A Review of Research on Rail-Oriented Commuting Behavior

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Abstract: As urban rail transit systems expand, commuters' reliance on rail has intensified, drawing increased attention to long-distance and extreme commuting. While scholars have extensively studied rail commuting from diverse perspectives, the multidisciplinary nature of the field has led to fragmented findings, hindering the development of an integrated research agenda. This study draws on existing literature and employs bibliometric methods to categorize rail-oriented commuting behavior into five core research areas: mode choice, emotional experience, physiological perception, activity utility, and simulation prediction. Through an explanatory review, we summarize these areas to provide interdisciplinary insights into evolving commuting dynamics amidst uneven urban development, clarify theoretical lineages, and refine a conceptual framework for future studies.

1. Introduction

Rail-oriented urban development has been a central planning theme for two centuries. As urban activity radii expand, "extreme commuting" has garnered significant attention. According to the *2024 Urban Travel Report*, 32.18% of residents in China's Tier 1 and "new" Tier 1 cities prefer subway travel, establishing rail transit as a primary mode. Statistical analyses indicate that rail transit accounts for approximately 27% of public transport commuting in Shanghai and 17.3% of all commuting modes, suggesting substantial potential for further integration into the urban transport network.

Given the diversity of travel modes, research has often remained broad, leaving rail-specific commuting behavior relatively under-explored. By focusing on rail-oriented commuting within the broader context of urban travel, this review seeks to identify refined methodologies to describe the behavioral characteristics and diverse needs of rail commuters in modern urban environments.

This paper adopts an explanatory review approach to integrate multidisciplinary perspectives and address three primary objectives: (1) defining relevant concepts; (2) mapping the evolution of commuting theories and pathways; and (3) employing bibliometrics to synthesize five core research themes.

2. Conceptual Framework and Research Pathways

2.1 Theoretical Evolution

Commuting theory has evolved over decades. By the 1960s, social physics and economic theory dominated, applying equilibrium theory to traffic assignment. The 1970s saw the rise

of behavioral choice theories (e.g., utility maximization), followed by activity-based modeling in the 1980s. Research shifted from a "movement-based" perspective to an "activity-based" one. Recent studies have integrated travel theory with social psychology and leveraged big data (e.g., mobile signaling, smart card data) to analyze dynamic spatiotemporal characteristics.

2.2 Research Framework

Commuting acts as a spatiotemporal transition between private and professional spheres. Following mobility practice theory, we identify personal and environmental factors as core drivers. Personal factors include social attributes (e.g., household structure, income) and biological/psychological traits (e.g., rationality vs. habits). Environmental factors consist of objective conditions (built environment, social culture) and subjective perceptions (congestion, comfort). (See *Fig. 1* for the synthesized research pathway).

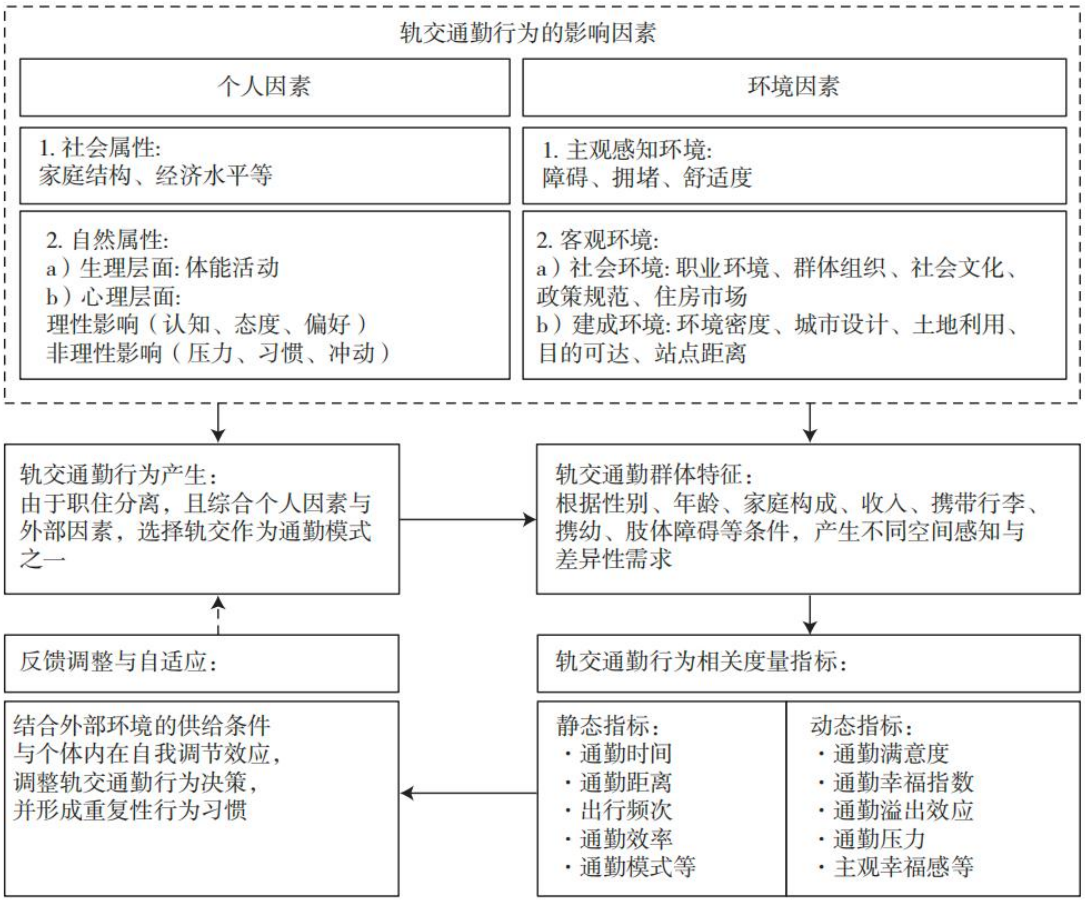

Fig.1 A framework map of research pathways to influence rail commuter behavior

3. Literature Review and Bibliometric Analysis

3.1 Data Collection

We searched Web of Science and CNKI for literature from the past 20 years. After rigorous screening—excluding news, patents, and repetitive reports—we selected 36 representative, highly-cited papers for in-depth analysis.

3.2 Quantitative Trends

"Rail transit" research has grown steadily since 2005, peaking in 2020. In contrast, "commuting behavior" as a specific academic focus has remained relatively low, indicating significant room for
integration.

Fig.2 Comparative analysis of knowledge meta-index between "rail transit" and "commuting"

3.3 Core Research Themes

Based on bibliometric clustering, we categorized existing studies into five themes:

1. Mode Choice: Studies focus on how station proximity and built environments influence the decision to use rail. Research confirms that rail accessibility reduces car dependency. Commuter perception of time (waiting vs. in-vehicle) is a critical factor, with optimal walking times typically identified between 8–12 minutes.

2. Emotional Experience: This dimension encompasses satisfaction and stress. Infrastructure quality positively correlates with subjective well-being. Conversely, commuting pressure—often measured via physiological markers like cortisol levels—negatively impacts mood, though comfort improvements can mitigate this.

3. Physiological Perception: Beyond subjective emotion, research investigates physical activity, noise, and air quality. Rail transit encourages more physical activity than other modes, with acceptable walking distances extending up to 2km.

4. Activity Utility: Guided by utility maximization, researchers analyze how commuting fits into daily activity chains. Findings suggest that rail availability can reconfigure work patterns and increase leisure opportunities.

5. Simulation Prediction: These studies employ complex modeling (e.g., SEM-Logit, activity-based models) to forecast demand and optimize network efficiency.

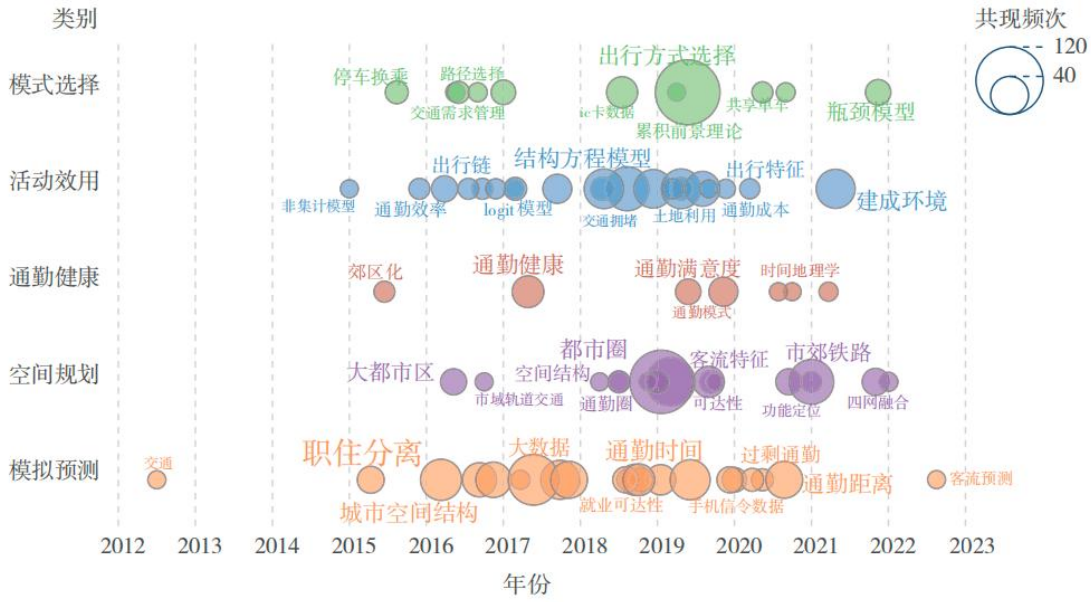

Fig.3 Clustering sequence diagram of five types ofcore Chinese language literature

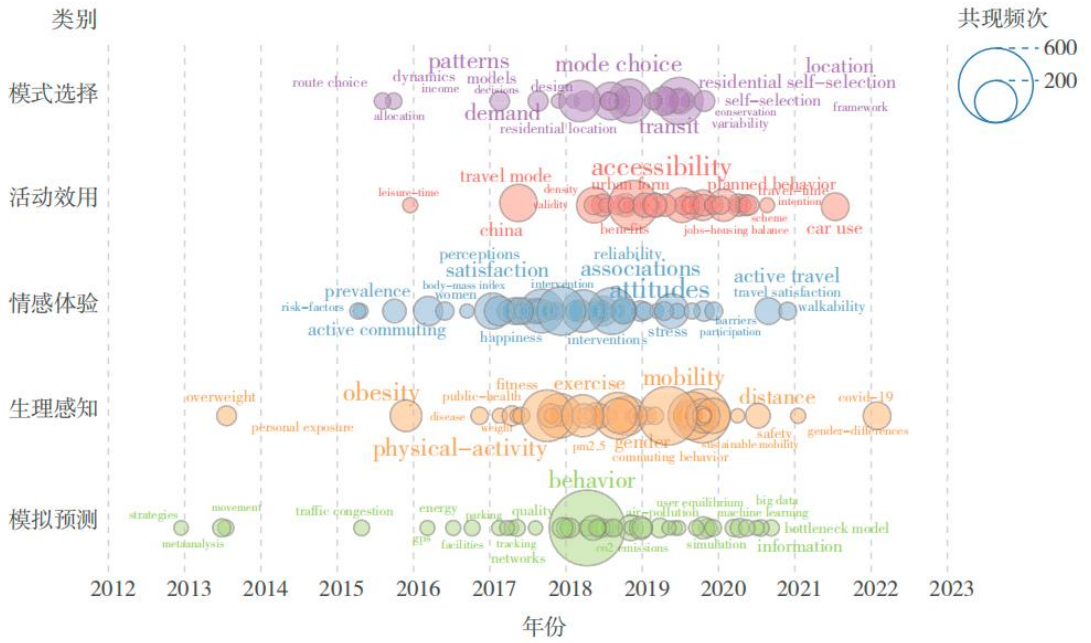

Fig.4 Clustering sequence diagram of five types of the core non-Chinese language literature

4. Discussion and Conclusion

4.1 Interdisciplinary Integration

While mode choice remains the dominant research theme, there is a clear need to bridge the gap between quantifiable engineering metrics (e.g., travel time) and qualitative social dimensions (e.g., social equity, well-being).

4.2 Addressing Data Limitations

Existing models often suffer from endogeneity due to omitted variables, such as the cumulative stress of waiting or the physical exhaustion of crowded environments. The transition toward digitalized behavior—supported by big data and AI—offers a path to overcome these traditional limitations.

4.3 Future Directions

Traditional planning focused on incremental infrastructure expansion. In the digital era, "platform-based" living facilitates real-time interaction between commuters and resources. Future research must transcend simple rational-utility models to incorporate the complexity of virtual-physical spatiotemporal behaviors. Integrating multidisciplinary perspectives is essential to fostering "happy commuting" and sustainable urban development.

References

（AI 辅助翻译）