The objective of this research is the analysis of pedestrians risk exposure along urban trips in relation to pedestrian crossing behavior. First, an appropriate microscopic indicator is selected for the estimation of pedestrians risk exposure while road crossing at isolated locations. This indicator expresses exposure as the number of vehicles encountered by pedestrians during the crossing of a single uncontrolled road lane, and can be further adapted and applied for various road design and traffic control measures. Moreover, the number and type of crossings along a pedestrian trip can be identified on the basis of the trip length and topology, whereas the choice set of alternative crossing locations for each crossing decision can also be defined. The crossing probability associated with each alternative location along the trip can be then estimated by means of a sequential logit model. Finally, a method is presented for the estimation of pedestrins exposure along a trip in relation to their crossing behavior. The proposed approach is demonstrated on the basis of a pilot implementation, for a typical pedestrian trip in the centre of Athens, Greece, for four scenarios containing different traffic conditions and pedestrians’ speed walking. The results show that pedestrians’ exposure along a trip is significantly affected by their crossing choices, as well as road and traffic characteristics. It is also revealed that pedestrians with increased walking speed may partly compensate for their risk exposure, so that it is not significantly affected by traffic volume. Moreover, specific locations with increased pedestrian risk exposure can be identified for each trip. The proposed microscopic, analytical approach of pedestrian exposure is proved to be advantageous compared to existing macroscopic ones, revealing the different possible definitions and aspects of pedestrians exposure, with useful implications for road safety analysis.

Methodology (cont.)

- **Microscopic Indicator of Pedestrian Exposure for Crossing at Isolated Locations**
  - An appropriate pedestrians’ exposure indicator is selected, namely the Routledge indicator (Routledge et al. 1974), as improved by Lassarre et al. (2007), which will be referred to as the “adapted Routledge indicator”.
  - The original Routledge indicator expresses the proportion of space unavaiable to pedestrians for crossing, i.e. the proportion of space occupied by vehicles. This proportion is the ratio of the distance covered by the vehicle during the pedestrian crossing movement (\(d\)) to the total space available between moving vehicles (\(L\)).
  - The proposed indicator was written as a more practical and implemental traffic flow relationships. The indicator now comprises a static part (the ratio of the two densities \(d/\rho\)), and a dynamic part (the number of vehicles encountered during the crossing) \(I_{\text{vehicle}}\). Exposure \(E\) will be free from static conditions and flow to high densities and lower can be calculated as:
    \[
    E = \frac{d}{\rho} + \sum_{i=1}^{n} I_{\text{vehicle}}
    \]
    - Values higher than 1, where the spaces occupied by moving vehicles overlap and no space is available for pedestrians, are attained rather quickly.
    - Lassarre et al. (2007) note that increased traffic density results in decreased vehicle speed and consequently crossing opportunities, although limited, may still exist. It is suggested to delete the static part of the indicator, resulting in the adapted indicator.

- **Modelling Pedestrian Crossing Behaviour along Entire Trips**
  - The choice of crossing location among the alternatives of the choice set can be modelled with discrete choice models.
  - Two hypotheses have been examined: a sequential choice process and a Hierachical choice process. The hierarchical choice process assumes that the pedestrian considers the entire set hierarchically, by first selecting a road link among the available alternatives (marginal choice), and then a specific location, either at junction or at mid-block within that link (sequential or crossroad-like models).
  - The sequential choice process assumed that a pedestrian examines the available choice set sequentially, by making a separate crossing decision for each trip of any pedestrian crossing trip along a route.
  - Both approaches were tested with data from a field survey in Athens, Greece, in which pedestrian trips were recorded in real time using a video camera. Survey participants were selected with simple random sampling from the exits of metro stations 491 pedestrian trips, including 2 418 road links, 884 primary road crossings, and 52 variables per trip.

- **Pedestrians’ Exposure in Relation to Crossing Behaviour**
  - The adapted Routledge indicator estimates pedestrian risk exposure (\(E\)) for crossing a road at an isolated location. The risk exposure implied by the adapted Routledge indicator is independent from the crossing probability, which is taken to equal 1.
  - The sequential model developed estimates the probability of pedestrians risk exposure (\(P\)) at each location along the trip, through the crossing of pedestrians along a trip.
  - Within a crossing location, the probability of pedestrians risk exposure at each crossing location depends on the traffic volume, the crossing probability lower than one corresponds to that location. In this case, the actual pedestrians exposure (\(R\)) for the pedestrian trip:
    \[
    R = \sum_{i=1}^{n} P_i + \sum_{i=1}^{n} I_{\text{vehicle}}
    \]
  - For the entire trip, the total risk exposure of pedestrians while road crossing is thus formulated in relation to the crossing probability:
    \[
    R = \sum_{i=1}^{n} P_i + \sum_{i=1}^{n} I_{\text{vehicle}}
    \]
  - A different definition of pedestrian exposure while road crossing is thus formulated in relation to the crossing probability:
    \[
    R = \sum_{i=1}^{n} P_i + \sum_{i=1}^{n} I_{\text{vehicle}}
    \]