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A Review of the Adaptability of Transit-Oriented Development in Mountainous Coastal Cities: A Case Study of Dalian

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Abstract

To clarify the constraints imposed by terrain, land, and coastal conditions on the implementation of transit-oriented development (TOD) and the progress of related research, this study takes Dalian as the context and systematically reviews the literature on the adaptability of development around rail transit stations in mountainous coastal cities. First, it summarizes the main adaptation problems from three aspects: walking on slopes and station access, construction land constraints and regeneration of existing urban areas, and coastal public space and equity of use. It shows that straight-line radius, network distance, and actual walking time are not equivalent representations of a station service area, and that slope, elevation difference, and the microscale built environment jointly determine walking cost. Second, it reviews four types of research on response paths: multilevel walking systems and service areas at mountain stations, station types and multimodal access, walking and landscape in coastal station areas, and rail transit-led regeneration of existing urban areas and its social impacts. It compares the different evidentiary contributions of behavioral models, accessibility evaluation, and design research, and examines the conditions under which experience can be applied by considering domestic and international cases in Chongqing, Qingdao, Hong Kong, Thailand, and Gulf cities. Finally, it proposes dimensions for cross-city comparison and planning implications for Dalian. The results show that actual walking time should be central to the evaluation of stations on slopes, with attention to the microscale built environment and vertical connections; stations in existing built-up areas are suited to small-scale, incremental regeneration; coastal stations need to balance transport distribution and the use of public space; and the main value of international experience lies in mechanism design rather than direct replication of a model. Future research should supplement data on slopes, routes, access connections, and land use at typical stations in Dalian, and test the explanatory power of commonly used station-area indicators under compound terrain conditions.

Keywords

transit-oriented development, mountainous cities, rail transit stations, walking accessibility, regeneration of existing urban areas, coastal public space

1. Introduction

In Dalian, undulating mountainous terrain, built-up urban areas, and coastal space jointly affect development around rail transit stations. A station may appear close to a residential area, workplace, or public

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activity place on a map, but the actual walk is often affected by slope, elevation difference, and road detours. Development in coastal station areas must also properly coordinate shoreline access, viewing corridors, and land use. As rail transit construction and urban regeneration continue, organizing transfer connections, arranging functions, and improving public space in accordance with these conditions has become an issue with clear significance for planning practice.

Transit-oriented development (TOD) emphasizes transport connections, walkability, functional diversity, and coordinated land use around stations. In areas with relatively flat terrain and relatively complete development space, walking distance and development intensity can be used as important planning bases. In mountainous coastal cities, however, these two indicators must also be understood in relation to the routes that people actually walk, the land that remains available for development, and coastal public space. In this study, "TOD adaptability" refers to the degree to which the transport and spatial organization principles of TOD coordinate with the terrain, land, landscape, and population needs of a particular city. Discussing adaptability helps distinguish which general practices can be retained and which must be adjusted flexibly to local conditions.

Existing studies have separately examined multilevel walking at mountain stations, access to rail transit, the walking environment in coastal station areas, and regeneration of old urban areas driven by rail transit, but their subjects, scopes, and evaluation methods are inconsistent. With Dalian as the main case, this study first summarizes the adaptation problems faced by TOD in mountainous coastal cities, then organizes related research by problem type and compares domestic and international experience, including cases in Qingdao and Thailand. It finally analyzes the conditions and boundaries for transferring this experience and identifies directions that subsequent research should verify.

2. Main Adaptation Issues for TOD in Mountainous Coastal Cities

2.1 Walking on Slopes and Station Access

A station service area is usually measured by its walking access range. Ning Zhang et al. [1] define it as the distance within which travelers can walk directly to a station without transferring, and note the empirical value commonly used in Chinese practice: "a 15-min walk at 4 km/h, a circle with a 1 km radius, and a reduced range of 600-800 m (usually 700 m)." This approach, however, treats distance as a planar quantity independent of the route. Mengdong Li [2] measured a reasonable 10-min walking distance of 750 m and noted that this distance forms a circular range on accessible flat ground, but contracts into a square rotated by 45° in a grid road network. The conventional "500 m radius circle" differs greatly from the actual service area. A station service area is essentially the superposition of multiple single-origin walking catchments, which extend with entrances and change with surrounding facilities. Ning Zhang et al. [1] further provide road-network conversion coefficients of 0.798 for a grid and 0.864 for a grid with diagonal passages, together with a slope correction coefficient of 0.95. Straight-line radius, network distance, and actual walking time are therefore not equivalent representations of a service area. Actual walking time integrates the effects of speed, slope, and facility-related delay.

Accordingly, walking cost in mountainous terrain cannot be characterized by distance alone. The north-south elevation difference around Tongyuanju Station in Chongqing is nearly 100 m, and the station is connected to the residential area to the south only by a mountain-city footpath. Within the 0-500 m range, the detour factor reaches 1.54; north-south connections are weak, and passenger flow is low [3]. Although multilevel pedestrian systems, including walkways, escalators, and vertical elevators, can compensate for elevation differences and detours, poorly designed paths, nodes, and vertical circulation can themselves become new obstacles [4]. Problems in Dalian's hillside residential areas, such as overly steep steps, discontinuous accessible facilities, and poor connections between walking routes and bus stops, provide supporting evidence [5].

The quality of access outside a station also depends on bus-stop placement, station entrances and exits, and street-crossing conditions. At 113 rail transit stations in Chongqing, the average transfer distance is 290 m and the average walking time is 3.6 min. Nine stations have no bus stop within 500 m. Separated transfers predominate, and excessive transfer distance is an important reason for low transfer volumes [6]. At Tongyuanju Station, the elevation difference between the station and the bus stop to the south is nearly 70 m,

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making access less efficient than travel by car [3]. In walking-environment research, shelter facilities, public security, and traffic safety have large effects on satisfaction, whereas the path convenience coefficient is small [7]. An empirical study of 15 metro stations in Delhi similarly shows that microscale built-environment factors play a decisive role in satisfaction with walking access, with effects stronger than those of meso- and macroscale layouts [8]. This finding indicates that smooth access depends more on details such as street-crossing safety and protection from wind and rain. Design should coordinate multiple modes; after coordinated optimization, residents' commuting time can be shortened by 12%, with a clear improvement in satisfaction [9].

The costs of transfers within stations and access outside stations have different components. Transfers within stations are affected mainly by transfer walking, waiting time, and the number of transfers. Compared with in-vehicle travel time, the transfer penalty has a greater effect on route choice [10]. Access outside stations is affected by the road network, terrain, and facility layout. Access distance, cost, duration, and station type all significantly affect mode choice. Travelers at peripheral stations rely more on motorized access, whereas those at mixed-use stations are more inclined to use bicycles and buses [11].

Trip purpose also affects route choice. Necessary walking trips, such as grocery shopping and escorting others, are sensitive to slope and distance and tend to favor convenient connections. Recreational walking instead tends to involve active selection of longer and more winding routes [5]. An adaptability evaluation of residential stations in Wuhan shows that path efficiency and transfer convenience account for more than half of the key indicators and are necessary conditions supporting rail transit use [12]. A study of 246 stations in Seoul clusters them into four TOD types according to walking accessibility and finds systematic differences in the walking environment and travel behavior [13].

Overall, accessibility at stations on slopes cannot be judged only by planar coverage. Evaluation should focus on actual walking time and jointly consider vertical facilities, transfer arrangements, and trip purposes. It should also distinguish natural constraints, such as terrain and elevation difference, from improvable elements, such as bus-stop placement, station entrances and exits, and street-crossing facilities. This distinction provides the basis for the comparative research discussed below.

2.2 Construction Land Constraints and Regeneration of Existing Urban Areas

Old urban areas have small spatial scales, high building density, and inadequate supporting services, while inefficiently used land is fragmented and dispersed. These conditions differ greatly from the contiguous land supply of the incremental development period. Shaofeng Guo et al. [14] note that TOD has mainly followed a single incremental development approach, and that blindly introducing large-scale, high-intensity development into existing urban areas is difficult to implement and can increase traffic pressure in old districts. Practice in Nanjing also shows that comprehensive TOD development along rail transit lines commonly faces a lack of detailed implementation rules, delayed land acquisition and reserve, insufficient planning coordination, limited financing methods, and mismatched construction and development sequences. Delayed land acquisition and land banking also cause losses in land-value gains [15].

Research is therefore shifting from incremental development toward regeneration of existing urban areas. Shaofeng Guo et al. [14] propose transit-oriented regeneration (TOR), arguing that regeneration thinking should shift from incremental development to systematic regeneration of existing urban areas. The focus should be on comprehensive benefits rather than land appreciation, and the development method should shift from phased development to long-term dynamic negotiation. Zhihuan Xu and Hui Ge [16] divide urban regeneration into three modes: large-scale demolition and reconstruction, renovation and improvement, and value exploration. They emphasize that "acupuncture-style" micro-regeneration is appropriate in an era of urban development centered on existing areas, with attention to the exploration and use of historical context and distinctive value. Practice in Ningbo shows that development above depots, interconnection of underground space, and reuse of demolished plots each have applicable conditions. Development above depots is suitable for station and depot areas with relatively complete land parcels and clear ownership; underground-space development depends on areas with dense stations and mature commercial districts; and reuse of demolished plots requires a balance between land acquisition costs and residents' acceptance.

Development intensity should also vary with station type; high-intensity development should not be treated as a common objective for all stations. Haiwei Chen et al. [15] recommend differentiated guidance at the city,

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corridor, and station levels, with guidelines formulated according to station function and classification. This recommendation supports the preceding conclusion that access modes should be adjusted by station type. Stations face different land conditions and development objectives, and their suitable regeneration paths should therefore also differ.

In summary, the core adaptation issue for stations in existing built-up areas is the tension between development intensity and land integration. An incremental path is suitable for stations with relatively complete land parcels, whereas regeneration of existing urban areas places greater emphasis on gradual improvement, provision of public services, and phased implementation. Before determining whether a path is applicable, the land area, ownership status, and functional positioning of the station must be clarified.

2.3 Coastal Public Space, Landscape, and Equity of Use

Coastal station areas must serve both transport distribution and public life, so their pedestrian systems are more complex than those of ordinary stations. Research on Qingdao shows that the overlap of rail transit and high-quality coastal space creates highly complex pedestrian systems within the influence areas of coastal stations, and that the needs of different groups impose higher requirements on pedestrian space [17, 18]. Most cities, however, still plan around motor vehicles. The result is fragmented pedestrian space, reduced accessibility, safety risks, and insufficient comfort [17].

The continuity of walking from a station to the coast and convenient access to public space are key evaluation concerns. Ying Xue [18] develops a pedestrian-friendliness evaluation system from the two dimensions of the physical environment and pedestrian perception. It covers seven categories: land use, the pedestrian network, coastal-space elements, spatial safety, environmental comfort, street convenience, and coastal attractiveness. The study proposes strategies such as improving coastal footpaths, strengthening station-coast connections, and creating visual corridors. Kailong Li [17] likewise identifies continuity and accessibility as prominent problems and attributes them to insufficient coordination and integrated design between rail transit and coastal space, as well as inadequate attention to human needs. The “station-coast” connection therefore depends on both the physical connection of the pedestrian network and the organization of visual corridors and nodes.

Trade-offs often arise between transport efficiency and the openness of public space. Motor-vehicle-oriented transport organization directly conflicts with pedestrian needs. If landscape presentation serves only sightseeing and tourism, it may also displace the everyday space of existing residents [17, 18]. Kailong Li [17] advocates integrating rail transit planning with coastal-zone planning so that stations and coastal areas can support each other. Ying Xue [18] emphasizes integrated “coast-station-city” development and interaction between stations and the coast. These approaches attempt to balance transport functions and coastal public life, but they must be examined in relation to station functions and shoreline conditions. No single approach should be assumed to be universally effective.

Equity of use must also be included in the discussion. A study in Xiamen shows that mean employment accessibility within metro-influenced areas increased by 36.6% compared with areas outside the influence of the metro. When the analysis area was expanded, however, the population-weighted standard deviation of the accessibility distribution increased by 8.4%, the quadrant with low housing prices and low employment accessibility expanded, and low-income groups faced residential segregation and employment difficulties. Housing-price increases associated with TOD may also intensify gentrification [19]. For older adults, slopes and steps reduce the area they can use, while discontinuous accessible facilities directly weaken access to public space [5].

In summary, the adaptation problems of coastal station areas mainly arise among transport distribution, landscape presentation, and the use of public space. Walking continuity and visual corridors indicate whether a “station-coast” connection can be established. Trade-offs between transport and public space must be examined through specific cases, and the distribution of accessibility benefits among groups determines whether development is equitable. All three aspects should be considered when evaluating coastal stations in Dalian.

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3. Related Cases and Research Response Paths

3.1 Multilevel Walking and Service Areas at Mountain Stations

Defining station areas in mountainous cities requires terrain correction. Jizhen Li et al. [20] note that drawing a radius around a station produces coverage that differs greatly from the actual service area. They therefore define the evaluation area as the range that can actually be reached within a 15-min walk from the station. Their empirical study of 216 stations in central Chongqing also shows that design factors, including the number and layout of entrances and exits, directly affect connections between stations and urban functions [20]. Tongyuanju Station provides a similar example. The elevation difference in the station area approaches 100 m, and the southern neighborhood is connected only by a mountain-city footpath. The area that appears accessible within a planar radius has very low actual passenger flow [3]. International research similarly uses road-network buffers and spatial statistics to define station areas. An empirical study in Pathum Thani, Thailand, uses 500, 1000, and 2000 m road-network buffers as TOD measurement units and applies hot-spot analysis and bivariate spatial autocorrelation to test the relationship between accessibility and land-use activities. Activity density is higher in areas close to the transport system, but the effect occurs mainly at central-area stations. Activity intensity and diversity within TOD areas at peripheral stations are distinctly lower [21].

Multilevel pedestrian systems are the main means of compensating for elevation differences and restoring pedestrian connections. Chongyu Wang [4] summarizes six design elements of multilevel pedestrian systems connected to stations: paths, nodes, vertical circulation, interfaces with surrounding buildings, spatial edges, and wayfinding systems. The study also argues that walkways, escalators, and vertical elevators can reduce detours and compensate for elevation differences, but that these facilities can create new walking costs. Large hubs provide higher-intensity examples. Shapingba Station and Shibuya Station both use an “urban core + urban corridor” model to address elevation differences. Shapingba Station is excavated approximately 47 m underground and has an 8-level three-dimensional transfer system, while Shibuya Station uses multiple urban cores and aerial walkways to create a multilevel pedestrian network [22]. This complex spatial organization is constrained by hub level and multiple development entities and cannot be directly applied to ordinary community stations. Multilevel design at ordinary stations should focus on entrances and exits, street-crossing facilities, and short-distance vertical connections.

Overall, service areas at mountain stations should be defined by actual walking time rather than planar radius, and multilevel pedestrian design should be graded by station level. Hubs can rely on multilevel integration, whereas community stations should emphasize continuous and accessible vertical connections.

3.2 Station Types and Multimodal Access

Methodologically, the access problems discussed above can be divided into three approaches: behavioral modeling, accessibility evaluation, and design research. Most studies use only one of these approaches, and the scope of their conclusions is constrained by the data and setting. Behavioral models describe mode choice, but their parameters vary with station environments and populations and are difficult to apply directly to another station. Accessibility evaluation defines station-area ranges, but its conclusions vary with the indicator algorithm and spatial scope. Design research focuses mainly on facilities and satisfaction, with evidence from field surveys and design trials [1, 2, 6, 7, 9-13]. The three approaches provide evidence of different reliability. Any one approach used alone has difficulty revealing the full scope of access problems under mountainous conditions.

The two-stage evaluation by Shixiong Jiang [23] is a relatively complete attempt at integration. It uses the cumulative-opportunity method to calculate station accessibility and a gravity model to calculate network accessibility. It also finds that a “bike-sharing-metro” mode can clearly improve accessibility at peripheral stations, providing a replicable framework for evaluating access outside stations. This result indicates that placing mode choice, range definition, and facility evaluation within the same framework provides a more complete account of access problems than relying on a single indicator.

Overall, improving access organization requires methods to be matched with settings. Peripheral stations need stronger bus service provision; residential stations should first ensure walking continuity and accessible connections; and mixed-use stations should integrate multiple modes. Method selection should also be adjusted

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according to station function and data conditions, rather than drawing conclusions from only one model or one indicator.

3.3 Walking and Landscape in Coastal Station Areas

Research on coastal station areas mainly uses two complementary methods: indicator-based evaluation and spatial survey. Ying Xue [18] develops a pedestrian-friendliness evaluation system from the physical environment and pedestrian perception and compares stations through scoring. Kailong Li [17] uses the Public Space and Public Life (PSPL) survey method to identify the causes of pedestrian-system problems in terms of the four aspects of continuity, safety, accessibility, and comfort. The first approach answers how coastal stations should be ranked, whereas the second identifies where problems occur. Used together, the two methods support both cross-station comparison and causal analysis, and the evaluation system and field survey can verify each other.

Improvement strategies generally focus on "station-coast" connections. They include improving coastal footpaths, strengthening connections between stations and the coast, creating visual corridors, and organizing spatial levels between stations and the coast [17, 18]. Further recommendations include structural integration of rail transit and coastal space, integrated design of pedestrian systems, and human-centered environmental design. Before Qingdao's experience is applied in Dalian, however, differences in elevation, the existing built environment, and station function must be tested. The two cities have similar coastal conditions and related problem types, but this similarity does not ensure that the design strategies will be directly effective. The overlap of slope and existing-area conditions may also alter the organization of the pedestrian network.

In summary, research on coastal station areas provides a complete set of tools from evaluation to strategy, but its conclusions were derived under specific coastal conditions. Their use in Dalian requires terrain and constraints in existing built-up areas to be included in the test.

3.4 Rail Transit-Led Regeneration of Existing Urban Areas and Social Impacts

Research on regeneration of existing urban areas focuses on implementation mechanisms. Shaofeng Guo et al. [14] propose a shift from TOD to TOR, moving the focus from land appreciation to comprehensive benefits and the development method from phased development to long-term dynamic negotiation. Using Ningbo as an example, Zhihuan Xu and Hui Ge [16] summarize paths including station-city integration, interconnection of underground space, and reuse of demolished plots. Haiwei Chen et al. [15] note that difficulties such as delayed land acquisition and reserve and mismatched construction timing directly weaken regeneration outcomes. These studies share the conclusion that development intensity, integration of land ownership, and phased implementation must be coordinated; otherwise, planning concepts are difficult to implement.

Hong Kong's "Rail + Property" model provides a reference for coordinating stations and cities. MTR Corporation and developers cooperate and obtain returns through profit sharing and other methods, linking network planning, land development, and property operation [24, 25]. R. Cervero and J. Murakami [24] further find that pedestrian-friendly design and station-city connections are associated with higher ridership and residential prices. This finding indicates that reserving interfaces in advance and ensuring pedestrian connectivity are key to transport benefits. C. Y. Huang and S. Mehndiratta [26], however, warn that conflicts may arise between development returns and the interests of surrounding residents; land appreciation created by rail transit does not automatically become a benefit for residents. Hong Kong's land system, land prices, and the role of the rail company also cannot be directly applied in Dalian. The relevant lesson is the mechanism for coordinated planning and phased implementation, rather than the profit model for property development.

Comparative research on Gulf cities further shows that the spatial form of TOD should be adjusted according to environmental constraints. The King Abdullah Financial District (KAFD) in Riyadh is a newly developed urban area with relatively strong integrated planning and multimodal connections, but its walking environment is constrained by an extremely arid climate, and active travel such as walking and cycling is limited. West Bay in Doha is a regeneration area. Because of earlier car-oriented planning, its public space is fragmented and its overall TOD integration is weak, but regeneration remains possible through infill development and tactical urbanism [27]. Comparing regeneration and new development shows that the two

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face different constraints. Regeneration of Dalian's coastal stations should be assessed under its climate and terrain conditions to determine whether specific paths are feasible.

Research on social impacts further distinguishes uncertainty in benefit distribution. The systematic review by T. Y. Wan et al. [28] on the equity effects of the built environment in TOD station areas shows that transport improvements may be accompanied by gentrification, housing-price increases, and residential pressure on low-income groups. Ridership growth cannot be directly equated with improved social equity. Research in Xiamen also shows that mean employment accessibility in metro-influenced areas increased by 36.6%, while spatial inequality intensified and areas with both low housing prices and low employment accessibility expanded [19]. Improved accessibility is supported by research evidence, whereas gentrification and residential segregation remain mainly potential risks that must be tested in relation to local housing and employment policies.

The adaptability of regeneration in existing urban areas therefore depends mainly on implementation mechanisms. Evaluation should consider not only land revenue and housing prices, but also public transport use, commuting burden, and the accessibility of disadvantaged groups. The part of Hong Kong's experience worth drawing on is the mechanism for coordinating transport, land, and operations. Its application in Dalian must still reflect local land ownership and market conditions.

4. Boundaries of Applicability and Research Prospects

4.1 Dimensions for Cross-City Comparison

Cross-city comparison should proceed in the sequence of problem type, case conditions, research method, main findings, and boundaries of applicability. In terms of problem type, research in Chongqing focuses on multilevel walking and service areas under terrain-related elevation differences [20, 22]; research in Qingdao focuses on walking continuity and public-space organization in coastal station areas [17, 18]; research in Ningbo, Nanjing, and other cities focuses on regeneration paths for existing urban areas [15, 16]; and Hong Kong's experience focuses on mechanisms for coordinating rail transit, land use, and property development [24, 25]. In terms of case conditions, substantial differences exist in station level, surrounding land use, land ownership, climate and environmental constraints, and governance systems. Multilevel hub-integration experience applies to large hubs rather than ordinary stations [22]; coastal walking experience presupposes similar shoreline conditions [17, 18]; and the cases in Thailand and Gulf cities show that the same TOD indicators do not have equal explanatory power under different climatic and terrain conditions [21, 27]. Conclusions are meaningful for comparison only when the problem types and case conditions are similar.

In terms of research method, behavioral models describe mode choice, but their parameters change with station environments and populations and are difficult to transfer across stations [1, 10, 11]. Accessibility evaluation defines station-area ranges, but its conclusions vary with indicator definitions and spatial scale [1, 2, 8, 20]. Spatial-survey and design research directly addresses facility problems [17, 18], while systematic reviews are suited to distinguishing conclusions about social impacts [28]. These three types of evidence are at different levels. Comparison must state the preceding conditions and verify the indicator calculation method and spatial scope; otherwise, the conclusions may be distorted.

4.2 Planning Implications for Dalian

The implications of existing research for Dalian can be stated as conditional directions. At the access and development level, service areas at stations on slopes should be tested using actual walking time rather than planar radius, with attention to vertical connections and the microscale built environment. Microscale factors such as slope, footpath width, and accessible facilities often have greater effects on walking access than the macroscale layout [3, 8, 20]. Stations in existing built-up areas may use small-scale, incremental regeneration. Development intensity should be graded by station type, and sites with clear ownership and complete land parcels should be prioritized for above-depot or underground-space development [14-16]. Access organization should vary with station function: peripheral stations should strengthen bus service provision, residential stations should ensure walking continuity and accessible connections, and mixed-use stations should coordinate multimodal access [11, 23].

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At the public-space and mechanism level, coastal stations should consider public access to the shoreline and landscape continuity, while balancing transport distribution and the use of public space [17, 18]. Evidence from hillside residential areas in Dalian indicates that overly steep steps and discontinuous accessible facilities reduce the area usable by older adults. Accessibility requirements should therefore be incorporated simultaneously into coastal footpaths and station-coast connection design [5]. Hong Kong's experience indicates that stations and surrounding plots should coordinate pedestrian interfaces and development timing, with a clear mechanism for returning benefits [24, 25]. The returns model of "Rail + Property," however, must be assessed against land ownership and market conditions in Dalian. The emphasis should be on mechanism design rather than direct replication of the model [26].

4.3 Research Questions Requiring Further Study

Future research should first supplement data for typical stations in Dalian, including slope, roads and walking routes, entrances and exits, bus access, land use, and coastal public space. These data are needed to test whether commonly used station-area indicators retain explanatory power under complex terrain [1, 20]. Stations should also be classified as central, peripheral, residential, and coastal to compare how the importance of each indicator differs by station type [11, 15]. User surveys should compare route choices and spatial needs among commuters, tourists, and older adults, rather than using a single average to represent all groups [5, 12]. Continuity of accessible routes should also be included in the indicator system as an independent evaluation dimension.

Finally, the implementation cost, land ownership, development timing, and public-space effects of different regeneration strategies should be evaluated individually. The elements of Hong Kong-style station-city coordination that can be transferred should also be analyzed clearly [26-28]. Longitudinal comparison before and after development is needed to test the actual performance of accessibility improvements and gentrification risks at specific stations, so that "adaptability" becomes a reproducible case analysis rather than only a conceptual judgment.

5. Conclusion

This review shows that TOD research in mountainous coastal cities must jointly consider actual walking conditions, transport access, existing land, and coastal public space. First, commonly used station-area indicators must be interpreted in their specific environments. Under sloping conditions, actual walking time is more reliable than planar radius, and the microscale built environment is more important than the macroscale layout [8]. Second, station types are matched with access modes and development intensity, while behavioral models, accessibility evaluation, and design research respectively address mode choice, range definition, and facility configuration [1, 11, 20]. Third, the adaptability of regeneration in existing urban areas and coastal public space depends on implementation mechanisms and environmental constraints. The value of international experience lies in drawing on mechanisms rather than replicating models [24, 26, 27].

Existing research on mountainous terrain, coastal areas, and urban regeneration provides different methods, but the research subjects and conditions are not the same. By summarizing problems, comparing the literature, and analyzing boundaries of applicability, this study establishes a research framework for Dalian. The importance of specific indicators and the effects of planning strategies still require further verification through station surveys and user data.

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Conflicts of Interest

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