A comprehensive evaluation of rural accessibility based on public transport: A case study from Hong Kong

Keywords: Rural Accessibility; Public transport; Public facilities; Inequality; GTFS dataset

Extended Abstract

The accessibility concept is used to describe the potential of opportunities for interaction (Hansen, 1959), closely surrounding topics such as mobility and social. The lack of accessibility is the determining factor of rural decline and regional development. For rural areas, a well-developed public transport system can enhance the possibility of accessing various opportunities offered by the city and then create a vital role in reducing social exclusion and contributing to well-being, achieving economic growth, and realising sustainable development.

However, few studies are focusing on rural accessibility based on public transport (RAPT). On one hand, the accessibility calculation based on public transport is more challenging in terms of methodologies. Compared to analysing accessibility based on single-mode travel such as only driving, walking, and bicycling (Neumeier & Kokorsch, 2021), the trip chain based on public transport involves transfers within multi-travel modes (i.e., walking to the bus stop, then riding on the bus and transferring to another bus, and walking to destination) and are limited by public transport's schedule and stations (Tomej & Liburd, 2020). Traditional single-mode network-based GIS approaches become poorly used and academics turn to open-source mapping application programming interfaces (API) (Costa et al., 2021). However, an ordinary user without a paid license to open-source API (i.e., Google Map) is subject to a daily query limit of 2500 geolocation requests, while RAPT usually involves a large-scale computation (millions of calculation requests) between thousands of rural origins and thousands of destinations. Besides, all data used in the computation are maintained by Google, lacking data transparency. On the other hand, most accessibility studies based on public transport were conducted in intra-urban areas (Hernández, 2018) and RAPT received less attention due to the low supply of public transport and the number of trips in rural areas. Not surprisingly, intra-urban accessibility and public transport are more popular topics, which relate to more residents' living and well-being. Even though some studies considered the rural areas in the accessibility map, their way to finding rural regions is by positioning the areas that do not appear to have too many services based on inertial thinking (Hernández, 2018).

This urges us to study RAPT, identify inequalities, and know how they can be part of the solution. It is important to stress that providing public transport services in rural areas is very challenging due to long distances and narrow flows of people, scattered development and peripheral character, as well as tightening financial targets. This means that assessing RAPT should focus on two aspects. RAPT 1 analyses how easily rural resident can access a public transport service (e.g., arriving at public transport stops and waiting for public transport vehicles) and RAPT 2 evaluates the average travel time by multi-mode public transport departing from rural tracts. What's worse, the unreasonable transport system planning practices contribute to large and growing rural-urban inequities in approaching public facilities such as adult employment, youth education, and maternal health. Therefore, how many public facilities residents can access through public transport should also become one part of RAPT, named RAPT 3.

This paper then conducts a study on the accessibility and inequality of travelling from/to rural areas based on service quality of public transport including station bus catchment, headway (the time interval between departures), operation days, and travel time, and further examine the accessibility of five categories of public facilities (education, healthcare, culture, shopping, and recreation) for rural areas. To calculate the RAPT, this study employs the popular data format General Transit Feed Specification (GTFS), which is a truly scalable and open data standard, containing routes, trips, stops, frequencies, fares, shapes, and other schedule information (Google Developers, 2020). Considering the limited data availability, GTFS data has become more and more popular worldwide to do public transport accessibility research. Most research explicitly obtained the travel impedance (time, distance, and cost) derived from GTFS data. This study uses Hong Kong GTFS data including operation information of sixteen public transport agencies to get the travel impedance matrix. We extracted 2203 bus routes and 48 ferry routes from GTFS data, which creates 23496 trips every day in Hong Kong. Combined with an OpenStreetMap file of Hong Kong, travel impedance including walking time and riding time on multi-mode travel including walk, bus, and ferry for 4,929,600 origin-destination pairs are calculated.

A case study is performed in Hong Kong and the results show that the problem for rural residents' using public transport services lies in long distance to the nearest public transport stations instead of spending a long time waiting for a public transport vehicle at stations. Due to the geographical structure of Hong Kong and disparities in public transport schedule, the RAPT map presents a pattern descending from the polycentric, which is close to urban areas and new towns, and performs better on weekday mornings and evenings. Last but not least, we find that some rural areas have difficulties in accessing basic public services such as education, health care and shopping based on public transport, presenting a huge inequality in approaching basic public facilities. The observed accessibility and inequities could direct transit agencies to replan and deploy services such as introducing demand-responsive transit (DRT) services and then contribute to a highly accessible rural community.

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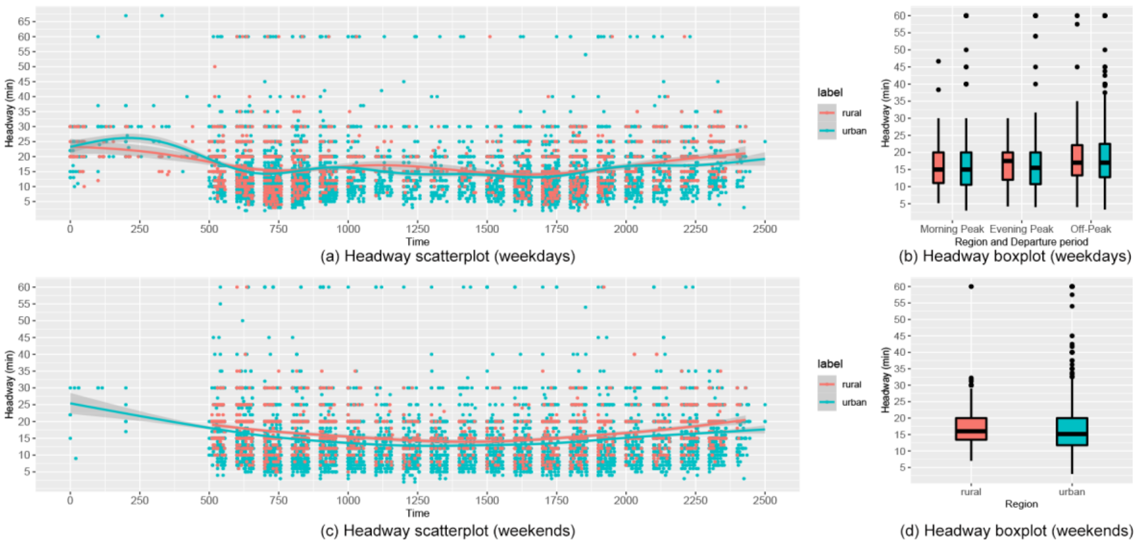

Figure 1. Distribution of Headway

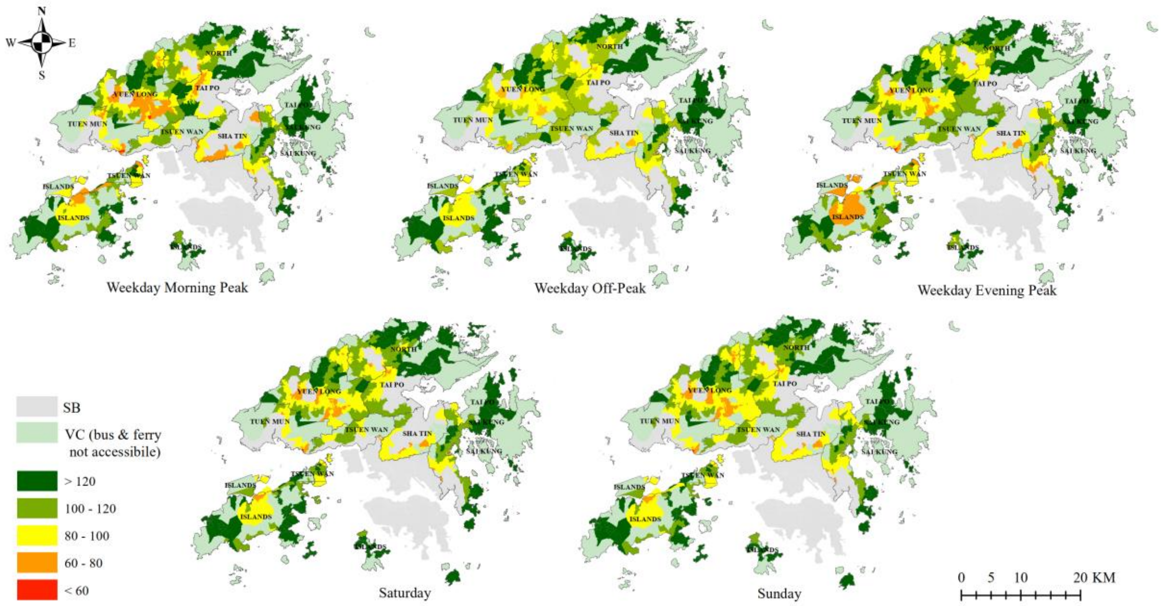

Figure 2. Average travel time based on public transport in rural areas (SB: street blocks; VC: village cluster