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Spatial Approach for the Assessment of Public Transit Node Accessibility in Urban Areas of Developing Countries: Evidence from Addis Ababa, Ethiopia

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Abstract:

Public transit has become the center of concern in modern transportation planning and policy-making. The popularity, in part, is due to its advantage in reducing congestion, traffic accidents, cost, travel time, and environmental impact, increased mobility, and equitable distribution of infrastructure for the masses. However, due to the lack of effective public transit in developing countries, the advantages of public transportation are not enjoyed. The challenges mainly emanate from the lack of prioritization in planning and coordination among different transportation stakeholders, infrastructure deficit and inadequacy, greediness of existing public transit systems and capacity, security issues, and social norms. In addition to the above-mentioned restrains, the existing public transit systems suffer from the problem of accessibility to the wider public, which is the prime goal of any transportation system. One way to achieve approachability is, therefore, to critically investigate the location of public transit nodes through state-of-the-art spatial methods.

In light of that, this study aims to investigate the approachability of public transit nodes in Addis Ababa, the capital of Ethiopia, and contribute by disclosing the state of the matter using empirical evidence. To that end, instead of using the conventional stand-alone distance approach, the study proposes to implement a spatial approach that measures the shortest road network distance followed by a map algebra approach. Specifically, the study proposes to follow a four-step approach. Firstly, implements the Dijkstra algorithm to find the shortest distance between public transport nodes and i) centroids traffic analysis units/administrative units; ii) educational establishments such as schools and kindergartens; iii) college and university locations; iv) health facilities; v) recreational, sport, and entertainment centers; vi) public service, retail, commercial, and financial centers. Secondly, the study uses three sets of threshold distances and the calculated shortest distance to identify the land-use area of interests that have access to the transit nodes. The distance thresholds used in the study are 350m, 875m, and 1,500m fixed, benchmarking the literature on the six-minute walking time distance and the average length of walking trips in the study area. Thirdly, the accessible land-use area of interest is spatially joined with the traffic analysis units to create a rasterized map of each threshold distance accessibility map. Finally, each rasterized map is algebraically added to produce a map showing the transit node accessibility of six areas of interest land-use categories with respect to the threshold distances.

Accordingly, the study employed 131 traffic analysis units and 437 transit nodes distributed over 47,651 road segments of 7,576.18km. Furthermore, 141 educational establishments, including schools and kindergartens; 33 colleges and Universities; 98 health facilities; 298 recreational, sport, and entertainment centers; 129 public service, retail, commercial, and financial centers are used to represent areas of interest land-use destinations. The results of the shortest path between the centroids of traffic analysis units and transit nodes show that there are 56,290 possible routes between the pairs. However, only 43, 388, and 1,113 pairs are found to satisfy the distance threshold of 350m, 875m, and 1,500m, respectively, implying that only 13, 62, and 96 traffic analysis units out of 131 have access to the transit nodes in the order of threshold distances. Similarly, it is found that 28, 96, and 122 schools and kindergartens out of the total have nearest transit nodes at a distance of 350m, 875m, and 1,500m, respectively. Interestingly, the result shows that students of 122 schools and/or kindergartens in Addis Ababa are expected to walk at least 1.5 km on their first and last mile trips, regardless of the other end or origin of their school trips. One of the important findings indicates that 89 of the 98 health facilities considered in the study are situated 1.5 km away from the transit nodes. Under scarcity of vehicles designed and equipped for carrying people to the health centers, this distance seems to suggest difficult to traverse under emergency situations. Public service, retail, commercial, and financial centers, on the other hand, are highly accessible compared to other destinations considered in the study, i.e., more than 41%, 79%, and 88% of the centers are found at a distance of 350m, 875m, and 1500m, respectively, from the transit nodes. Schools and/or kindergartens, recreational, sport, and entertainment centers represent the least accessibility for transit nodes at a distance threshold of 350m and 875m. Health

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facilities, public service, retail, commercial, financial, recreational, sports, and entertainment centers are the top accessible destinations at a distance of 1.5km from the transit nodes.

Overall, ensuring spatial accessibility is a critical element in contemporary transportation planning, where sustainability is of the utmost concern. In view of that, this study attempted to empirically assess the status approachability of public transport nodes to various land-use destinations in Addis Ababa using a spatial approach. Based on the result, it is inferred that public transit nodes have limited approachability to the wider population. It is important for the planners and policymakers of the city administration to primarily focus on improving the connectivity of administrative units and physical accessibility of transit nodes through redesigning routes, repositioning the existing nodes, ensuring spatial approachability, application of well-designed first and last-mile feeder systems by the implementation of community shuttles and bike-sharing systems. Although the findings of the study are expected to add an empirical output to the small pool of literature in the study context and shed light on future planning options, they suffer from the lack of a traffic analysis unit map and data resolution. Hence, future work is strongly recommended to enhance the traffic analysis units, use higher resolution data, and implement advanced methods.

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