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The Operation Characteristics of Public Transport and Development Suggestions in Dongguan

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Abstract

Prioritizing public transport is crucial for sustainable urban development on a global scale, yet it faces challenges from emerging mobility services and socio-economic changes following the pandemic. Focusing on Dongguan, this study employs a data-driven approach to analyze bus and rail transit operations using multi-source datasets, including 2021 GPS data, IC card data, rail payment records, and municipal statistics. The analysis reveals systemic deficiencies. Firstly, the modal share is low, at only 4.8%, far below the 50% national target. Secondly, the infrastructure is inadequate. For instance, only 13.7% of bus depots are formal, and the bus ownership is 6.35 units per 10,000 people. Thirdly, the service quality is poor. The average bus speed is 20 km/h, and the punctuality rate is only 60%. Fourthly, the coverage is limited, with 89% accessibility to bus stops within 500 meters. Rail transit remains underdeveloped, with only a single line in operation. It exhibits significant spatial and temporal passenger concentration, with high passenger volumes during peak hours and in certain key areas. The study concludes by proposing evidence-based strategies to: 1) establish a multi-tiered public transport system; 2) enhance multi-modal integration; 3) optimize facilities (including hubs, corridors, and network structure); 4) improve operational service quality; 5) foster transit-oriented spatial development. Near-term implementation priorities identified include rail network expansion, bus network optimization, and critical infrastructure upgrades to facilitate Dongguan's transition towards a greener, more efficient, and sustainable transportation future.

Keywords

Dongguan City, Public Transportation, Operation Characteristics,

Development Suggestions

1. Introduction

Public transport prioritization constitutes a fundamental strategy for urban development globally. Major cities such as Beijing, Shenzhen, and Shanghai have implemented systematic enhancements to their public transport networks, primarily structured around bus and metro systems. However, the advent of new services, such as mobility-on-demand services, has presented challenges to traditional public transportation systems. Compounded by the socioeconomic repercussions of the COVID-19 pandemic, urban public transport systems necessitate immediate restructuring of their developmental frameworks. Leveraging big data on passenger travel patterns and operational data analysis represents a direct and efficacious approach to understanding passenger behaviors and requirements. This analytical method holds significant importance in enhancing the quality of urban public transportation services, alleviating current traffic congestion issues, and ensuring the methodical nature of urban planning.

Dongguan City, a pivotal hub in the Guangdong-Hong Kong-Macao Greater Bay Area, has undergone accelerated urbanization accompanied by sustained population expansion, driving heightened demand for public transport services. However, this growth coincides with a surge in private vehicle ownership, exacerbating urban traffic congestion and undermining public transport operational efficiency and service quality. Notably, the passenger volume of buses and subways in Dongguan peaked at 8.16 billion in 2015 (Shenzhen Urban Transport Planning Center Co., Ltd. & Dongguan Geographic Information and Planning Research Center, 2016), declined to 7.09 billion in 2019 (Dongguan Geographic Information and Planning Research Center, 2019), and further dropped to 5.33 billion in 2022 (Dongguan Geographic Information and Planning Research Center, 2021). Therefore, a systematic analysis of public transport operational dynamics and evidence-based development strategies are imperative to alleviate urban mobility pressures and enhance service standards.

This study aims to conduct a systematic analysis of the operational performance of public transport in Dongguan, including both rail transit and conventional bus systems. The primary objectives are to diagnose existing problems and shortcomings within the system and to formulate targeted recommendations for enhancement. The ultimate objective is to provide a scientific basis for optimizing Dongguan's public transport system, thereby contributing to the development of a greener, more efficient, and sustainable urban transport system.

The remainder of the paper is organized as follows: Section 2 is the data source; Section 3 is the characteristics of bus operation; Section 4 is the characteristics of rail transit operation; Section 5 is the assessment of public transport development; Section 6 is the suggestions for the development of public transportation; and Section 7 summarizes the conclusions.

2. Data Sources

2.1. Bus Operation Data

The bus data primarily derives from the annual bus operation data for 2021 provided by Dongguan public transport enterprises. This dataset includes comprehensive information, including bus routes, stations, vehicles, and passenger flow. To enhance the analysis, Global Positioning System (GPS) data and Integrated Circuit (IC) card data were incorporated, enabling a thorough evaluation of the conventional bus system's operational efficiency, service coverage, and passenger flow patterns.

2.2. Rail Operation Data

The rail operation data primarily consist of the 2021 annual fare transaction records provided by Dongguan Rail Transit Co., Ltd. These datasets encompass multiple payment methods, including contactless smart cards (e.g., Yikatong), single-journey tickets, UnionPay transactions, and QR code payments. The data capture critical operational metrics such as passenger volumes, spatiotemporal ridership patterns, and station transfer characteristics, enabling a comprehensive analysis of the rail transit system's performance.

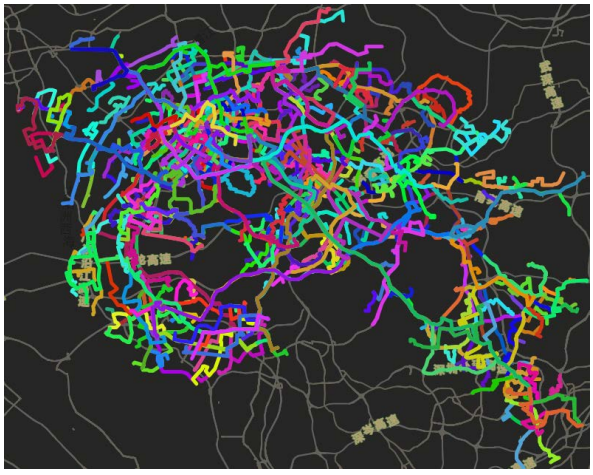
2.3. Supplementary Data

Beyond rail transit and bus data, this research also references statistical data and policy documents released by relevant Dongguan municipal departments (e.g., Dongguan Municipal Bureau of Statistics, Transport Bureau), along with relevant domestic and international research findings and case studies.

3. Bus Operation Characteristics

3.1. Infrastructure Status

3.1.1. Bus Routes and Stops

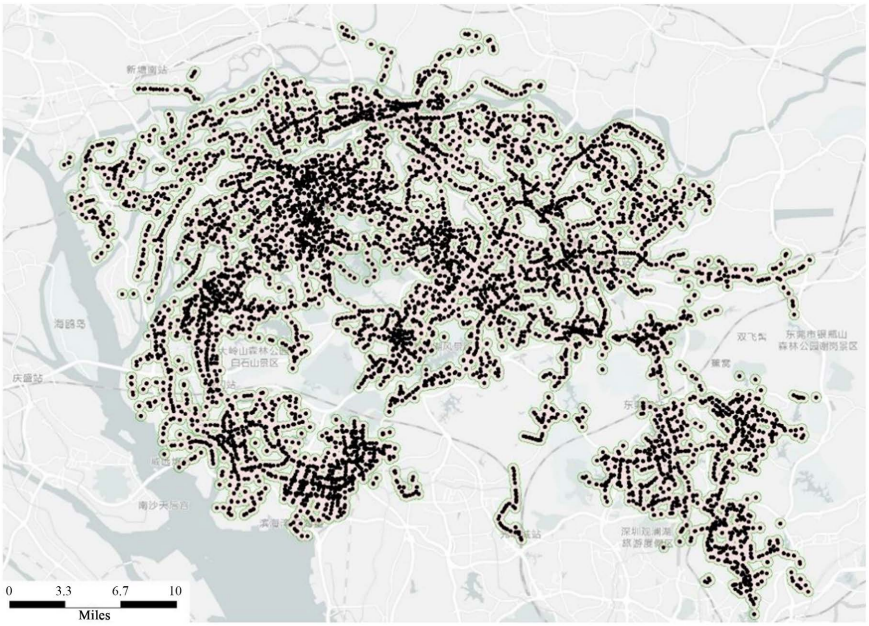


Data source: Dongguan public transport big data analysis platform.

Figure 1. Dongguan public transport network.

By the end of 2021, Dongguan's bus network consisted of 479 fixed routes, demonstrating relative stability in network scale. The system featured a total route length of 9,463 km, with an average route length of 20 km (Dongguan Geographic Information and Planning Research Center, 2021). The bus network's nonlinear coefficient (serves as a key parameter for evaluating the detour degree of transit routes) of 1.85 suggests suboptimal route directness in the network topology (see **Figure 1**).

Dongguan has a total of 9,763 bus stops, categorized into 3,373 official stations, 3,663 simple stations, and 2,727 stations without facilities. In 2021, the 500-meter service coverage ratio reached 89.0% (Dongguan Geographic Information and Planning Research Center, 2021), falling 6 percentage points below the 95% minimum mandated by the Urban Comprehensive Transportation System Planning Standard (GB/T 51328-2018). This statistically significant shortfall reveals substantial accessibility gaps within the urban fabric, particularly in peripheral zones (see **Figure 2**).



Data source: Dongguan public transport big data analysis platform.

Figure 2. Dongguan bus stop 500-meter coverage area.

3.1.2. Bus Depots and Vehicles

Dongguan faces a significant shortage of formal bus depot facilities. Among the city's total of 635 bus depots, only 87 (13.7%) are formal facilities. In terms of bus fleet size, Dongguan operated a fleet of 6,330 buses in 2021 (Dongguan Geographic Information and Planning Research Center, 2021). This translates to a bus ownership ratio (per capita fleet size) of 6.35 standard bus units (SBUs) per 10,000 residents, which falls significantly below the national standard of 12 SBUs per 10,000 residents. These findings highlight substantial deficiencies in both the scale of the bus fleet and the supporting depot infrastructure, indicating significant

room for improvement in overall public transport service capacity.

3.1.3. Bus Lanes

Dongguan's bus lane infrastructure is currently concentrated within the central urban area. The city originally established four bus lanes in this zone, but operational challenges have led to only the Guanchang Road corridor maintaining active enforcement against unauthorized vehicle intrusions. As of 2021, the Phase I implementation of the central urban bus lane network spanned 62.5 kilometers, exclusively configured as curbside lanes. This configuration achieves a 12.8% bus lane coverage rate in the central district, while peripheral areas remain completely devoid of dedicated bus lanes (Dongguan Geographic Information and Planning Research Center, 2021). This spatial disparity fundamentally undermines the system's ability to ensure transit priority across the metropolitan area (see **Figure 3**).

Data source: Dongguan public transport big data analysis platform.

Figure 3. Distribution of bus lanes in the central urban area of Dongguan.

3.2. Bus Passenger Volume Characteristics

3.2.1. Temporal Variation in Passenger Volume

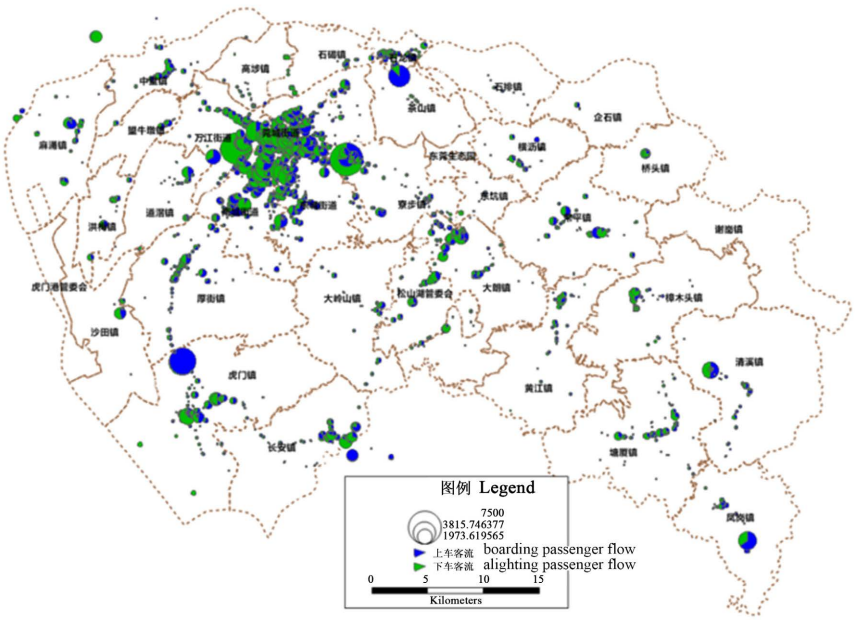
Dongguan's bus passenger volume experienced a persistent decline from 2015 to 2021, reflecting diminishing attractiveness and competitiveness amid growing competition from private vehicles and ride-hailing services. Average daily ridership fell from 1.146 million passenger trips in 2015 to 506,000 in 2021, representing a cumulative decrease of 56% (Dongguan Geographic Information and Planning Research Center, 2021).

Operational data for 2021 revealed an average bus trip distance of 9.22 km. While passengers on direct trips averaged 29 minutes of travel time, those requir-

ing transfers experienced significantly longer journeys, averaging 72 minutes. Peak travel demand was concentrated in distinct periods: the morning peak occurred predominantly between 07:15 and 08:15, and the evening peak between 17:30 and 18:30 (Dongguan Geographic Information and Planning Research Center, 2021).

3.2.2. Spatial Variation in Passenger Volume

Analysis of boarding and alighting volumes reveals distinct spatial patterns. The bus stops recording the highest combined boarding and alighting volumes were Dongguan East Bus Station (4127.2 passenger trips per day), Humen High-Speed Rail Station (2690.5 passenger trips per day), and Dongguan Central Bus Station (3250.67 passenger trips per day), respectively. High-volume stops are predominantly clustered within Guancheng Subdistrict, Wanjiang Subdistrict, Nancheng Subdistrict, and Liaobu Town. The distribution of stop activity demonstrates significant disparity: a substantial majority of stops (7039 stops, 81%) recorded low volumes of fewer than 100 passenger trips per day. Stops handling moderate volumes of 100 - 500 passenger trips per day numbered 1424 (16%), while those with 500 - 1000 trips per day totaled 175 (2%). Only 83 stops (1%) processed high volumes exceeding 1000 passenger trips per day (Dongguan Geographic Information and Planning Research Center, 2021). The spatial distribution of stop-level passenger volumes is illustrated in **Figure 4**.



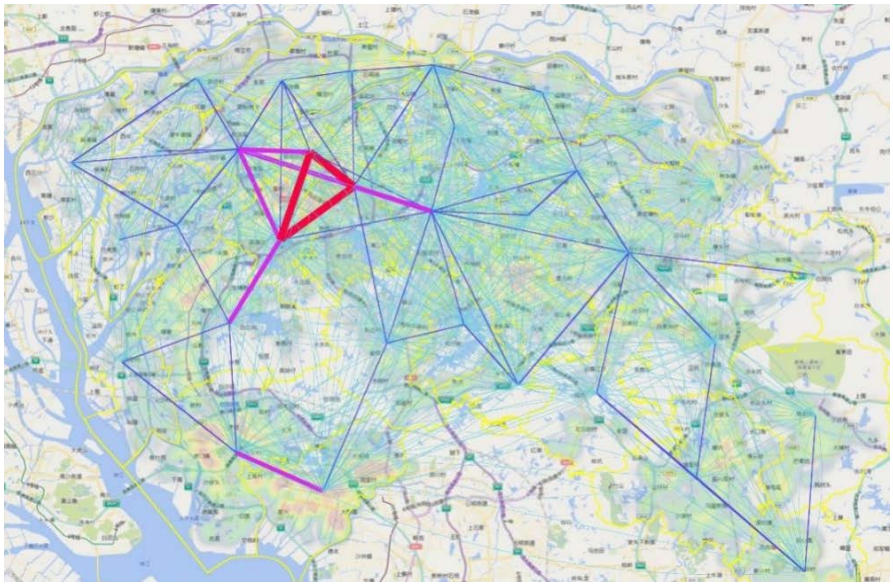
Data source: Dongguan public transport big data analysis platform.

Figure 4. Spatial distribution of bus passenger flow at various stations in Dongguan city.

Dongguan's bus network demonstrates a transfer coefficient of 1.1, with daily transfer volumes of approximately 33,060 passenger-trips, constituting 11% of total ridership. Dongguan East Bus Station registers the peak transfer volume (2003

passenger-trips/day). Transfer activity is primarily concentrated in Guancheng Subdistrict, Wanjiang Subdistrict, and Liaobu Town.

Bus travel in Dongguan is predominantly characterized by intra-town trips, with the highest volumes observed in Chang'an Town (22,100 passenger-trips/day), Dongcheng Subdistrict (2000 passenger-trips/day), and Humen Town (1900 passenger-trips/day). Inter-town travel primarily connects the core urban subdistricts of Dongcheng, Guancheng, and Nancheng. The town connections for public transportation are shown in Figure 5.



Data source: Drawn by the author.

Figure 5. Spatial connection of bus passengers in Dongguan.

3.3. Public Transport Service Evaluation

3.3.1. Operational Speed and Punctuality

Dongguan's bus system operates at comparatively low speeds, with an average velocity of 20 km/h. Certain routes demonstrate significantly lower operational speeds. For instance, parts of the routes that are greatly affected by road congestion and stop configurations have operational speeds 30% - 50% lower than the average. In some extremely congested sections, the speed can even drop below 10 km/h.

Besides, regarding punctuality, the on-time performance rate necessitates significant improvement. Currently, the on-time performance rate of Dongguan's bus system is only 60%, far below the industry average, and it is urgent to raise it to over 85% to meet passenger demands. Irregular headways (the time interval between two consecutive buses arriving at the same stop) and complex road conditions on specific routes contribute to reduced punctuality. Due to poor punctuality, passengers often have to wait at stops for a long time. Especially for office workers and students, this may lead to their being late, affecting work and study efficiency. Meanwhile, the unstable bus operation time also makes it difficult for

passengers to arrange their travel plans reasonably, increasing the uncertainty and psychological pressure of travel, thus adversely impacting passenger travel experience.

3.3.2. Service Quality and Satisfaction

Service quality across Dongguan's bus network is highly inconsistent. Aging vehicles and inadequate facilities on particular routes have resulted in diminished passenger satisfaction. Furthermore, limited service coverage impedes mobility for residents in remote areas. Compounding these issues are inconvenient transfers and lack of real-time information transparency, collectively degrading the overall travel experience.

4. Operational Characteristics of Rail Transit

4.1. Passenger Volume Analysis

Dongguan's rail transit network currently consists of a single operational line: the 37.8 km Line 2, which commenced service in May 2016. Spanning six administrative units (Shilong Town, Chashan Town, Dongcheng Subdistrict, Nancheng Subdistrict, Houjie Town, and Humen Town), the line connects Dongguan Railway Station to Humen Railway Station via 15 stations with 62 access points. Annual ridership exhibited consistent growth post-launch, accumulating a 150% increase from 2016 to 2019. The COVID-19 pandemic, however, triggered a 34.8% year-on-year decline in 2020 (35.06 million trips). Following pandemic containment, ridership rebounded to 40.74 million in 2021, marking a 16.2% year-on-year recovery. Current average weekday ridership reaches 128,000 passenger-trips (Dongguan Comprehensive Transportation Survey Data Analysis Report, 2021). Detailed weekday passenger volume metrics are presented in **Table 1**.

Table 1. Passenger volume indicators of Dongguan metro line 2.

Indicators	Daily Total	AM Peak Hour	PM Peak Hour
Route Length (km)	37.7	37.7	37.7
Passenger Volume (10,000 pax)	12.81	1.55	1.56
Passenger-Kilometers (10,000 pax-km)	170.56	17.12	18.04
Load Intensity (pax/km/10,000)	0.34	0.40	0.40
Max. Unidirectional Section Flow (10,000 pax)	-	0.51	0.42

Passenger trip purposes on Dongguan Rail Transit Line 2 exhibit distinct temporal patterns: Full-day weekday travel is predominantly dominated by combined business and leisure purposes; AM/PM peak hours demonstrate a primary concentration in commuting behavior. The trip purpose distribution for passengers

on Dongguan Metro Line 2 is shown in Table 2.

Table 2. Trip purpose distribution for passengers on Dongguan rail transit line 2.

Time Period	Business (%)	Leisure (%)	Commute (%)	School-Related (%)	Other Purposes (%)
Daily Total	17.6	33.1	35.9	3.9	9.6
AM Peak	8.5	12.4	69.1	2.2	7.8
PM Peak	9.5	25.6	52.8	6.3	5.8

4.2. Spatiotemporal Distribution Patterns of Passenger Volume

4.2.1. Temporal Characteristics

Dongguan's rail transit passenger volume exhibits pronounced bimodal peaking, with the AM peak period (07:00 - 09:00) accounting for 18.8% of the daily volume and the PM peak (17:00 - 19:00) constituting 18.2%. Collectively, the peak periods represent 37% of the total daily volume, confirming distinct temporal concentration. Weekend distributions demonstrate relative uniformity without significant peaking behavior.

4.2.2. Spatial Characteristics

Spatial heterogeneity manifests strongly, with passenger volumes heavily concentrated at stations within central urban areas and key towns. High-demand stations, notably Hongfu Road, Humen Railway Station, and Dongcheng Station, each record daily entry/exit volumes exceeding 15,000 passenger-trips. These hubs exhibit strong attraction characteristics due to proximate commercial districts, transport interchanges, and high-density residential zones. Conversely, peripheral stations register substantially lower utilization, with daily volumes below 1000 passenger-trips. During the morning peak period on Line 2, the mean rail travel distance was 11.1 km (equivalent to 3-4 station intervals), with 80% of trips concentrated within 0 km - 17 km. Correspondingly, the evening peak period demonstrated a mean distance of 11.2 km (3 - 4 station intervals), during which 80% of trips occurred within the 0 km - 20 km range (Dongguan Geographic Information and Planning Research Center, 2021; Liao & Wei, 2014).

4.3. Feeder Mode Characteristics

4.3.1. Feeder-Mode Structure

The feeder modes to Dongguan Rail Transit stations are predominantly walking, cycling, and public transport. According to survey data, the proportions of walking, cycling, and public transport as access modes are 22.9%, 21.6%, and 27.1%, respectively. For station access (arrival), walking accounted for 42%, cycling for 16%, and bus for 15%. Regarding station egress (departure), walking constituted 61%, cycling 11%, and bus 12% (Dongguan Geographic Information and Planning Research Center, 2021).

4.3.2. Access Time and Distance Characteristics

Dongguan rail transit stations exhibit an average access time of 13 minutes, with 41% of passengers reporting access durations between 10 and 15 minutes. Regarding access distance, 50% of passengers travel within 0.6 km of stations, while 95% complete access trips within 2.5 km, indicating a predominant preference for short-distance access modes. Station-specific access times are detailed in Table 3.

Table 3. Access time by mode for Dongguan rail transit line 2 stations.

Station	Motorized Access	Non-motorized Access	Average Access Time
Dongguan Railway	13	13	13
Chashan Station	15	11	14
Liuhua Park	11	9	10
Xiaqiao	11	9	10
Tianbao	11	9	10
Dongcheng	17	9	12
Qifeng Park	16	12	14
Hongfu Road	19	11	13
Xiping	12	11	11
Hadi	9	9	9
Chenwu	11	12	12
Liaoxia	12	9	10
Shanmei	13	9	10
Convention Center	10	6	8
Humen Railway	21	8	19
Weighted Average	15	10	12

5. Public Transport Development Assessment

5.1. Public Transport Mode Share

The modal share of public transport in Dongguan is relatively low, making it difficult to meet the city's transportation development needs. According to data analysis, Dongguan's public transport modal share was only 4.8% in 2021, far below the national requirement of at least 50% (China's "Public Transport Metropolis" Assessment Requirements) for the modal share of motorized trips via public transport in megacities and large cities. Meanwhile, the modal share of private cars increased from 26.3% in 2016 to 35.8%. This indicates that public transport in Dongguan is becoming increasingly marginalized within the city's overall transportation system, with the travel structure continuing to shift towards private transportation.

5.2. Public Transport Service Quality

The quality of public transport services in Dongguan is uneven and fails to meet

the diverse needs of passengers. On certain routes, outdated vehicles and rudimentary facilities contribute to low passenger satisfaction. Additionally, the limited coverage of bus services creates inconvenience for residents in remote areas. Problems such as inconvenient transfers and a lack of transparent information further compromise the passenger experience. For rail transit, while operational punctuality is high, capacity utilization efficiency requires improvement and passenger flow intensity remains low.

5.3. Public Transport Infrastructure Provision

Dongguan's public transport infrastructure supply level is inadequate to support its development needs. Regarding bus depots and stations, the number of formal facilities is insufficient, accounting for only 13.7%. In terms of bus fleet size, the number of buses per 10,000 residents falls below national standards. For rail transit, although one line is operational, the network scale remains underdeveloped, with limited coverage. Furthermore, infrastructure elements such as bus stops and routes exhibit deficiencies (Dongguan Geographic Information and Planning Research Center, 2021).

5.4. Public Transport Policy Orientation

Dongguan lacks a clear, systematic, and forward-looking policy framework for public transport development. The principle of prioritizing public transport over private vehicles has yet to be solidified and implemented, as the foundational concept of "transit-first" development remains unestablished. Concurrently, the absence of systematic "push-pull" regulatory policies, combining transit prioritization with travel demand management, has resulted in insufficient momentum and support for public transport advancement.

6. Suggestions for Public Transport Development

6.1. Establishing a Multi-Tiered Public Transportation System

Based on the spatial structure layout of Dongguan, the transformation and upgrading of industries, the enhancement of residents' quality of life, the diversification of travel demands, and the application of transit-oriented development principles, higher requirements have been placed on the network layout, capacity allocation, and hub system planning of the entire public transportation system. To achieve the development goals of establishing a "Transit Metropolis" and prioritizing public transport, it is essential to delineate the respective functions of different transportation modes within various urban areas. This will facilitate the construction of an integrated multimodal public transportation system characterized by "1-kilometer walking accessibility, 3-kilometer cycling coverage, 5-kilometer bus service, and rail transit for journeys exceeding 5 kilometers".

The rail transit system serves as the primary backbone network, responsible for medium- to long-distance trips within or between urban clusters. It primarily facilitates high- and medium-capacity rapid transit connections within Dongguan's

central urban area, between urban clusters, and along major development corridors, constituting the backbone of the city's public transportation framework. This system comprises intercity rail, urban rail, and innovative medium-capacity transit modes.

The conventional bus system functions as the core network, primarily providing services along corridors with lower travel demand while offering feeder connections to rail transit. Its composition includes bus rapid transit lines, high-frequency trunk bus lines, and branch bus routes (incorporating micro-buses). The auxiliary transit system operates as a complementary network, delivering supplementary public transportation services. Customized buses cater to premium commuting and business travel needs; taxis (including ride-hailing services) address personalized, door-to-door mobility requirements, whereas bicycles primarily serve short-distance travel while providing last-mile connections for low- and medium-capacity transit systems.

6.2. Integrating Multi-Modal Bus Public Transport

Through the restructuring of network layout and the reorganization of functions, this program organically integrates high/medium-capacity rail transit with low-capacity transportation modes, motorized and non-motorized transportation, as well as intra-and extra-central urban public transport systems. It promotes the integration of four types of networks, namely high/medium-capacity rail transit networks, conventional bus networks, and slow-traffic networks, thereby establishing a unified public transport system that encompasses the entire travel chain and provides seamless multi-modal services.

In the near term, the priorities are centered on transforming public travel behavior from "route-dependent trips" to "network-based trips". This involves the following aspects: constructing a streamlined conventional bus network based on a trunk-feeder framework; developing high-frequency trunk corridors with operational characteristics similar to those of rail transit; and consolidating redundant parallel routes along major corridors to improve operational efficiency and service effectiveness. In the medium-to-long term, the strategies, which are in line with the deployment of high/medium-capacity rail transit, will give priority to the following: optimizing bus networks that overlap with rail corridors; and forging a multi-layered integrated transit network centered on seamless interchange connectivity with rail systems.

6.3. Establishing a Coordinated Facility Optimization Framework: Hub Terminals (Nodes) + Corridor Right-of-Way (Arterials) + High-Density Road Networks (Areal Systems)

6.3.1. Node-Level Optimization: Hierarchical Terminal System

A strategically deployed network of multimodal transit hubs shall be established to facilitate public transport network restructuring and seamless intermodal integration. Functioning as critical traffic flow aggregators and distributors, these hubs serve three fundamental roles: 1) as topological anchors for the entire public

transport network; 2) as operational nuclei that optimize system scale and efficiency through integrated scheduling; 3) as distribution control points that rationalize passenger flows and maximize transit operational efficacy.

6.3.2. Arterial-Level Optimization: Equitable Right-of-Way Allocation

Implementing a human-centered street space hierarchy prioritizing Pedestrians & gt; Cyclists & gt; Transit Users & gt; Private Vehicle Occupants. This paradigm shift will systematically institutionalize: Continuous pedestrian priority networks; Protected cycling corridors; Exclusive bus transitways; collectively reconfiguring urban mobility infrastructure toward sustainable transportation equity.

6.3.3. Areal-Level Optimization: High-Density Grid Network

Adopting the internationally recognized "fine-grained grid" urban design principle, the strategy entails: constructing a functionally stratified road hierarchy integrating expressways, primary/secondary arterials, and capillary access roads; eliminating discontinuous street segments to enhance network permeability and connectivity; capitalizing on infrastructure modernization to specifically elevate nonmotorized transport (NMT) and mass transit service quality.

6.4. Public Transport Service Enhancement Strategy: Holistic Optimization of Operational Services

This initiative reconstructs bus networks through high-quality, high-performance service delivery, employing a consumer behavioral analytics framework to optimize finite transit resources. The strategy establishes a rail-emulating service network characterized by an "easy to recognize and remember network" as well as "High-frequency operations".

Based on the demand system for public transport development reconstructed around high-quality and high-performance services and leveraging comprehensive foundational data and information, a precise and high-efficiency public transport supply system should be established. First, enhancing network development. In areas devoid of bus services, efforts will focus on increasing network density and coverage. The hierarchical structure of bus routes will be systematically organized to establish a tiered service framework. Corresponding service quality indicator systems will be formulated according to route functions and demand characteristics to guide operational practices. The layout and facility development of bus stops will be optimized to expand stop coverage, reduce residents' first- and last-mile travel time, and improve waiting environments at stations. Second, strengthening operational management. Adopting a passenger-centric approach, operational scheduling plans will be refined to prioritize travel demand. Flexible operational strategies will be employed to enhance service adaptability and competitiveness, encompassing intelligent information systems, humanized vehicle scheduling, comfortable in-vehicle environments, and reliable, punctual timetables.

6.5. Developing Urban Spatial Structures Conducive to Public Transport Development

At the macro level, urban expansion and development should be guided by the public transport skeletal framework. Public transport corridors should be delineated based on Dongguan's urban morphology, land-use patterns, and spatial distribution of travel demand. Medium-to-high-capacity public transport modes will be deployed along these corridors. By integrating transport corridors with hubs, a robust public transport framework will be established, substantially enhancing systemic capacity. Public service facilities, residential, commercial, and office functions will be progressively concentrated along these corridors. This spatial strategy will channel travel demand toward corridor-adjacent areas, forming a linear urban development belt characterized by bead-like spatial organization anchored to the public transport backbone.

At the meso level, public transport-oriented communities will be developed around transit nodes. High-intensity mixed land uses will be implemented in station-vicinity areas, concentrating the highest travel volumes within immediate walking catchments. This approach minimizes the cumulative access distance for passengers. Concurrently, comprehensive and three-dimensional development of public transport facility sites will be promoted, supported by stringent mandatory provisions for integrated transit facilities in major building developments.

6.6. Near-Term Implementation Measures

6.6.1. Expansion of Rail Transit Network Scale

Dongguan is recommended to intensify rail transit infrastructure development to expand network coverage. Accelerated advancement of Phase I projects for Urban Rail Lines 1 and 3, along with Phase III of Line 2, will establish the skeleton framework of express urban rail corridors. This will form an efficient metropolitan rail transit network while promoting intercity rail integration with Guangzhou, Shenzhen, and adjacent cities to enhance regional transportation cohesion.

6.6.2. Enhancement of Rail Operational Efficiency

Rail transit authorities should strengthen operational management through optimized train diagrams, improved punctuality rates, and reduced headways. These measures will elevate service quality and system attractiveness. Concurrently, multi-modal integration between rail stations and surrounding areas should be enhanced to increase transfer convenience.

6.6.3. Optimization of Bus Network Configuration

Public transport departments should restructure conventional bus routes according to passenger flow patterns and travel characteristics. Route coverage and operational efficiency should be improved through strategic additions, adjustments, and consolidations, with priority given to central urban districts and major townships to accommodate diverse mobility demands.

6.6.4. Service Quality Enhancement

Implementation of fleet renewal and maintenance programs is recommended. Deployment of new energy buses and the retirement of aging vehicles will improve passenger comfort and safety. Complementary improvements include upgraded stop facilities and real-time passenger information systems that will enhance travel convenience.

6.6.5. Strengthening Public Transport Infrastructure Development

It is recommended that Dongguan Municipality enhance the development of public transportation depots and elevate their supply capacity. By implementing new construction, renovation, and expansion initiatives, the municipality should increase the number of depots while optimizing their facilities. Priority should be given to depot construction in central urban districts and key towns/subdistricts to fulfill functional requirements for vehicle parking, charging infrastructure deployment, and routine maintenance.

Dongguan's public transportation authorities are advised to reinforce the development and administration of transit stops through comprehensive facility enhancement. This includes expanding stop coverage, rationalizing spatial distribution, and upgrading passenger information systems to improve service accessibility and convenience. Concurrently, seamless multi-modal integration with rail transit nodes should be prioritized to enhance interchange efficiency for commuters.

7. Conclusion

Through an in-depth analysis of the operational characteristics of public transport in Dongguan, this study has revealed the prevailing issues and deficiencies in key areas, including passenger volume, operational efficiency, and service coverage. Based on the evaluation results of public transport development, targeted recommendations have been proposed, including intensifying the construction of rail transit, optimizing the layout of conventional bus networks, enhancing the development of public transport infrastructure, implementing public transport priority policies, and promoting the intelligent development of public transport. These recommendations are of great significance for improving the service level of public transport in Dongguan, alleviating urban traffic congestion, and advancing urban transportation toward a green, efficient, and sustainable direction. With the continuous economic growth and accelerated urbanization in Dongguan, public transport will face more opportunities and challenges. Therefore, it is essential to remain attentive to the dynamics of public transport development, timely adjust and optimize development strategies to adapt to the new demands of urban growth.

However, this study has certain limitations. The 2021 data may reflect unique pandemic-related travel patterns, and the analysis does not cover informal transport modes. Therefore, further research should be conducted based on the continuous collection of relevant data.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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