

OPTIMIZATION OF THE EVACUATION OF THE MUSIC FESTIVAL GROUNDS USING A NUMERICAL MODEL

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- FEMTC 2020 -



OPEN AIR FESTIVALS



FESTIVAL AREAS



HISTORIC TRAGICAL EVENTS



CASE STUDY

INFORMATION ABOUT AREA:

- Liqueurs area (in the Czech Republic)
- Total area 25, 000 m²
(11,050 m² is freely accessible to visitors)
- Dozens of music festivals every year
- Capacity of 20 000 people
- 2 entrances / exits (= 2 emergency exits)



CASE STUDY – AGENT-BASED MODEL OF FESTIVAL

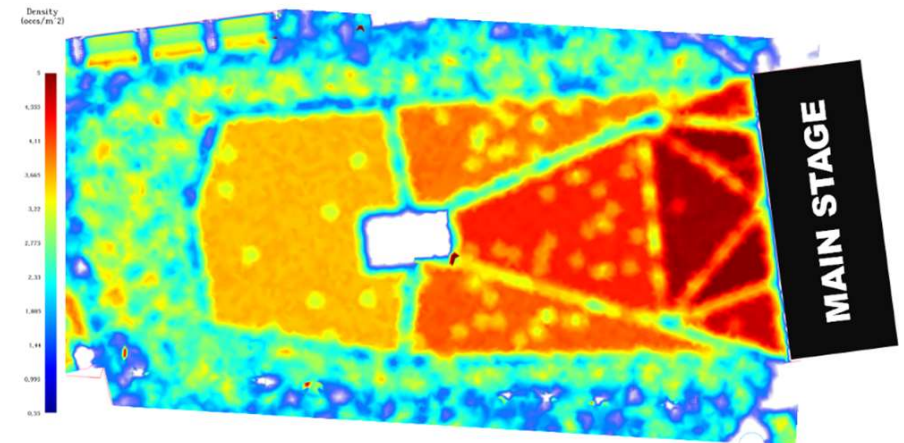
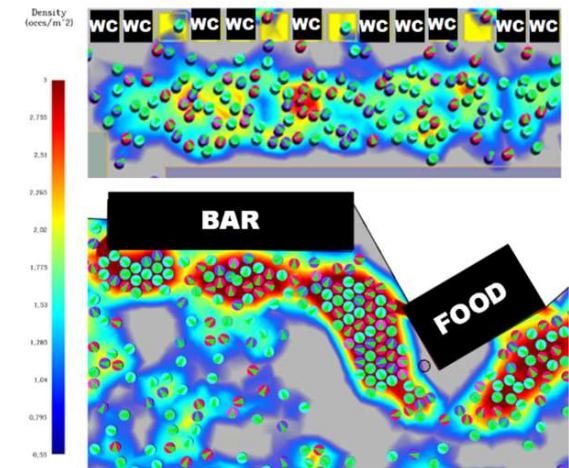
INPUT DATA:

Composition and occupancy of the festival area

Age and gender composition of the population

- **Field survey** (distribution people, behavioral)
- **Information from the organizers** (geometry, security, operation)
- **Available statistics** (ages composition of festival participants)
- **Testimonials from visitors** (realistic view)

Persons	Representatio n [%]	Persons	Representat ion [%]
Women (< 30 years)	25,80	Men (<30 years)	30,20
Women (30-50 years)	14,70	Men (30-50 years)	17,30
Women (> 50 years)	5,50	Men (> 50 years)	6,50

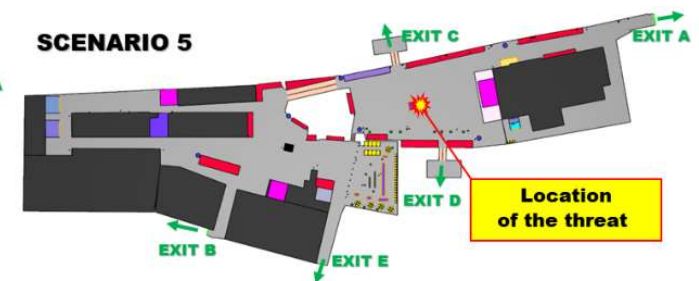
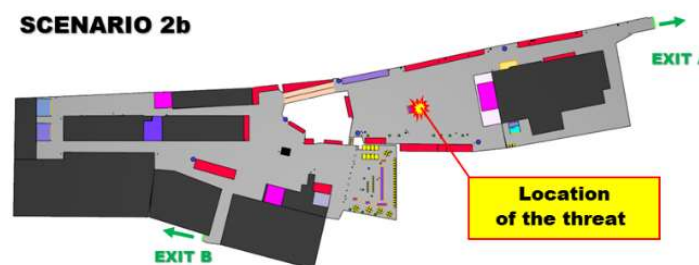
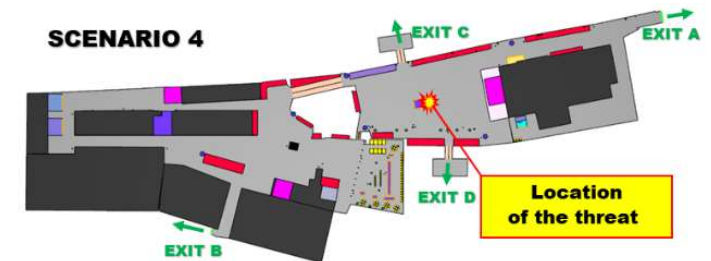
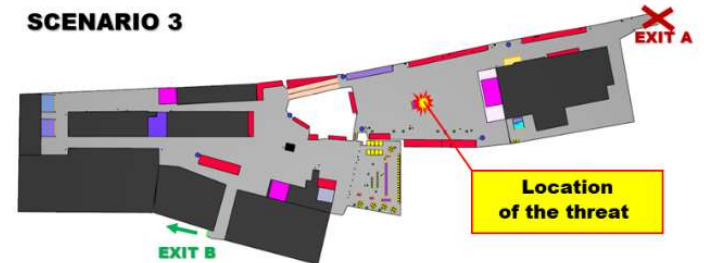


CASE STUDY – AGENT-BASED MODEL OF FESTIVAL

SCENARIO:

6 variant scénářů:

- S1 - Normal operation
- S2a - Simple evacuation (non-optimized)
- S2b - Simple evacuation (optimized)
- S3 - Barrier exit A
- S4 - Addition of new emergency exits C, D
- S5 - Addition of new emergency exits C, D and E



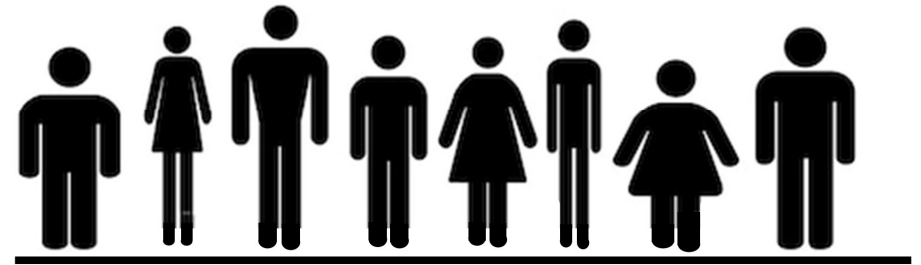
CASE STUDY – AGENT-BASED MODEL OF FESTIVAL

INPUT DATA:

Body space

(S. Pheasant)

Years	Gender	5% percentile	Mean μ	St. Dev σ	95% percentile
19 - 25	Women	35,5	39,5	24	43,5
	Men	41,5	46,5	29	51,0
19 - 45	Women	35,5	39,5	24	43,5
	Men	42,0	46,5	28	51,0
45 - 65	Women	35,0	39,0	24	43,0
	Men	41,5	46,0	27	50,5

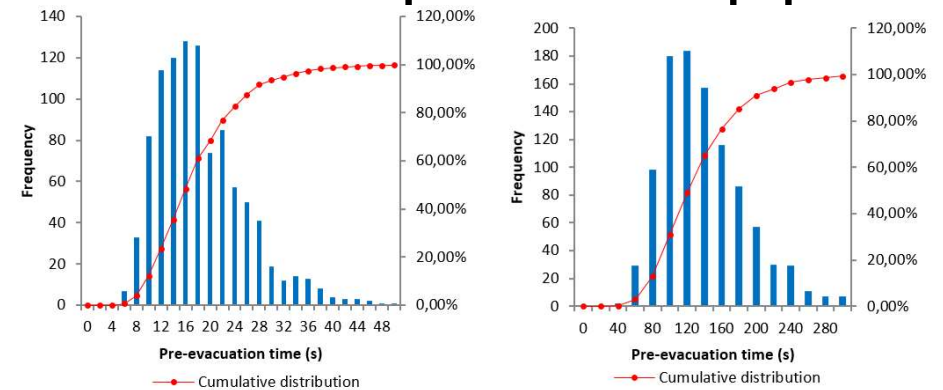


Walking speed

Years	Gender	Movement speed [m.s ⁻¹]				
		Flat surface	Stairs		Ramps	
			Range	Down	Up	Down
< 30 years	Women	0,516 - 1,433	0,315 - 0,873	0,285 - 0,791	0,415 - 1,153	0,400 - 1,112
	Men	0,580 - 1,610	0,439 - 1,217	0,296 - 0,822	0,509 - 1,414	0,438 - 1,216
30-50 years	Women	1,255 - 1,371	0,486 - 0,530	0,457 - 0,499	0,870 - 0,950	0,856 - 0,935
	Men	1,410 - 1,514	0,666 - 0,716	0,495 - 0,513	1,038 - 1,115	0,952 - 1,023
50 > years	Women	0,605 - 1,255	0,307 - 0,637	0,254 - 0,528	0,456 - 0,946	0,430 - 0,891
	Men	0,671 - 1,392	0,37 - 0,768	0,281 - 0,583	0,520 - 1,080	0,476 - 0,987

(U. Wiedmana + J. Fruin)

Pre-evacuation composition of the population



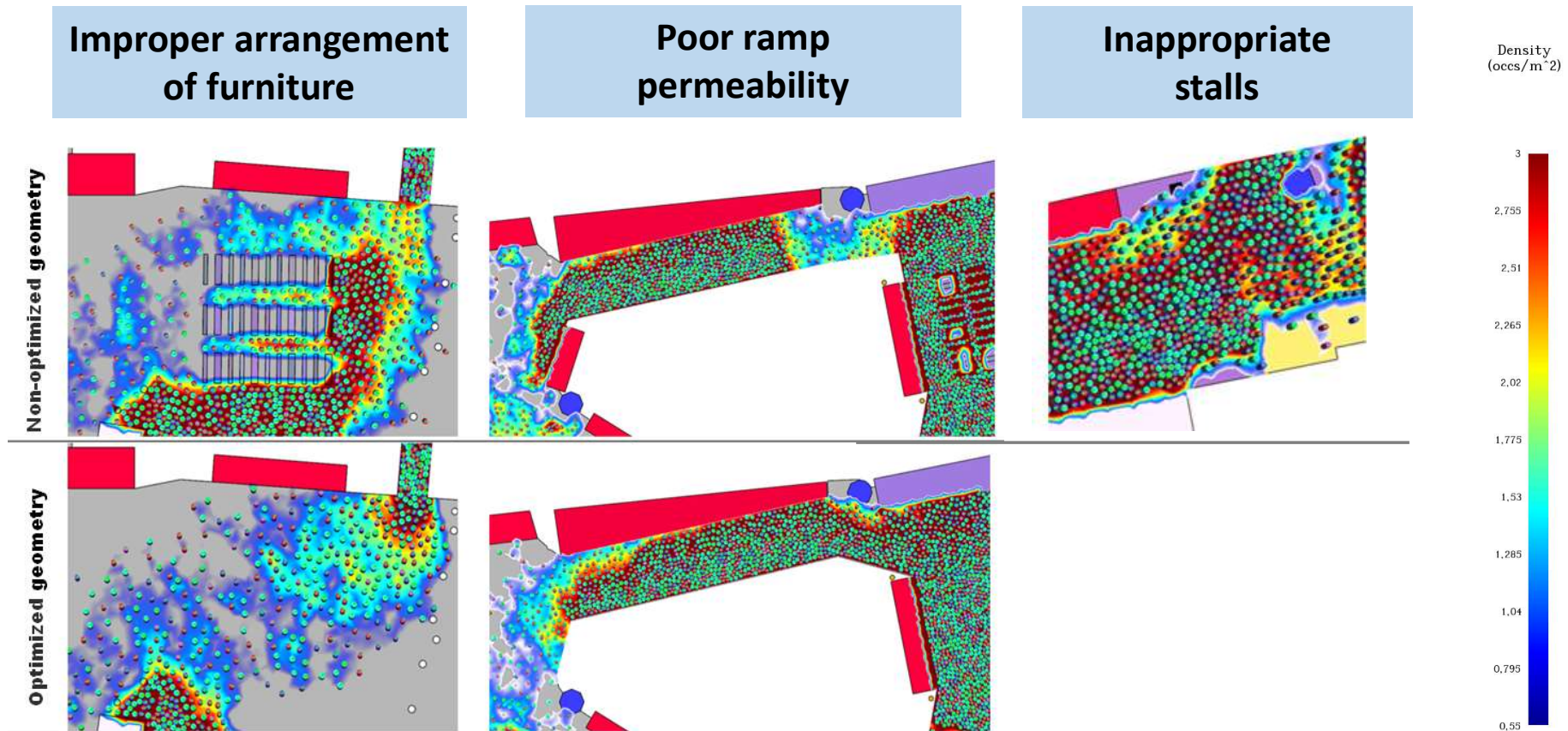
Histograms log-normal distribution pre-evacuation time determined on a sample of 1000 persons for – persons near the incident before the main stage (left), with parameters $\mu = 2.8$, $\sigma = 0.4$, 5th percentile = 8.5 s, 95th percentile = 32 s and persons further away from the main stage (right), $\mu = 4.8$, $\sigma = 0.4$, 5th percentile = 63 s, 95th percentile = 237 s.

(E. A. Maylor + J. Stratus + RIMEA)

CASE STUDY – AGENT-BASED MODEL OF FESTIVAL

RESULTS:

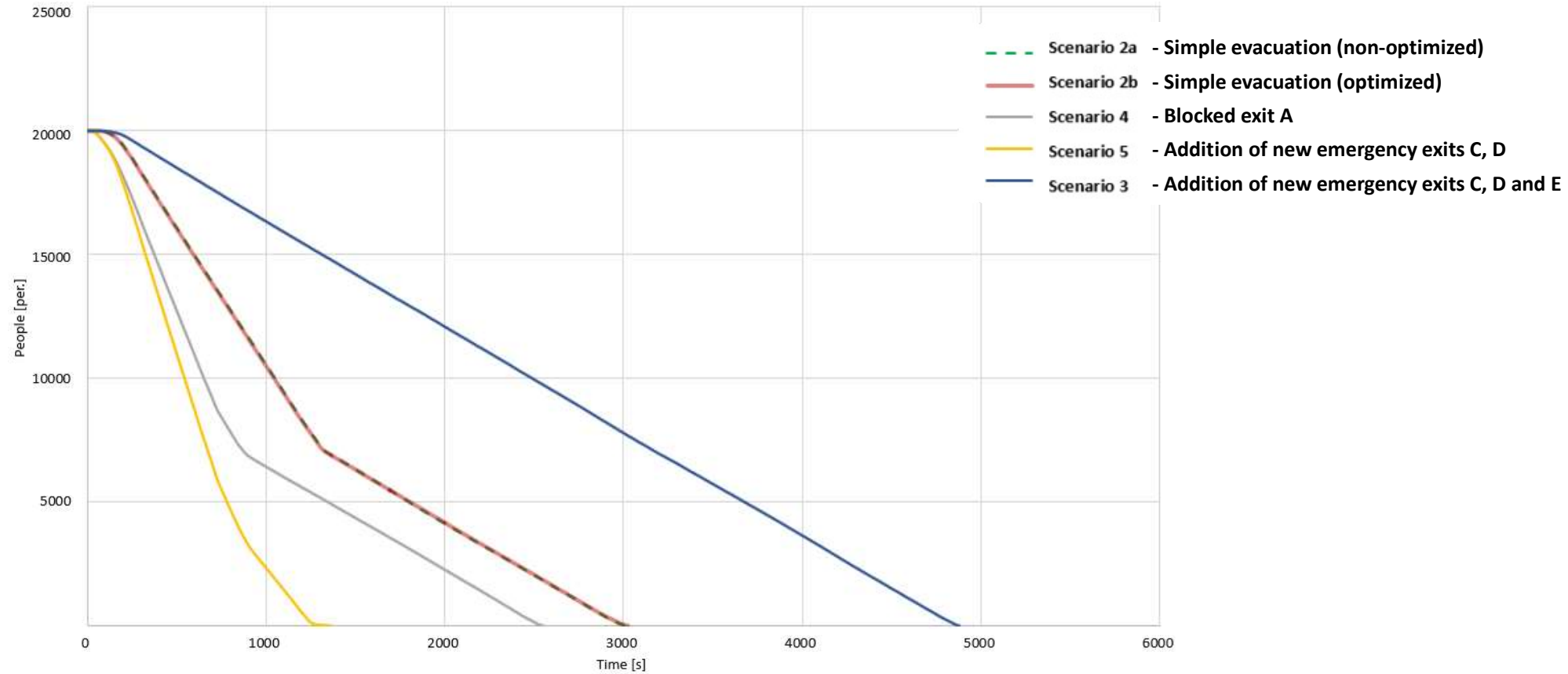
- Optimization of area geometry (S1 - Normal operation + S2a - Simple evacuation)



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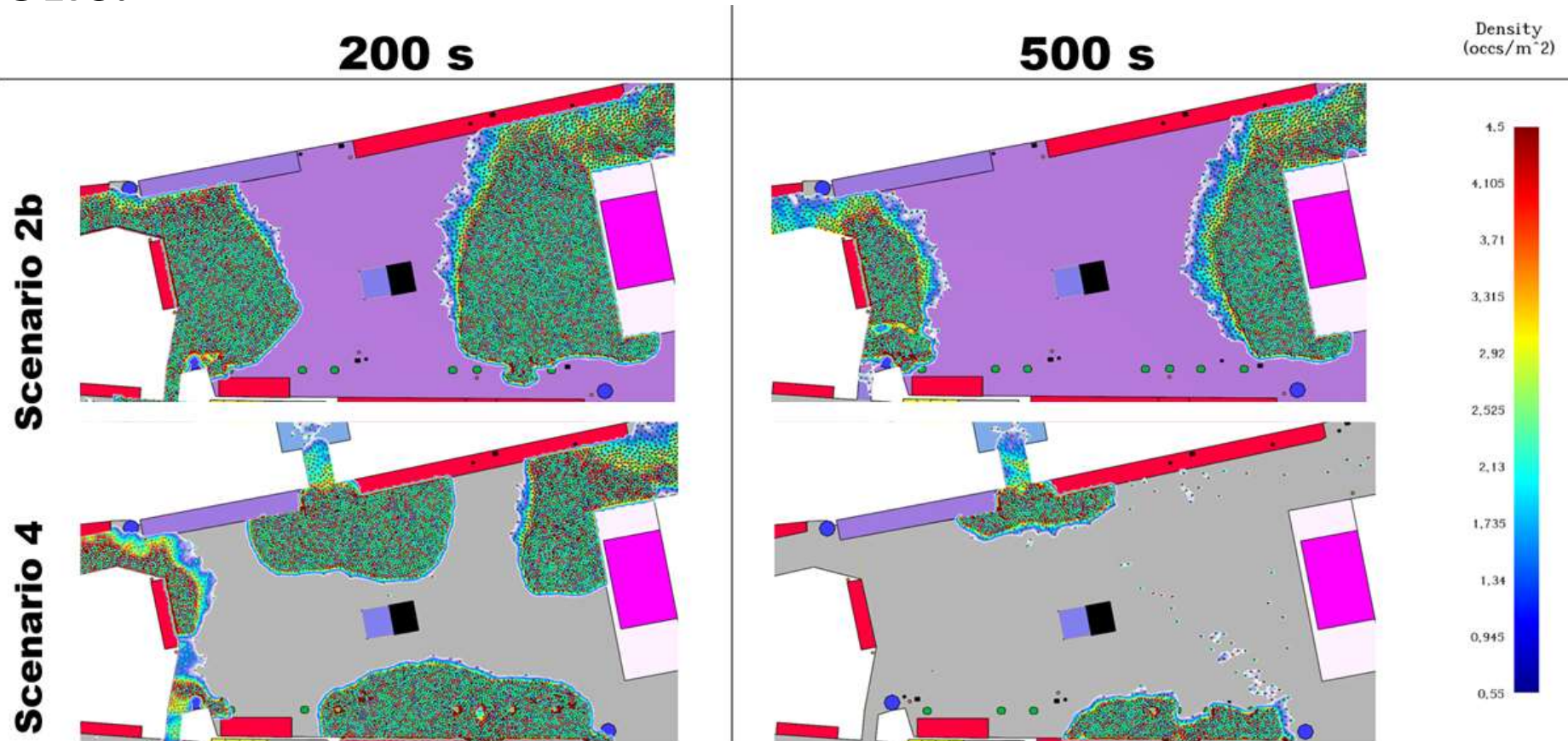
RESULTS:

Total evacuation time



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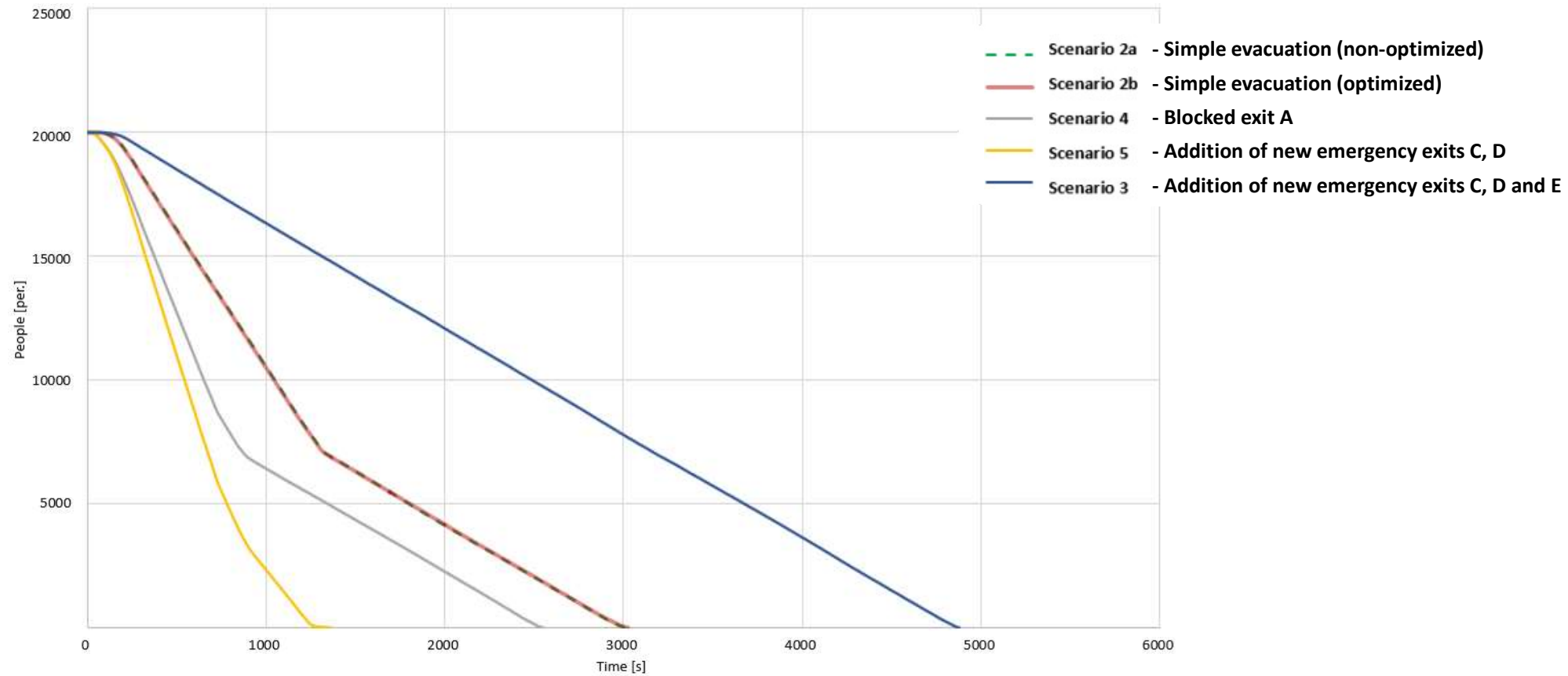
RESULTS:



CASE STUDY – AGENT-BASED MODEL OF FESTIVAL

RESULTS:

Total evacuation time



CONCLUSION

BENEFITS OF USING THE NUMERICAL MODEL:

- Verification of the correctness of the solution – various scenarios
- Geometry optimization (arrangement, number of exits, etc.)
- Increasing the safety and comfort of movement of people
- Možnost opakovaných změn geometrie, scénářů a jejich ověření

CONCLUSION:

- Numerical models are a suitable and effective tool for event. planning
- Future - collection of data of visitors and their behavior within individual festivals => provide quality input, calibration of numerical models for this type of event

Thank you for your attention



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