# Beyond Hyper-Proximity: A Multimodal, Multi-City Framework for Assessing Urban Accessibility and Connectivity

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## 1 Extended Abstract

Urban systems generate heterogeneous, multimodal data, e.g., street networks, transit schedules, population grids, points of interest (PoIs), and socio-economic statistics, that increasingly underpin foundation models for urban analytics. Their deployment hinges on principled benchmarks, transparent baselines, and careful interrogation of fairness and socio-spatial bias. We present a multimodal, multi-scale analytical framework that fuses pedestrian networks, public-transit schedules, PoIs, gridded population estimates, and socio-economic data to jointly evaluate *walkable accessibility to services* and *transport connectivity* across cities. We position it as complementary to foundation-model approaches: an interpretable data-fusion pipeline whose outputs can serve as supervision signals, evaluation targets, or fairness diagnostics; and an empirical critique of hyper-proximity paradigms (e.g., the 15-minute city [2]) that any urban system should account for when generating policy recommendations. The 15-minute city aims to improve livability, sustainability, and inclusion by ensuring essential services are reachable within a short walk or bicycle ride from home [2]. However, its broader social implications remain insufficiently understood: it is unclear whether improving local access translates into greater inclusiveness, or whether it may reinforce segregation through gentrification or displacement. Addressing this requires fusing heterogeneous urban data sources within a unified lens, aligned with the FM4Urban agenda of multimodal urban data integration and trustworthy urban AI.

Our analysis covers 81 cities worldwide [3, 1], including ten Italian cities for which official socio-economic data are available. Urban space is represented using pedestrian networks from *OpenStreetMap* (OSM), with street intersections as residential proxies; population is assigned using WorldPop, and PoIs are extracted from OSM and classified into seven functional categories following [3]. Public transport is integrated via GTFS feeds from Transitland and local sources. Accessibility is measured through three dimensions: **PoI-proximity** ($\mathcal{P}$), the minimum walking time to reach at least one service per category; **PoI-density**

($\mathcal{D}$), the concentration of services within walkable isochrones; and **PoI-diversity** ($\mathcal{E}$), entropy-based service heterogeneity. These are linearly combined into a synthetic **PoI-accessibility** score. To assess connectivity and segregation, we construct transport networks using public-transit edges weighted by travel time [1] and compute closeness centrality ($\mathcal{C}$) at every node: low closeness signals isolation, high closeness stronger integration.

City-level rankings reveal substantial variability. Paris, Barcelona, and Athens rank highly in PoI-accessibility with narrow inter-quartile ranges, indicating uniform access, whereas lower-scoring cities display wider distributions and stronger intra-urban inequalities. Ranking by closeness, these cities drop to 71st, 16th, and 38th place, respectively, showing how connectivity captures segregation invisible through accessibility alone; the two metrics show no clear linear relationship, and cities cluster into distinct patterns, some showing high accessibility but weak connectivity, others the opposite. The framework also supports multi-scale analysis by aggregating node-level measures into neighborhoods detected with Infomap [4]. For Italian cities, we relate accessibility and connectivity to official income data. In Turin, their positive relation reflects a socio-economic gradient: lower-income neighborhoods exhibit both low accessibility and weak connectivity, while some high-income ones also show low accessibility and limited integration, suggesting voluntary isolation and reliance on private mobility. Similar patterns appear elsewhere, indicating the case generalizes beyond Turin.

Our results show that hyper-proximity alone does not guarantee inclusiveness and may obscure socio-economic inequalities in isolation. For the FM4Urban community, we offer three contributions: (i) a reproducible multimodal data-fusion baseline combining OSM, WorldPop, GTFS, and socio-economic layers, against which urban foundation models can be benchmarked on accessibility and connectivity prediction; (ii) an interpretable fairness lens for evaluating models that recommend 15-minute-city-style interventions; and (iii) a natural 81-city testbed for transfer-learning studies. More broadly, 15-minute-city strategies should be complemented with citywide connectivity interventions, particularly in underserved and peripheral neighborhoods, a nuance that foundation models for urban planning and digital twins should encode to support inclusive, resilient, and cohesive cities.

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