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Spatial and Group Equity of Public Services in Oil-and-Gas Cities: A Cross-National Comparison of China and Kazakhstan

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Abstract. Long-term industrial priority development of resource-based cities often squeezes livelihood investment, leading to unbalanced public service distribution, a common problem for oil cities. This paper selects Karamay, China, and Almaty, Kazakhstan, two oil- and gas-related cities as research subjects and compares their levels of spatial accessibility from the perspectives of spatial equity and group equity. The results show Karamay achieves better overall public service equalization, yet road and public transport infrastructure in oil workers' residential areas lags far behind main urban districts. In Almaty, public resources are allocated mainly through market-oriented mechanisms, concentrating high-quality livelihood resources in central urban zones. Suburban settlements for eastern oil-gas workers suffer weak supporting facilities. Income stratification and jobs-housing separation further widen public service access gaps among different groups. Such equity gaps between the two cities stem from distinctions in public service supply systems, industrial spatial layouts and urban planning logics. This research provides references for balancing public resources in domestic resource-based cities, and offers ideas for Chinese-funded energy enterprises to optimize overseas livelihood supporting construction within the Belt and Road framework.

Keywords: resource-based cities, urban planning, public services, spatial accessibility

1. Introduction

Resource-based cities rely on local mineral, forest exploitation and processing, covering all administrative levels and underpinning China's energy security and economic development. Long-term extensive resource exploitation tends to crowd out livelihood investment. Local fiscal spending prioritizes industrial construction, resulting in insufficient supply of educational, medical, transport and other public supporting facilities and restricting equitable access to public services [1]. Oil industry-driven cities serve as typical research samples. Almaty, Kazakhstan, does not take oil and gas exploitation as its core industry, yet as a key Central Asian hub, local PetroChina branches have long participated in urban livelihood supporting construction. Karamay, China, grew out of oil exploitation, plagued by common resource-city drawbacks including single industrial structure and

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ecological pressure, with public service construction mainly financed by local government [2]. Resource-dependent regions commonly face uneven public resource distribution and inadequate service access for vulnerable groups, which provides theoretical basis for this cross-national comparison [3]. The two cities differ greatly in public service supply subjects. Varying government and enterprise participation modes directly shape disparities in public service spatial equity. Accordingly, this paper selects Karamay and Almaty to compare and analyze gaps and root causes of equitable public service utilization between the two locales.

Research on public services in resource-based cities started earlier, and the policy level is based on the national sustainable development plan for resource-based cities. It clarifies the strategic positioning of resource-based cities to ensure national energy supply and support economic development. This oil city relies on local finance to promote the renovation of old residential areas, the construction of smart cities, and annual livelihood projects without conducting cross-border comparisons [4]. Single-industry towns are prone to imbalanced spatial distribution of social infrastructure and prominent gaps in the construction of supporting facilities for urban and suburban livelihoods [5]. The social facilities in the central urban area of Almaty are well-developed, but the supporting facilities in the suburbs are lagging, resulting in significant spatial polarization [6]. Chinese oil companies have landed various livelihood-supporting projects in Kazakhstan [7].

Currently, most research on public services in resource-based cities in China only focuses on analyzing domestic cities separately. Existing foreign literature in Kazakhstan mostly revolves around urban shrinkage and urban-rural ecological differentiation, lacking a comparative analysis of government financial supply and enterprise supplementary supply models from a transnational perspective. This paper selects Karamay and Almaty to carry out a comparative study, theoretically enriching transnational research cases of public service fairness in resource-based cities, and expanding the comparative research framework of post-Soviet industrial and mining towns and Chinese resource cities. In practice, it provides experience and reference for the balanced allocation of public resources in domestic oil cities, and provides ideas for the optimization of overseas social responsibility layout of Chinese energy enterprises along the "Belt and Road".

2. Research framework

The petroleum industry runs through the whole development process of Karamay and Almaty and shapes their development track, industrial structure, population composition and spatial layout. Karamay was founded in 1955 alongside oil exploitation, with urban expansion synchronized with oil and gas mining zones. Almaty acts as Kazakhstan's comprehensive economic center, hosting supporting oil refining industries in its eastern area, and long-term urban planning caters to oil freight and industrial supporting demands. The petrochemical sector forms Karamay's economic pillar, while its government fosters emerging industries to push urban transformation. Almaty's core industries are commerce and finance, with oil processing and energy services as auxiliary sectors. Both cities have mobile energy-industry populations: Karamay's permanent residents are mostly oil workers, and Almaty forms a spatial structure of central business core plus eastern oil industrial zones constrained by oil-related facilities. The scale of local oil and gas industries shapes municipal finance, supporting infrastructure and spatial layout in both cities.

This paper defines public service equity from two perspectives: spatial equity and group equity, corresponding to the spatial distribution of public facilities and the disparities in service access among different population groups. Spatial equity focuses on the balance of supporting resources across different urban areas [8]. Almaty exhibits significant spatial polarization, with well-developed medical and educational resources in the central districts, while social amenities in suburban areas

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have remained lagging for a long time. Karamay, as a petroleum resource city in China, also exhibits disparities in infrastructure between the main urban area, peripheral oilfield zones, and old and new residential communities, primarily reflecting spatial-level equity gaps. Group equity focuses on the accessibility of services for different occupational, registered residence, and income groups [9]. Both cities gather a large number of migrant workers in the energy industry. Almaty and foreign energy practitioners have settled down for a long time. The permanent population of Karamay is mainly oil workers and their families. The difference in the threshold of access to public resources between industry-related groups and local permanent residents is the core entry point to measure group equity. The two types of fairness perspectives are interrelated, and an imbalance in spatial layout will further widen the gap in the enjoyment of livelihood facilities by different groups, forming the basis for comparative research [10].

Combining available local data, this paper constructs an evaluation system covering education, medical care, transportation and leisure, four major types of daily public services. Karamay's data derive from its municipal statistical yearbook and official government bulletins, while Almaty's data come from its Construction and Urban Planning Administration. For education indicators, Almaty plans to add 188 schools, and Karamay carries out annual educational livelihood renovation projects. Medical standards adopt general hospitals and community clinics, matching Almaty's clinic upgrading plans and Karamay's grassroots medical improvement policies. Traffic indicators reflect real commuting status: Kazakhstan's average commute time reaches 35.5 minutes, Almaty downtown suffers heavy congestion, and Karamay oilfield residents face long commuting distances. Leisure indicators take urban green and waterfront spaces as core metrics. Almaty expands greenbelts along rivers, and Karamay renovates ecological green spaces in mining areas. These four categories fully reflect spatial and group public service equity differences.

3. Institutional background of public service resources

3.1. Municipal equalization

The public service supply system of Karamay relies on the supporting model of oil state-owned enterprises. At the initial stage of urban construction, oil and gas enterprises undertook most of the supporting construction for people's livelihood, and resource allocation was inclined to the oilfield staff group. The oil field factory area is equipped with complete schools, clinics, cultural and leisure venues, prioritizing the living needs of frontline mining and refining personnel. However, the pace of supporting construction in scattered residents and suburban areas lags behind industrial factories, naturally forming a group and spatial stratification of public services. With the completion of the transfer of functions for the three supplies and one industry of state-owned enterprises, public services have been fully integrated into the municipal system for overall planning. Livelihood facilities that were originally monopolized by oil and gas enterprises have gradually been transferred to local municipal departments for unified operation, and the main body of public service supply has completed the transformation from independent support by enterprises to centralized supply by urban finance.

This transformation has synchronously adjusted the allocation standards and spatial layout principles of public services in urban planning. Local governments have carried out multiple rounds of urban overall planning to achieve global equalization, no longer solely focusing on the layout of supporting facilities around oil field operation areas. At the planning level, unified indicators for education, healthcare, and green space allocation and construction will be established. In response to the supporting gap between the old and new urban areas, as well as the peripheral oil field areas of

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the main urban area, livelihood renovation projects will be implemented year by year, and public resource gaps in the suburbs and mining areas will be filled through balanced financial investment. Under the municipal overall planning model, the layout of public services is no longer dependent on oil fields, but is distributed evenly according to population distribution, weakening the gap between early state-owned enterprise employees enjoying high-quality supporting facilities and continuously narrowing the spatial differentiation of public services within the city.

3.2. Market-oriented supply

The background of Almaty's public service system originated from the industrial welfare system during the Soviet era. The oil and gas industry was the core industrial sector, and the education and medical facilities for supporting construction were funded by the state. All industry practitioners could enjoy universal welfare guarantees. The allocation of public resources relied entirely on industrial production layout, and the eastern oil and gas area was synchronously equipped with basic living facilities, without obvious barriers to access for groups. After the dissolution of the Soviet Union in 1991, Kazakhstan completed a comprehensive market-oriented transformation, breaking the original national centralized public service model and fundamentally transforming the logic of public resource allocation. After the transformation, the government's finances tightened, and it was unable to fully bear the investment in the operation, maintenance, and construction of urban livelihood facilities. A large number of medical clinics, preschool education, and leisure services were operated by market capital, and the resource allocation logic was oriented towards special income. Funds flowed mostly to densely populated and more consumer-capable central urban areas.

The population mobility in the eastern oil and gas industrial zone of the city is strong, the average income level of residents is limited, the willingness of market capital investment is low, and the updating of supporting facilities is slow, resulting in a continuous widening gap between the central and suburban supporting facilities. In the market-oriented stage, high-quality public services are concentrated in the core areas with strong consumer demand, while the eastern region where oil and gas workers gather only retains basic necessities and facilities, making it difficult to obtain high-quality livelihood resources. Comparing the institutional differences between the two cities, Karamay relies on stable finance to allocate resources in a balanced way, with municipal planning as the main task and the market as the supplement. Almaty has a higher proportion of market-oriented supply, with diverse supply themes but stronger constraints on capital returns. These two types of systems have shaped a differentiated pattern of public service space and group fairness between the two regions.

4. Analysis of fairness in the use of public services

Karamay's public service resources present obvious spatial differentiation: downtown residential areas own complete education, medical and leisure facilities, while three oil worker residential zones merely have basic commuting roads. Its overall road network density is 6.06km/km² and branch road ratio 23.17%, both lower than national standards. The main urban area boasts sound trunk roads and dense bus stop for easy access to public resources. Oilfield roads only serve factory commuting, lacking auxiliary roads linking living spaces, with sparse bus routes forcing workers to travel far for high-quality services. This gap stems from land functions matching residents' occupations. Downtown prioritizes residential construction with full supporting facilities, yet oil zones focus on production and lack internal medical, sports and cultural venues, relying on downtown resource radiation. Though fiscal equalization reform is carried out, traffic defects left by early industrial

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planning take long to fix, making oil workers' disadvantaged service access the city's most prominent equity problem.

Almaty forms a typical single-center polarized pattern, with premium medical, educational and green resources concentrated in central Almalin District, equipped with mature subway and BRT for high-income civil servants and service employees. Residents here have a 35.7-minute average one-way commute with sufficient livelihood supplies. Eastern oil workers' suburban settlements have weak supporting facilities, only covered by regular buses without rail transit and lacking industrial-residential ecological buffer belts. Residents must cross districts to obtain high-quality public services. After the Soviet Union's collapse, Kazakhstan's full marketization restricted government fiscal capacity, pushing most livelihood services to profit-driven market capital that clusters in consumption-intensive central zones. Low oil worker incomes trap them in suburbs. Jobs-housing separation and income gaps widen group service disparities. Eastern improvement plans will not finish until 2040, so equity gaps cannot be eased in the short term.

Three core factors create public service equity gaps between Karamay and Almaty: supply systems, industrial spatial layouts and residents' income structures. Supply modes play a decisive role. Karamay realized unified municipal fiscal supply after state-owned enterprises transferred social functions, using balanced fiscal investment to offset industrial zone facility shortages and reduce spatial differentiation, with the market only as supplement. Almaty's market-dominated supply and weak fiscal regulation let profit-seeking capital gather quality resources downtown, leaving eastern suburbs underserved. Karamay's downtown-oilfield layout retains old traffic flaws in industrial areas for slow remediation. Almaty's long single-center development separates eastern oil zones from core urban areas. Karamay's homogeneous oil-worker population enables targeted fiscal support, while Almaty's severe income stratification and jobs-housing separation enlarge resource gaps, forming distinct public service equity patterns in the two cities.

5. Conclusion

This paper compares spatial and group equity of public services in two oil-gas cities to analyze their differentiated distribution patterns of public resources]. Karamay adopts unified municipal finance to balance public supporting resources and achieves remarkable overall equalization of urban public services. However, road network, public transit and cultural-educational facilities in oil worker residential areas still lag behind central living districts, creating objective gaps in resource accessibility between zones. Almaty's market-oriented supply system concentrates high-quality public resources in central urban areas. Eastern suburban oil worker settlements suffer inadequate supporting infrastructure, while functional separation and income stratification raise access thresholds of premium livelihood resources for different groups. The core equity divergence between the two cities originates from distinctions in public service supply systems, industrial spatial layouts and urban planning logics. Chinese oil cities should persist in balanced fiscal investment and upgrade branch roads and transit networks in industrial zones. Kazakhstan's similar cities need governmental intervention to guide market capital to suburbs and build multi-center urban layouts to narrow regional public service gaps.

The main contribution of this paper is to build a transnational comparative analysis framework of public services in oil and gas-related cities between China and Kazakhstan. Through the targeted comparison between Karamay and Almaty, it details the differentiated role path of the two supply modes of government coordination and marketization on the fairness of public resource distribution, and provides empirical reference for the livelihood-supporting construction of domestic and foreign oil cities in the context of the "Belt and Road" energy cooperation. There are still certain limitations

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to this article, as only two representative cities were selected for analysis. The sample coverage is limited, and the calculation is based on official public statistical data and urban planning texts. Subsequent research can expand the sample size of cross-border oil cities, improve the quantitative evaluation of group equity by combining resident field questionnaires, and incorporate long-term time-series data to track the dynamic changes in the balance level of public services, deepening the comparative study of resource-based cities across borders.

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