

Rethinking Compact City Strategies in Car-Oriented Regional Cities: A Multi-Modal Accessibility Assessment of 15-Minute Urban Living under Limited Public Transport Networks in Japan

Hiroki Kikuchi (kikuchi.hiroki@nihon-u.ac.jp), Fumiki Koyama (csfu22041@g.nihon-u.ac.jp)

Department of Transportation Systems Engineering, College of Science and Technology, Nihon University, Japan

INTRODUCTION & AIM

- Regional Japanese cities remain highly car-dependent due to dispersed urban structures and limited public transport networks.
- Although the “15-minute city” concept has been widely discussed in transit-oriented European cities, its applicability to automobile-oriented regional cities remains unclear.
- This study evaluates 15-minute accessibility to urban functional facilities across four transport modes:
 - Walking
 - Bicycle
 - Public transport
 - Automobile
- Using GIS-based network analysis and population mesh data, the study compares accessibility patterns across five regional Japanese cities.

METHOD

Study Area

Five regional Japanese cities were selected to represent different urban structures and levels of automobile dependency:



These cities were selected considering:



Target Facilities

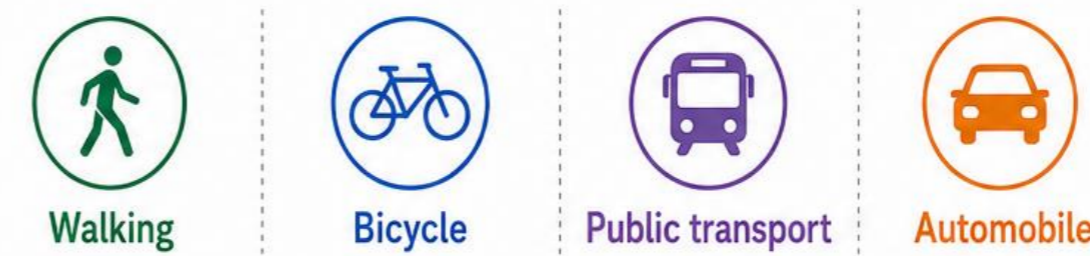
Six types of urban functional facilities were analyzed:



Accessibility Analysis

Accessibility was evaluated under a common 15-minute travel condition using GIS-based network analysis in ArcGIS Pro.

Four transportation modes were compared:



Public Transport Accessibility

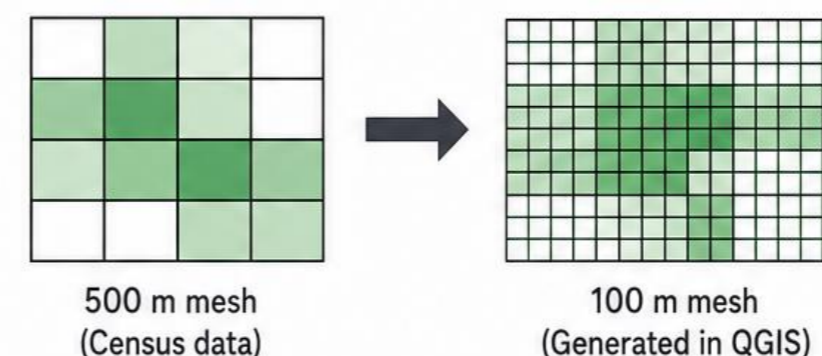
Public transport travel time included:

walking to stations/stops + waiting time + in-vehicle travel time + walking after alighting

Average waiting time was calculated as half of the service interval.

Population Coverage

A 100 m population mesh dataset was generated from census-based 500 m mesh data using QGIS.



Population coverage within each 15-minute service area was calculated to evaluate accessibility differences across:

- transportation modes
- facility types
- cities

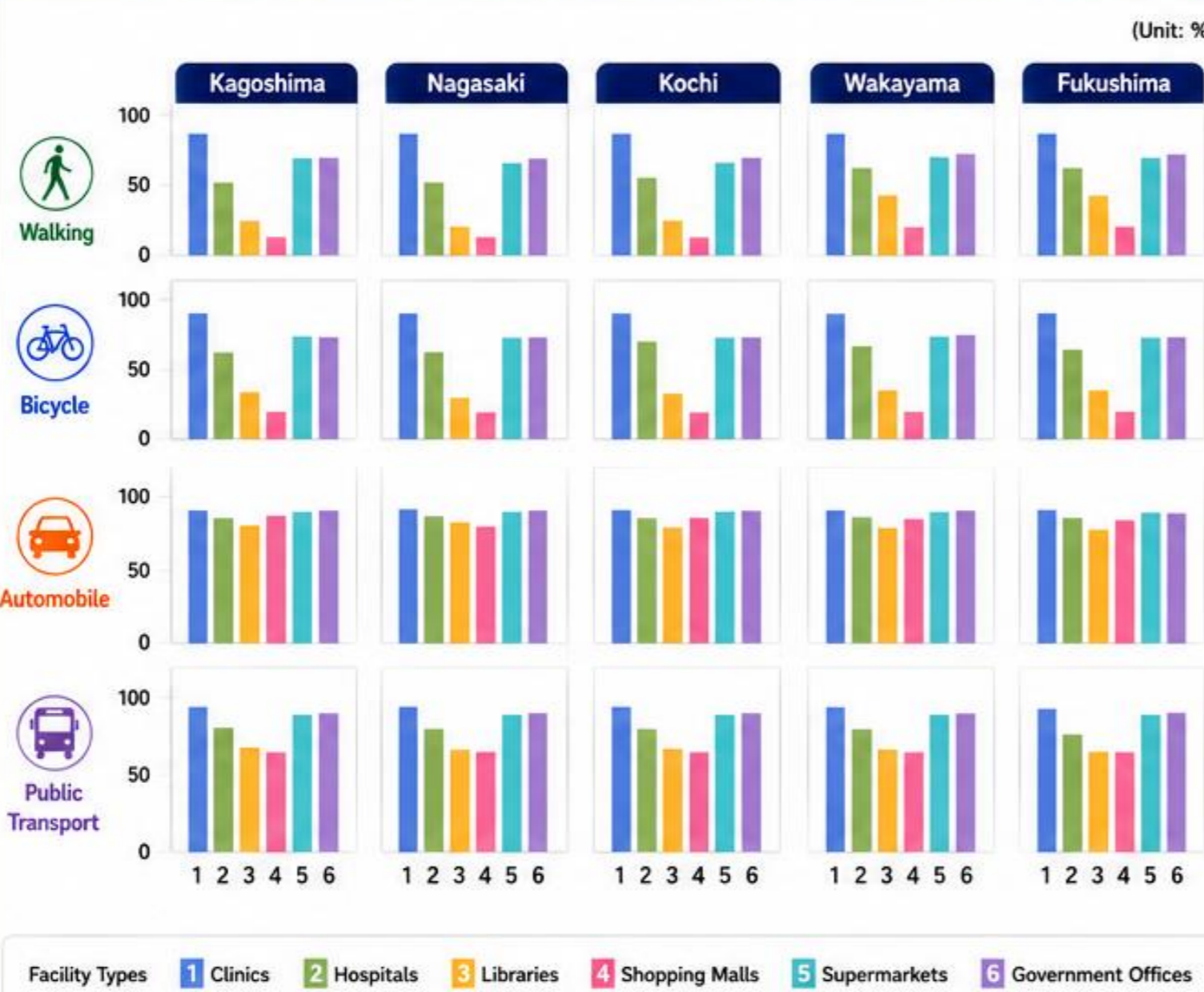
RESULTS & DISCUSSION

Main Findings by Transportation Mode

- Walking**
 - Relatively high for clinics and supermarkets.
 - Limited for hospitals, libraries, shopping malls, and government offices. Shopping malls showed particularly low walking accessibility in all cities.
- Bicycle**
 - Substantially expanded the reachable population compared with walking.
 - Especially significant for hospitals and libraries.
 - Differences among cities remained for shopping malls and government offices, indicating dispersed urban structures constrain bicycle accessibility.
- Automobile**
 - Showed the highest accessibility in all cities and facility types.
 - Differences among cities and facility types became relatively small.
 - In many cases, over 80–90% of residents could reach major facilities within 15 minutes by car.
- Public Transport**
 - Partially complemented walking accessibility, particularly for clinics and hospitals.
 - Improvements remained limited for shopping malls and government offices.
 - Effects varied substantially among cities depending on network structure, stop locations, and facility distribution.



15-Minute Population Coverage Rate by Transportation Mode and City



Urban Structure Differences Across Cities

Compact Urban Structures Wakayama / Kochi	Dispersed Urban Structures Fukushima / Kagoshima	Corridor-Type Urban Structure Nagasaki
<ul style="list-style-type: none"> Relatively compact urban structures. Facilities are continuously distributed within urbanized areas. Higher walking accessibility Smaller modal disparities Stronger bicycle accessibility 	<ul style="list-style-type: none"> Large urban areas Suburban facility distribution Strong automobile dependence Limited walking accessibility Fragmented living areas Dominant automobile accessibility 	<ul style="list-style-type: none"> Corridor-shaped urban structure strongly influenced by topography. Accessibility patterns are concentrated along: <ul style="list-style-type: none"> Railway corridors Coastal areas Major transport routes
Supermarkets and clinics are particularly well integrated into neighborhood living areas.	Although facilities are numerous, they are spatially fragmented.	As a result, accessibility remains spatially fragmented despite relatively high facility density.

Accessibility by Facility Type

Facility Type	Key Findings	Accessibility (Mode Trend)
Clinics	High accessibility across all modes because clinics are widely distributed throughout residential areas.	Walking > Bicycle > Public transport > Automobile
Hospitals	High bicycle and automobile accessibility, while walking accessibility remains limited due to fewer facilities and spatial concentration.	Walking > Bicycle > Public transport > Automobile
Libraries	Low walking and public transport accessibility in all cities. Bicycle and automobile substantially expand reachable population.	Walking > Bicycle > Public transport > Automobile
Shopping Malls	Strongest automobile dependence. Located in suburban areas, along arterial roads, and outside compact residential districts.	Walking > Bicycle > Public transport > Automobile
Supermarkets	Relatively high accessibility across all modes. Widely distributed in residential areas, providing stable population coverage.	Walking > Bicycle > Public transport > Automobile
Government Offices	Low walking and public transport accessibility and strong automobile dependence due to spatial concentration.	Walking > Bicycle > Public transport > Automobile

Higher Walking > Bicycle > Public transport > Automobile Lower

Metric Results: Public Transport Accessibility Increase

Compared with walking-only accessibility

- +16,239 people** Government offices in Kagoshima
- +13,393 people** Shopping malls in Nagasaki

In Wakayama, accessibility improvements remained extremely limited for several facilities.

These results indicate strong spatial disparities in public transport effectiveness.

CONCLUSION

Main Findings

- Accessibility differed substantially by transportation mode, urban structure, and facility distribution.
- Automobile accessibility remained dominant in all cities, while walking and public transport accessibility were often limited.
- Bicycle accessibility played an important intermediate role by expanding the reach of living areas.

Implications

- Regional Japanese cities cannot simply adopt European-style transit-oriented compact city models.
- Instead, regional cities may require hybrid approaches that improve walkability, strengthen bicycle accessibility, and strategically integrate public transport.
- Automobile-oriented urban development patterns strongly influence accessibility inequality in regional cities.