A Feasibility Study on "Jin Mo Brownouts"

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Abstract. This paper mainly studies the influence of "Jin Mo brownouts" policy of the city traffic system, using the idea of mathematical modeling to prove the scientificity and feasibility of the policy. Taking the example of Changsha City, this paper analyzes the consumption of time and space resources of the city leading system. We use data analysis and transfer ratio of banned electric car and motorcycle driving on the main road, city road system significantly reduced the consumption of time and space, which proves the feasibility of "Jin Mo brownouts" traffic in the city.

Introduction

With the development of society and economy, the problem of urban road traffic is becoming more and more complicated. Urban road traffic resources are limited, and the safety and environmental impacts of various vehicles, especially motor vehicles, must be controlled. It is unrealistic to satisfy everyone's demands and desires without restriction [1]. Many city has taken the "Jin Mo brownouts", get the support of the majority. It is necessary to conduct a scientific and ideological argument. This paper establish the mathematical model and quantitative analysis without ideological argument about "Jin Mo brownouts", basing on the factors such as the total amount of traffic resources, the structure of traffic demand, the efficiency of all kinds of vehicles and the influence on the safety and environment, which proves the scientific nature of the policy [2].

Overview of Time and Space Resources of Road System

Time and space resource analysis have different description methods in various disciplines, but generally similar[3]. According to the formula method of forming time and space resources of road system, road by the use of different properties can be divided into motor vehicles, non motorized road and sidewalk[4]. According to the classification of urban planning road grade, it can be divided into urban rapid road, urban trunk road, urban secondary road and branch road[5][6]. The total resources of urban roads are the product of the total area of urban roads and the service time of urban roads:

$$R = L \times T = \sum_{i=1}^{4} R_i = a_v \times R_v + a_n \times R_n + a_p \times R_p = a_v \times (L_v \times T_n) + a_p \times (L_p \times T_p) \tag{1}$$

Which: The "R" for road time resources, "L" is used in the area of City Road, "T" for the city service unit time (h),The “R_i” for city for different levels of road resources (such as 1,2,3,4 representing the city rapid road, city road, city road, City Road Branch) The "a_v", "a_n", "a_p" represent the city motor vehicle, non motorized vehicles, the use of the pavement coefficient. The "R_v", "R_n", "R_p" represent the motorized vehicles, non motorized vehicles, the time and space resources of the sidewalk. The "L_v", "L_n", "L_p" represent the use of motorized vehicles, non motorized road pavement area road, The "T_v", "T_n", "T_p" are on behalf of motorized vehicles, non motorized vehicles, road pavement using time (h).

Analysis on the Consumption of Time and Space Resources of Motorcycle and Electric Vehicle

Model Establishment. The use of electric vehicles and motorcycles based on the spation temporal analysis for urban road traffic[7][8]. Define the total amount of time and space resources for the road vehicles for the “*R*”. There is a model formula:

$$R = \sum R_i (i \in I), R_i = K_i \times C_i \times a_i = M \times N \times P_i \times C_i \times a_i \quad (2)$$

Among them: The "R" for all kinds of traffic tools for the total demand of space-time resources. The "R_i" for the I transport for their traffic space resources demand (The "I" type set). The "K_i" for the I class transportation passenger volume per unit time. The "M" calculation of the region's total population. The "N" for the average daily travel intensity calculation area residents. The "P_i" for the I transport residents travel choice rate. The "C_i" for the I class vehicles per capita road space resources share. The "a_i" for the transportation of road resources comprehensive utilization.

The formula for determining the "C_i" of the space and time resources per capita:

$$C_i = \frac{R_i}{Z_i} = \frac{D_i \times H_{di} \times T_i}{Z_i} = \frac{D_i \times H_{ti} \times L_i}{Z_i} \quad (3)$$

Among them: The " C_i" for the I class vehicles per capita road space-time resource quantity. "R_i" for the I transport time and space resources total quantity. The "Z_i" is the number of class I vehicles carrying an average. The "D_i" for the I class vehicle safety driving transverse distance. The "H_{di}" for the I class vehicle driving safety headway. The "T_i" for the I class vehicle average travel time. The "H_{ti}" for the I class vehicle driving safety headway. The "L_i" for the I class vehicle average trip distance. The "V_i" for the I class transportation average speed.

Example Application of the Model. According to the literature access to the relevant data of various types of vehicles, the data of all kinds of transportation is shown as Table 1.

Table1 Data of all kinds of transportation

Index way	walking	bicycle	e-bicycle	moto-cle	index van	car	bus
Average speed	5000	12000	18000	20000	25000	25000	15000
Lateral clearance	0.75	1.5	2	2	3.5	3.5	3.75
Headway	1.8/3600	2/3600	2.2/3600	3.2/3600	3.33/3600	3.23/360	4.991/3600
passenger capacity	1	1	1	1	1	2	50

Data sources: the impact of urban passenger and freight transport on the demand for road resources

The Table 1 data into the type of 3, get in the travel distance under certain conditions (i.e. travel distance is L). The per capita amount of time and space occupied by the road is shown in Table 2.

Table2 The amount of time and space occupied by various travel modes

Index way	walking	bicycle	e-bicycle	moto-cle	index van	car	bus
Per capita road space occupancy /L	00.000375	0.000833	0.001222	0.001778	0.003238	0.001570	0.000102

According to table 3 the data can be drawn that the percentage of all the road resources occupied by the way of travel. From Table 3 we can see that a large proportion of the electric vehicle and motorcycle travel, we can also get electric vehicles and motorcycles on the consumption of space and time is also very large, reaching 28%. That is, nearly 30% of the amount of time and space consumption of the residents' travel road is used for electric vehicles and motorcycles.

The results show that the electric vehicle has become one of the main choices for people to travel, and has considerable influence. In a short period of time. It is difficult to eliminate the formation of electric vehicles and the residents of the dependence on electric vehicles travel simply relying on the prohibition of electric vehicles and motorcycles.

The Influence of Electric Vehicle Travel on the Time and Space Consumption of Urban Road System. It can be said that since the large-scale electric vehicles stationed in the urban traffic system began, a variety of norms for the electric car policy emerge. In the face of electric car violations seem to be repeated phenomenon, many cities do not hesitate to give up the electric car travel this mode to eliminate the problems caused by electric cars. This led to the original transfer of electric vehicles to travel the public had to return to its original mode of transport. Due to the proportion of Changsha electric car travel transfer data is not mature, we choose a relatively perfect transportation system for the transfer of electric vehicles in Shanghai survey data to discuss, see table 4. We assume that the Changsha electric vehicles (EVS) LPG (electric bicycle) ratio of 1 to 1, the transfer traffic volume of Gas Scooter and subway and bus respectively according to the direction of the bicycle transfer calculation. We can get the ban on electric vehicles to travel after the new Changsha travel choice proportion table, see table 4.

Table 3 The amount of time and space occupied by each trip

Travel mode	Trip proportion	Trip volume	Per capita space and time	Total time consumption
Walk	26.7	133.5	0.000375L	500.625L
Bicycle	5.1	25.5	0.000833L	212.415L
Electric vehicle	7.5	37.5	0.001222L	458.25L
Motorcycle	5.2	26	0.001778L	462.28L
Private car	5.6	28	0.001570L	435.96L
Taxi	6.7	33.5	0.001570L	525.95L
Official car	2	10	0.003238L	323.8L
Shuttle Bus	2.1	10.5	0.0005397L	56.665L
Bus	37.9	189.51	0.000102L	193.3L
Other	0.3	1.5	No	No
All modes	100	500.02	No	3169.25L

Table 4 Shanghai electric vehicle traffic transfer scale

	Bus	Bicycle	Walking	metro	Taxi	Gas car	Car	Shuttle Bus	Motorola	Other
Electric vehicle	50%	18%	10%	7%	7%	2%	2%	1%	1%	2%
LPG	46%	18%	8%	8%	11%	1%	1%	3%	2%	2%

Data sources: analysis and Countermeasures of urban electric vehicles

The simulation of electric vehicles is prohibited after the Changsha traffic mode data into the same proportion of 3, still assume that calculation can get a new Changsha city traffic travel time and space resources consumption table travel distance were L cases, see Table 5.

Table 5 road occupancy in Changsha after the traffic volume transfer

Trip proportion	Trip volume	Per capita space and time	Total time
Walking	27.4	137.0	0.000375L
Bicycle	6.6	33.0	0.000833L
Private car	5.7	28.5	0.001570L
Taxi	7.4	37.1	0.001570L
Official car	2.0	10.0	0.003238L
Shuttle Bus	3.6	18.0	0.000539L
Bus	42.1	210.5	0.000102L
Other	1.8	No	No
All modes	100.0	500.0	No

As can be seen from figure two, if the prohibition of electric car travel, most of the original choice of electric vehicles and motorcycles travel people will return to public transport travel. The city public transportation is to solve traffic problems. Because the average passenger preferred public transportation is private transport more, so its per capita from the data, regardless of the road resource consumption, and pollutant emissions data are better than private transportation. Comparison table 5 and figure one can be found, if the electric car travel is prohibited, the total amount of travel time and space consumption decreased by 14%.

Conclusion

We use and transfer the proportional data analysis to get the conclusion that the time and space consumption of the urban road system is obviously reduced after the main road is prohibited. Through a series of model and demonstration, we conclude that the implementation of the "Jin Mo brownouts" policy can effectively improve the local traffic situation. Thus we prove the feasibility of "Jin Mo brownouts" in the city traffic in.

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