Hindawi
Complexity
Volume 2020, Article ID 6629119, 11 pages
https://doi.org/10.1155/2020/6629119

Research Article

Environmental and Social Problems and Countermeasures in Transportation System under Resource Constraints

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Received 3 November 2020; Revised 9 December 2020; Accepted 10 December 2020; Published 23 December 2020

Academic Editor: Wei Wang

With the rapid development of urban economy and the acceleration of urbanization, the demand for urban traffic is increasing rapidly. The single traffic-oriented planning does not take into account the requirements of traffic development on resources and the impact on the environment. The traffic construction of most cities can not fully meet the standard of ecotype. In this paper, the vehicle distribution route optimization problem under multiresource constraints such as vehicle energy capacity and vehicle loading capacity is studied, and the static and dynamic models of distribution route optimization under multiresource constraints are established. In the static distribution route optimization model, the distribution route optimization problem with subloops is solved by modifying the network structure and adding virtual resource points. In the dynamic model, the spatiotemporal network model is used to avoid the generation of subloops, and the description of the vehicle distribution route planning problem is more intuitive and accurate. The model enriches the vehicle distribution route selection scheme at the cost of expanding the model scale. And it can solve the time when the vehicle arrives and leaves the customer point. This paper provides a good countermeasure for solving the environmental and social problems in the transportation system under the condition of resource constraints.

1. Introduction

In the economics of resources and environment, resources are generally defined as its narrow side, that is, natural resources, which includes exhaustible and nonexhaustive resources. The former means that the stock of the resource will gradually decrease with the passage of time [1]. And the latter can be divided into two categories: renewable natural resources and nonrenewable natural resources. Nonrenewable resources are resources that do not have the ability of self-circular growth and are gradually consumed with the use of human beings. They can be divided into recyclable nonrenewable resources and nonrecyclable nonrenewable resources. Resource constraint not only refers to the shortage and price increase of natural resources caused by the decrease in quantity, quality, and difficulty of development and utilization of natural resources, which restricts economic growth, but also known as the quantity control constraint of natural resources. It also refers to the superior resource endowment, the oversupply of resources, and serious environmental problems caused by overexploitation of resources, and the over-reliance on rough processing industry leads to the constraint of low-end industrial structure on economic growth, which is also called quality control constraint [2, 3]. Cities have a vast territory, the distribution of resources in different regions is uneven, the two situations, shortage of resources and abundance of resources, may occur, and shortage and relatively abundant resources of the region are facing different resource constraints. Environmental constraint refers to both environmental carrying capacity and environmental regulation. Environmental carrying capacity refers to the capacity of the ecosystem to pollutants in a certain region under the conditions of certain environmental quality and living conditions and within the allowable limit of the ecosystem [4]. If the pollution discharge exceeds the load of the environment, the environment will be seriously damaged, which will affect people's production and life and restrict the development of economy [5]. Environmental regulation is a very important social regulation, which means that the government regulates the economic activities of enterprises by formulating corresponding environmental protection policies and measures, and its purpose is to control the negative externalities caused by enterprise environmental pollution [6]. There are generally two kinds of environmental regulation means: one is the direct regulation means; the other is the economic means of indirect regulation. The direct regulation means generally include environmental protection standards, quota use restrictions, permits, etc. And the economic means of environmental regulation generally include pollution right trading system, pollution charge system, environmental tax system, and so on. Through the automatic adjustment mechanism of the market, enterprises are guided to take the initiative to make decisions in accordance with environmental standards. The environmental constraint referred to in this paper refers to environmental regulation [7–10].

Because of these resources and constraints, with the rapid development of urban economy and the acceleration of urbanization, the demand for urban traffic increases sharply. In order to meet the needs of urban economic development, urban construction departments have invested a lot of money in the planning [11]. However, because the traditional method of urban traffic planning is a single traffic-oriented planning, without taking into account the requirements of traffic development on resources and the impact on the environment, the traffic construction of most cities does not fully meet the ecological standards [12, 13]. Not only the traffic problems still exist, the resources can not be used reasonably, and the environmental quality is deteriorating day by day. Urban traffic is still a factor restricting the development of urban economy and the improvement of people's living standards [14]. Under the background of many disadvantages of traditional traffic planning, in view of the problems existing in the passenger transportation system, the ecological traffic planning theory of the passenger transportation system is studied from four aspects: land use, traffic structure, traffic infrastructure, and traffic planning evaluation [15]. Land use mainly studies the ecological land use model from the point of view of land use intensity and land use layout, so that the traffic demand can be distributed reasonably and the total cross-regional travel distance can be reduced to the minimum [16, 17]. In the study of traffic structure planning, by analyzing the effects of different traffic modes on ecology, and according to the established traffic structure optimization model, the optimal traffic structure which aims at the highest traffic operation efficiency and satisfies ecological constraints is solved [18]. Traffic infrastructure planning is the core content of ecological traffic planning. Ecological transport infrastructure planning methods are put forward from three aspects: road network planning, public transport planning, and passenger hub planning [19, 20]. According to the four aspects of the land use model, traffic structure, traffic infrastructure, and ecological status, the evaluation index system including 14 indicators is selected to evaluate the traffic planning scheme [21, 22]. In the research process of ecological traffic planning theory, the improvement of traditional traffic planning methods is mainly reflected in the following aspects: the connotation of the ecological transportation system planning and buffer zone is defined. In this paper, the goal of ecological traffic planning which meets both traffic demand and ecological constraints is put forward, and from the point of view of land use layout, the optimization model of land use layout structure based on the minimum cross-regional travel distance is established [23]. Here, we can see that, in Figure 1, a traffic structure optimization model aiming at the highest traffic operation efficiency is established, and the concept of road network capacity is supplemented in terms of traffic supply capacity. The calculation method of ecological capacity of road network is put forward [24, 25]. The constraints of resources on economic growth are affected by the level of local economic development, industrial agglomeration, technological progress, and so on. If this region has a similar level of economic development and relative shortage of resources with neighboring regions, the two regions will jointly increase investment in technological innovation, form high-tech industrial clusters, and break through resource constraints, which will promote the growth of green total factor productivity in this region and neighboring regions.

For ecological research, most of the energy at home and abroad has been devoted to urban planning, studying how to carry out urban planning in order to meet the requirements of ecology [26, 27]. In these areas, a lot of international works have been published and certain results have been achieved. In the aspect of traffic planning, the research on ecological factors is not much and not deep enough, and all of them are concentrated in each itemized planning, which does not form a complete theoretical system of ecological traffic planning. In this paper, the vehicle distribution route optimization problem under multiresource constraints such as vehicle energy capacity and vehicle loading capacity is studied, and the static and dynamic models of distribution route optimization under multiresource constraints are established. In the static distribution route optimization model, the distribution route optimization problem with subloops is solved by modifying the network structure and adding virtual resource points. In the dynamic model, the spatiotemporal network model is used to avoid the generation of subloops, and the description of the vehicle distribution route planning problem is more intuitive and accurate. The model enriches the vehicle distribution route selection scheme at the cost of expanding the model scale. And it can solve the time when the vehicle arrives and leaves the customer point. The commercial optimization software is used as a tool to verify the above two models, and numerical experiments are carried out.

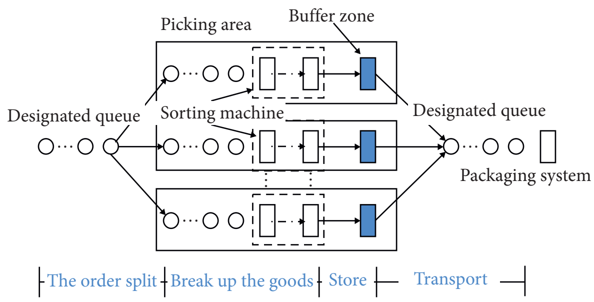

Figure 1: The designated queue in the expanding population.

2. Impact of Resource Constraints on Environmental and Social Problems

2.1. Influence of Resource Constraints on Industrial Production. The shortage of natural resources leads to insufficient supply of natural resources, which is difficult to cope with economic development. In the short term, under the background of the accelerated process of regional industrialization and modernization, the shortage of natural resources will intensify the contradiction between supply and demand of natural resources, directly restrain economic development, and even appear stagnation or retrogression. In the long run, the shortage of natural resources may lead to abnormal development of industrial structure, and economic development will be affected, thus reducing total factor productivity. However, many countries with rapid economic development in the world do not have rich natural resources. These countries change the structure of energy demand and break through the quantitative constraints of resource shortage through technological progress, resource substitution, industrial structure adjustment, and reducing energy consumption. The shortage of resources will force the state and enterprises to increase investment in technological innovation, so as to achieve technological progress. Here, we pointed out that on the one hand, technological progress has reduced the cost of exploiting existing resources; on the other hand, new resources will be discovered and old resources are replaced effectively (such as shale oil, and shale gas and combustible ice). The emergence of each new alternative provides a strong driving force for new economic growth. At the same time, technological progress also promotes the improvement of energy efficiency and the reduction of energy consumption. We also pointed out in the study that countries with shortage of resources will form a system of high-tech industrial clusters and actively optimize the allocation of resources, so that industrial development has to be tilted to low-energy-consuming industries and industries and give up high energy-consuming and high-pollution traditional large and medium-sized state-owned heavy industrial enterprises. It can increase the proportion of technology- and knowledge-intensive industries and focus on the development of high-tech industries.

The constraints of resources on economic growth are affected by the level of local economic development, industrial agglomeration, technological progress, and so on. If this region has a similar level of economic development and relative shortage of resources with neighboring regions, the two regions will jointly increase investment in technological innovation, form high-tech industrial clusters, and break through resource constraints, which will promote the growth of green total factor productivity in this region and neighboring regions. If the two regions have relatively abundant natural resources, both have a crowding-out effect on technological innovation and form pollution-intensive industrial clusters, which will hinder the growth of green total factor productivity in this region and adjacent regions. Resource shortage will intensify the contradiction between supply and demand of resources and cause abnormal industrial development and reduce green total factor productivity. However, if we can realize resource substitution and improve energy efficiency through technological progress, we can break through resource constraints and improve green total factor productivity. Resource abundance will reduce green total factor productivity through the "Dutch disease effect," in terms of trade fluctuation, crowding-out effect, and institutional weakening effect. And resource constraints will also have an impact on green total factor productivity in neighboring areas. Secondly, through the analysis of the mechanism of environmental regulation on green total factor productivity, we can know that environmental regulation also affects the green total factor productivity of this region through technological innovation, industrial structure, and FDI and also affects the green total factor productivity of neighboring regions. Finally, the analysis of the mechanism of the interaction between resources and environmental constraints on industrial green total factor productivity shows that different regions will have an uncertain impact on green total factor productivity when facing different resource constraints and environmental regulations. And the impact of resource constraints on environmental and social problems can be seen in Figure 2. Resource constraints themself have the attributes of public goods, externalities and the integrity of environmental protection, and the cocontrol of pollution in adjacent areas can greatly reduce pollution emissions. Previous reports pointed out in the study that the level of environmental regulation is affected by different levels of local economic development, different levels of implementation of officials, discretionary choices of enterprises, different public awareness of environmental protection, and so on. If this region has a similar level of economic development with neighboring regions, officials' implementation of environmental policies is up to standard, the government and

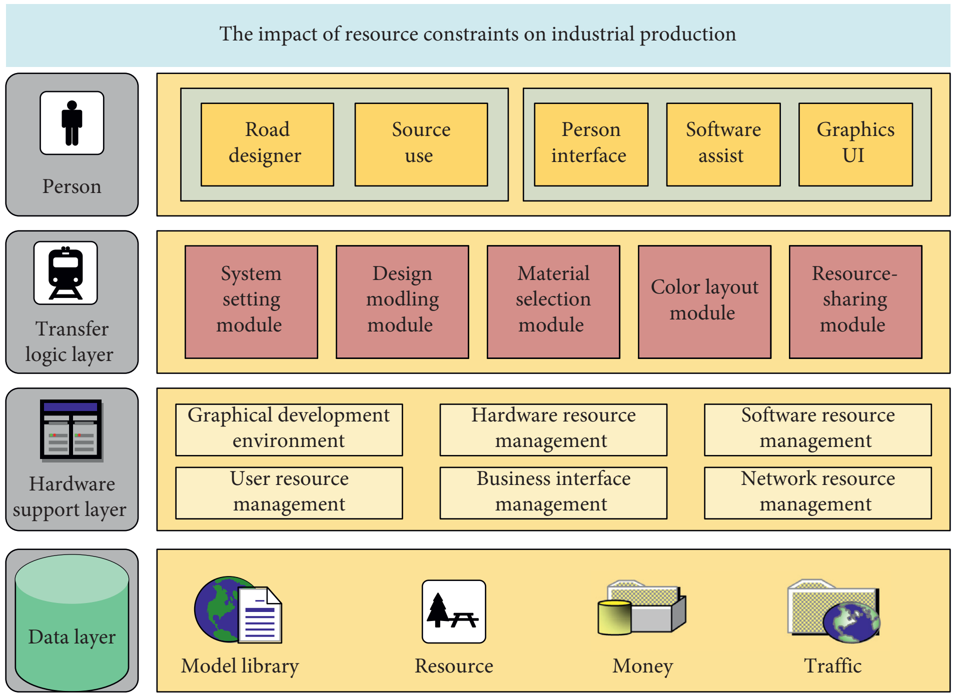

Figure 2: Impact of resource constraints on environmental and social problems.

enterprises increase capital investment in innovation, and the public has a strong awareness of environmental protection. The joint control of pollution by the two regions will promote the growth of green total factor productivity in this region and adjacent regions. If there is a regional environmental gradient difference, it will lead to the transfer of pollution-intensive industries to neighboring areas, resulting in the increase of GTFP in this region but the decline of green total factor productivity in neighboring regions.

2.2. Analysis of Supply and Demand of Resources. As resource constraints, environmental regulation, technological innovation, and foreign direct investment have an impact not only on the region but also on the surrounding areas, it is an important link to expand the existing research to explore the spatial spillover effects of variables such as technological innovation and foreign direct investment on GTFP. Considering the proprietary benefits of spatial Darwinian models (SDMs) in identifying spatial relationships and structural patterns of variables, this paper selects this model to investigate the level of resource constraints and environmental controls, and the effects of various control variables on gtfp. Econometric models are (Figure 3)

$$x_{it} = \rho W y_{it} + \varepsilon_i Y_{it} + \lambda_i \sum W_{ij} Y_{it} + \varphi_{it},$$
$$P = \frac{\sum_{i=1}^{a} x_1 + x_2 + \ldots + x_a}{a}. \tag{1}$$

2.3. Traffic Route Optimization Model. This paper studies the distribution route optimization problem of using multiple vehicles to deliver goods to multiple demand points (customers) from the distribution center (logistics stronghold) under the constraints of a variety of limited resources in the process of vehicle driving. In order to control the warehousing cost, retailers (customers) hope that the upstream distributors will choose a small number of distribution methods for goods distribution, a car usually needs to serve multiple customer points, and the distance required for a vehicle to complete a distribution task is greatly increased. In order to prevent the increase of driving distance caused by insufficient fuel on the way of distribution, refueling stations are added to the road network when planning the distribution route. Here, according to the model of resource and traffic factors, we can see that when the population penetration was in around 1.5 m, the traffic impact can get the most relax as shown in Figure 4.

This paper mainly studies the influence of multi-resource constraints on route optimization. All vehicles can meet the transport demand while achieving less total travel time, and the following conditions are met: (1) to meet the resource change constraint, the vehicle must reach the resource increase point before the vehicle resources are consumed. And the amount of vehicle resources will be increased to saturation at the resource increase point. (2) The demand of each customer point must be met, and the delivery can only be completed by one vehicle, and the number of times the vehicle can visit the resource increase point is unlimited. (3) The distribution vehicle starts from the warehouse to complete the distribution and return to the warehouse.

The static distribution route optimization model is based on the traffic flow and describes the state of the vehicle based on the physical network to increase the resource consumption constraints:

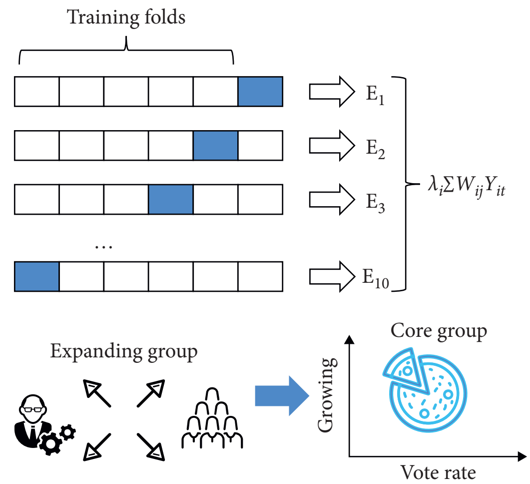

Figure 3: The training fold model for the expanding and core groups.

(1) The objective function minimizes the total time taken by all vehicles to complete the distribution task:

$$R = \min \sum_i \sum_j \sum_k q_{it} x_{ij}^k. \quad (2)$$

In the formula, q_{it} is the time, and it takes for the vehicle to pass through the arc. And $x = dy/s$.

(2) The model considers flow balance constraints, service uniqueness constraints, resource change constraints, and variable value constraints to ensure that vehicles meet the constraints in the distribution route.

Because vehicles are allowed to access the same resource increase point multiple times, the optimal distribution route may include subloops. However, the description of the amount of capital is based on the nodes on the one-dimensional physical network, so it is impossible to express the states of multiple resources on one node; that is, the distribution problem with subloops can not be solved. The direct cause of the subloop in the distribution route is that the vehicle visits the resource increase point many times, so the vehicle visits one resource increase point multiple times into the vehicle visits multiple resource increase points, and each resource increase point can only be accessed once. And the corresponding number should not be less than the number of times that the vehicle needs to visit a resource increase point before conversion. The actual points and their corresponding virtual points are not connected to each other.

3. Result Analysis

3.1. Analysis on the Problems of Passenger Transportation System. The planning of ecological transportation systems is not only a concept but also a practical goal. Combined with the concept of transportation planning, we can define the concept of ecological transport planning for passenger transportation systems after defining the concept of ecological transportation systems: considering transportation constraints in urban passengers and considering transportation requirements and transportation planning and construction, and the concept of transportation planning to minimize environmental pollution and resource consumption caused by the operation of passenger transport systems. The analysis of the implications of ecological traffic planning in passenger transportation systems and the goal of development of ecological transport planning must meet the requirements of transportation demand and ecological constraints simultaneously. First of all, we should not be limited to the traditional traffic planning and only pay attention to facility planning and guide traffic simply from the point of view of meeting traffic demand as mentioned in model 1. At the same time, we should also pay attention to the fact that ecological transportation system planning pursues the optimization of ecological benefits on the basis of traffic planning according to model 2. Therefore, we can not just blindly pursue ecology, while ignoring the most basic functions of traffic planning. Therefore, it can be said that "ecological traffic planning of the passenger transport system" is a higher requirement of urban development for transportation system planning. It is an important way to solve the contradiction between traffic development and traffic pollution to the environment, and the depletion of traffic resources, which has been perplexing us for a long time. Whether it can be realized or not is directly related to the future development trend of the world where the ecology is damaged and scarred. Here, the importance of intervention can be seen in Figure 5, and when the resources are not enough, the intervention could be much more important than human's activities. In order to ensure the sustainable development of urban transportation, it is necessary to introduce environmental protection and optimal utilization of resources into urban traffic planning and change the situation that the only goal of traditional planning is to meet traffic demand, optimize the utilization of resources, and improve environmental quality at the same time. The theoretical framework of urban transportation planning is

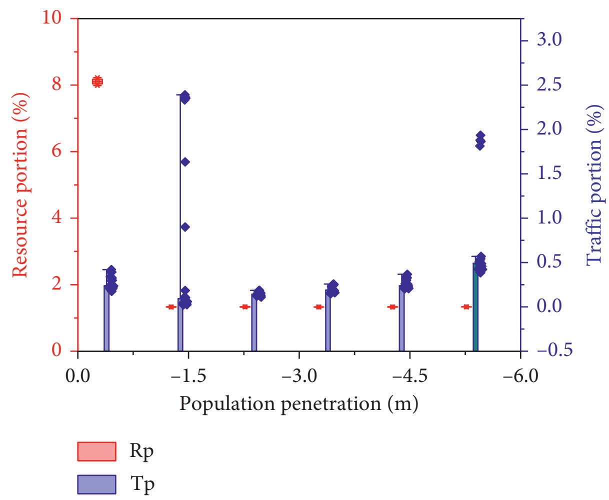

Figure 4: Resources and traffic portion in the population penetration.

established, which is in line with cities's national conditions and is in line with the ecological development of the urban transportation system.

The theoretical framework of ecological traffic planning mainly includes the selection of the land use model, the establishment of ecological traffic structure, the research on the planning method of ecological infrastructure, and the discussion of ecological traffic planning evaluation. The status of urban land use and its spatial structure and shape significantly affect the travel of the urban transportation system. Reasonable urban land use can not only reduce a large number of invalid traffic demand, which can reduce the overall traffic load and traffic imbalance coefficient. Ecological land use planning mainly studies two aspects: reasonable land development intensity and reasonable land use layout. The intensity of land development should not exceed the capacity of the road network under a certain level of service, and the reasonable intensity of ecological land use should be solved according to this train of thought. The mixed land use model is mainly recommended in the land use layout, and the optimal structure proportion of land use can be solved by establishing a land use structure model based on the minimum inter-regional trip. From the point of view of reducing the proportion of traffic demand for cross-regional travel, we can solve the traffic problem and alleviate the traffic ecological pressure. As there are differences in the requirements of various traffic modes for the utilization of resources and environmental pollution, the different choices of urban traffic structure will have a great impact on the ecological development of the city. It even leads to the adjustment of traffic structure in a city or even a country. Therefore, the reasonable planning of traffic structure is of great significance to the ecological development of the urban traffic system. The purpose of traffic structure optimization research is not to put forward the specific traffic structure of a single city but to put forward the methods of traffic structure optimization under various constraints. The optimization of ecological traffic structure is to guide the development of the transportation system to the ecological direction from the perspective of macro strategy. Under the constraints of energy resources, environmental resources, and urban development, a reasonable traffic structure model is established, which takes the objective function as the maximization of traffic efficiency. The ultimate goal of traffic structure optimization is to apply the established traffic structure model to cities of different sizes to guide the development direction of urban traffic. Ecological transport infrastructure planning mainly adds the ecological concept to the road network system, parking system, public transport system, and passenger transport hub system. The capacity of the road network system must have certain restrictions, which can not infinitely expand the capacity of the road network and stimulate more traffic demand. And the layout of the road network should be consistent with the flow direction of traffic demand, so as to reduce detour or uneven distribution. The road network should ensure a certain level of service so that motor vehicles can travel at a uniform speed at their design speed. Ecological public transport planning improves the sharing rate of public transport through the study of reasonable public transport planning methods, mainly through the establishment of line network, station distance, and station location optimization model to study the layout method of the public transport line network. The determination of public transport station distance and the selection of public transport station location are factors to be considered. The ecological passenger transport hub planning can reduce the detour distance of external traffic out of the city by choosing the directional external passenger transport hub mode, and the public transfer hub mainly improves the public transport sharing rate through reasonable layout. For the urban central areas with large traffic demand, it is suggested to use cars or bicycles to improve the public transport sharing rate, reduce the traffic pressure in the central area, and alleviate the ecological problems.

3.2. Perturbation Analysis of Pedestrian Traffic System. Walking is not only the most important way of travel in residents' daily life, but also a healthy and low-carbon lifestyle, which has significant social, economic, environmental, and health benefits. From the traffic point of view, walking can increase the accessibility of public

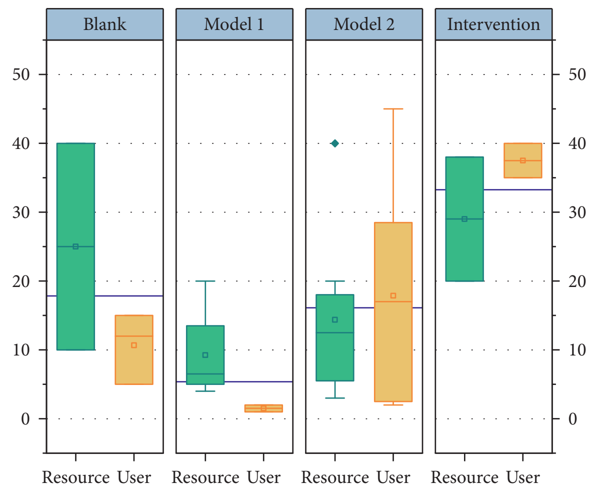

Figure 5: The portion of resource and person in the blank, model 1, model 2, and interventional conditions.

transport and reduce car travel, thus alleviating traffic congestion, air pollution, and other environmental problems. From the perspective of public health, walking means increasing physical activity, improving health, and reducing medical expenses. At present, the international promotion of physical activity has become a priority for the development of public health. A large number of studies have explored the potential correlation and determinants of walking, and more and more empirical studies have provided evidence for the relationship between built environment and walking behavior. Empirical evidence from western developed countries shows that there is a relationship between walking and specific built environments such as population and employment density, mixed land use, street connectivity, accessibility of sidewalks or daily living facilities and proximity, neighborhood type, safety, and aesthetic design of walking environment. In recent years, the research on the relationship between public transport use and walking behavior has gradually become the focus of attention. The study found that the use of public transport is positively related to walking and physical activity, and only walking related to public transport can improve the level of physical activity of public transport users. Compared with those who do not use public transport, public transport users and commuters are two to eight times more likely to reach the recommended amount of pollutant discharge as shown in Figure 6. We analyzed more than 200 empirical literature studies on built environment and travel behavior before 2010 by using the metamethod and found that only three studies took walking as a dependent variable and the distance to a bus stop as an independent variable.

At present, the international related research still has the following main limitations: first of all, most walking studies directly apply the research model of built environment and travel behavior, ignoring that the theoretical framework of travel behavior research is not completely applicable to walking. Even if one chooses to walk to the destination, walking itself may be as important as the destination. Therefore, it is important to distinguish between walking for leisure purposes (such as walking, exercise, or other forms of leisure walking) and walking for transportation purposes (such as walking to the store and walking to work). Some studies have also pointed out that the factors that affect these two types of walking may be very different. Secondly, self-choice has become an unavoidable scientific problem in the study of built environment and travel behavior. The relationship between built environment and walking behavior may come from the effect of self-selection. For example, urban residents who have a preference for public transportation and walking will deliberately choose communities where public transportation and walking are convenient when choosing where to live. In this case, it may be their attitudes and preferences that affect their travel behavior and patterns, not necessarily the attributes of community public transport facilities or the built environment. If self-selection is not controlled, its influence will be mixed into the effects of public transport and built environment, making it difficult to reveal the real influence mechanism. Although the problem of self-choice is one of the frontiers and hotspots in the field of international travel behavior research, only part of the research on the impact of built environment on walking behavior controls self-choice. In the empirical research on cities, there is a lack of consideration of the effect of self-choice. Only in the study, Li Gong and others are mainly concerned about the impact of rail transit on travel mode choice, while Yang Wenyue and others are concerned about the impact of self-choice and built environment on travel carbon emissions. Third, most of the empirical studies on the impact of built environment on travel behavior have not stripped off the impact of urban rail transit. As a result, it is impossible to identify whether the travel behavior is affected by the characteristics of the built environment around the urban rail transit station (such as high density, mixed utilization, and walkable environment), or whether the urban rail transit itself also has an independent effect on it. In recent years, several studies have distinguished the impact of urban rail transit and built environment on travel behavior, but the main dependent variables are the use of public transport, the ownership and use of cars, and the lack of research on walking behavior. For urban development and policymaking, it is important to distinguish the effects of the above confusion. Because if the accessibility of urban rail transit does not have an independent effect on walking behavior, only the built environment needs to be improved. On the contrary, accessible urban rail transit services must be provided. In addition, most of the empirical studies come from the urban cases of developed countries in North America and Europe, which are quite different from the general development model of cities. Due to the period of institutional transformation and rapid spatial reconstruction, there are significant differences between eastern cities and western cities in transportation development, spatial pattern and form, population growth and internal migration, land use diversity, urban design, and so on.

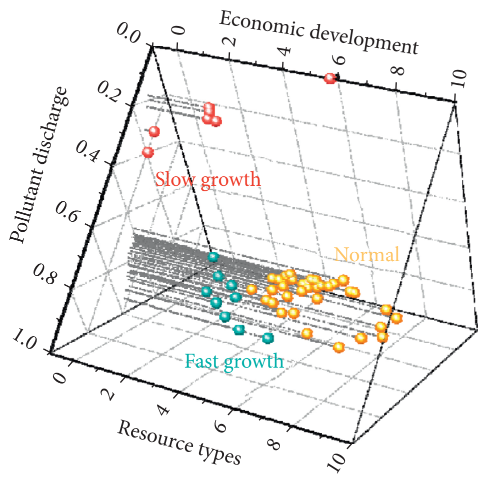

Figure 6: The relationships among economic, resource, and pollutant discharge in different groups.

3.3. Countermeasure Analysis. Therefore, it is difficult to directly apply the framework and results of foreign research. Here, we use multilevel independent variables to estimate the dependent variables, and we can get more reliable statistical results. At the same time, compared with the traditional model, the multilayer model can provide effective estimation of variance and covariance, thus improving the simplicity of the model. In the multilayer model, the intercept and slope of the first layer can be determined by the independent variable of the second layer. In this paper, the first layer is defined as the individual layer, and the second layer is defined as the community layer. The structure of the model is as follows:

$$m_{ij} = \frac{m_{ij}}{\sum_{i=1}^{m} m_{ij}},$$
$$U_j = \frac{1}{\ln m} - \sum_{i=1}^{m} m'_{ij} \cdot \ln m_{ij}. \quad (3)$$

Before building a complete model, it is necessary to construct an unconditional average model with no explanatory variables in both layers. The unconditional average model can determine the correlation degree of walking frequency in the community through variance contribution and, at the same time, indicate whether the community level variation of walking frequency is significant. People who perceive that there is a park or open space nearby have a higher frequency of leisure walking. The findings are similar to previous findings, such as Gilescorti's finding that proximity to large, attractive public open spaces can encourage a higher level of walking. The results of a survey conducted in Portland, Oregon, show that greening and open space are closely related to more frequent walking activities. Empirical studies in developed countries have proved that rare metal and traffic within walking distance from home are positively related to physical activity. For example, Duncan and other studies in Queensland found that there is a strong positive correlation between the wood and oils. This study also confirms this as shown in Figure 7 and recognizes that convenient walking facilities have an important impact on the increase in leisure frequency in leisure. People who are aware of the safety of children's outdoor play and people at the same economic level as local residents will take a leisure walk more often. The results of this study are similar to those of developed countries, and safety is an important factor affecting walking behavior. The objective level of built environment variables does not have a significant impact on the frequency of leisure walking. The result of this study is similar to that of previous studies. The possible reason is that when explaining leisure walking behavior, the individual's perception of the walking environment is more important than the characteristics of the objective community built environment.

It may also be because the objective built environment characteristic variables used here can not well reflect the impact of the built environment on individual leisure walking. The above analysis shows that residents' walking behavior is affected by social and economic attribute factors, travel attitude preference factors, perceived built environment factors, and objective built environment factors at the community level. And there are differences in the effects of perceived and objective built environment variables on walking behavior for different purposes.

This paper empirically studies the effects of urban rail transit, built environment, and self-choice on traffic walking frequency and leisure walking frequency. By comparing the results of the two types of walking frequency models, some interesting conclusions about walking behavior are obtained. First of all, these two models show that self-choice factors such as travel attitude and preference have an important impact on personal walking behavior. People who like walking and public transportation have relatively higher traffic walking frequency and leisure walking frequency. Therefore, the ability to manage travel behavior by shaping the built environment may be limited by obvious residents' travel attitudes and preferences. Second, after controlling the individual socioeconomic attributes and self-choice factors, the built environment has an impact on walking behavior, especially the respondents' perception of the built environment greatly affects the walking frequency. However, traffic walking and leisure walking are affected by different dimensions of perceived built environment variables. Perceived factors such as the appearance of data storage, the quality of bus service, and the convenience of walking facilities have a significant impact on traffic walking frequency. As for the frequency of leisure walking, the main factors affecting the frequency of leisure walking are the perceived accessibility of open space, the convenience of walking facilities, the safety of children, and the identification of neighbors. And the growth rate shows an obvious decreasing with the increasing of model calculating weeks, as shown in Figure 8. However, both traffic walking and leisure walking frequency are significantly affected by the perceived convenience of walking facilities. It can be seen that sidewalks and other walking facilities play an important role in creating a safe walking environment and encouraging walking. Third, there are differences in the impact of objective built

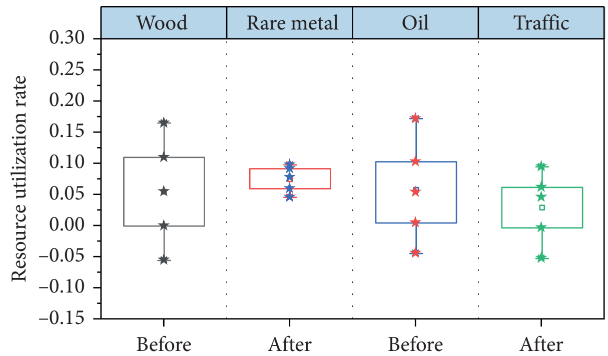

Figure 7: The resource utilization rate.

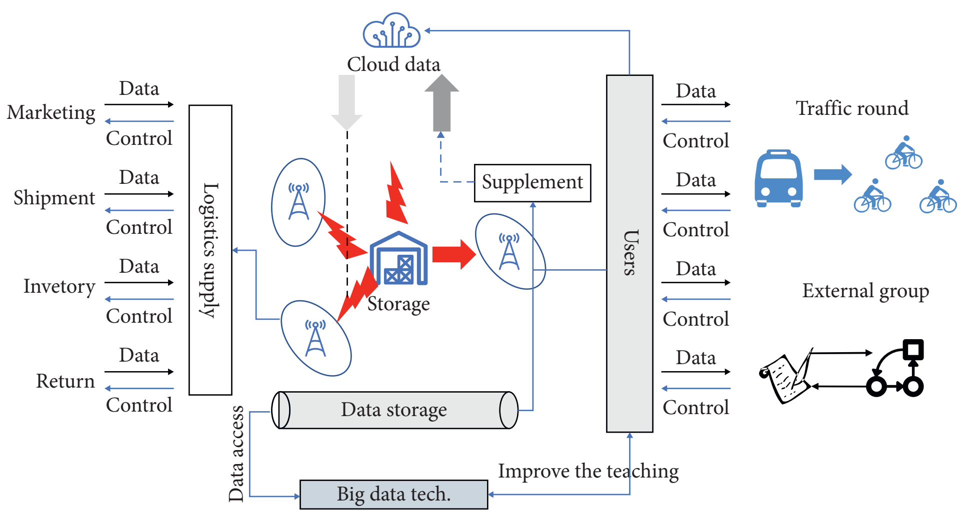

Figure 8: The schematic diagram of logistics supply analyzed by experimental and comparation data.

environment variables on traffic walking and leisure walking behavior. In this study, no significant effect of density was found in either the traffic walking or leisure walking frequency model. In the objective built environment variables, the number of surrounding shopping and catering facilities and the number of conventional bus stops have a significant positive effect on traffic walking frequency. It shows that the characteristics of the business district around the community, shopping accessibility, and public transport accessibility are very important for traffic walking.

Good public transport accessibility and services are of great significance for the promotion of traffic walking. However, for leisure walking, the population density, the number of road intersections, the number of shopping and catering POI, and the number of conventional bus stops objective built environmental variables do not have a significant impact. Therefore, in order to accurately obtain and explain walking behavior and avoid offsetting and underestimating the impact of built environment and population characteristics on walking behavior, it is very important to distinguish different walking patterns in investigation and research. Fourth, after controlling the built environment, self-choice, and the socioeconomic characteristics of residents, the subway still has a significant independent impact on traffic walking frequency. This conclusion affirms the positive role of subway construction, indicating that it has an independent impact on walking behavior independent of the built environment. The conclusion of this study shows that in the relevant planning and policy formulation, the measures to promote walking by improving the accessibility of urban rail transit and improving the built environment are also applicable in the context of cities. At the same time, attention should be paid to the differences in the adjustment of built-up environmental factors based on different travel purposes. In addition, different socioeconomic attributes and attitude preferences of travelers are also important influencing factors of residents' walking behavior. In the context of urban social spatial differentiation and reconstruction in cities, it should be fully recognized that the ability to manage travel behavior by shaping the built environment may be limited by obvious residents' travel attitudes and preferences. At the same time, this paper finds that in the empirical study of cities, the impact of objective built environment variables on walking behavior is different from that of developed countries. In most empirical studies in developed countries, density is usually associated with an increase in walking and physical activity. In this study, no significant effect of density was found in either the traffic walking or leisure walking frequency model. This is also consistent with the conclusions of some empirical studies on built environment and physical activity in cities. Even some empirical studies in cities have found that there is a negative correlation between density and leisure walking and physical activity. It can be seen that due to the significant differences in the social economy and reality between eastern cities and western developed countries, in the context of cities, the relationship between urban rail transit proximity, built environment, and walking behavior may be different from that of western countries.

4. Conclusion

This paper finds that in the empirical study of cities, and the impact of objective built environmental variables on walking behavior is different from that of developed countries. In most empirical studies in developed countries, density is usually associated with an increase in walking and physical activity. In this study, no significant effect of density was found in either the traffic walking or leisure walking frequency model. This is also consistent with the conclusions of some empirical studies on built environment and physical activity. Even some empirical studies have found that there is a negative correlation between density and leisure walking and physical activity. It can be seen that due to the significant differences in the social economy and reality between cities and western developed countries, in the context, the relationship between urban rail transit proximity, built environment, and walking behavior may be different from that of western countries.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by the Fundamental Research Funds for the Central Universities (no. 3102018QD108).

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