# Abstract (EN)

This study presents a mesoscopic model that predicts pedestrian evacuation in large gatherings with probabilistic methods. The model is based on a coarse network representation of buildings, where occupants are treated at a different scale according to their location.

A microscopic approach is used to represent people in the initial enclosure: here individual characteristics and behaviours are attributed to each occupant through random sampling from user-defined probabilistic parameter distributions, and individual timelines are used to determine the initial flow of evacuees. A macroscopic representation is implemented in the following parts of egress routes, where occupants are treated as a homogeneous crowd with uniform characteristics. The SFPE hydraulic model is used to predict movement until a place of safety.

Two automatic iterative processes are implemented within the evacuation model to address variability and uncertainty. In the first step, behavioural uncertainty is investigated by running the same evacuation scenario multiple times until results meet user-defined converge criteria based on inferential statistics. In the second step, input parameters/distributions are modified automatically to predict evacuation in different scenarios for quantitative risk assessment.

Multiple tests show good agreement between the results of the proposed mesoscopic model and a microscopic model employed for benchmarking (Pathfinder used in SFPE mode). For horizontal egress routes, the proposed tool provides detailed and accurate outputs (evacuation curves, flow rates, queue size, etc.) with short computational time. For vertical egress routes, mesoscopic predictions capture well the qualitative evolution of the egress process, but quantitative results are underestimated and necessitate additional investigation.

Lastly, a quantitative risk assessment is performed for a case study, in which the proposed model is used for the calculation of the evacuation curve in several scenarios. The efficiency of modelling and calculation processes highlights that the proposed model represents a valuable contribution for the probabilistic analysis of fire evacuation in large gatherings.

**Keywords**: human behaviour, crowd evacuation, mesoscopic modelling, hydraulic model, large gatherings, fire safety, performance-based design, quantitative risk assessment, consequence analysis, uncertainty analysis, probabilistic modelling.