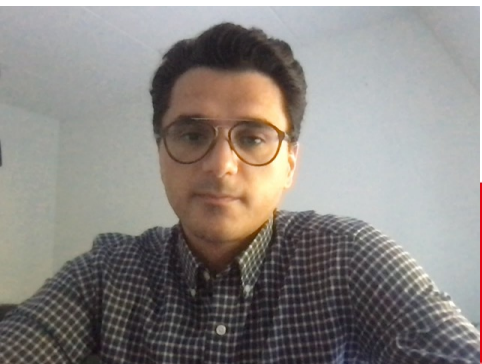


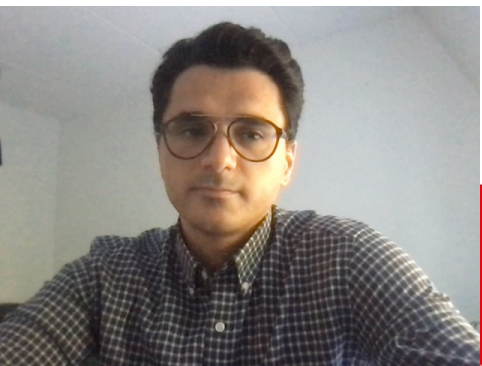
Enhancing Internal Vertical Logistics Flows in High-Rise Construction: An Exploratory Study

Alaa Barazi, Olli Seppanen, Ergo Pikas, Joonas Lehtovaara, Antti Peltokorpi



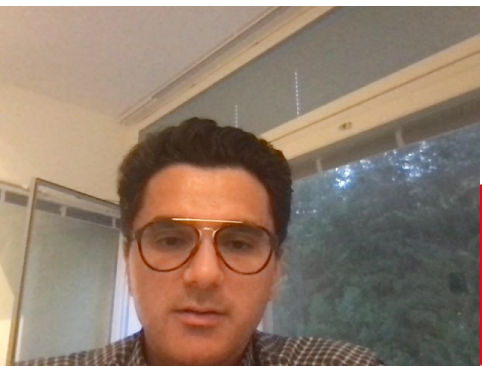
AGENDA

- Introduction
- Research Methods
- Results
- Discussion
- Limitations
- Conclusion



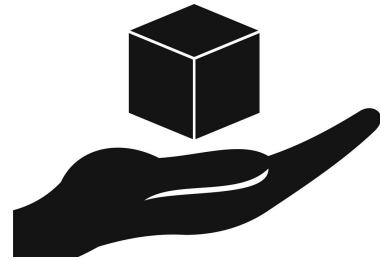
INTRODUCTION

- Optimized vertical transportation is crucial in high rise buildings (HRB) construction to minimize wastes
- We have developed a proof of concept agent-based model that could be used in high rise projects to study, pre-plan and determine the performance of hypothetical strategies for vertical transportation systems.

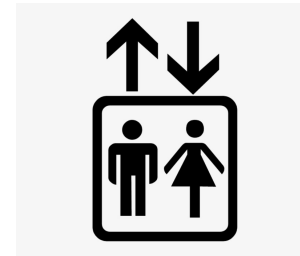


RESEARCH METHOD

Design science research methodology involve getting feedbacks from researchers and practitioners seeded this methodology



Model



Elevator



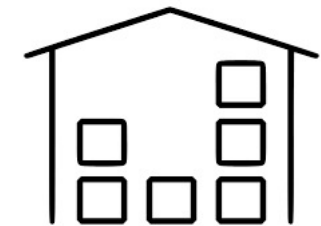
Wagon



Worker



Breakroom



Storage



RESEARCH METHOD - Takt plan

A simple takt plan to illustrate the progress of HRB production was used. The takt plan contains information on the simplified structural, exterior, and interior phases of a 40-floor HRB (see Figure 1).

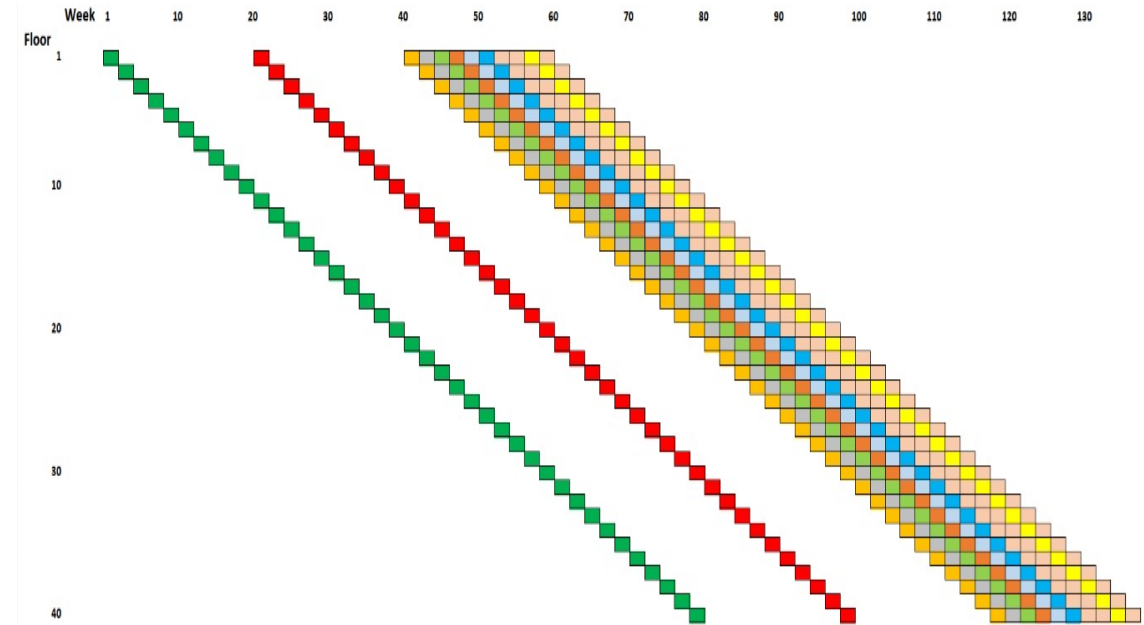
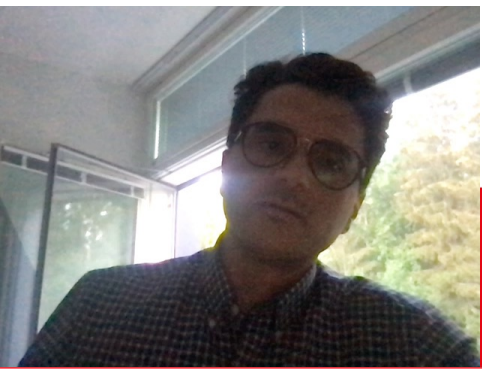


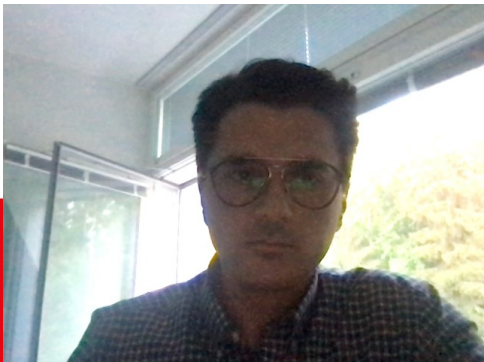
Figure 1. Hypothetical simple takt plan



RESEARCH METHOD - Metrics

A new metric called **system latency** is suggested in this study. We define it as the average time required by the transportation system, including elevators and staircases, to fulfil workers' intentions

The **utilization rate** index is used to assess the average percentage of time workers' spent in their working location.



RESEARCH METHOD – Agents Properties (Examples)

ID	Parameters	Explanation
1	Number and type of lifts	The number of installed elevators at a given time.
2	Elevators range	Which floors are served with each elevator?
3	Elevator's usage	Materials/logistics or people
4	Material lifting strategies.	As part of the structural works cycle in weekends
4	Break room's locations	On every 5th and 10th floor breakrooms in site
5	Elevators ordering options.	One button for each elevator or other methods
6	Waste production	Consideration for waste flow
7	Probability of using the elevator	i.e., faster elevators or elevators with more range
8	Location of material storage	One floor or many
9	Location of waste disposable	One floor or many
10	Height: 10, 30 and 50 floors	By changing the time wagons move up.

Table 1. Agents properties used to construct scenarios/strategies

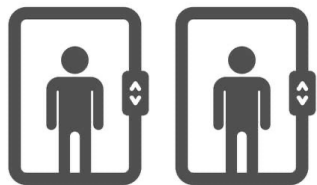


RESULTS



In total, 54 simulation runs in two iterations were conducted in this pilot study. The generated data were analysed and visualized. KPIs were calculated after simulating one week per scenario.

The investigated 27 scenarios are formed from the combinations of the following parameters three parameters: the number of elevators, breakroom(i.e. coffee, lunch) location, and starting day



The numbers of elevators: two, four, and six.



break rooms' locations: only ground floor, every fifth floor, and every 10th floor



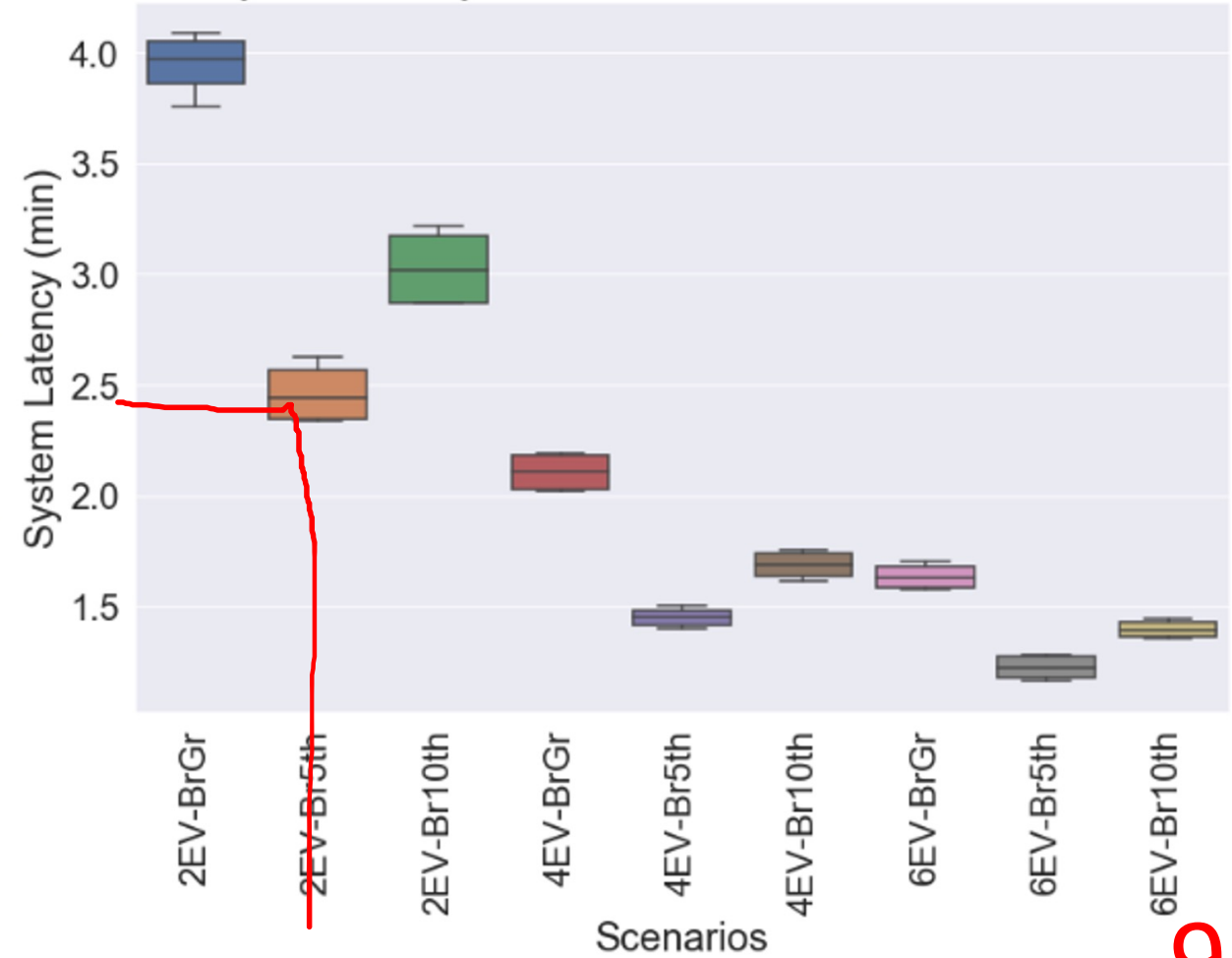
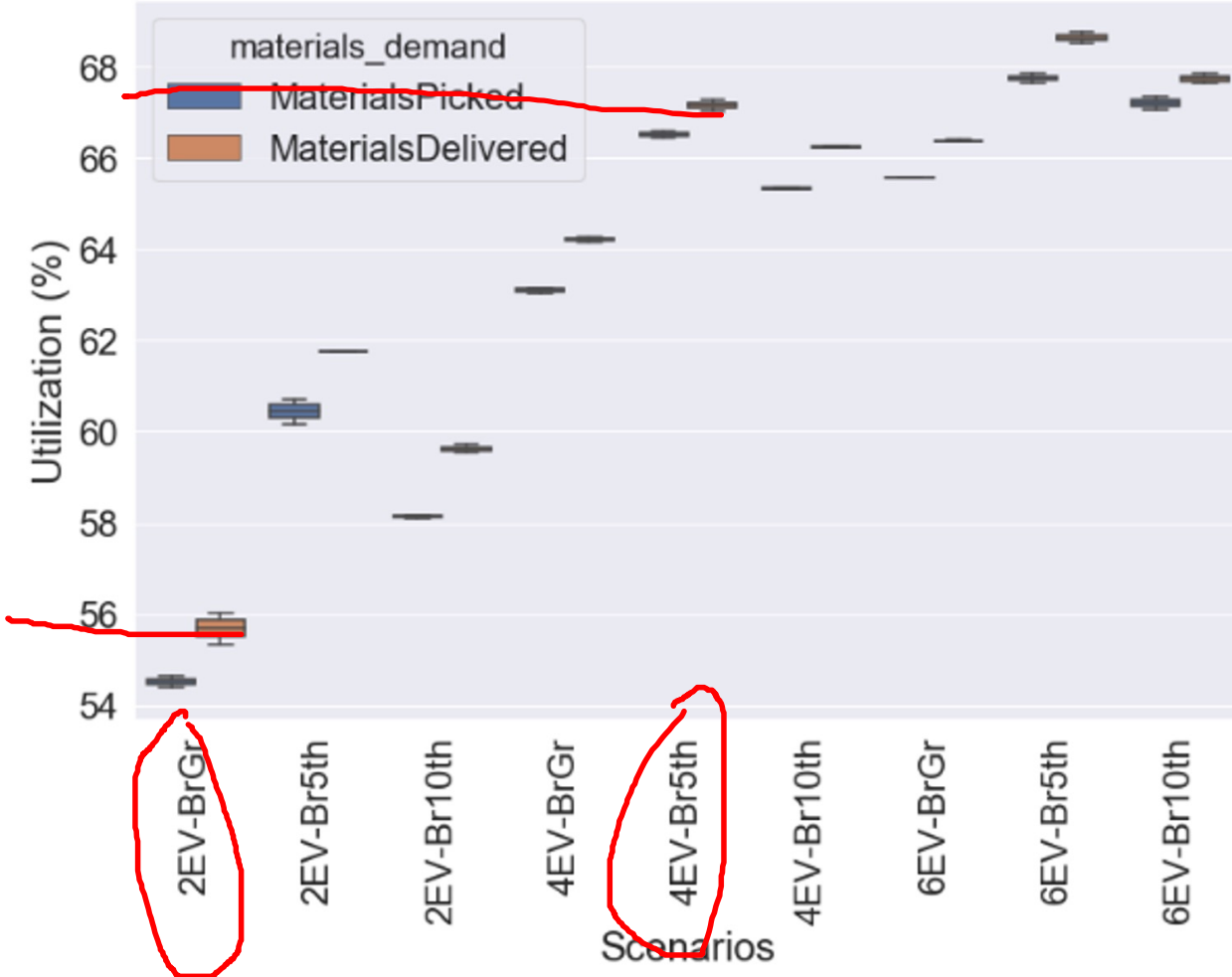
Simulation starting days are 200, 400 and 600

RESULTS – Day 400



Utilization - All Scenarios - 40th Floor

System latency - All Scenarios - Scenarios- 40th floor



Discussion

- significant correlation between system variables and the overall performance of the vertical transportation system.
- It was possible to increase the utilization rate ca 18% by changing the system's variables.
- The simulation model helped to quantify the impact of these changes on system performance.
- The increase in the utilization rate was not linear.
- In some cases, adding more break rooms resulted in better performance than adding elevators



Some Limitation

- No distinction between external elevator with operator and internal elevators without operator was made.
- the speed of elevators in this research is considered all equal and slow for construction elevators.
- System performance at peak times should be considered
- Validation is required in pre-planning phase and during construction phase.

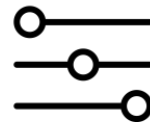


ON GOING RESEARCH AND CONCLUSIONS

simple simulation model that can predict some performance metrics for vertical construction logistics systems was developed

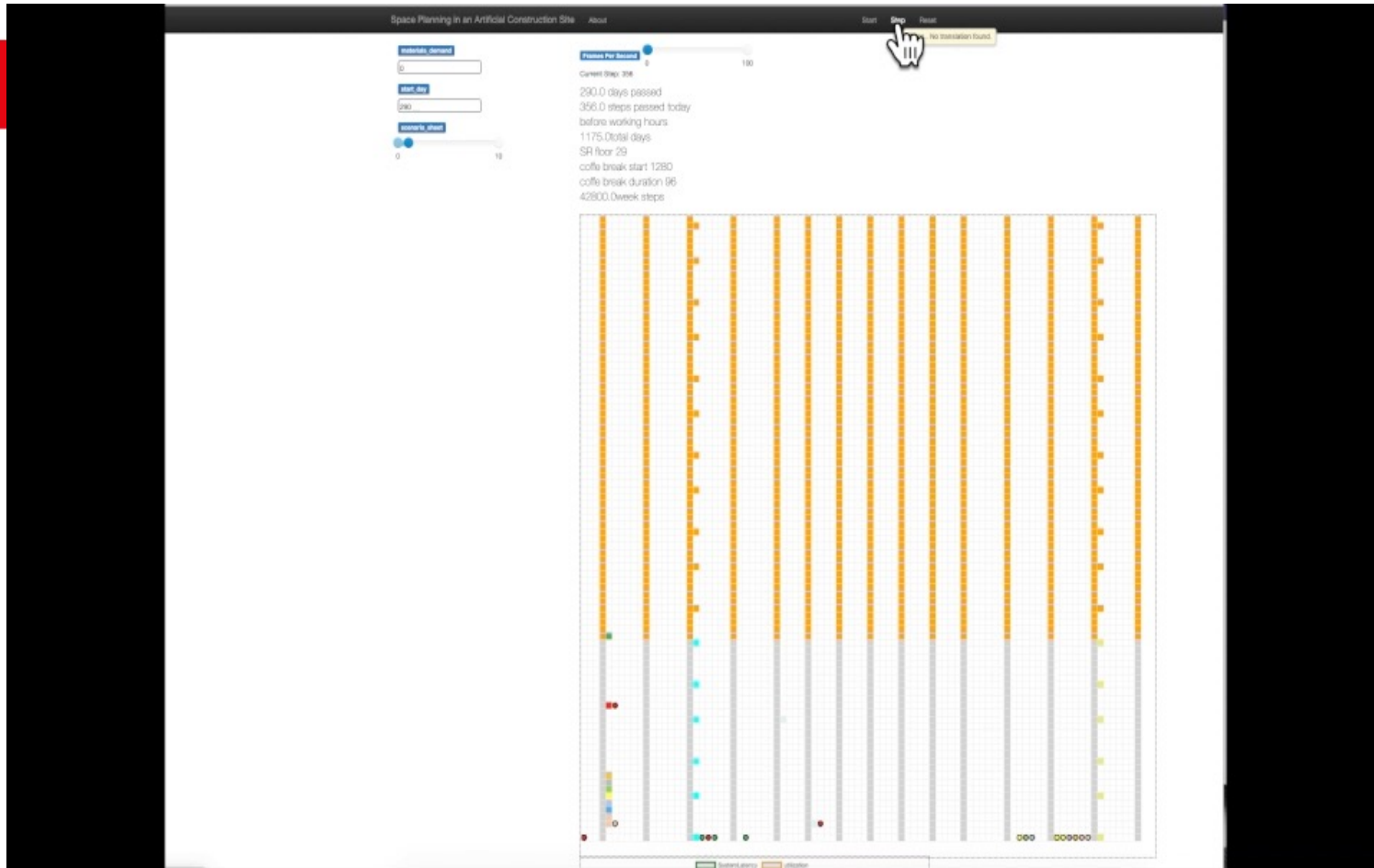


The proof of concept showed the significance different parameters have on the performance of vertical transportation systems.



The model is piloted by two major companies and planners to update their current planning methods and produce better plans.





THANK YOU!
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