Soft Target Protection Analysis Using Pedestrian Simulation

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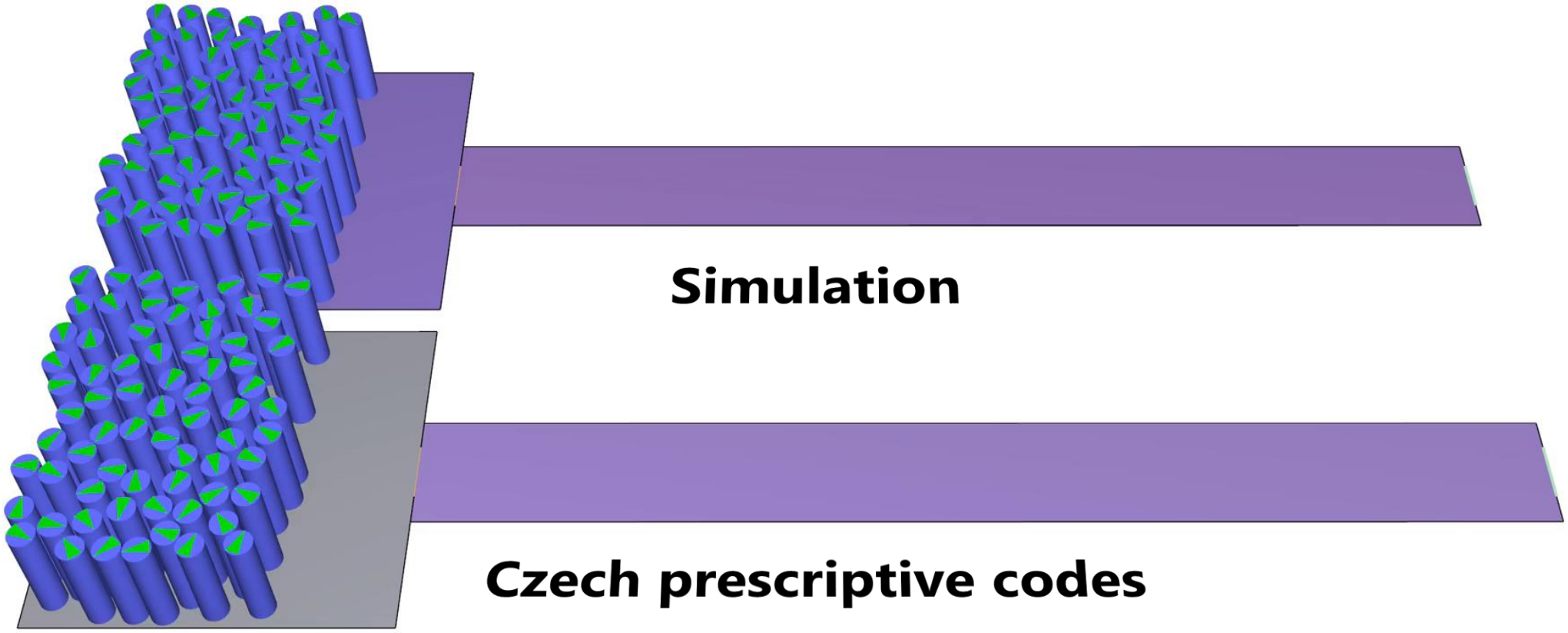
Prescriptive Codes vs Realistic Simulation



Prescriptive Codes vs Realistic Simulation

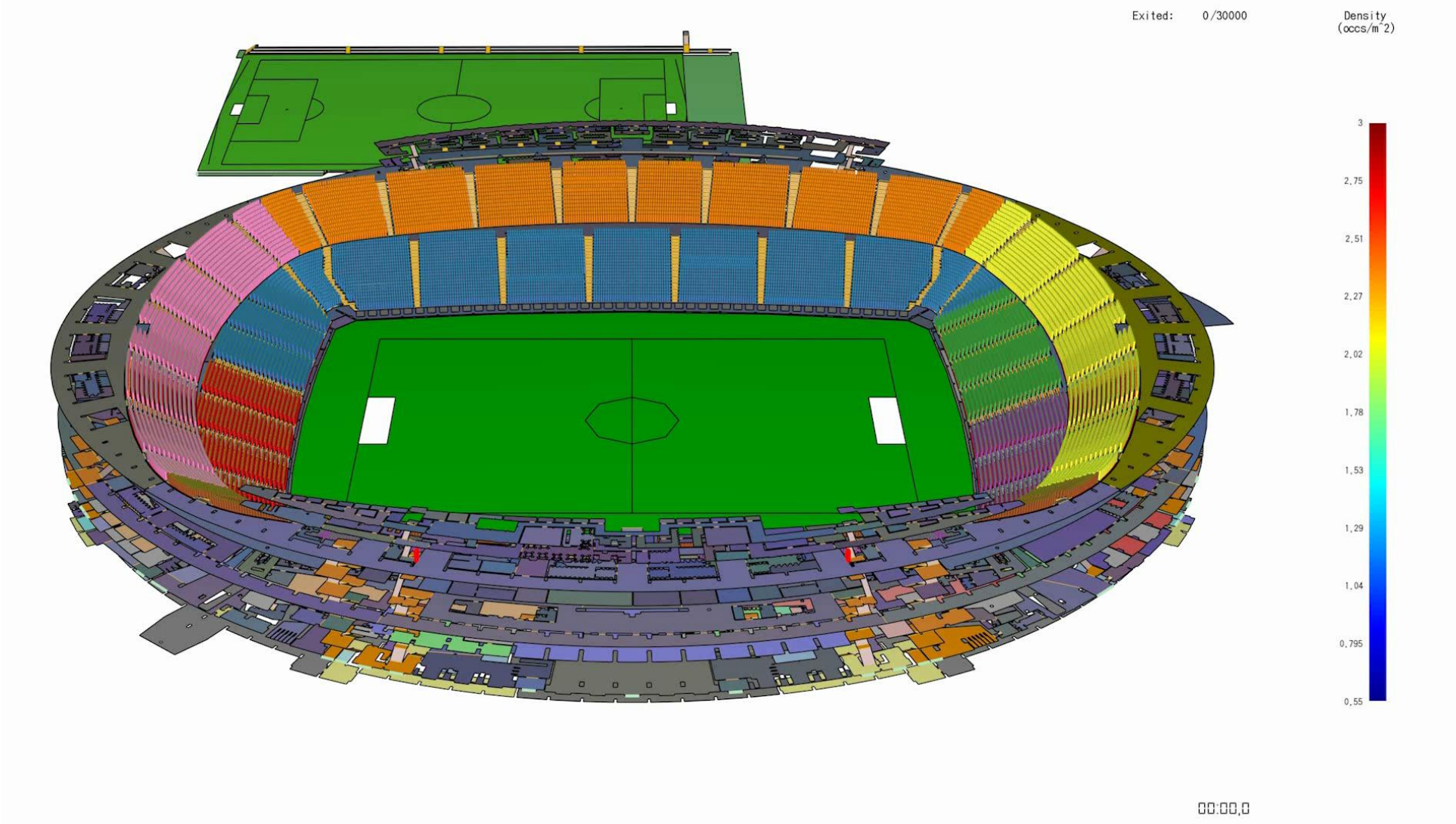
The codes do not consider different speeds according to age or ability to move, also assume immediate evacuation, i.e. a zero reaction time to alarm. Pedestrians with reduced mobility are taken into account in the larger required width of the escape route.

These significant simplifications are compensated by very restrictive basic values, especially the walking speed. The final assessment is thus significantly on the safe side.

Parameter	Value (Czech prescriptive code)
Pre-movement time	0 s
Walking speed	0.418 - 0.583 m/s (stairs and flat surface)

So Why Do We Need Pedestrian Simulations?

Brno Football Stadium, 30,000 Pedestrians



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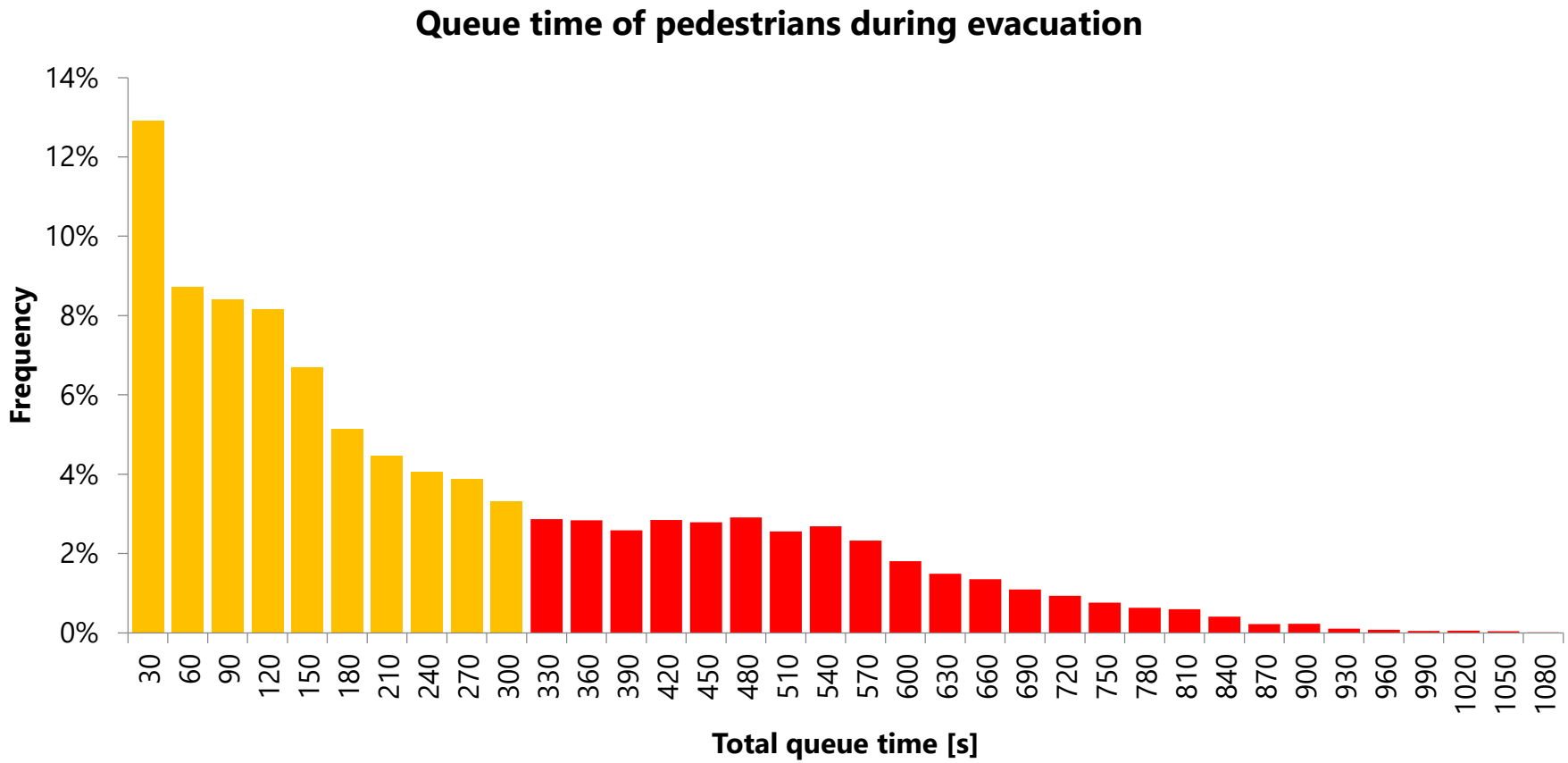

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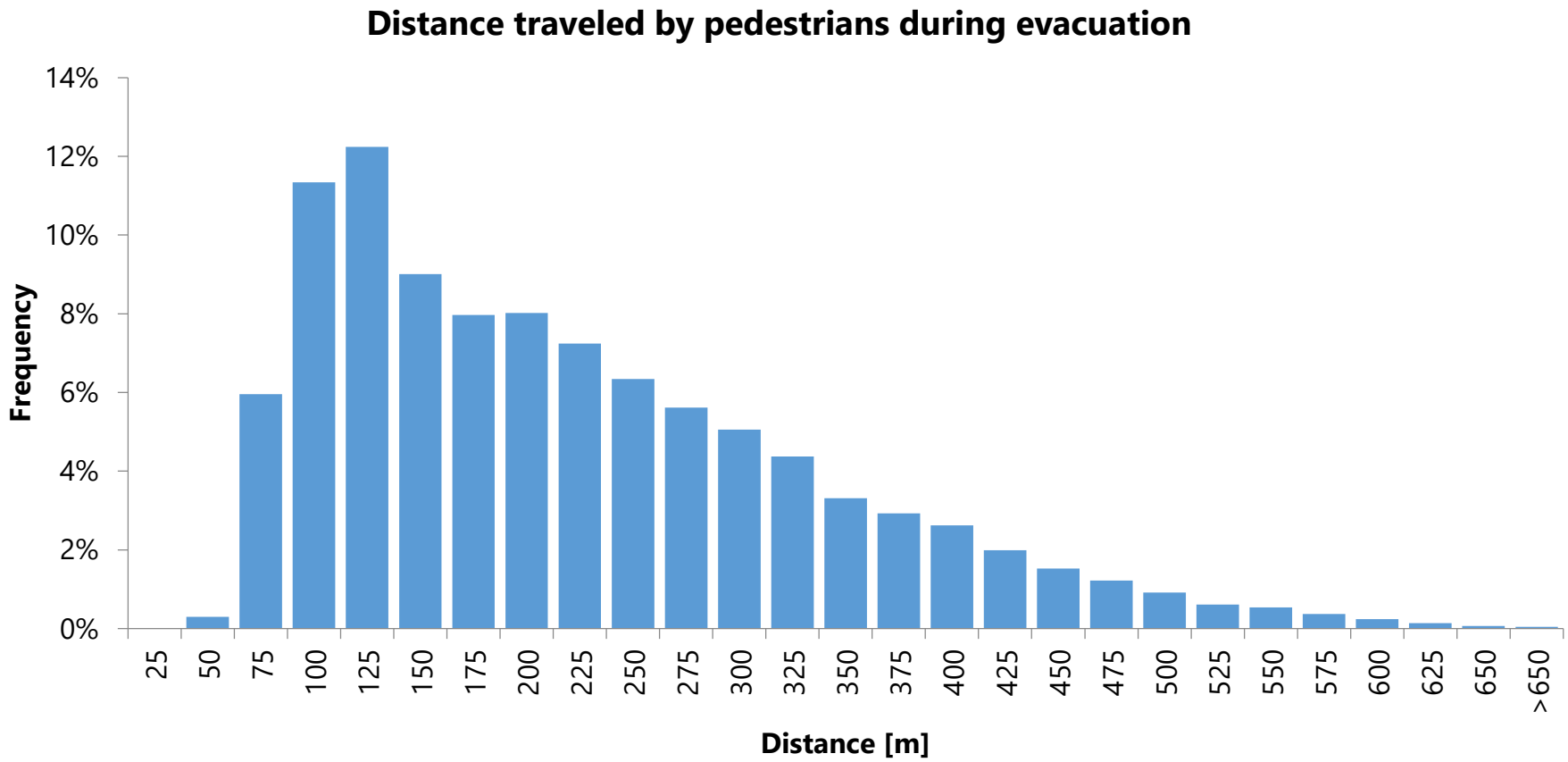


Soft Targets and Pedestrian Simulations

The term is used by the security community for places with a high concentration of visitors and a low level of security against violent attacks.

These objects do not necessarily have to be complex or complicated as in the first example of stadiums, but the attack will cause a situation where the assessment of a classical evacuation through a prescriptive code is worthless.

The reason is simple: the fire safety assessment using prescriptive codes is designed for a case of fire, where all safety infrastructure is powered on and working.

However, the attacker's very basic motivation is to change this situation.

Soft Targets and Pedestrian Simulations

For these reasons, it is necessary to perform a risk analysis, identify possible attack scenarios, and determine the impacts of these scenarios.

It does not make sense to search for example the exact probability of a knife attack, if it occurred in the object only exceptionally, or even not at all.

On the other hand, the same qualitative analysis is too simple to study the impacts of these scenarios. The security manager should demand specific data on the number of affected persons, an extension of evacuation time, reduction of visibility due to smoke, etc.

Simulation tools are extremely suitable for these answers.

Prague Main Railway Station

Risk Analysis

Risk identification (R) has the following phases:

- Asset analysis (A).
- Threat analysis (T).
- Vulnerability analysis (V).
- Determination of the resulting risk.

Risk Analysis

The risk assessment of asset, threat, and vulnerability values using semi-quantitative approach.

Score	Asset value (A)	Threat value (T)	Vulnerability value (V)
0	None or not rated	Once every 10 years	None
1	Low	Once a year	Low
2	Not very significant	Once in half of year	Not very significant
3	Medium	Once a quarter	Medium
4	High	Monthly	High
5	Very high	Once a week	Very high

$$R = A \times H \times Z$$

Quantitative risk analysis with their correlation

If possible, we should also express how the risks can interact with each other. For this purpose, we can apply quantitative risk analysis with their correlation.

	Index	1	2	3	4
Index	Risk	High temperature	Lightning	Fall of a tree	Icing
1	High temperature	X	1	0	0
2	**Lightning**	**1**	**X**	**1**	**0**
3	Fall of a tree	0	0	X	0
4	Icing	0	0	1	X

Active and Passive Risks

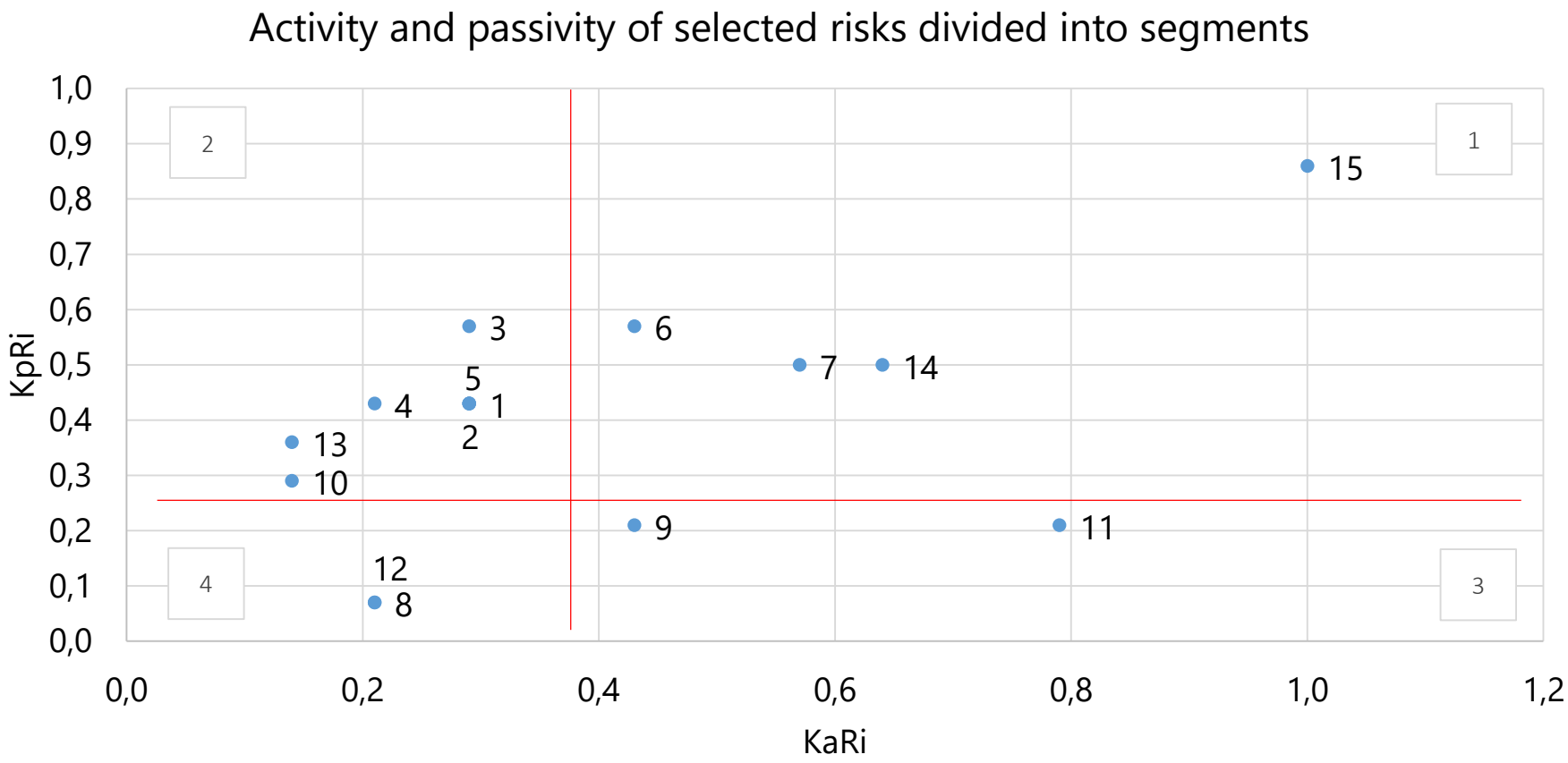
Activity expresses the overall potential of the risk to cause additional risks. On the contrary, passivity expresses that other risks that can cause a given risk.

The following relations are used to calculate the given coefficients:

$$K_A R_i = \frac{\sum R_i}{x - 1}$$

$$K_P R_i = \frac{\sum R_i}{x - 1}$$

Active and Passive Risks



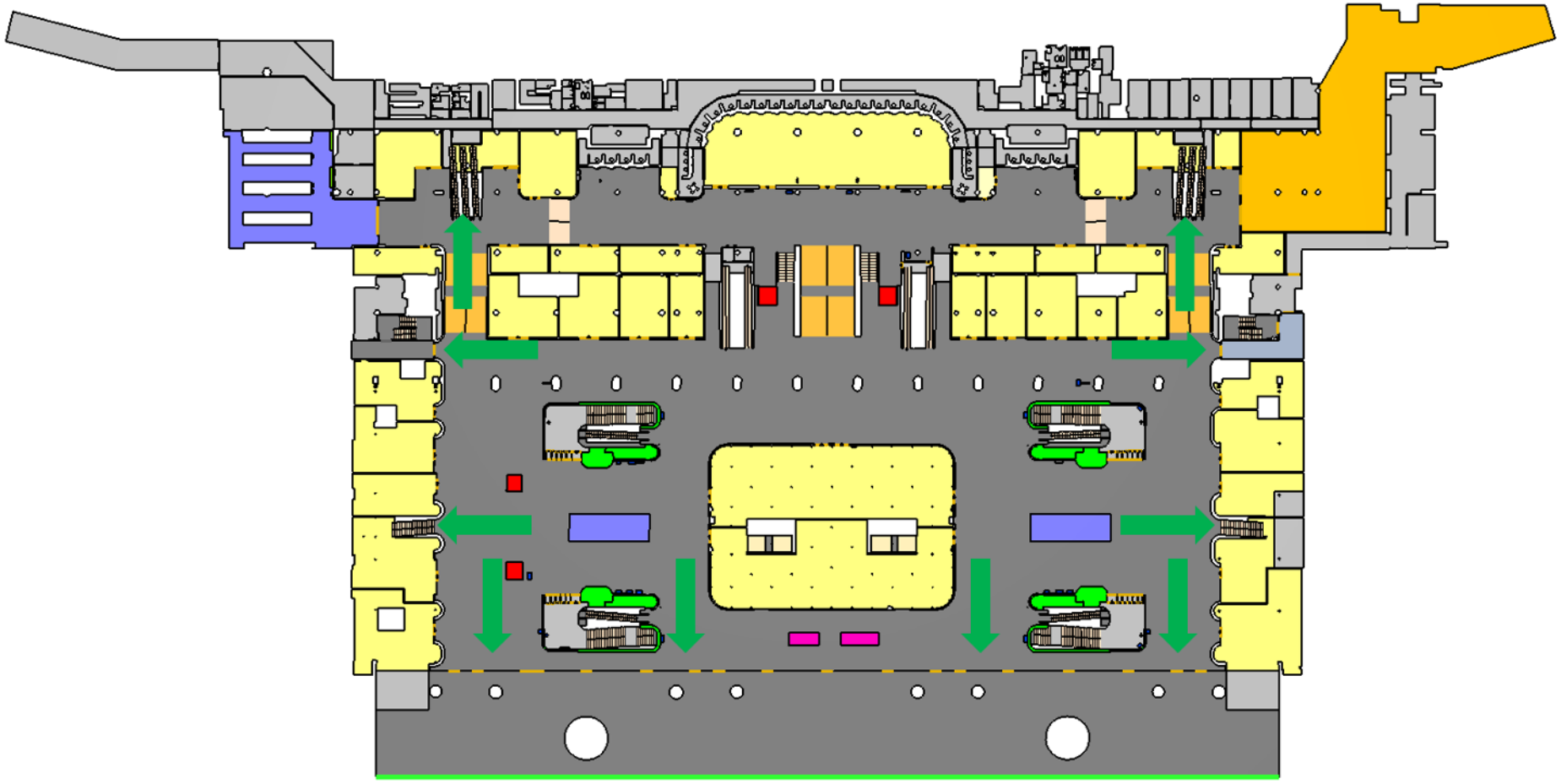
Prague Main Railway Station

The described analytical procedure was also applied in the case of Prague main railway station.

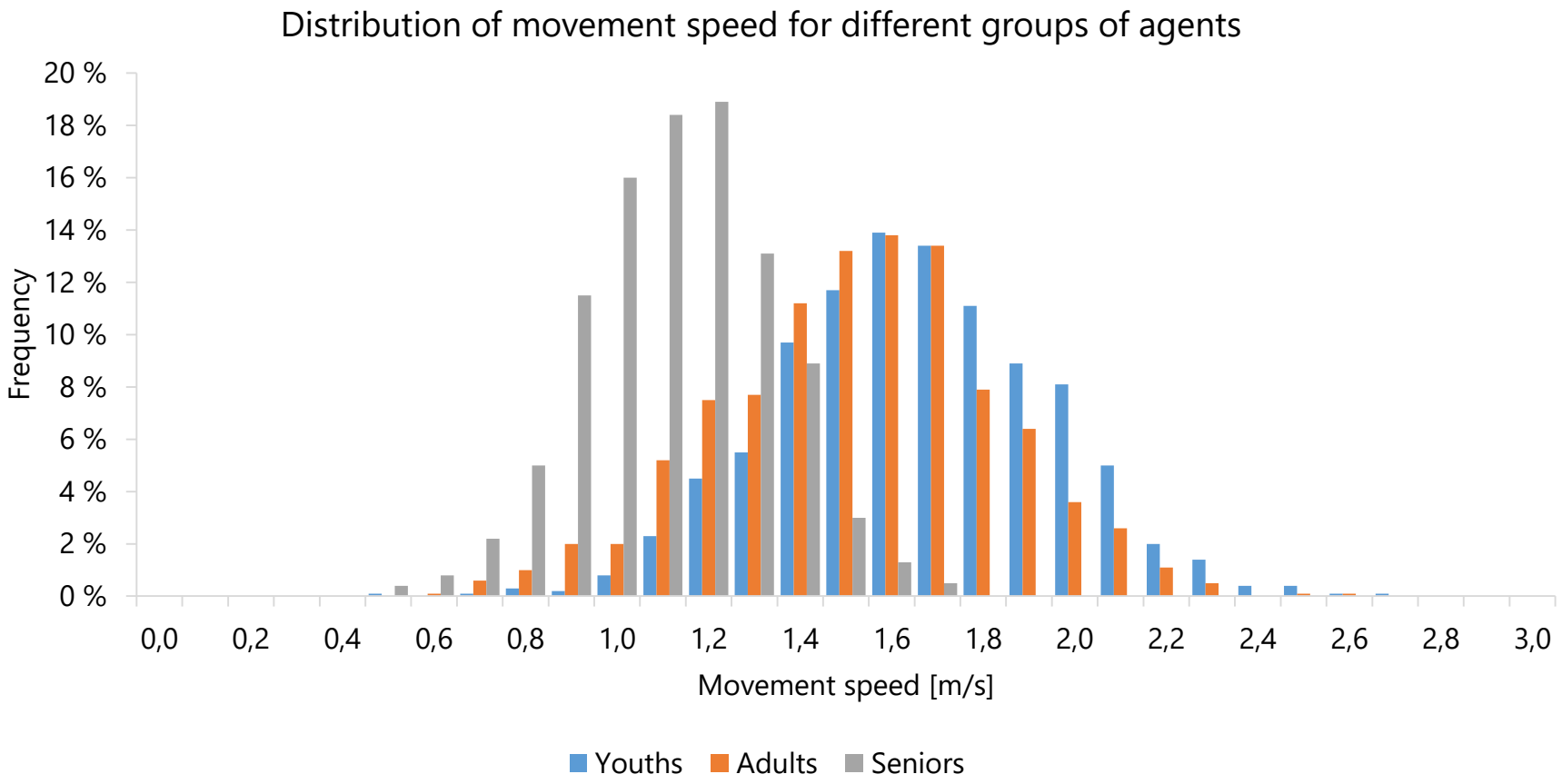
The results risk analysis was used for the identification of 7 specific scenarios. Examples include the following:

- Simple evacuation (all exits are available).
- An attack in the central part of the station (blocking of the central tunnel).
- An attack at the main exit, or the identification of an explosive device nearby.

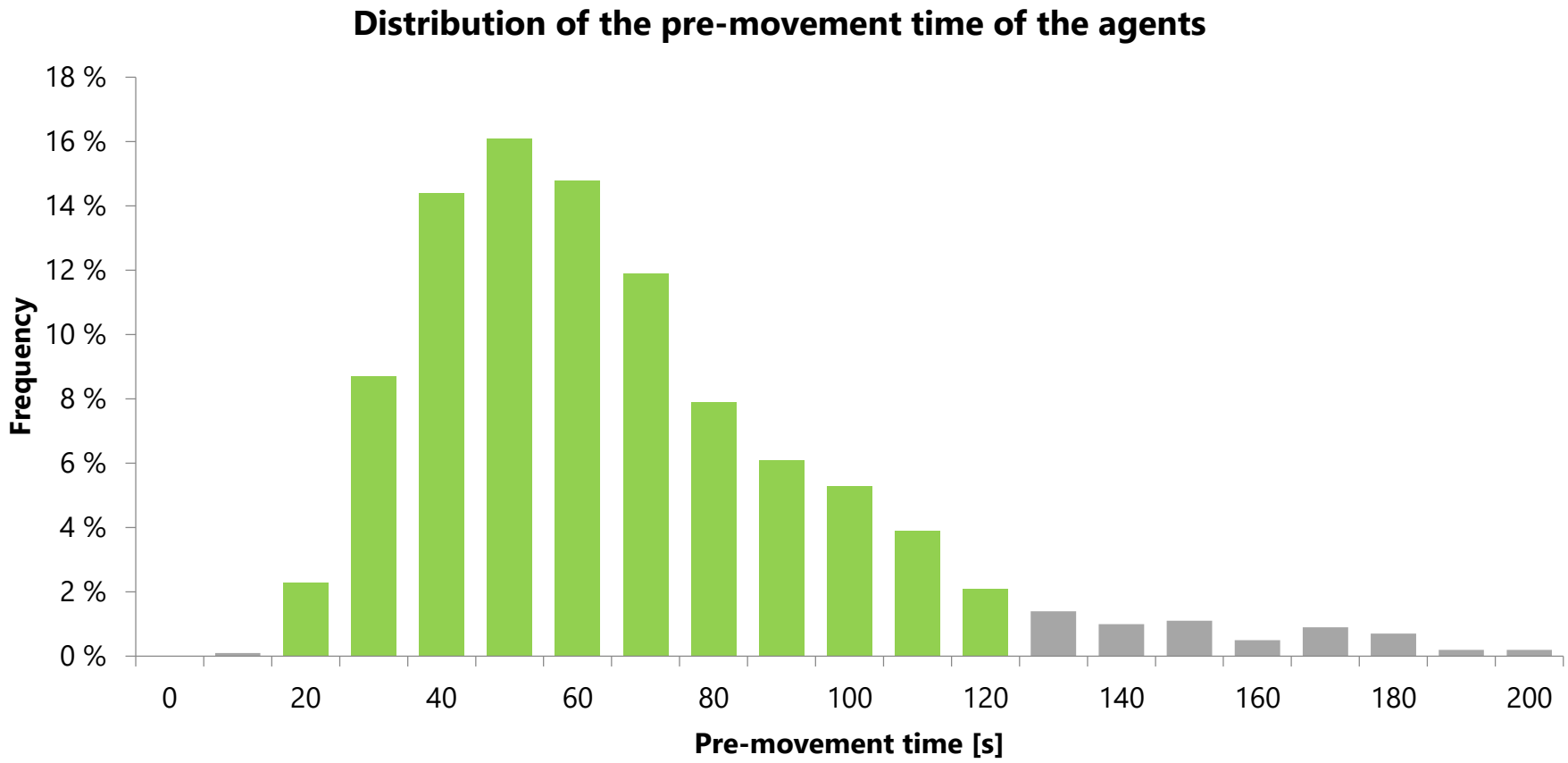
Prague Main Railway Station



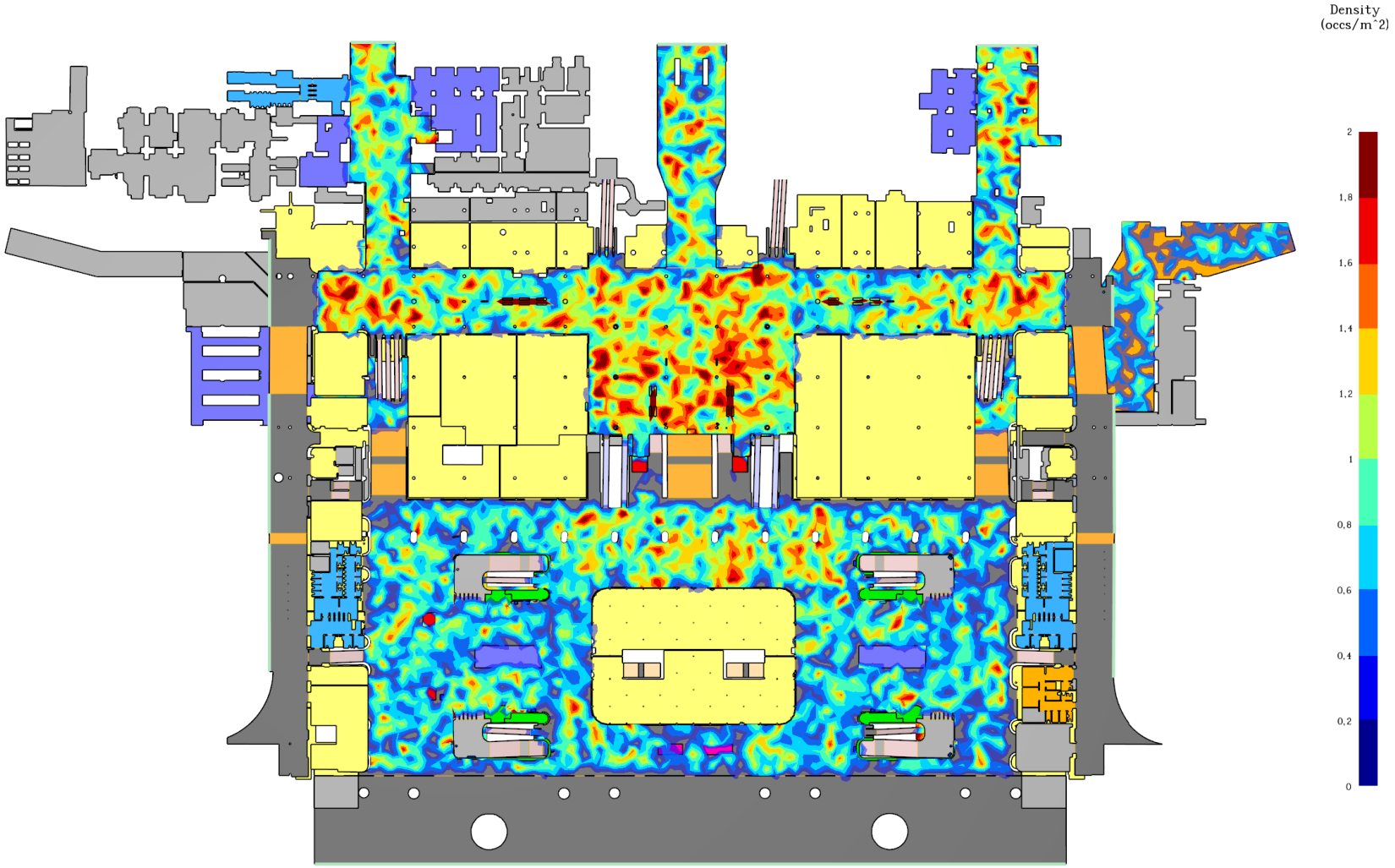
Movement Speed



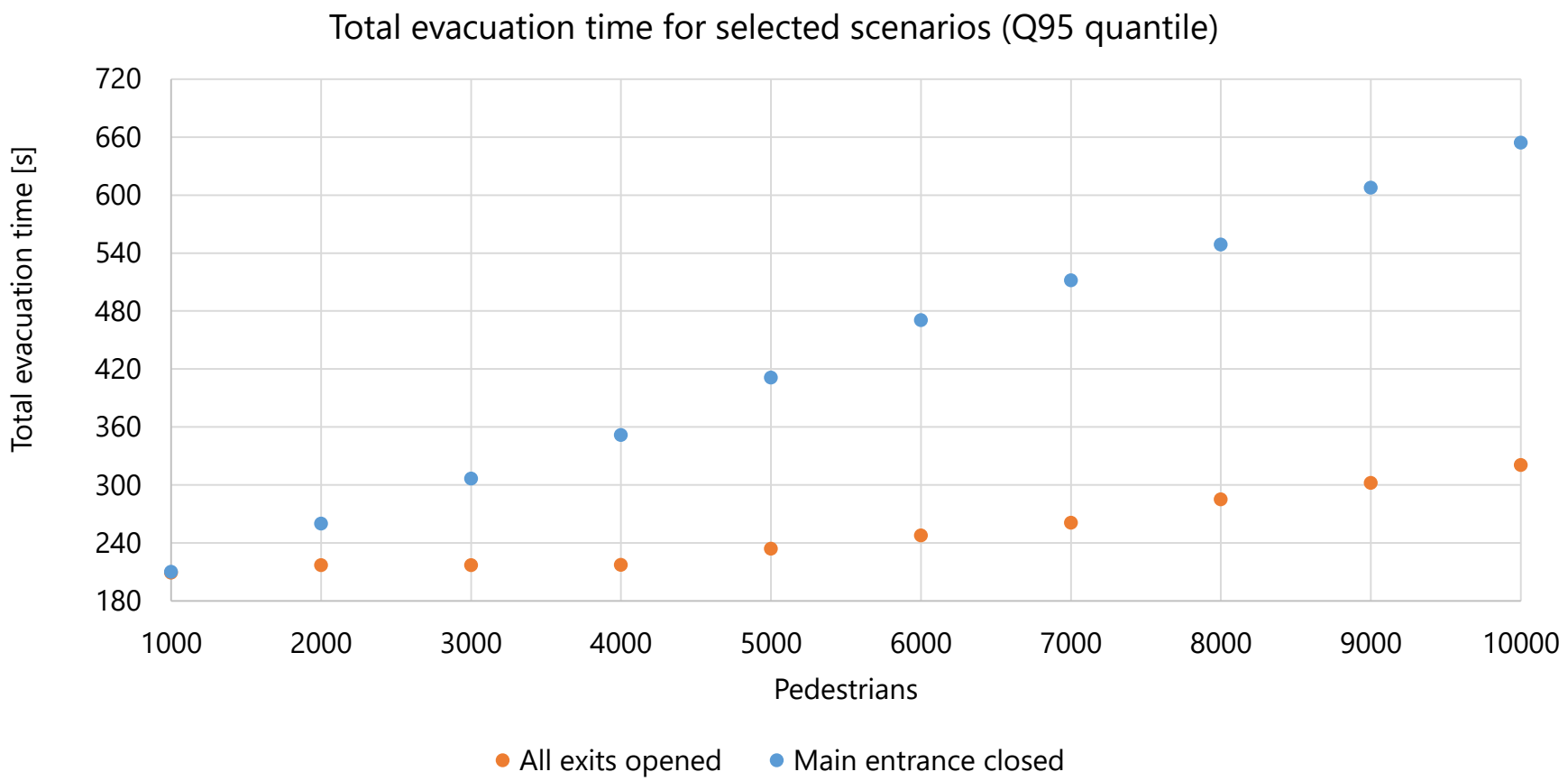
Pre-movement Time



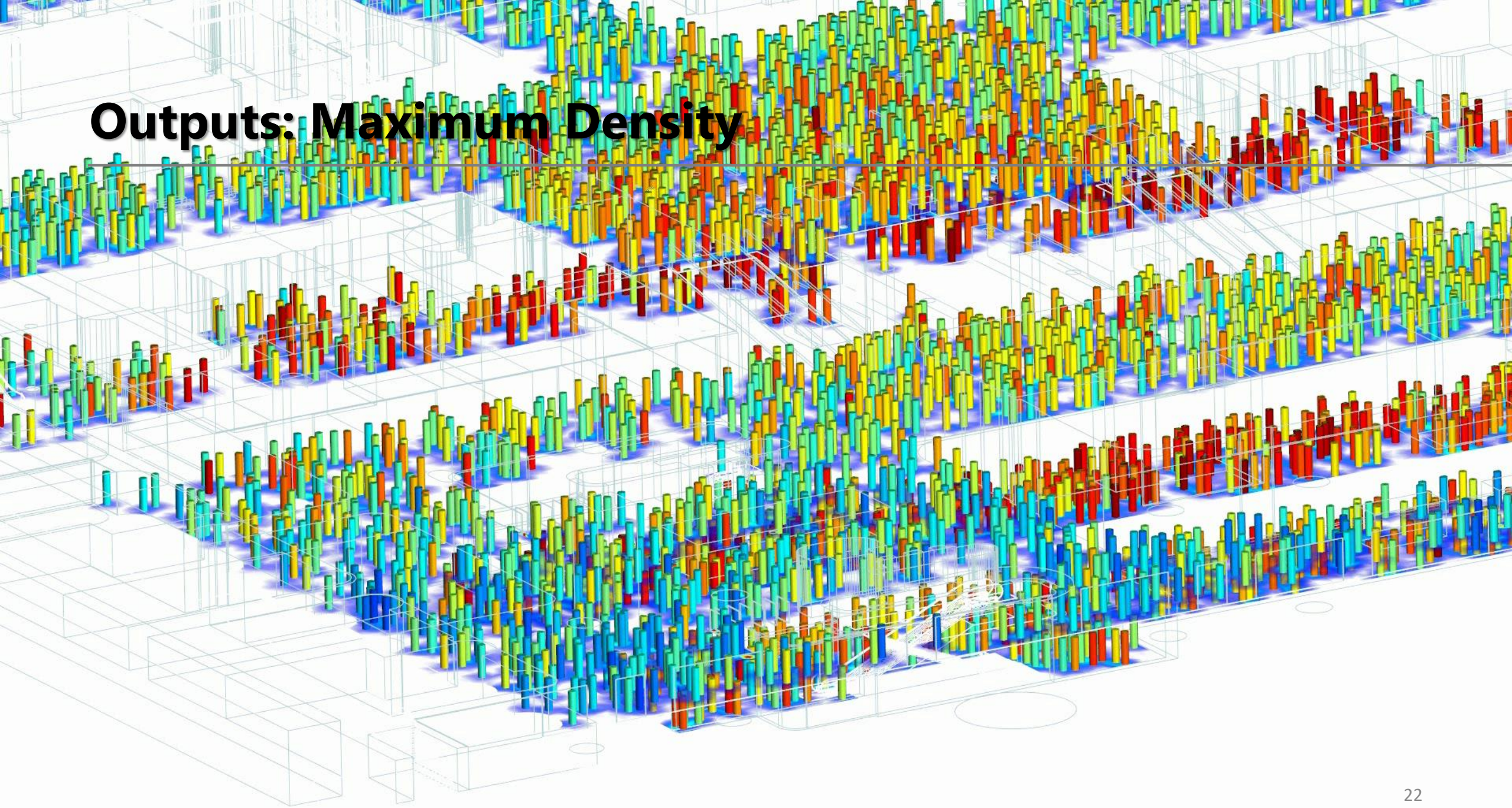
Occupancy



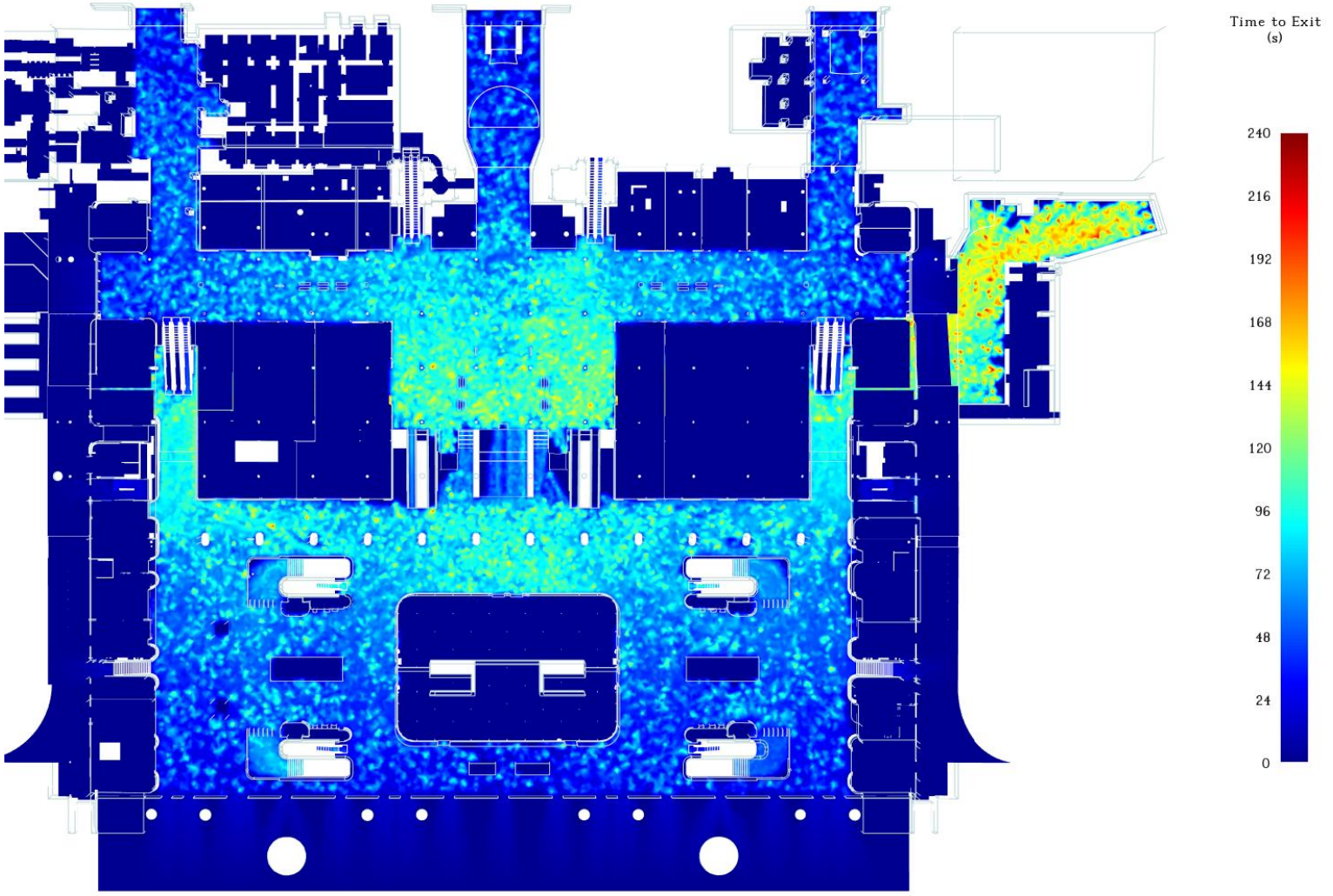
Outputs: Total Evacuation Time



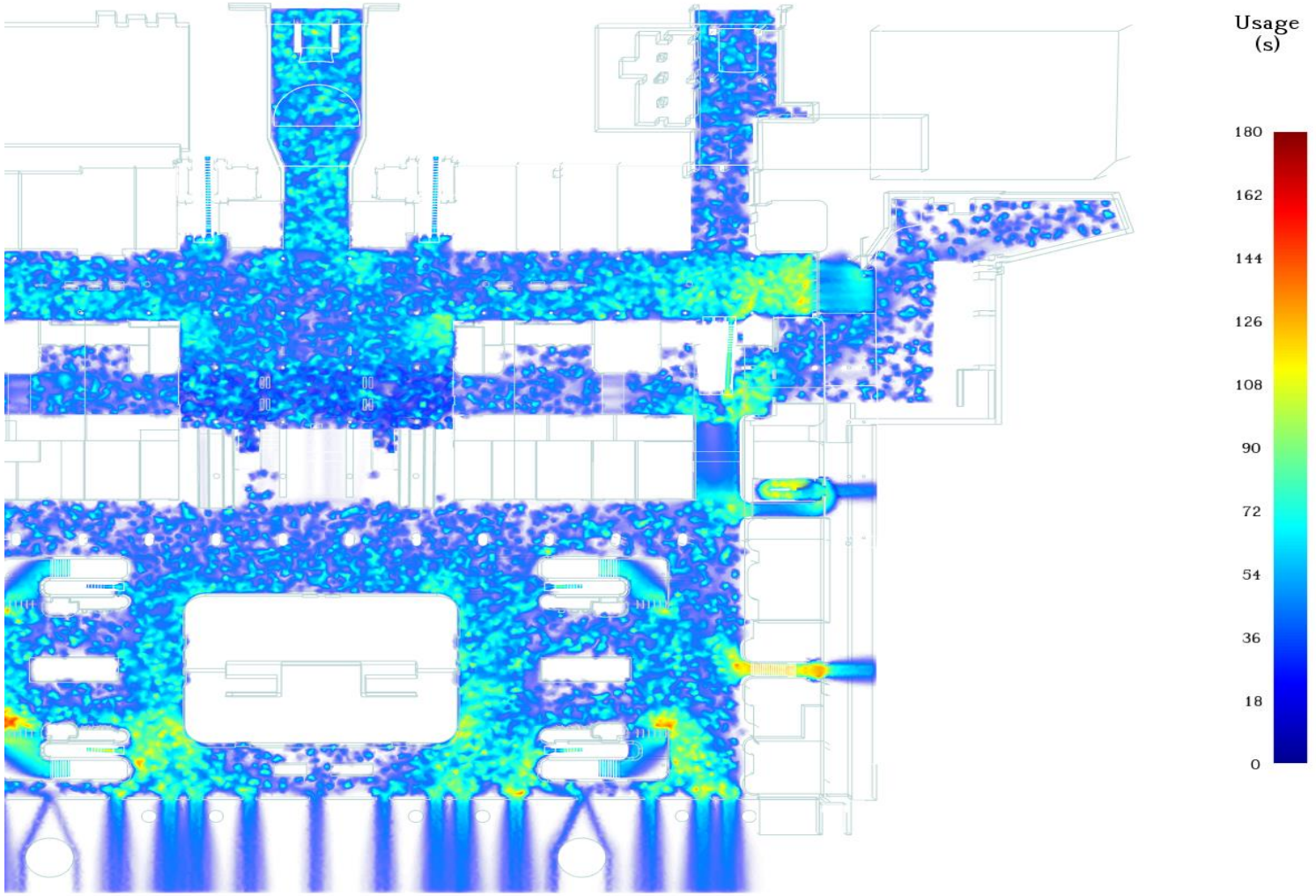
Outputs: Maximum Density



Outputs: Maximum Time to Exit



Outputs: Maximum Usage



Outputs: 3D flyby with VR support

Workflow Automation

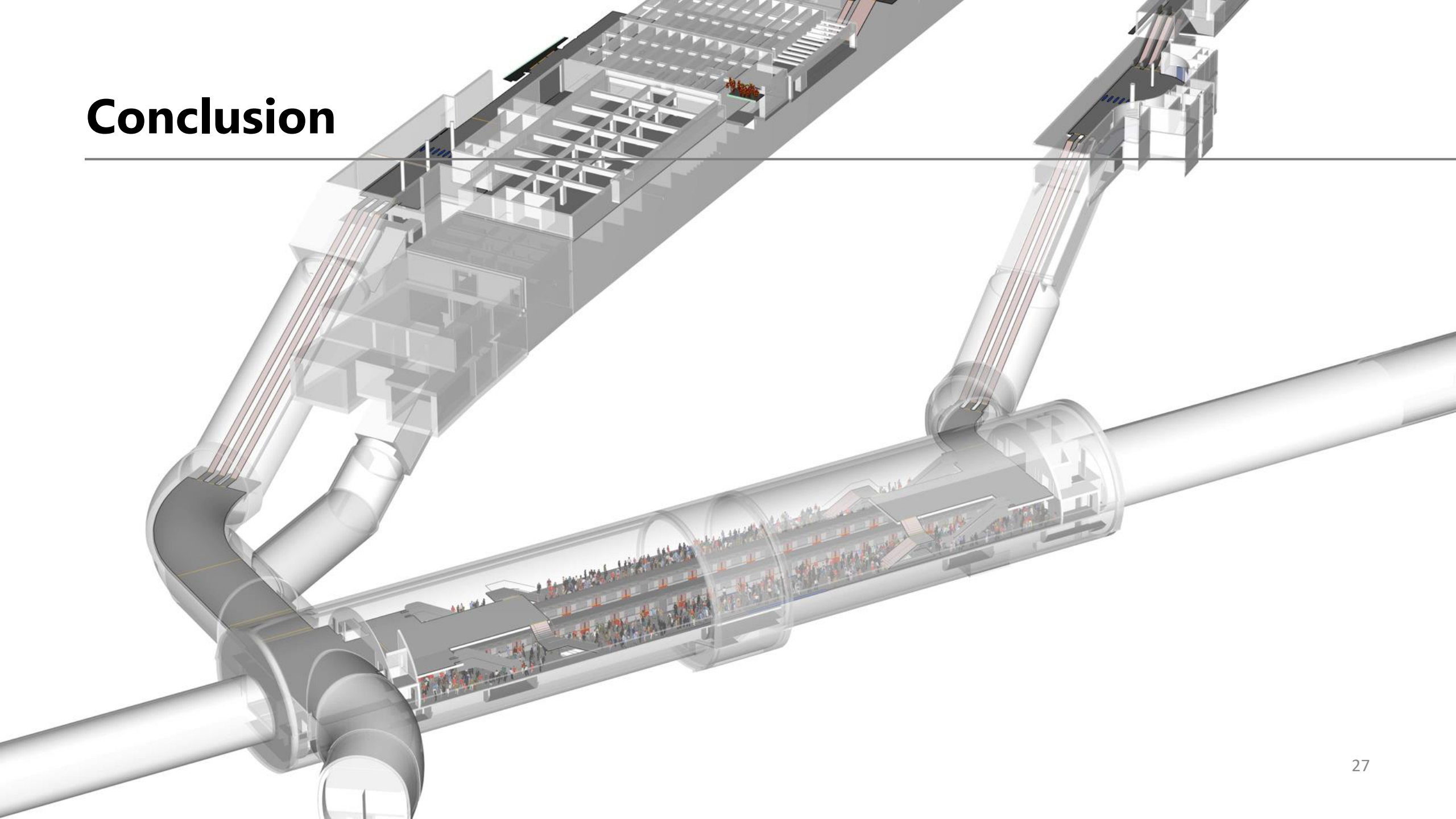
We analyzed a total of 7 different scenarios, each with a capacity of 1,000 to 10,000 people, for each occupancy tens of simulation runs with random input parameters. This means several thousands of individual simulations.

We use R scripts to change the Pathfinder Input File to achieve the following changes in particular: a number of agents, parameters of agents, random seed, open or close the doors.

The results have been processed using the same approach.

Simulations were deployed on dual CPU Intel Xeon with 24 cores to use the multi-threaded capability of Pathfinder.

Conclusion



Thank you for your attention

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