

## **Development of Pedestrian Level of Service along Urban Streets: A Novel Three-Construct based Measure Using Unsupervised Mining**

By

Dipanjan Nag

Supervisors: Dr. Arkopal K Goswami & Prof. Joy Sen

### **Abstract**

Pedestrian Level of Service (PLOS) is a widely used tool to assess pedestrian facilities in urban contexts. This research carried out a systematic review of literature from 1971 to 2019 to understand existing PLOS models, culminating in a palpable research gap observed from 47 PLOS studies, viz. there is an absence of a single PLOS that captures all three constructs, i.e., traffic flow characteristics (FC), built walking environment (BE), and users' perception (PT), which represents an entire walking environment. Therefore, attempt was made to develop a comprehensive PLOS measure, including the three constructs, for urban 'footways' using unsupervised mining approach. Varanasi is selected for the study as it is representative of a mid-sized Indian city characterized by dense population, narrow right-of-way, aging infrastructure, and largely absent pedestrian infrastructure. As a first step, the study was able to develop a screening tool, using experts' and users' opinion, for selecting the final 11 PLOS attributes. Secondly, these 11 attributes were measured using exhaustive data collection procedures at Varanasi, undertaken in three phases—reconnaissance, intermediate and final. Thirdly, an unsupervised technique, Association Rule Mining (ARM) was used to generate the PLOS model. Results show that the walking environment performance was largely impacted by the attributes of *connectivity*, and *discontinuity*. Commonality analysis showed that combined contribution of the FC, BE, and PT attributes was close to 29.3% (almost one-third), which confirmed that the model was indeed providing a better picture of the walking environment performance. The developed model was compared to existing PLOS models of IRC-103 and IndoHCM, both of which estimated LOS A for most urban links in Varanasi, contrary to the findings of the developed model. Landis' method was found to be biased to socioeconomics of the urban area. The novelty of this doctoral work lies in (a) a structured attribute selection method; (b) BE attribute measurements; (c) a PLOS model including all constructs; (d) a PLOS measure for urban streets, with or without sidewalk infrastructure; (e) inclusion of Space-Syntax in the PLOS process; and (f) unsupervised mining-based PLOS. Future research studies could further apply the current methodology to varied urban contexts.

**Keywords: Pedestrian Level of Service; Association Rule Mining; Built Walking Environment; Flow Characteristics; Users' Perception**