PhD Open Days

LINES: muLtImodal traNsportation rEsilience analysis

PhD in Computer Science and Engineering

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This study aims to contribute to more **sustainable mobility** solutions by proposing robust and **actionable methods to assess the resilience** of a multimodal transport system. Resilience is seen in a dynamic lean setting, looking at aspects in the network topology and user's flow and demand throughout a parameterizable period. We hypothesize that this network's appropriate **multi-layered and traffic-sensitive modeling** can promote the integrated analysis of different transport modes and trace resilience vulnerabilities. We operationalize the lean resilience conceptual construct with the methodological process proposed: muLtImodal traNsportation rEsilience aSsessment (LINES). Using the city of Lisbon as a study case, we illustrate the relevance of the proposed methodology to detect actionable vulnerabilities in the bus–tram–subway network.

We model the multimodal the Lisbon Public transport network [3] and measured centralities of paths and stations to understand topological propensity for higher flows. Using smart card validations [1], we estimate user profiles [7] and graphed the spatial dispersion of temporal usage.

Then we propose the measurement of lean resilience, to trace the demand supply imbalances per network segment [2].

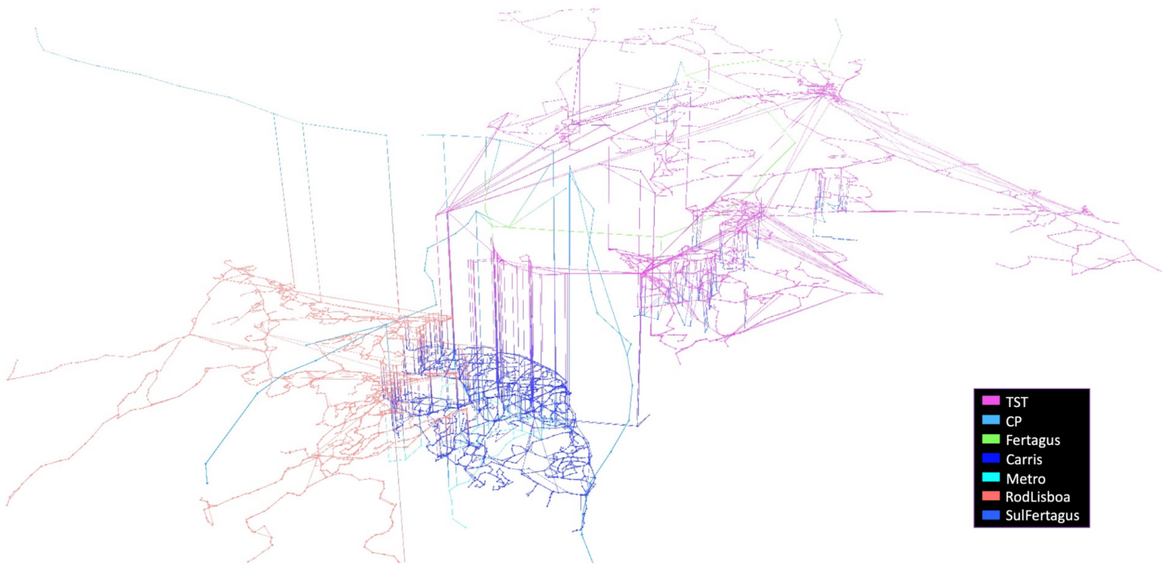
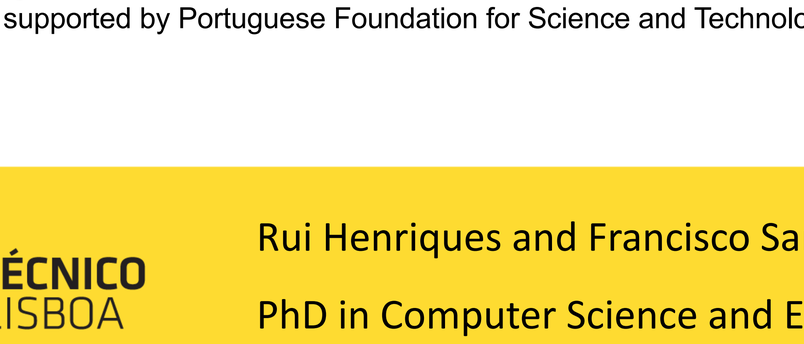


Figure 1. Multilayer transport network topology of the Lisbon metropolitan area (LMA) on a 3D representation with all of the layers.



$$LR = \frac{\int_{t_1}^{t_2} \frac{T_{demand}(t)}{T_{supply}(t)} dt}{t_2 - t_1}$$

$$c_B(v) = \sum_{s,t \in V} \frac{\sigma(s,t \mid v)}{\sigma(s,t)}$$

Figure 2. METRO low resilience links in accordance with demand supply dynamics on the left and topological criticality on the right in accordance with betweenness centrality.

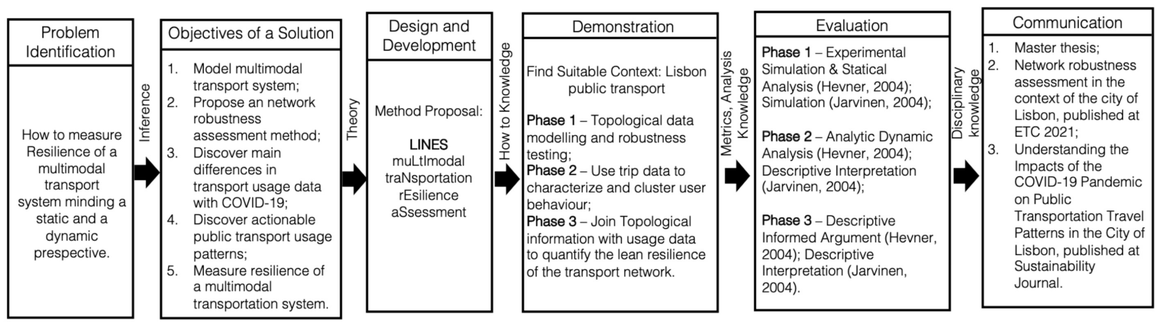


Figure 3. Methodological phases of the present research, based on Peffers et al [4] framework

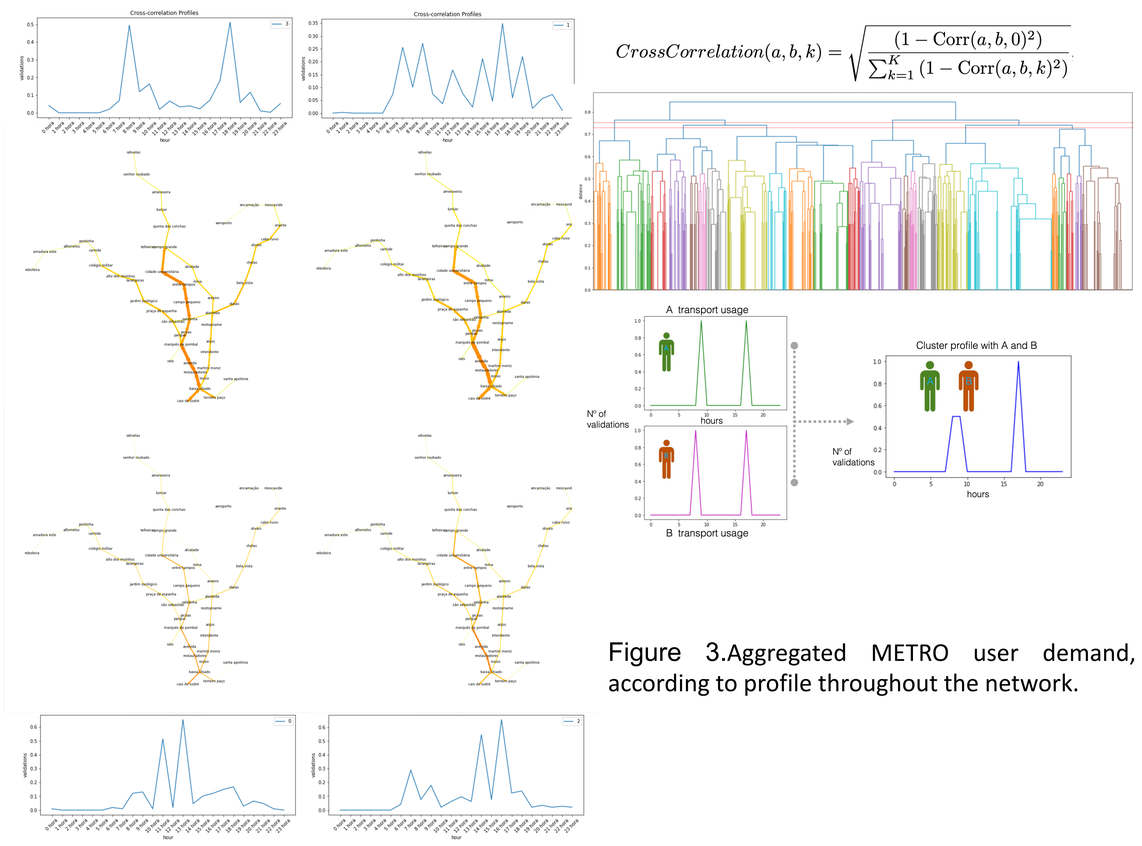


Figure 3. Aggregated METRO user demand, according to profile throughout the network.

	Build	Evaluate	Theorize	Justify
Construct	Public Transportation Lean Resilience	-	-	-
Model	-	-	Resilience model; User profile impact	Usage patterns; Clusters of users.
Method	Network resilience measurement process: LINES	Robustness testing comparing multi and singleplex	-	-
Instatiation	Network modelling; Usage patterns and resilience analysis Software;	Robustness tests; Cluster solutions	-	-

Table 1 Research outputs

References:

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[4] Peffers, Ken, et al. "A design science research methodology for information systems research." *Journal of management information systems* 24.3 (2007): 45-77.
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[6] Hevner, Alan R., et al. "Design science in information systems research." *MIS quarterly* (2004): 75-105.
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Acknowledgments:

This work is supported by Portuguese Foundation for Science and Technology (FCT) individual PhD grant to JTA UI/BD/153587/2022

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