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Study on the Relationship Between Urban Rail Transit and Urban Tourism: A Case Study of the Top Ten Cities in China

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Abstract: In order to explore the intrinsic relationship between rail transit and urban tourism, this study employs a combination of literature review, expert consultation, and analytic hierarchy process. An online and offline dual-channel survey was conducted through the Credamo platform, collecting 1,253 valid responses. The sample covers different age groups, income levels, and regions, and the survey includes six core dimensions. The survey results show: 1) The 21–40 age group has the highest tourism consumption capacity and travel tendency; 2) Income is positively correlated with willingness to travel, while the correlation becomes negative among high-income, busy groups; 3) Groups relying on the subway for daily transportation are more likely to choose it for tourism and prefer accommodation near subway stations; 4) The development level of the subway network is an important factor in destination choice; 5) Empirical analysis of 10 sample cities shows that tourists' subway use is strongly correlated with subway mileage, while satisfaction is moderately correlated with transfer factors, confirming a significant association between rail transit and tourism. This study also incorporates urban cultural resources, tourism appeal, population density, and ground transportation into its theoretical framework, emphasizing that rail transit does not influence urban tourism independently. Instead, by improving the accessibility of cultural tourism resources, optimizing visitors' spatial movement patterns, and reducing travel time costs, it interacts with the distribution of urban cultural spaces and tourism resources to shape visitors' behavioral decisions. Based on these findings, the study concludes that a multidimensional interactive relationship exists between urban rail transit and urban tourism, providing theoretical and practical references for rail transit network optimization, cultural tourism resource allocation, and urban tourism governance.

Keywords: Rail transit; Urban tourism; Questionnaire survey; Correlation; Tourism resource allocation

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Introduction

As an important component of the modern urban transportation system, rail transit not only serves the daily commuting needs of urban residents, but has also gradually become a vital form of infrastructure connecting tourist attractions, historic districts, commercial centers, cultural venues, and public leisure spaces. As urban tourism shifts from traditional sightseeing toward cultural experience, leisure consumption, and integrated spatial experience, the influence of rail transit on urban tourism is no longer confined to the level of "transport accessibility"; rather, it has become further embedded in tourists' perception, selection, and consumption of urban cultural resources.

As the core of modern urban transportation, rail transit integrates into the urban transport system with characteristics of green safety, speed, and convenience. It is not only the key link to connect cultural and tourism resources and stimulate consumption [1], but also aligns with the logic of traffic optimization and the reshaping of the regional tourism flow structure. Among these, the subway can alleviate surface congestion and enhance transportation efficiency. By relying on its routes to connect scenic spots, business districts, and

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other cultural tourism nodes, it fosters consumer clusters and empowers the integrated development of culture and tourism. However, influenced by the differences in network planning and resource endowment, the spatial correlation between the subway and cultural tourism nodes exhibits significant regional differentiation characteristics [2].

From the perspective of cultural tourism, the attractiveness of urban tourism derives not only from natural landscapes or commercial consumption spaces, but also from cultural resources such as museums, historic and cultural districts, intangible cultural heritage exhibition spaces, urban landmarks, and art galleries. By shortening the temporal distance required for tourists to reach these cultural resources and reducing the cost of cross-regional visits, rail transit can significantly enhance tourist accessibility to cultural resources and improve the efficiency of tourism conversion. Therefore, research on the relationship between rail transit and urban tourism should not remain limited to transport mileage and tourists' travel preferences; it should also examine how rail transit influences tourists' access to, experience of, and consumption within urban cultural spaces. There are still some gaps in existing research: first, there is a noticeable lack of studies on the impact mechanism of the subway on urban tourism development and its quantitative evaluation; second, the actual driving effect of rail transit on urban tourism needs further empirical research for validation. Third, although some studies have examined the influence of rail transit on the spatial structure of tourism, they insufficiently incorporate "culture" as a core element of urban tourism and rarely discuss how rail transit affects tourist behavior by connecting cultural attractions, historic districts, and consumption spaces. Fourth, in empirical analysis, some studies tend to directly interpret the correlation between rail transit mileage and tourists' propensity to travel as a causal relationship, while neglecting the effects of control variables such as urban tourism attractiveness, population density, surface traffic congestion, city recognition, and cultural resource endowment. As a result, there is a certain risk of "spurious correlation."

From a historical development perspective, the world's first subway was built in the UK in the 1820s, pioneering underground urban transportation and providing a new path for expanding urban cultural and tourism spaces. In the 1960s, a global wave of subway construction emerged, and countries integrated cultural and tourism resources along subway lines, making it the core carrier for underground space development and the exploration of cultural tourism value. The construction of subways in China started relatively late [3]. In 1961, the first subway in Beijing began construction, and after eight years, a 23.6-kilometer line was completed and put into operation. This marked the beginning of a new era in urban underground transportation in China and laid the foundation for later connecting cultural and tourism resources with rail transit and building distinctive cultural and tourism routes.

From the perspective of functional value, rail transit plays a key role in modern cities. It not only improves urban transportation but also breaks the limitations of a single mode of travel [4]. It deeply integrates into the urban transportation system, driving economic development, optimizing spatial structure, extending functional boundaries, and improving resource allocation, thus becoming an important support for the integration of culture and tourism. This effect not only aligns with the analysis by Li Jinglong et al. [5] on the deep connection between urban tourism and urban development but also validates Wei Xiao'an's [6] view on the core role of transportation elements in the construction of tourism cities, providing theoretical anchor points for subsequent research. More specifically, the influence of rail transit on urban tourism is mainly reflected in three dimensions. First, at the level of transport accessibility, metro networks can shorten the travel time of tourists among scenic areas, commercial districts, and cultural nodes, thereby improving the efficiency of tourism activities. Second, at the level of spatial organization, rail transit routes and stations influence the scope of tourist activities, enabling originally scattered tourism resources to be incorporated into continuous urban tourism routes. Third, at the level of cultural experience, rail transit enhances the accessibility of cultural venues, historic districts, and urban public cultural spaces, strengthening tourists' depth of perception of urban culture and thereby influencing tourism satisfaction and destination choice.

Based on the above theoretical and practical foundation, foreign scholars have conducted empirical research on the relationship between the two. Kormoss IBF [7], focusing on Northwestern Europe, revealed the potential impact of future transportation patterns on the tourism industry by examining the interaction between transportation and tourism. Becker C and George B P [8], using the Madrid Metro as a case study, empirically demonstrated that the layout of subway lines and station settings have significant suburban effects, promoting population aggregation, enhancing land-use efficiency, and driving the integration of tourism resources and industrial prosperity, providing a reference from outside the country.

Domestic scholars, on the other hand, focus on local urban cases for in-depth research from multiple perspectives. Hu Jiangchuan [9], based on cultural capital theory, proposed that the subway has transcended its role as a mere transportation tool and has become a composite carrier with functions of transportation, industrial clustering, and cultural bearing, providing core support for the prosperity of tourism. Bian Xianhong and Weng Biyun [10], using Hangzhou as a case study, confirmed that improving the accessibility of tourism peripheral areas can stimulate demand, drive the extension of growth poles, and empower the construction of new urban districts. Zhang Ning and Zhang Xiaoling [11], using Nanjing as a case study, systematically analyzed the empowerment mechanism of the subway on the tourism industry from the dimensions of spatial integration, scope expansion, product innovation, and demand adaptation. Overall, however, existing studies have mostly examined rail transit from the perspectives of transporta-

tion infrastructure construction, accessibility improvement, and tourism mobility efficiency, while discussions of the relationship between rail transit and urban cultural tourism resources remain relatively insufficient. Particularly at the empirical level, further improvements in research design and econometric modeling are still needed to distinguish the effect of rail transit itself from the combined effects of factors such as urban tourism attractiveness, population size, cultural resource density, and surface transportation conditions.

In conclusion, as the degree of integration between urban rail transit and urban tourism continues to deepen, related theoretical systems become more refined, and empirical research methods are constantly optimized, the study of the impact of the subway on urban tourism development has become a hot topic in academia. Existing research has conducted extensive exploration in this area, accumulating rich theoretical achievements and empirical experience, providing a solid foundation for this study. However, it also highlights the research gaps mentioned earlier: existing studies still have significant shortcomings in analyzing the impact mechanism of the subway on urban tourism development and in its quantitative evaluation. The actual driving effect of rail transit on urban tourism also requires deeper empirical research for verification. This clarifies the core entry point and research direction for this study. Therefore, this paper takes ten major Chinese cities—Beijing, Shanghai, Guangzhou, Shenzhen, Chengdu, Wuhan, Chongqing, Xi'an, Nanjing, and Hangzhou—as its research objects. By combining questionnaire survey data with city-level indicators, it focuses on analyzing the influence of rail transit on tourists' transportation choices, accommodation preferences, tourism experiences, and destination choices. Meanwhile, based on existing variables such as metro mileage and transfer coefficients, this paper further emphasizes the importance of control factors including urban cultural tourism resources, urban tourism attractiveness, and the transportation environment, in order to enhance the explanatory power and rigor of the research conclusions. Through this study, references can be provided for urban rail transit planning and tourism resource development, while also offering supplementary insights into transportation–tourism interaction research in the context of urban culture-tourism integration.

Research Methods and Data

Research methods

This study employs two core research methods:

First, the questionnaire survey method. Targeting groups from different regions, age ranges, income levels, and tourism experiences, a questionnaire survey is conducted through both online and offline channels via the Credamo platform to collect basic research data.

Second, the data analysis method. The survey data is subjected to statistical analysis to clarify the general relationship between rail transit and urban tourism. At the same time, regional differentiated indicators are integrated to deeply explore the core influencing factors.

Third, the analytic hierarchy process is applied. In this paper, the analytic hierarchy process is specifically used to determine the indicator weights for evaluating the value of rail transit in influencing urban tourism. Based on the research objectives, an evaluation system consisting of a "target layer–criterion layer–indicator layer" is constructed.

Fourth, the literature analysis method is adopted. By reviewing relevant studies on urban tourism, transport accessibility, cultural capital, tourism spatial structure, and rail transit network effects, this paper provides theoretical support for the construction of the research framework.

Fifth, the expert consultation method is used. During the process of questionnaire design and indicator system construction, this paper solicits opinions from experts in relevant fields, focusing on whether the indicator settings are reasonable, whether the questionnaire items can reflect tourists' actual behavior, and whether the AHP evaluation indicators are hierarchical and operational. The results of expert consultation are mainly used to optimize the questionnaire structure, revise the wording of indicators, and provide a basis for the subsequent construction of the judgment matrix (**Figure 1**).

Research subjects

The survey on the impact of rail transit on urban tourism included 1,253 respondents from different age groups and regions across provinces and cities. The respondents have visited cities such as Beijing, Shanghai, Guangzhou, Shenzhen, Chengdu, Wuhan, Chongqing, Xi'an, Nanjing, and Hangzhou, with the purpose of tourism. The sample selection is based on the following criteria:

1. The above-mentioned cities (as shown in **Figure 2**) are representative examples in China with leading rail transit mileage and visitor reception volume, having established or progressively perfected their rail transit systems. By selecting visitors as the survey subjects, the study essentially focuses on cities with high-level integration of rail transit and cultural tourism, ensuring the representativeness and typicality of the sample. At the same time, these ten cities are highly representative in terms of historical and cultural resources, urban commercial vitality, tourism reputation, and rail transit development. For example, Beijing, Xi'an, Nanjing, and Hangzhou possess prominent historical and cultural tourism resources, while Shanghai, Guangzhou, Shenzhen, Chengdu, and Chongqing are typical examples in terms of modern urban tourism, commercial consumption, and public transportation network construction. Therefore, using these cities as sample cities can effectively reveal the differences in the impact of rail transit on tourism activities across different types of cities.
2. Different age groups were selected to explore the differentiated impact of age on respondents' perception of the value of rail transit's empowerment of urban tourism.

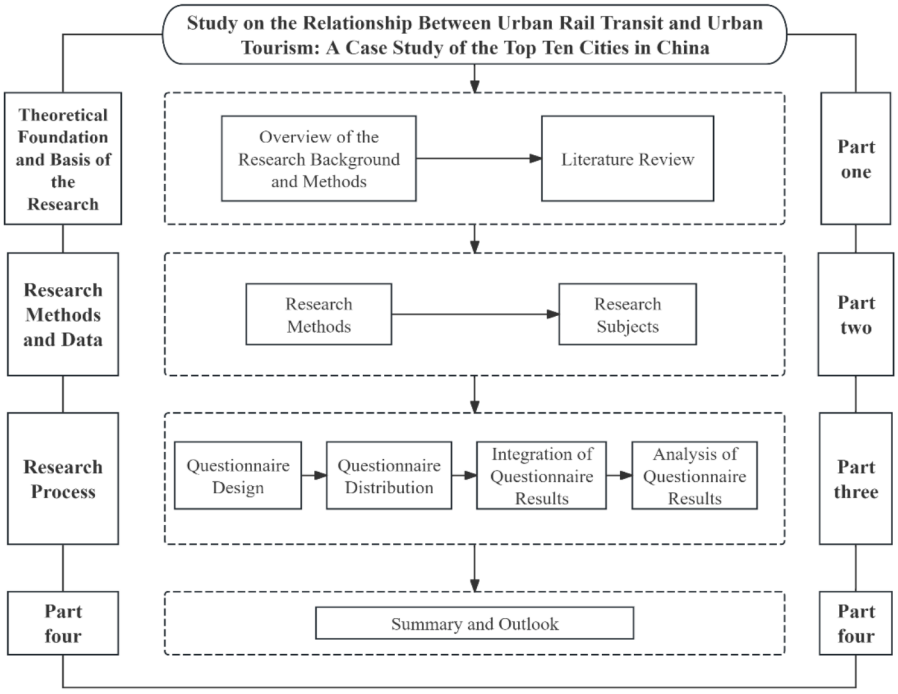

Figure 1 | Research Framework

Age affects not only tourists' physical conditions and tourism consumption preferences, but also their adaptability to metro ticket purchasing, transfers, walking connections, and other travel procedures. Therefore, this paper treats age as an important individual characteristic variable to analyze differences among age groups in their tendency to use rail transit for tourism purposes.

3. Various income groups were included to verify the influence of income differences on the perception of this value. Income level affects tourists' trade-offs among travel costs, accommodation location, tourism comfort, and time efficiency. In general, middle- and high-income groups may pay greater attention to travel efficiency and accommodation convenience, whereas lower-income groups may be more concerned about transportation costs. Therefore, incorporating income as a variable in the analysis helps explain differences in how different tourist groups perceive the tourism value of metro systems.
4. Different origin groups were incorporated to explore the potential role of the rail transit support situation in the respondents' hometowns on their dependence on rail transit during their tourism activities and related value perceptions. Whether a respondent's place of residence has a rail transit system influences their daily travel habits and familiarity with metro use. Respondents who have long lived in cities with metro systems are often more likely to develop metro dependence and habitual metro use, whereas respondents whose places of residence lack metro systems may be less inclined to choose the metro during tourism because they are unfamiliar with procedures such as ticket purchasing, transfers, and route identification. Therefore, this variable can serve as an important control factor for explaining differences in tourists' metro usage.

Variable selection and model design

This paper regards metro mileage as one of the important explanatory variables influencing tourists' propensity to choose the metro, and conducts a comprehensive analysis by incorporating factors such as urban tourism attractiveness, population density, surface traffic conditions, and cultural tourism resources.

Explained variables

This paper establishes two core explained variables. The first is tourists' propensity to choose the metro, denoted as Y_1. This variable is represented by the proportion of tourists in each sample city who choose the metro as their primary mode of transportation during tourism, and is used to measure tourists' degree of dependence on the metro in the process of urban tourism. The second is tourists' satisfaction with the metro, denoted as Y_2. This variable is represented by the proportion of tourists in each sample city who report being satisfied or very satisfied with their metro travel experience, and is used to measure tourists' subjective evaluation of the service quality of rail transit for tourism purposes.

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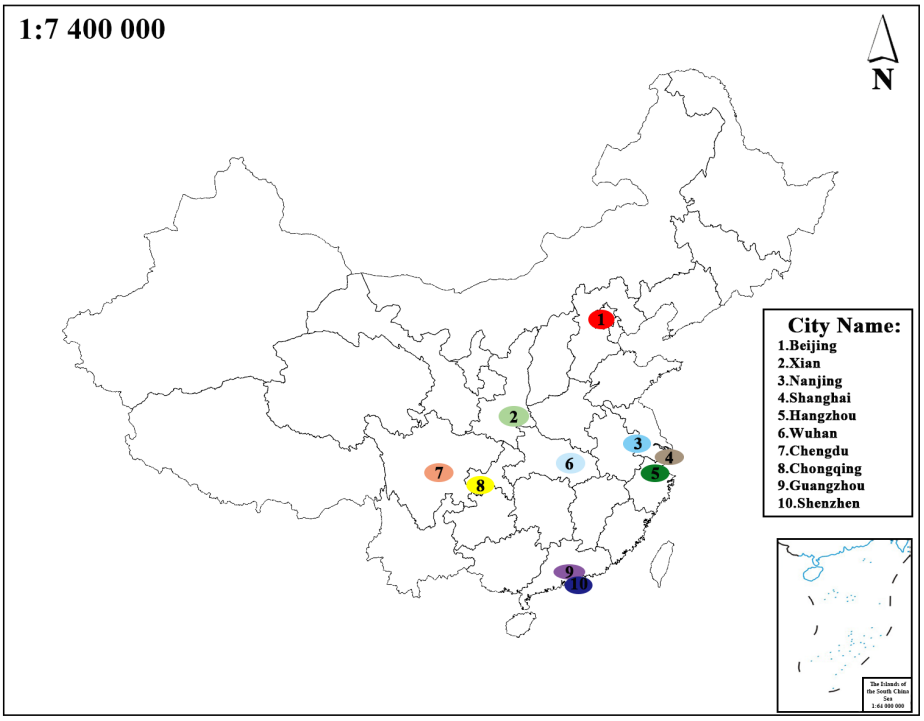

Figure 2 | Map showing the locations of the top ten cities

Core explanatory variables

This paper sets two core explanatory variables. The first is metro operating mileage, denoted as X_1, which is used to reflect the scale of the urban rail transit network. The longer the metro operating mileage, the wider the route coverage, and the greater the convenience for tourists in reaching scenic areas, commercial districts, and cultural venues. The second is the transfer coefficient, denoted as X_2, which is used to reflect the transfer structure and route connectivity of the urban rail transit network. An appropriate number of transfer nodes can improve connectivity efficiency among routes; however, excessive transfer complexity may also increase tourists' travel burden. Therefore, its effect on satisfaction may not follow a simple linear relationship.

Control variables

To avoid mistakenly attributing a city's inherent attractiveness to the influence of rail transit, this paper further introduces the following control variables. First, urban tourism attractiveness, denoted as C_1, can be approximated by the number of tourist visits, the scale of tourism reception, or the number of respondents in the questionnaire who have visited the city. Cities with stronger tourism attractiveness may obtain higher tourist arrivals and travel frequency even when their rail transit conditions are only average. Second, the level of cultural tourism resources, denoted as C_2, can be measured by the density of major cultural attractions, historic districts, museums, cultural landmarks, and other resources in the city. The richer the cultural tourism resources, the more evident the supporting role of rail transit in facilitating tourists' spatial mobility and cultural experience. Third, population density, denoted as C_3, affects urban traffic congestion, metro passenger-flow pressure, and tourists' travel comfort, and may therefore influence both whether tourists choose the metro and how they evaluate their satisfaction with it. Fourth, surface traffic conditions, denoted as C_4. When surface road congestion is severe, tourists are more likely to choose the metro, which offers relatively stable travel times; conversely, in cities where surface transportation is more convenient, tourists' dependence on the metro may decline. Fifth, metro conditions in the place of residence, denoted as C_5, are used to indicate whether respondents have long lived in a city with a metro system, thereby controlling for the influence of daily travel habits on tourism transportation choices.

Model specification

In the analysis of tourists' propensity to choose the metro, this paper constructs the following basic model:

$$Y_1 = \alpha_0 + \alpha_1 X_1 + \alpha_2 C_1 + \alpha_3 C_2 + \alpha_4 C_3 + \alpha_5 C_4 + \varepsilon \quad (1)$$

where Y_1 represents tourists' propensity to choose the metro, X_1 represents metro operating mileage, C_1 to C_4 respectively represent urban tourism attractiveness, the level of cultural tourism resources, population density, and surface traffic conditions, and ε is the random error term.

In the analysis of tourists' satisfaction with the metro, this paper constructs the following basic model:

$$Y_2 = \beta_0 + \beta_1 X_2 + \beta_2 X_1 + \beta_3 C_2 + \beta_4 C_3 + \beta_5 C_5 + \mu \quad (2)$$

where Y_2 represents tourists' satisfaction with the metro, X_2 represents the transfer coefficient, X_1 represents metro operating mileage, C_2, C_3, and C_5 respectively represent the level of cultural tourism resources, population density, and metro conditions in the place of residence, and μ is the random error term.

It should be noted that, since the number of sample cities in this paper is ten, the city-level regression analysis is more exploratory in nature. It is mainly intended to reveal statistical associations and directional characteristics among variables, rather than to conduct causal identification in the strict sense. To improve the robustness of interpretation, this paper combines questionnaire results, descriptive statistics, cross-tabulation analysis, and theoretical mechanisms to make comprehensive judgments, thereby avoiding excessive conclusions based solely on a single regression result.

Research framework and analytical logic

The research framework of this paper can be summarized as four links: "rail transit conditions—tourism resource connectivity—tourist behavioral response—urban tourism effects."

First, rail transit conditions include factors such as metro operating mileage, number of lines, transfer coefficient, station coverage, and ticket-purchasing convenience, which determine the basic conditions for tourists' mobility within the city.

Second, tourism resource connectivity is mainly reflected in the ability of rail transit to connect tourism nodes such as scenic areas, commercial districts, cultural venues, and historic districts. Rail transit does not affect tourism activities in isolation; rather, it exerts its influence by improving accessibility among tourism resources and enhancing the efficiency of their spatial combination.

Third, tourist behavioral response includes whether tourists choose the metro as their primary mode of transportation, whether they tend to stay near metro stations, whether they believe that a well-developed metro network can improve the tourism experience, and their level of satisfaction with metro-based tourism services.

Fourth, urban tourism effects are reflected in the improvement of tourism experience, the expansion of tourism space, the enhancement of cultural resource utilization efficiency, and the release of cultural-tourism consumption potential.

Based on the above logic, this paper argues that the influence of rail transit on urban tourism does not operate through a single pathway. Instead, it is a composite mechanism formed by the joint effects of transport accessibility, accessibility to cultural resources, tourists' travel habits, and the city's overall attractiveness. The subsequent questionnaire analysis and regression analysis will be conducted around this framework.

Questionnaire Survey on the Impact and Value of Rail Transit on Urban Tourism

Questionnaire design

In order to scientifically explore the impact value of rail transit on urban tourism and accurately capture the cognitive and behavioral tendencies of the survey subjects, this study combines multiple research methods, including literature review, expert consultation, and analytic hierarchy process, to systematically design a questionnaire on the impact value of rail transit on urban tourism. The questionnaire serves as the core tool for developing a comprehensive evaluation standard for assessing the impact of rail transit on urban tourism, ensuring the scientific nature of the survey process and the reliability of the results.

The survey adopts a random sampling method to select respondents, with a total of 1,253 participants from different age groups and regions. This approach considers both the heterogeneity and randomness of the sample, providing a reasonable sample base for subsequent analysis of cognitive differences and exploration of influencing factors. The questionnaire content is closely aligned with the core of the study, on one hand collecting basic information such as the geographical coordinates and local cities of the respondents, and on the other hand, designing a series of selective questions focusing on respondents' perceptions and behavioral tendencies regarding the impact of rail transit on urban tourism. Specific questions include whether they prefer to choose the subway as the main transportation mode for tourism, whether they prefer to stay near subway stations, whether they prioritize cities with well-developed subway networks as travel destinations, and their satisfaction with subway tourism services in cities they have visited. At the same time, the questionnaire incorporates respondents' attention to urban cultural resources into the analysis. Specifically, it examines whether respondents tend to visit cultural attractions along metro lines, whether they believe the metro improves the convenience of urban cultural experiences, and whether they pay attention to the connections between metro stations and historic districts, museums, and urban landmarks. This design helps reveal that rail transit does not influence tourism activities merely through "increased mileage," but rather acts on urban tourism experiences by improving the accessibility of cultural resources, reducing the cost of cross-regional visits, and optimizing tourists' itinerary organization. In order to further explore the core driving factors behind the differences in respondents' perceptions of the impact of rail transit on urban tourism, the questionnaire also includes questions about age group, average annual income, and other relevant information to enrich the data collection dimensions.

The questionnaire structure consists of seven core modules: first, the questionnaire title; second, survey instructions; third, basic information of respondents; fourth, perceptions of the relationship between rail transit and urban tourism; fifth, perceptions of accessibility to cultural tourism resources through rail transit; sixth, personal travel prefer-

Table 1 | Indicator System Based on the Analytic Hierarchy Process

Target Layer	Criterion Layer	Indicator Layer
Value of rail transit in influencing urban tourism	Transport accessibility	Metro operating mileage, station coverage, transfer convenience
Value of rail transit in influencing urban tourism	Tourism experience	Degree of time savings, riding comfort, safety, tourist satisfaction
Value of rail transit in influencing urban tourism	Cultural resource connectivity	Number of cultural attractions along metro lines, degree of connection with historic and cultural districts, cultural guidance services
Value of rail transit in influencing urban tourism	Travel cost and service convenience	Fare rationality, ticket-purchasing convenience, accommodation convenience around metro stations

Table 2 | Judgment Matrix for the Criterion Layer

Criterion Layer	Transport Accessibility	Tourism Experience	Cultural Resource Connectivity	Travel Cost and Service Convenience
Transport accessibility	1	2	2	3
Tourism experience	1/2	1	1	2
Cultural resource connectivity	1/2	1	1	2
Travel cost and service convenience	1/3	1/2	1/2	1

Table 3 | Weight Results for the Criterion Layer

Criterion Layer	Weight
Transport accessibility	0.424
Tourism experience	0.227
Cultural resource connectivity	0.227
Travel cost and service convenience	0.122

ences and travel experiences; and seventh, concluding remarks. By adding the module on "perceptions of accessibility to cultural tourism resources," this study can more comprehensively analyze the role of rail transit in the integration of culture and tourism. The questionnaire structure was systematically refined, and each question was accompanied by clear completion guidelines and detailed explanations to ensure that respondents could accurately understand the requirements and reduce response bias.

To improve the quality of the questionnaire, this study conducted a small-scale pilot test before formal distribution and adjusted the wording of some items based on the feedback received. For example, the question "Do you think the metro contributes to urban tourism?" was further refined into more specific questions, such as "Do you think the metro helps tourists reach scenic areas?", "Do you think the metro helps tourists reach cultural venues?", and "Do you think the metro can reduce transfer time between tourist attractions?" This refinement helps reduce respondents' misunderstanding and improves the interpretability of the questionnaire data.

In the questionnaire design and indicator evaluation, this study further constructs an analytic hierarchy model for assessing the value of rail transit in influencing urban tourism. The model consists of three levels: the target layer, the criterion layer, and the indicator layer.

The target layer is the value of rail transit in influencing urban tourism. The criterion layer includes four dimensions: transport accessibility, tourism experience, cultural resource connectivity, and travel cost and service convenience. The indicator layer includes specific indicators such as metro operating mileage, station coverage, transfer convenience, degree of travel time savings, riding comfort, safety, tourist satisfaction, number of cultural attractions along metro lines, degree of connection with historic and cultural districts, cultural guidance services, fare rationality, ticket-purchasing convenience, and accommodation convenience around metro stations, as shown in Table 1. Based on expert consultation, this study constructs the judgment matrix for the criterion layer, as shown in Table 2. After calculation, the weight results for the criterion layer are presented in Table 3.

The maximum eigenvalue of the judgment matrix is approximately 4.010, the consistency index, CI, is approximately 0.0035, and the consistency ratio, CR, is approximately 0.0038, which is less than 0.10. This indicates that the judgment matrix passes the consistency test and that the weight results have an acceptable level of rationality. The weight results show that transport accessibility remains the primary factor through which rail transit influences urban tourism. However, the weights of cultural resource connectivity and tourism experience are equal, indicating that the role of rail transit in urban tourism is reflected not only in "whether tourists can reach destinations," but also in "whether rail transit can better connect cultural resources and improve the tourism experience."

Questionnaire distribution

Content of the questionnaire distribution

The main content of this questionnaire focuses on three core data collection modules, as detailed below:

1. Basic Information Module of Respondents: This module collects basic demographic information from the respondents, including gender, occupation, age, average annual income, and the city of residence. This data supports the subsequent exploration of cognitive differences in the impact of rail transit on urban tourism across different groups.
2. Perception of Rail Transit and Urban Tourism Module: This module focuses on respondents' perceptions and

behavioral tendencies regarding the relationship between rail transit and urban tourism. It includes core content such as the evaluation of the importance of the subway in urban tourism, whether they prefer to choose the subway as the primary transportation mode for urban tourism, whether they prefer to stay near subway stations, and whether they tend to choose cities with well-developed subway networks as travel destinations.

3. Tourism Travel Experience Module: This module primarily investigates respondents' travel-related experiences, including the cities they have visited for tourism, whether they have used rail transit during their tourism activities in those cities, and their evaluation of the convenience of the city's rail transit system.
4. The cultural tourism resource perception module focuses on respondents' perceptions of the relationship between the metro and urban cultural tourism resources. This includes whether the metro improves the convenience of visiting cultural attractions, whether it enhances respondents' willingness to visit urban historic and cultural districts and cultural venues, and whether they believe that the distribution of cultural resources along metro lines influences their tourism route planning.

Based on the previous support from literature review and expert consultation methods, the tourist survey questionnaire on the impact of rail transit on urban tourism has been highly endorsed by experts in terms of content design, structural rationality, and overall conception. This indicates that the questionnaire has high validity and is ready for formal distribution. During the expert consultation process, some experts pointed out that urban tourism is not influenced solely by transportation conditions, but also by factors such as city recognition, scenic attraction appeal, cultural resource density, and the level of commercial services. Therefore, in the subsequent analysis, this paper does not treat metro mileage as an independent decisive factor. Instead, it regards metro mileage as one important variable influencing tourist behavior and interprets it in combination with other control variables.

Method of questionnaire distribution

This study uses both online and offline channels for the questionnaire survey. Due to practical space limitations, the data collection is primarily conducted through online QR code surveys. In the implementation process, an electronic questionnaire was designed and published through the Credamo system. Once respondents fill out the survey online, all valid data is collected and integrated through the system's backend.

Data collection was carried out through three methods:

1. Using the QR code generated by the Credamo system to collect questionnaires from respondents in different regions across the country.
2. Distributing paper questionnaires in high-traffic areas that meet the characteristics of the research subjects.
3. Sharing the survey QR code and fill-in link through various online communities and QQ groups to widely collect feedback from tourists.

To enhance the validity and participation rate of the survey, this study relied on the Credamo platform, offering a red envelope incentive to participants who completed the survey. Participants must fully complete the questionnaire in order to receive the red envelope reward at the end of the survey. Additionally, to ensure the authenticity and completeness of the data, mandatory fields and a time-limited submission mechanism were set up to avoid missing content and ensure the standardization of data collection.

During the data cleaning stage, this study established three criteria for excluding invalid questionnaires. First, questionnaires with an obviously short completion time, which could not ensure careful responses, were excluded. Second, questionnaires with clear contradictions among logically related items were removed, such as cases in which respondents had never visited a sample city but nevertheless evaluated their satisfaction with that city's metro system. Third, questionnaires showing highly mechanical or continuously repetitive response patterns were excluded. Through these procedures, the interference of invalid samples with the research conclusions was minimized as much as possible.

A total of 1,300 questionnaires were distributed, with 1,278 returned. After excluding 25 invalid questionnaires, 1,253 valid questionnaires were obtained, including 1,197 electronic questionnaires and 56 paper questionnaires. The effective response rate was 96.38%. According to related research on sociology questionnaire response rates, the minimum acceptable valid response rate for surveys is 90% [12,13]. The effective response rate of this survey is significantly higher than the standard value, meeting the data collection requirements for this study.

In terms of sample structure, the questionnaire covers groups with different ages, income levels, places of residence, and tourism experiences, and can therefore reasonably reflect tourists' tendencies to use rail transit and their subjective evaluations during urban tourism. However, it should be noted that the questionnaire sample still consists of tourists' subjective behavioral data, which may be affected by factors such as recall bias, personal preferences, and impressions of cities. Therefore, in the subsequent analysis, this study combines questionnaire data with city-level rail transit indicators to improve the robustness of interpretation.

Integration of questionnaire results

Analysis of the overall situation of the questionnaire survey

Before officially conducting the questionnaire survey, this study made a forward-looking prediction of the survey

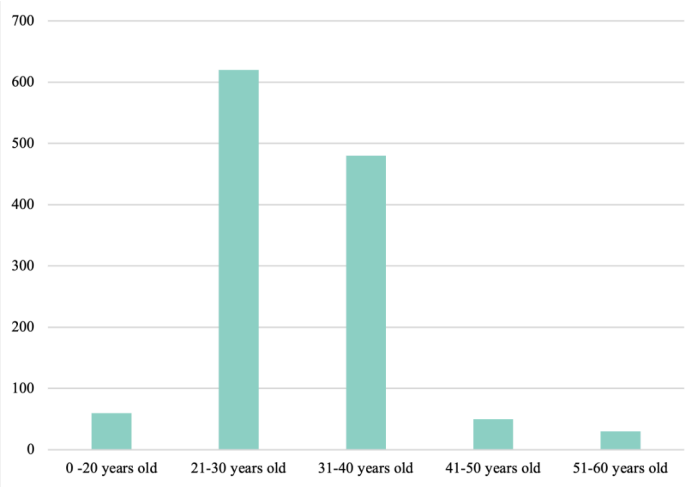

Figure 3 | Age Composition of Survey Respondents

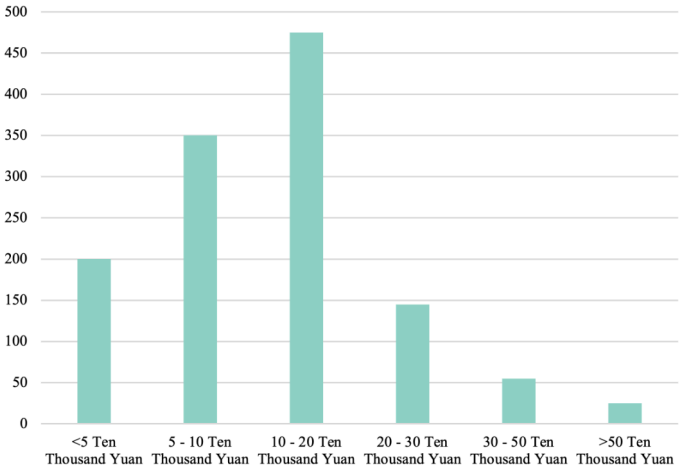

Figure 4 | Composition of Respondents' Average Annual Income

results and conducted a detailed comparison and in-depth analysis between the predicted results and the actual collected data. Overall, the demographic characteristics of the survey respondents were highly consistent with the predicted results, supporting the high scientific and reliability of the data collected, which can support further in-depth research and analysis.

Age of respondents. As shown in Figure 3, the largest proportion of respondents in this survey falls within the 21–30 age group, followed by the 31–40 age group. The number of respondents in these two age groups is significantly higher than the total number of respondents in the 0–20, 41–50, and 51–60 age groups. From a practical consumption perspective, within the 0–60 age range, the 21–30 and 31–40 age groups have a higher tourism consumption capacity, supported by factors such as physical strength, tourism interest, and economic conditions, when compared to other age groups. The age distribution characteristics of the survey respondents are highly consistent with this reality, further confirming that the age structure of the sample is reasonable. However, it should be noted that age structure can only indicate behavioral differences among different age groups in tourism travel, and cannot independently prove a direct causal effect of rail transit on tourism willingness. Therefore, in the subsequent analysis, this study treats age as an individual-level control factor and interprets tourists' propensity to use the metro in combination with variables such as income, metro conditions in the place of residence, and tourism experience.

Income of respondents. As shown in Figure 4, there is a stage-based correlation between the respondents' willingness to travel and their average annual income. For income levels ranging from below 50,000 to the 100,000–200,000 range, the willingness to travel shows a significant upward trend as income increases. However, once the average annual income surpasses 200,000, the willingness to travel exhibits a negative correlation with further increases in income. This characteristic may be closely related to factors such as the busy work schedules of high-income groups and their limited leisure time and discretionary energy for travel. The income variable has a dual influence on rail-transit-based tourism behavior. On the one hand, low- and middle-income groups may attach greater importance to the advantages of metro travel, such as low fares and stable travel times, and may therefore be more inclined to choose the metro as a mode of transportation during urban tourism. On the other hand, higher-income groups may place greater emphasis on comfort and privacy, and may choose taxis, ride-hailing services, or other modes of transport in certain tourism scenarios. Therefore, the relationship between income and the propensity to choose the metro may not be simply linear, but is jointly influenced by time costs, comfort preferences, and differences in tourism modes.

Current residence of respondents. The current residence of respondents is a core research dimension in the tourism travel status questionnaire. This dimension contains rich research information, as an individual's place of residence can directly reflect their lifestyle habits. Different urban locations and living environments shape differentiated cognitive characteristics. This dimension provides important support for the subsequent analysis of cognitive differences regarding the impact of rail transit on urban cultural tourism among different groups. Whether respondents' current city of residence has a metro system is an important variable for explaining tourists' propensity to use the metro. Respondents who have long lived in cities with metro systems are generally more familiar with operational procedures such as route searching, QR-code entry, and transfer planning, and are also more likely to develop metro travel habits. By contrast, respondents whose current cities of residence do not have metro systems may show a relatively lower willingness to choose the metro during tourism due to their lack of daily usage experience. Therefore, metro conditions in the place

Table 4 | Statistical Data of Individuals' Tendency to Use the Subway and Availability of Subway in Their Current City of Residence

Availability of Subway in Current City of Residence	Highly or Somewhat Inclined Group	Other Groups	Total
Cities with subways	509	18	527
Cities without subways	633	93	726

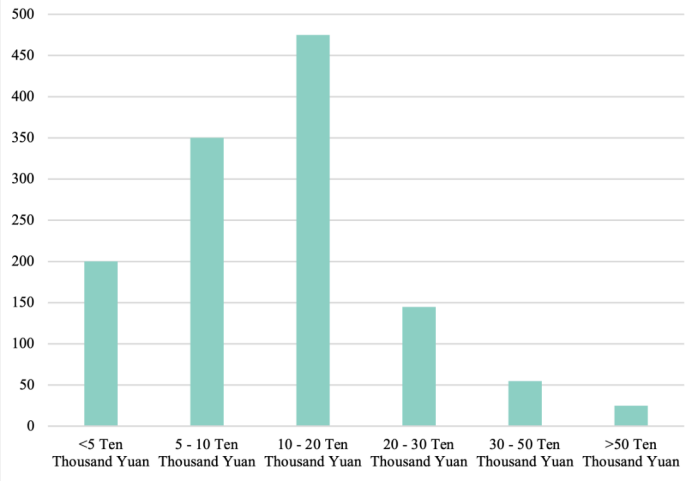

Figure 5 | Distribution of the Tendency to Use the Subway as the Main Mode of Transportation for Urban Tourism

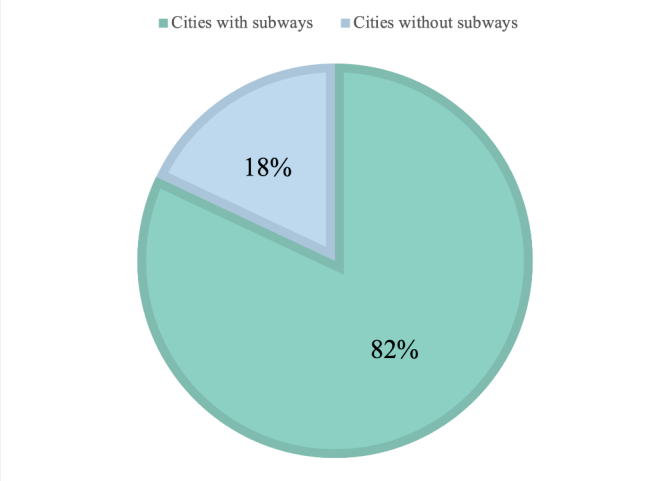

Figure 6 | Distribution of Subway Availability in the Current City of Residence for Individuals Not Inclined to Choose the Subway

of residence reflect not only differences in transportation infrastructure, but also differences in individual travel habits and travel psychology.

Views on rail transit and urban tourism.

Ference for subway as the main transportation mode for urban tourism. As shown in Figure 5, out of the 1,253 respondents, 666 people (more than half of the sample) prefer to use the subway as the main transportation mode for urban tourism. Among them, 476 respondents are very inclined to choose the subway. In total, these two groups (1,142 respondents) account for over 90% of the sample. This indicates that many respondents prefer the subway as the main transportation mode when traveling to urban tourism destinations. This result suggests that the metro has become a highly recognized mode of transportation among tourists visiting large cities. This is due not only to the advantages of the metro, such as relatively stable fares, predictable travel times, and limited exposure to surface traffic congestion, but also to the fact that metro lines in most sample cities already provide relatively good coverage of core scenic areas, commercial districts, and areas where cultural resources are concentrated. Therefore, tourists' propensity to choose the metro is in fact the result of the combined effects of transport efficiency, route coverage, tourism resource distribution, and individual travel habits.

The group that is either very inclined or somewhat inclined to use the subway as the main mode of transportation for urban tourism consists of 1,142 people. Among them, 509 people (44.5%) reside in areas that have subway lines, while 633 people (55.5%) live in areas without subway lines.

Table 4 statistics show that among the respondents living in cities with a subway, 96.5% are highly or somewhat inclined to use the subway as the main mode of transportation for urban tourism. In contrast, among respondents living in cities without a subway, this inclination is 87.1%, a difference of 9.4 percentage points, with the latter being significantly lower than the former.

As shown in Figure 6, in this study, there are 17 respondents who are not inclined or completely not inclined to choose the subway. Among them, 14 live in cities without a subway, accounting for much of this group.

It can be inferred that people living in cities with subways have developed varying degrees of dependency on subway travel in their daily lives. Therefore, when choosing the main mode of transportation for urban tourism, they are more inclined to use the convenient and efficient subway. On the other hand, individuals who are not inclined to use the subway have no subway travel experience in their daily lives and have not developed this travel habit or dependency. As a result, their inclination to choose the subway as the main mode of transportation for urban tourism is significantly lower than that of the former group. However, in drawing conclusions, this paper should avoid directly interpreting "whether the current city of residence has a metro system" as the sole cause. More accurately, there is a clear correlation between whether the current city of residence has a metro system and tourists' propensity to choose the metro during tourism. This relationship may operate through mediating

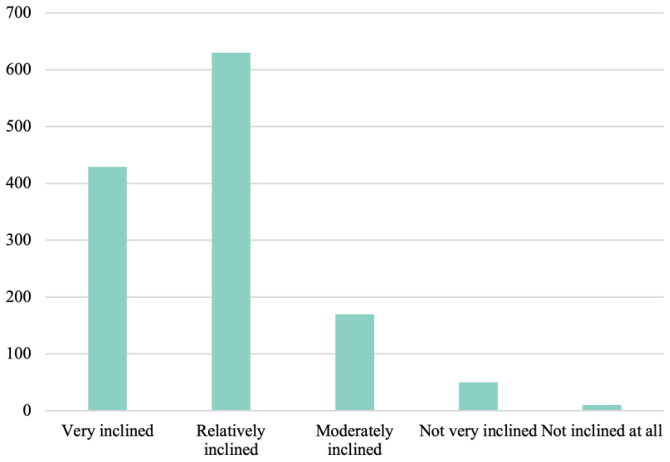

Figure 7 | Distribution of the Number of People Inclined to Stay Near Subway Stations

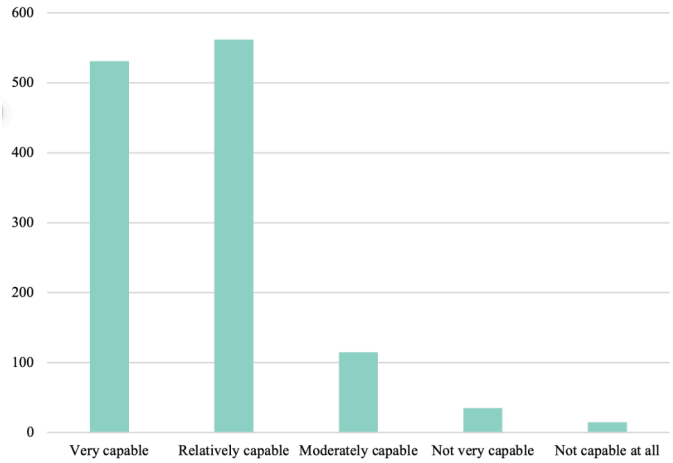

Figure 8 | Distribution of the Number of People Who Believe That Cities with a Developed Subway Network Enhance the Tourism Experience

factors such as daily travel habits, familiarity with metro operations, and perceptions of metro safety and convenience.

Tendency to choose accommodation near subway stations. As shown in Figure 7, among the 1,253 respondents, 630 are somewhat inclined to stay near a subway station, accounting for more than half of the sample; 429 are highly inclined to this choice. The total of these two groups is 1,059, accounting for over 80% of the total respondents. This result further confirms that the vast majority of respondents have a high dependency on rail transportation in urban tourism, and therefore tend to choose accommodations near subway stations to reduce the time cost of traveling to the subway station. This also reflects the group's dependency on subway travel from the perspective of accommodation choices during urban tourism. From the perspective of urban tourism spatial organization, tourists' preference for accommodation near metro stations indicates that rail transit stations influence not only tourists' transportation choices, but also their accommodation location choices and tourism route planning. Areas around metro stations often have high accessibility and a concentration of service facilities, which can help tourists improve the efficiency of moving between attractions within limited travel time. Therefore, the impact of rail transit on urban tourism does not occur only "during travel," but also extends to accommodation choices, consumption spaces, and the radius of tourism activities.

The effect of subway network development on enhancing urban tourism experience. As shown in Figure 8, among the 1,253 respondents, 562 believe that cities with a developed subway network can better enhance the tourism experience, accounting for more than half of the sample. 531 respondents think such cities can greatly enhance the tourism experience. The combined total of these two groups is 1,093, which makes up over 80% of the total respondents. This result further confirms that many respondents recognize that "a developed subway network has a positive effect on enhancing the urban tourism experience."

It can be inferred that the development level of the subway network has become an important factor when people choose urban tourism destinations. A well-developed rail transportation network can effectively improve the travel efficiency between various tourist attractions in the city, significantly reducing both the time and economic costs of travel. Furthermore, the improvement of tourism experience brought about by a well-developed metro network is mainly reflected in three aspects. First, it improves the connection efficiency among scenic areas, enabling tourists to visit multiple attractions or cultural nodes within a relatively short period of time. Second, it reduces tourists' dependence on unfamiliar urban road traffic and lowers the uncertainty caused by problems such as traffic congestion, detours, and parking difficulties. Third, it enhances the overall accessibility of urban tourism spaces, allowing cultural tourism resources in peripheral urban areas or non-core areas to attract greater tourist attention.

Perceptions of rail transit and cultural tourism resources. This dimension focuses on whether tourists believe that the metro improves the convenience of reaching museums, historic and cultural districts, urban landmarks, and cultural-commercial districts, as well as whether they arrange cultural tourism routes according to metro lines.

From a theoretical perspective, the tourism value of urban cultural resources depends not only on the reputation of the resources themselves, but also on whether tourists can reach them conveniently. If cultural attractions are far from the main transportation network, tourists may give up visiting them due to time costs and transfer complexity, even if they are interested. Conversely, if cultural resources are located along metro lines or in areas with convenient transfers, they are more likely to be incorporated into tourists' itineraries. Therefore, by improving the accessibility of cul-

Table 5 | Ranking of Subway Mileage in China

Ranking	City Name	Number of Rail Lines	Operating Mileage (Kilometers)
1	Beijing	27	836
2	Shanghai	20	831
3	Guangzhou	16	653
4	Chengdu	13	562
5	Shenzhen	16	556
6	Chongqing	12	538
7	Hangzhou	12	516
8	Wuhan	12	488
9	Nanjing	12	460
10	Xi'an	9	310

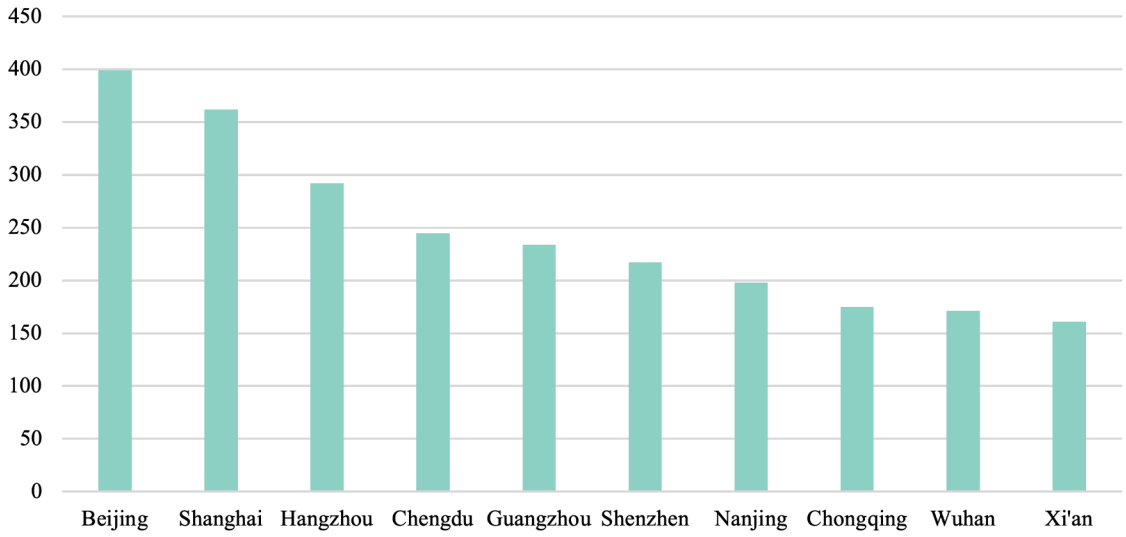

Figure 9 | Cities Visited by Survey Respondents Primarily for Tourism

tural resources, rail transit can enhance the tourism conversion capacity of those resources.

The data from this section can be combined with subsequent city-level cultural resource variables to analyze the relationship among "metro network—cultural resource accessibility—tourist experience." In this way, the present study can extend from a general analysis of transportation convenience to an analysis of the mechanism of culture-tourism integration.

Analysis of the questionnaire survey for each city

This survey targets the top ten cities in China by subway operating mileage at the end of 2023 [14] (as shown in Table 5). The study focuses on tourists' travel choices, transportation selection, travel experience evaluation, and reasons for non-subway travel, among other travel experiences. It conducts an integrated analysis of tourists who have visited the above cities, exploring how the differences in subway systems across cities influence tourists' perceptions and dependency on local rail transportation, as well as the causes behind these effects. By integrating the analysis results from each sample city, the study identifies the core factors influencing tourists' choice of subway as the main mode of transportation in urban tourism. This empirical foundation provides a micro-level perspective for exploring the relationship between rail transportation and urban tourism in this paper.

By integrating the analysis results of each sample city, this study identifies the core influencing factors that affect tourists' choice of the metro as their main mode of transportation during urban tourism. From a micro-level perspective, this provides an empirical foundation for examining the relationship between rail transit and urban tourism.

This study summarizes and analyzes the relevant data of respondents who visited the cities primarily for tourism, as shown in Figure 9. Among all respondents, the largest number visited Beijing, with 399 people; the fewest visited Xi'an, with only 161 people. The number of respondents visiting each sample city is ranked as follows: Beijing (399), Shanghai (362), Hangzhou (292), Chengdu (245), Guangzhou (234), Shenzhen (217), Nanjing (198), Chongqing (175), Wuhan (171), and Xi'an (161). This ranking closely matches the subway operating mileage ranking in Table 2. The fol-

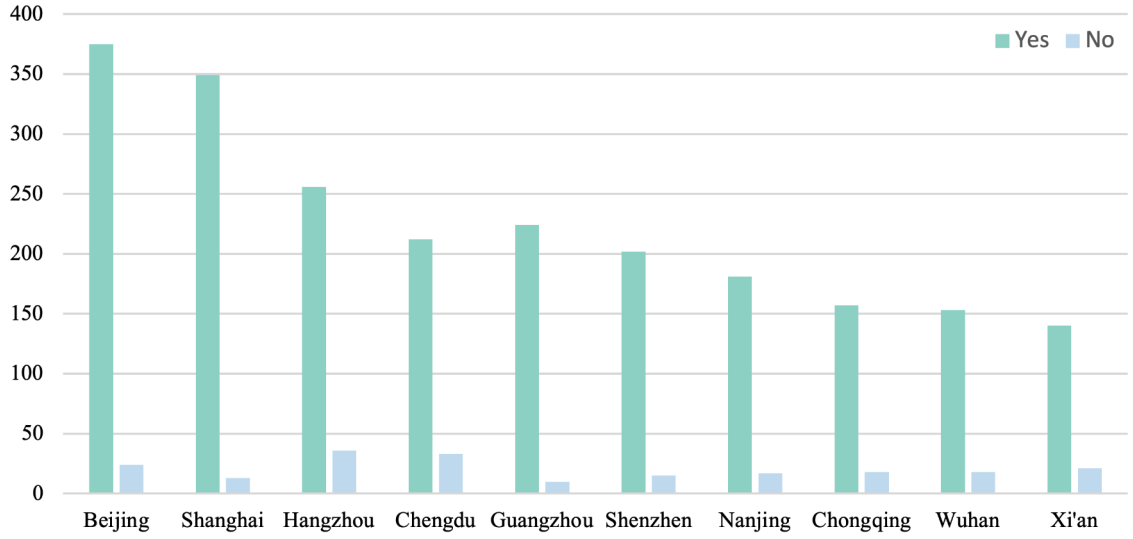

Figure 10 | Whether the Subway is Used as a Mode of Transportation

lowing section will provide a unified comparative analysis of the data from the top ten cities.

In the comparative analysis of cities, this paper focuses not only on metro operating mileage, but also on urban tourism attractiveness, cultural resource endowment, surface traffic conditions, and differences in tourist structure. Differences in metro usage tendencies across cities may be simultaneously influenced by factors such as route coverage, attraction distribution, city size, tourism image, and cultural resource density. Therefore, this paper interprets intercity differences as the result of multiple interacting factors rather than as being determined solely by metro mileage.

As shown in Figure 10, among the respondents included in this survey, the majority chose the subway as their mode of transportation. This indicates that, during their travels in these cities, most tourists prefer to use the subway, a convenient and efficient mode of transportation, as their primary means of getting around. From a city perspective, the attractiveness of the subway as a tourist transportation tool mainly depends on whether its routes cover frequently visited areas by tourists, the convenience of transfers between attractions, the clarity of signage around stations, and whether the subway connects cultural attractions, commercial consumption areas, and accommodation areas. If the subway lines are long but poorly connected to core tourism resources, tourists may still choose other transportation methods; conversely, if the routes effectively link major scenic spots and cultural nodes, even if the operating mileage is not the highest, they may still achieve a high usage rate.

Based on the aforementioned ten city cases, this study further investigates tourists who use the subway as their primary mode of transportation, aiming to assess their overall satisfaction in terms of convenience, comfort, and safety. The survey results, shown in Figure 11, indicate a high overall level of satisfaction among tourists. This data strongly supports the core argument of this study, which is that, from the perspective of tourist experience, choosing the subway for urban tourism is a rational and feasible travel strategy. The high satisfaction among tourists suggests that rail transit can, to some extent, meet the efficiency and safety demands of urban tourism. However, satisfaction is not solely determined by the number of lines or operating mileage, but also influenced by factors such as transfer complexity, congestion levels, ticketing convenience, in-station signage systems, tourism information services, and the clarity of cultural attraction signage. Therefore, subsequent analysis needs to explain the differences in satisfaction from a multivariable perspective.

In this questionnaire survey, attention was also paid to respondents who did not choose the metro as their main mode of transportation for urban tourism, and the reasons for their choices were statistically analyzed. The reasons for not choosing the metro vary across different cities, but they are generally concentrated in aspects such as route coverage, crowding levels, transfer efficiency, ticket-purchasing convenience, safety perception, and cost perception. This indicates that, in the view of most tourists, the price, convenience, safety, and other aspects of metro-based tourism in Beijing still require further optimization.

As shown in Figure 12, factors such as metro crowding, time-consuming transfers, unfamiliarity with ticket-purchasing procedures, and insufficient route coverage are important reasons why tourists do not choose the metro as their tourism transportation mode. This result suggests that the expansion of rail transit network scale does not necessarily lead to improved tourist satisfaction. Only when route coverage, transfer organization, riding comfort, and service information are optimized simultaneously can rail transit serve urban tourism more effectively.

This study conducted a systematic statistical analysis of the data from respondents in the ten sample cities who did

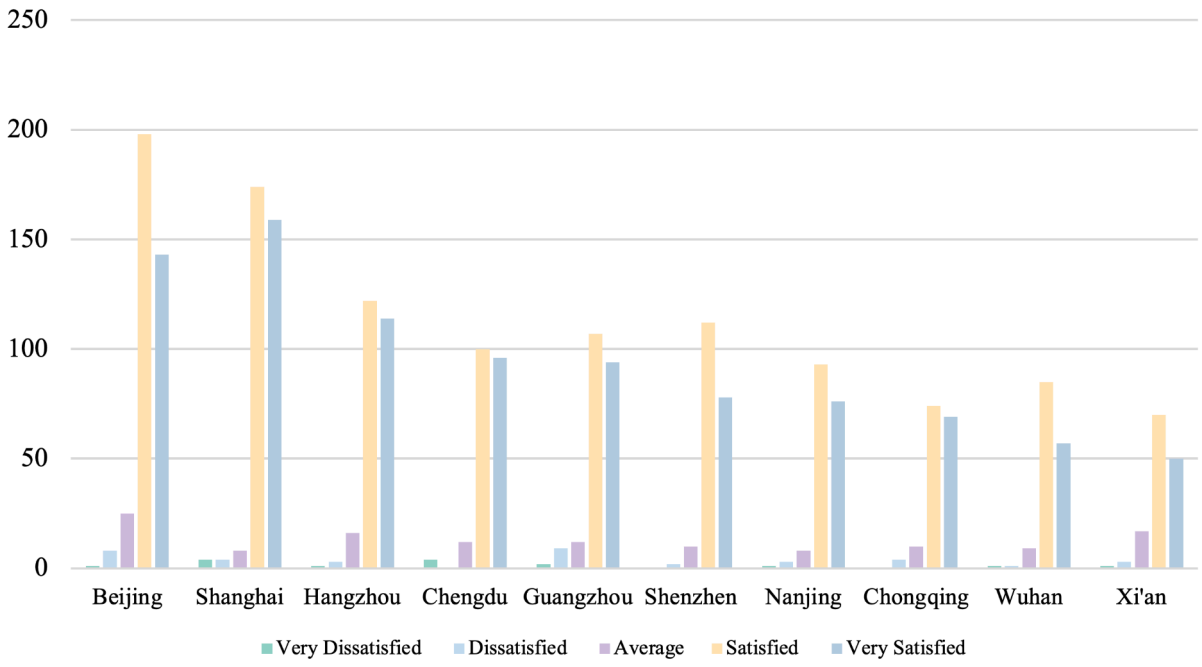

Figure 11 | Satisfaction with the Subway

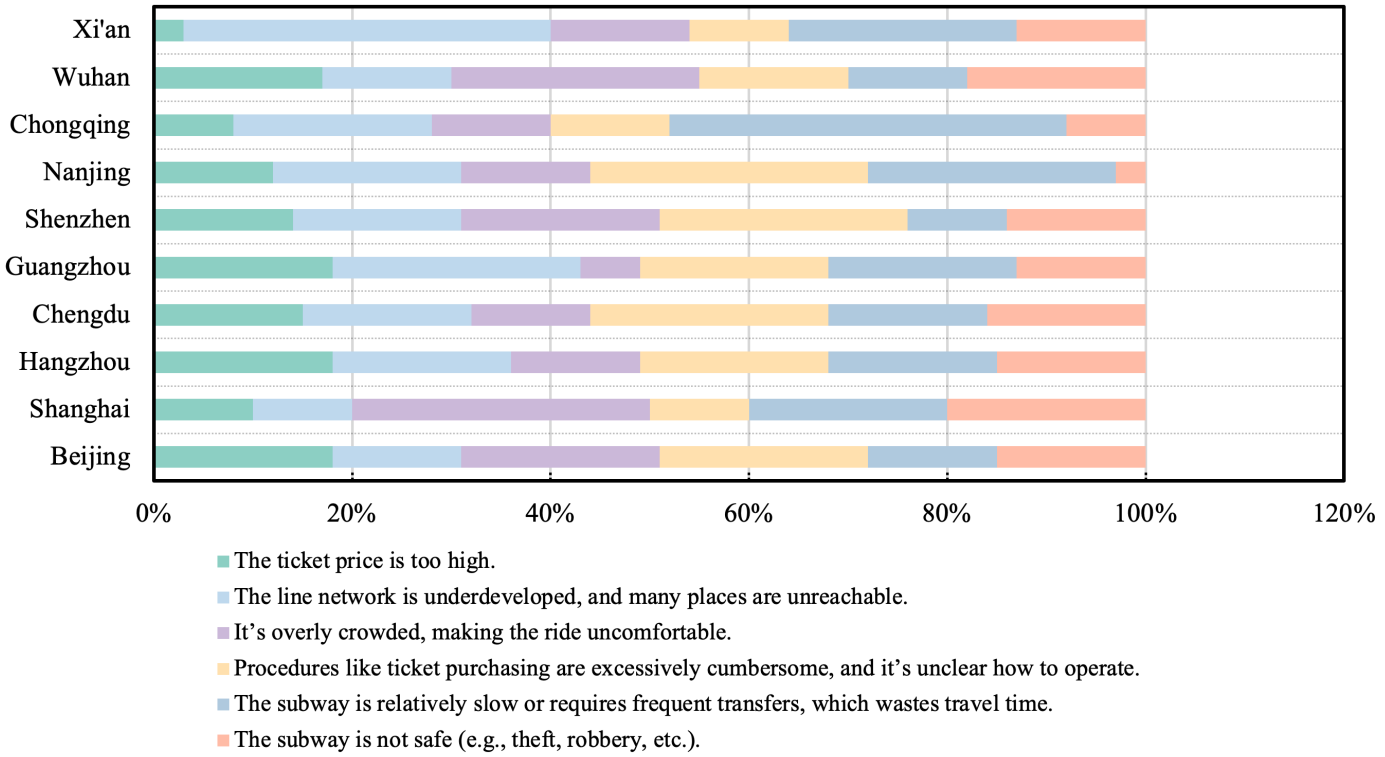

Figure 12 | Reasons for Not Choosing the Subway as a Mode of Transportation

not consider the subway as the main mode of transportation for urban tourism. The results indicate that the core limiting factors affecting respondents' choice of travel modes exhibit both commonalities and significant differences: From a commonality perspective, the core pain points identified by respondents focus on six key dimensions: ticket pricing, safety guarantees, network layout, transfer convenience, operational efficiency, and ticket purchasing experience. These dimensions represent the general shortcomings in the subway systems of the ten cities when adapted to tourism travel scenarios. From a differentiation perspective, the core limiting factors show significant differences across cities, with each city emphasizing different aspects. In addition, insufficient cultural tourism service information is also an issue requiring attention. During metro travel, some tourists may not be aware of whether cultural attractions, historic districts, or distinctive tourism resources exist around a particular station. If wayfinding systems and tourism information prompts inside metro stations are insufficient, even when metro lines are close to relevant resources, their role in directing visitor flows toward cultural tourism resources cannot be fully realized. Therefore, in the future, urban metro systems may strengthen cultural attraction signage, tourist maps, transfer guidance, and multilingual guide services at key stations.

In conclusion, the subway systems in the ten cities still have considerable room for optimization and quality improvement to better meet the demands of tourism travel. It is necessary to target the specific characteristics of each city's core limiting factors, improve infrastructure and service provisions, and further enhance the attractiveness and adaptability of subways in urban tourism contexts. From the perspective of culture-tourism integration, rail transit optimization should not focus solely on the growth of route length, but should also attach importance to the spatial matching relationship between rail transit lines and cultural tourism resources. By improving station coverage of cultural attractions, optimizing connection routes to scenic areas, and improving guidance systems inside and outside stations, rail transit can further release its comprehensive driving effect on urban tourism.

Analysis of the questionnaire results

Integrating the differentiated indicators presented in the previous analysis of the ten cities based on survey results, this study selects the tendency of tourists to choose the subway as their mode of transportation and the satisfaction during the subway journey as the core analysis indicators. Control variables such as urban tourism attractiveness, cultural tourism resource level, population density, surface traffic conditions, and metro conditions in the place of residence are introduced for systematic analysis, in order to identify the key factors influencing the above indicators.

Regression analysis of the tendency to choose the subway for tourism

As shown in the previous analysis, the tendency of tourists to choose the subway as their primary mode of transportation during urban tourism correlates highly with the ranking of subway mileage in various cities. Based on this, the proportion of survey respondents who selected the subway as their primary transportation mode among the total respondents for each city is chosen as the dependent variable Y_i, representing the tourism subway tendency indicator for the i-th city. The independent variable X_i is the city's subway mileage (unit: km), reflecting the differentiated level of subway mileage in each city. A classical overall regression model is constructed [15]. To enhance the rigor of the model, this paper further interprets tourism-related metro usage propensity as the result of multiple interacting factors and constructs an extended model [16]:

$$Y_i = \alpha_0 + \alpha_1 Metro_i + \alpha_2 Tour_i + \alpha_3 Culture_i + \alpha_4 Density_i + \alpha_5 Road_i + \varepsilon_i \quad (3)$$

where Y_i represents the proportion of tourists in city who choose the metro as their main mode of transportation during tourism; represents metro operating mileage; represents urban tourism attractiveness; represents the level of cultural tourism resources; represents population density; represents surface traffic conditions; and ε_i is the random error term.The purpose of this model specification is to distinguish the influence of metro mileage itself from the combined effects of factors such as urban tourism attractiveness and cultural resource endowment. For example, in some cities, even if metro mileage is relatively long, the metro usage rate among tourists may still be affected by factors such as the dispersed distribution of scenic areas, complex transfers, or a relatively high proportion of tourists choosing self-driving travel. Conversely, although some cities may not have an absolute advantage in metro mileage, if their major scenic areas and cultural districts are concentrated along metro lines, they may still achieve a relatively high rate of metro use for tourism purposes (**Table 6**).

As shown in **Table 7**, the multiple correlation coefficient (Multiple R) for this analysis is 0.759, and the coefficient of determination (R Square) is 0.576. This indicates a strong correlation between tourists' preference for subways and the length of subway routes. The greater the length of subway routes in a city, the more likely tourists are to use the subway as their primary mode of transportation during their visit to that city. However, it should be further noted that an R Square of 0.576 means that metro mileage can explain part of the difference in tourists' propensity to choose the metro, while approximately 42.4% of the difference still needs to be explained by other factors. Therefore, this paper cannot simply equate "longer metro mileage" with "tourists will inevitably be more inclined to choose the metro." Rather, it should be understood as follows: the expansion of metro mileage generally improves the coverage of urban rail transit, and, when interacting with the distribution of scenic areas, cultural resource connectivity, transfer convenience,

Table 6 | Statistical Table of Variables Required for Regression Analysis

City Name	Operating Mileage	Subway Preference	Transfer Coefficient	Satisfaction
Beijing	836	94.0%	1.8199	93.0%
Shanghai	831	96.4%	1.8047	95.4%
Guangzhou	653	95.7%	1.8302	95.7%
Chengdu	562	86.6%	1.7659	92.5%
Shenzhen	556	93.0%	1.7065	94.0%
Chongqing	538	89.7%	1.59	91.1%
Hangzhou	516	87.6%	1.6476	92.2%
Wuhan	488	89.4%	1.584	92.8%
Nanjing	460	91.4%	1.6679	93.4%
Xi'an	310	86.9%	1.5378	85.7%

Table 7 | Regression Distribution Statistics of Subway Preference and Subway Mileage

Regression statistics	
Multiple R	0.759
R Square	0.576
Adjusted R Square	0.524
Standard Error	0.025
Observed Values	10

Table 8 | Confidence Intervals for Correlation Coefficients

Multiple Correlation Coefficient R	Correlation
R>0.75	Strong Correlation
0.75>R>0.5	Moderate Correlation
0.5>R>0.25	Weak Correlation
R<0.25	No Correlation

Table 9 | Regression Distribution Statistics of Tourist Satisfaction with the Subway and Transfer Coefficient

Regression statistics	
Multiple R	0.646
R Square	0.417
Adjusted R Square	0.344
Standard Error	0.023
Observed Values	10

and tourists' travel habits, increases the likelihood that tourists will choose the metro.

With the advancement of urbanization in our country, the urban rail transit systems in various cities are gradually being improved and upgraded. The expansion of subway operating mileage mainly reflects the extension of line networks and the broadening of station coverage, laying the foundation for enhancing the convenience and accessibility of rail transit. This optimization can significantly increase tourists' preference for choosing the subway for travel, which validates the rationale behind the correlation between subway mileage and tourists' inclination to choose the subway, completing the logical argument. From the perspective of cultural tourism, the expansion of metro mileage can fully realize its tourism value only when it effectively connects cultural attractions, historic districts, tourism commercial areas, and accommodation areas. Therefore, future rail transit planning should emphasize the coupling between route construction and the spatial layout of cultural tourism resources, rather than simply pursuing growth in operating mileage.

Regression Analysis of Tourist Satisfaction with the Subway

Combining the statistical results of the tourist survey conducted in ten sample cities mentioned earlier, among the tourists who did not choose the subway as their main mode of transportation, inconvenient transfers and crowded carriages are the primary concerns. From the perspective of optimizing rail transit operations, various cities often alleviate congestion and enhance transfer convenience through optimizing transfer coefficients and adding transfer stations, thus improving the passengers' riding experience and laying the logical foundation for subsequent exploration of the relationship between transfer coefficients and tourist satisfaction with the subway.

Based on the data from Table 6 and the regression analysis logic discussed earlier, the proportion of satisfied subway passengers among subway-traveling tourists in each sample city is defined as tourist satisfaction with the subway (the dependent variable Y); the subway transfer coefficients of each city are used as the independent variable X to conduct a regression analysis, exploring the intrinsic relationship and evolution of both. To improve the explanatory depth of the satisfaction analysis, this paper constructs the following extended model:

$$S_i = \beta_0 + \beta_1 Transfer_i + \beta_2 Metro_i + \beta_3 Crowd_i + \beta_4 Service_i + \beta_5 CultureGuide_i + \mu_i \quad (4)$$

where S_i represents tourist satisfaction with the metro in city i; $Transfer_i$ represents the transfer coefficient; $Metro_i$ represents metro operating mileage; $Crowd_i$ represents the degree of crowding; $Service_i$ represents the convenience of ticket purchasing, wayfinding, in-station services, and related services; represents the completeness of cultural tourism guide information in the metro system; and μ_i is the random error term. This model emphasizes that tourist satisfaction depends not only on the transfer coefficient, but also on whether the transfer process is clear, whether carriages are crowded, whether ticket purchasing is convenient, and whether stations provide clear tourism guide information. Therefore, satisfaction improvement should be promoted simultaneously from both transportation organization and tourism service perspectives.

The results of the regression analysis (as shown in **Table 9**) indicate that the multiple correlation coefficient (Multiple R) is 0.646, and the coefficient of determination (R Square) is 0.417, suggesting a moderate strength of correlation, and indicating that it is not a completely linear relationship, showing dynamic association characteristics overall. In the initial stages of subway construction, improving transfer coefficients can help tourists reduce time costs, flexibly choose routes, and enhance the utilization of subways in urban cultural tourism, as well as the tourist experience when accessing attractions; however, as the number of lines and stations increases, excessively adding transfer stations may increase the burden on tourists and weaken the positive impact of transfer coefficients on satisfaction, potentially leading to a negative correlation. This pattern confirms the regression relationship between the two, resonating with the earlier research logic and enhancing the coherence of the argument. Therefore, the influence of the transfer coefficient on tourist satisfaction has a "dual nature." Moderate transfers help improve route accessibility and travel flexibility, while overly complex transfers may increase tourists' cognitive burden and time costs. Especially for non-local tourists, route identification during transfers, walking distance within stations, clarity of language signage, and station guidance systems all affect their actual experience. Therefore, when serving tourism scenarios, urban rail transit should improve network connectivity while reducing transfer complexity.

Discussion

This study shows that there is a significant multidimensional relationship between urban rail transit and urban tourism. Rail transit is not merely a basic mobility carrier; rather, by optimizing the accessibility of cultural tourism nodes such as scenic areas, commercial districts, cultural venues, and historic districts, it profoundly influences urban tourism development from multiple dimensions, including travel behavior, accommodation choice, route planning, and tourism experience.

From the perspective of tourists' travel behavior, the survey shows that the metro is the preferred mode of transportation for tourists in urban tourism. The main reasons are that it offers stable travel times, high cost performance, and clear routes, while also helping tourists avoid surface traffic congestion and meet their travel needs in unfamiliar cities. However, rail transit is not the only determining factor in tourists' travel choices. Urban cultural tourism attractiveness, the spatial layout of scenic areas, and tourists' personal characteristics all exert intervening effects. Therefore, rail transit is an important conditional variable affecting tourism behavior, rather than a decisive variable.

At the level of accommodation choice, tourists generally prefer accommodation near metro stations, and rail transit stations have become core spatial references in the layout of tourists' cultural tourism activities. Tourists' accommodation decisions take price, service, and transportation location into account. Accommodation near metro stations can effectively reduce travel time costs, improve the efficiency of visiting scenic areas, and promote the formation of urban cultural tourism consumption spaces, reflecting the significant tourism spatial spillover effect of rail transit.

From the perspective of cultural tourism resource utilization, rail transit can improve the accessibility and utilization rate of various urban cultural resources. The spatial matching degree between metro lines and cultural scenic areas, historic districts, and distinctive consumption areas directly affects the overall quality of urban tourism. Efficient route connections can form a coherent cultural tourism sightseeing system, whereas a disconnect between cultural tourism resources and the rail transit system may restrict the release of their tourism value.

The empirical regression results show that the scale of the rail transit network is highly correlated with tourists' travel choices, while the transfer structure has a moderate correlation with tourist satisfaction. This confirms that the level of rail transit construction and network efficiency significantly affect the cultural tourism travel experience. At the same time, tourist satisfaction is also constrained by multiple factors, including carriage crowding, transfer convenience, signage and guidance, safety, and services.

In summary, empowering cultural tourism development through urban rail transit requires a shift from a single route-construction orientation to a comprehensive development orientation that coordinates network efficiency, service experience, and culture-tourism integration.

Conclusion

Based on the statistical analysis of questionnaire survey data, this paper explores the correlation and influence mechanism between urban rail transit and urban tourism, and draws the following conclusions.

First, the 21–40 age group shows significant advantages in tourism consumption and travel propensity, making it the main group in urban tourism. Age cannot independently affect tourists' tourism behavior; rather, it works together

with factors such as income level, leisure time, and digital travel ability to influence tourists' transportation choices in urban tourism.

Second, the influence of income on tourism behavior is staged and complex. An overall increase in income can positively promote tourism willingness, but for some high-income groups, insufficient leisure time may lead to a negative correlation between tourism willingness and income. Travel preferences differ significantly among income groups. Middle-income groups are more attracted to the economy and convenience of the metro, while high-income groups prefer comfortable and personalized travel modes. Therefore, urban cultural tourism transportation services need to provide differentiated supply.

Third, tourists' metro-use experience directly affects their tourism transportation choices. Tourists who reside in cities with metro systems are more inclined to use the metro when traveling. Most tourists plan travel routes and choose accommodation locations near metro stations based on metro access. Rail transit deeply intervenes in tourists' travel and accommodation decisions and has become a core framework through which tourists perceive and organize the spatial pattern of urban tourism.

Fourth, the degree of improvement of the rail transit network is an important reference for tourists in choosing tourist destinations. Its cultural tourism value does not lie primarily in operating mileage, but in the degree of spatial coupling and adaptation with tourism resources such as scenic areas, cultural venues, commercial areas, and accommodation. Only efficient connection with resources can fully realize its supporting role in cultural tourism.

Fifth, based on the regression analysis of the sample cities, metro mileage and tourists' propensity to use the metro, as well as the transfer coefficient and tourism satisfaction, respectively show strong and moderate correlations. These results only reflect correlations among variables and cannot determine strict causal effects. In the future, long-term panel data and spatial econometric models can be used to conduct more in-depth research.

Sixth, rail transit can effectively improve the accessibility of urban cultural tourism resources, optimize the organization of cultural tourism routes, and enhance the efficiency of transforming cultural resources into tourism value.

In summary, rail transit is an important support for the high-quality development of urban culture and tourism, but it is not the only determining factor. This paper constructs a composite mechanism of "transport accessibility—tourism resource connectivity—tourist behavioral response—tourism experience improvement," comprehensively explaining the integrated role of rail transit in empowering culture-tourism integration, urban spatial organization, and the upgrading of tourism consumption.

Practical implications

Based on the above research conclusions, this paper proposes the following practical implications.

First, urban rail transit planning should strengthen coordination with the layout of tourism resources. When constructing or optimizing future rail transit lines, full consideration should be given to the connections among core scenic areas, historic and cultural districts, museums, urban landmarks, commercial consumption areas, and transportation hubs, so as to improve the coverage of tourism resources by rail transit.

Second, the service functions of key tourism stations should be optimized. For metro stations near scenic areas, cultural venues, and commercial districts, tourist guide maps, directional signs to scenic areas, walking-time reminders, multilingual signage, and introductions to urban culture can be added to reduce the route-identification costs of non-local tourists in unfamiliar cities.

Third, transfer convenience and riding comfort should be improved. The study shows that there is a moderate correlation between the transfer coefficient and tourist satisfaction, but overly complex transfers may weaken tourists' experience. Therefore, tourists' metro travel experience should be improved by optimizing in-station circulation, shortening transfer distances, improving transfer signage, and strengthening passenger-flow organization during peak periods.

Fourth, the integration of rail transit and cultural tourism products should be promoted. Cities can create cultural tourism themed routes around metro lines, such as historical and cultural routes, museum routes, night-tour consumption routes, and urban landmark routes, thereby transforming rail transit from a single travel tool into a platform for urban cultural display and tourism experience organization.

Fifth, attention should be paid to the differentiated needs of different tourist groups. For elderly tourists and tourists from cities without metro systems, ticket-purchasing guidance, route inquiry services, and manual consultation should be strengthened. For younger tourists, digital guidance, online transfer planning, and tourism recommendations along metro lines can be enhanced to improve service precision.

Limitations and outlook

Although this paper can provide certain insights for tourism transportation policy formulation, it still has the following limitations.

First, the number of sample cities is limited. This study selects ten Chinese cities with relatively high metro operating mileage as samples, which can reflect the basic characteristics of cities with relatively developed rail transit. However, its explanatory power for small and medium-sized cities, tourism-oriented cities, and cities in the early stage of rail transit development remains limited.

Second, the data in this paper mainly come from questionnaire surveys. Although the sample size is relatively large, the results may still be affected by respondents' subjective perceptions, recall bias, and individual preferences.

Third, the regression analysis in this paper is mainly based on cross-sectional data, which can reveal correlations

between rail transit indicators and tourist behavior, but remains insufficient for identifying causal relationships.

Fourth, due to limitations in data availability, this paper has not yet conducted refined spatial analysis of the spatial distribution of cultural resources, the actual distances between metro stations and cultural attractions, and tourists' real movement trajectories.

Future research can be further deepened in the following aspects. First, the scope of sample cities can be expanded to include cities of different sizes, different tourism types, and different stages of rail transit development for comparison. Second, multi-year panel data can be introduced to analyze changes in urban tourism flows and tourist behavior before and after the opening of rail transit lines. Third, POI data, mobile signaling data, metro smart-card data, and tourist trajectory data can be combined to conduct more refined spatial econometric research. Fourth, future studies can focus on analyzing the spatial coupling relationship between rail transit and cultural tourism resources, further revealing how rail transit influences urban cultural tourism experiences and cultural tourism consumption spaces.

In conclusion, there is a significant interactive relationship between urban rail transit and urban tourism. Rail transit not only improves tourists' travel efficiency, but also serves as an important support for the high-quality development of urban tourism by connecting tourism resources, reshaping tourism spaces, enhancing the accessibility of cultural resources, and optimizing the tourism experience. In the future, a more coordinated mechanism should be established among rail transit planning, tourism resource development, and urban cultural space governance, so as to promote a positive interaction between urban transportation construction and the integrated development of culture and tourism.

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