Research on Regulation Method of Bus Driver's Total Wages Based on Labor Intensity and Operation Efficiency – A Case Study of Yantai City

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Abstract. In view of the common inconsistency between salary and labor intensity of bus drivers in China, combined with the requirements of the latest policy documents issued in the fields of domestic public transport and purchase of services, aiming at solving the problem of sustainable development of public transport, improving the level of public transport services and improving the efficiency of capital use, and comprehensively considering the labor intensity and operation efficiency of bus drivers, Optimize the regulation method of bus driver's total salary. This method reflects the idea that the wage expenditure of public transport operation is inclined to front-line drivers, while taking into account fairness and efficiency. Finally, taking Yantai City as an example, this paper calibrates the parameters of the regulation method and writes it into the official policy document of Yantai public transport purchase service implementation plan (2021–2023). This result can be used as a reference for government departments and social institutions in similar cities.

Keywords: Public transportation · cost regulation · bus drivers · wages

1 Introduction

With the establishment and acceptance of two batches of "national transit cities" by the Ministry of transport, the development of public transport in China has entered the "post transit city era", and the national strategy of giving priority to the development of urban public transport has become the consensus to guide the development of cities; public transport has also entered the stage of high-speed development, the infrastructure, capacity and service quality of urban public transport have been improved, and the people's livelihood has been improved The degree of satisfaction and sense of gain of the students were greatly improved. However, the bottleneck of sustainable development of public transport has not been solved: (1) the policy deficit of public transport operation is increasing rapidly, the local financial pressure is increasing year by year, and the

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total amount of financial subsidies is growing out of control; (2) public transport enterprises are generally in a state of loss, and the endogenous power of saving expenditure, improving quality and efficiency is insufficient.

In order to effectively solve the above problems and realize the sustainable development of public transport, cities begin to resort out and clarify the responsibilities and rights of all participants in public transport, and actively explore the purchase service mode, capital scheme, operation system and mechanism; among them, the reasonable regulation of public transport operation cost is the main basis for the implementation of public transport purchase service, which is to alleviate the burden of capital. It is an important way to realize the contradiction between the financial subsidy and the development of public transport, and to reflect the rationality, legality and fairness of financial subsidies. For most cities, the salary and wage expenditure of public transport practitioners account for more than 50% of the total operating cost, which has been the focus of attention of all parties. This paper focuses on the regulation method of total salary of public transport main practitioners - bus drivers, and takes Yantai City as an example, based on the labor intensity and operation efficiency of local bus drivers, puts forward some suggestions.

2 Technical Thinking

The specific technical ideas are shown in the figure below (Fig. 1):

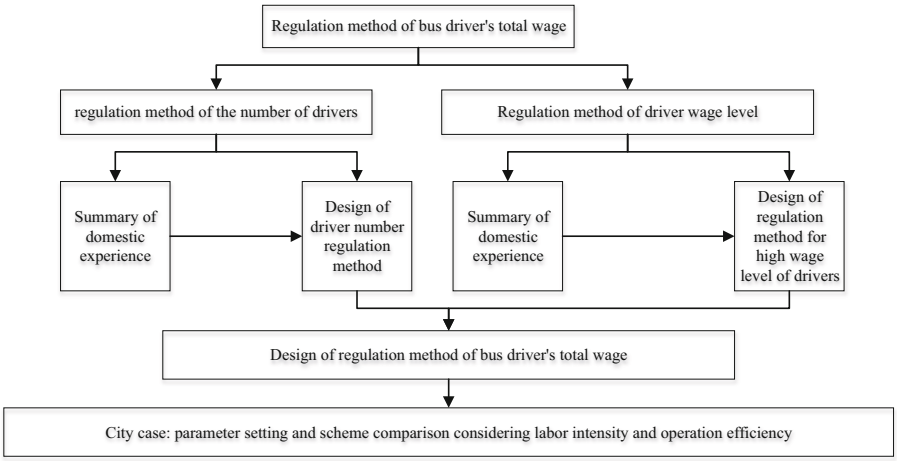

Fig. 1. Research technology route

3 Regulation Method of the Number of Drivers

3.1 The Domestic Common Regulation Method of the Number of Drivers

At present, there are three main methods to regulate the number of drivers in China:

Method 1: Regulate the Number of Drivers Through the Average or Weighted Average of the Actual Ratio of People to Vehicles in Recent Three Years Shijiazhuang, Changzhou and other cities adopt the single index "comprehensive ratio of people to vehicles", while Tianjin adopts "ratio of drivers to vehicles". The formula is: the number of regulated drivers = the number of vehicles × the proportion of regulated drivers. Due to the technological progress and the improvement of enterprise management level, the ratio of people to vehicles is declining year by year. This method has certain rationality and is easy to operate. However, the existing problems are insufficient constraints, different working intensity of drivers in different cities, different road operation environment, different turnover efficiency of drivers and vehicles, and the number of vehicles can not reflect the labor intensity and transportation efficiency Business efficiency is not comparable among different cities.

Method 2: Regulate the Number of Drivers According to the Vehicle Operation Time The required drivers are regulated by departure frequency, legal working days and average number of vehicles. The calculation formula is: average daily departure times of that year × 365/legal working days/annual average number of vehicles. Compared with the first calculation method, this calculation method has the following advantages: it reflects the efficiency of enterprise scheduling and vehicle utilization, and solves the driver vehicle ratio problem. The premise of using this method to calculate the driver vehicle ratio is that the enterprise scheduling and transport capacity allocation are relatively reasonable and efficient.

Method 3: Regulate the Number of Drivers According to the Working Hours of the Whole Year By calculating the ratio of the total annual working hours of drivers to the standard working hours of drivers, the number of drivers is regulated. The calculation formula is: total working hours of drivers on all operating lines/annual working hours of drivers per capita. The standard of annual per capita working hours is 1880 h/person · year - 2432 h/person · year, which is also the calculation method recommended in the industry standard "urban bus and tram enterprise operating cost calculation specification". The advantage of this method is that it fully considers the labor intensity of the driver, and combines with the labor law and other standards to encourage bus drivers not to work overtime. However, there are some risks in this method: (1) regarding the driver's working time as the total operation time, the corresponding efficiency constraints are insufficient; (2) there is a risk that the driver deliberately reduces the operation efficiency, leading to the cost increase.

3.2 Design of Regulation Method to Guide the Number of Drivers to Improve Efficiency

With the development of public transportation informatization, it's easy to obtain the operating mileage and working hours of drivers. Therefore, we can make full use of

the relationship between the total working hours and the standard working hours in the industry standards to overcome the problems of drivers deliberately reducing the speed and increasing the non-passenger time, and establish the regulation formula of the number of drivers as follows:

$$JR = \frac{\frac{ZL}{S}/(1-\mathrm{f})}{Rt} \tag{1}$$

where:

JR——Number of drivers regulated;

ZL——Annual passenger working mileage;

S——Annual average passenger carrying speed, which is related to the degree of bus lane and road congestion in each city, and it is recommended to calculate according to the historical average level;

f——The ratio of non-passenger working time to total operation time is suggested to be 20%–30%;

Rt——The standard working hours of the whole year refer to the industry standard, and the value range is 1880 h/person–2432 h/person.

4 Regulation Method of Driver's Wage Level

4.1 The Domestic Common Regulation Method of Driver Wage Level

For the regulation method of driver level, the domestic cities are basically the same, and the general calculation formula is as follows:

$$\mathrm{JZ} = \mathrm{W} \times (1 + \mathrm{Rg}) \times (1 + \mathrm{a}) \tag{2}$$

where:

JZ——Driver's salary level;

W——the reference salary benchmark, which is generally the average wage of the previous year issued by the government in the regulatory year;

Rg——With reference to the benchmark wage growth rate, which is generally taken according to the average growth rate of the wage benchmark in recent three years;

a——Driver's wage factor.

4.2 Design of Driver Wage Regulation Method Considering Growth Regulation Mechanism

According to the "opinions of the State Council on reforming the wage determination mechanism of state owned enterprises" issued in 2018, the regulation method of driver's wage level linked with public transport service quality assessment is designed.

$$\mathrm{JZ} = \mathrm{W} \times (1 + \mathrm{Rg} \times \mathrm{b}) \times (1 + \mathrm{a}) \tag{3}$$

where, the same index is consistent with the above. Besides,

b——The adjustment coefficient of driver's salary. When the examination result is excellent, the value is 1–1.5; when the examination result is qualified, the value is 0.5–1; when the examination result is unqualified, the value is 0. The assessment of public transport should include cost control, service quality, operation efficiency, support ability and other indicators.

This can effectively avoid the problem that the wage growth is divorced from the service quality assessment, effectively promote the bus companies to continuously improve the level of cost control and service quality, and effectively improve the efficiency of the use of financial funds.

5 Regulation Method of Bus Driver's Total Wage

Based on the results of the regulation of the number of drivers and the regulation of the wage level, the calculation formula of the total wage of drivers is as follows:

$$JZ = JR \times JG = \left[\frac{\frac{ZL}{S}}{\frac{1-f}{RT}} \right] \times [\mathrm{W} \times (1 + \mathrm{Rg} \times \mathrm{b}) \times (1 + \mathrm{a})] \tag{4}$$

where, the same index is consistent with the above.

6 Formula Parameter Value of Comprehensive Labor Intensity and Operation Efficiency - Taking Yantai City as an Example

6.1 Status Assessment

6.1.1 Labor Intensity of Bus Drivers

According to Yantai's bus intelligent system, the annual working hours of drivers are 3268 h, far higher than the recommended value of 1880 h/person–2432 h/person in the industry standard. In addition, through horizontal comparison of the average operating mileage of drivers in various cities, Yantai reached 54817 km/person in 2019, which is much higher than that in other cities. As shown in the figure below (Figs. 2, 3 and 4).

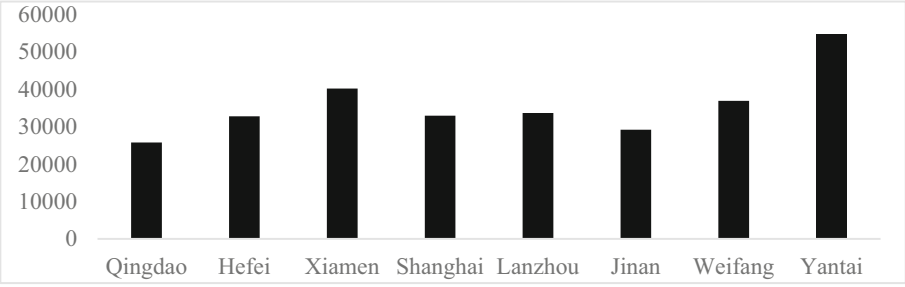

Fig. 2. Comparison of per capita operating mileage of drivers in different cities

6.1.2 Salary Level of Bus Drivers

In 2016–2019, the salary level of bus drivers in Yantai city is 102–112% of the average wage level of Urban Non private enterprises, which is at a high level; however, the average wage converted into 1920 h (the recommended value of cost regulation industry standard) is only 59–65% of the average wage level of Urban Non private enterprises. In contrast, the salary level of bus drivers in Qingdao, Jinan and other cities can reach about 90%. Therefore, under the same labor intensity, the salary of bus drivers in Yantai is at a lower level.

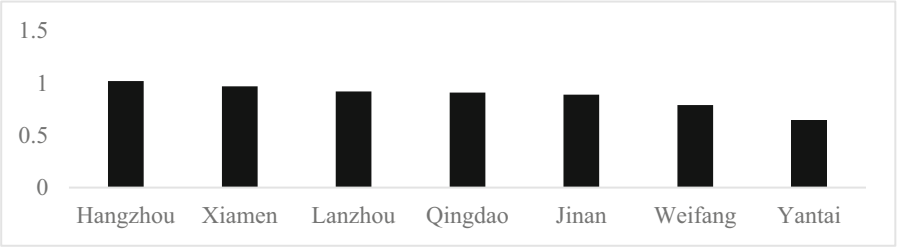

Fig. 3. Converted into 1920 h driver wage/average wage of non-private enterprises in local cities and towns in the current year

6.1.3 Bus Driver Efficiency

The work efficiency of bus drivers mainly involves the setting of two parameters: annual average passenger carrying speed and the ratio of non-passenger working time to total working time.

1. The average passenger carrying speed of Yantai is 23 km/h, which is in the medium level and can be taken as a parameter;
2. Yantai's non passenger working hours (refueling, gas filling, in and out, waiting for duty, etc.) account for 31.4% of the total operation time, which is higher than other cities. This is due to the relatively low efficiency of scheduling. Drivers have long operating mileage and long non passenger carrying time, so the labor intensity is high. Therefore, in the selection of regulatory parameters, we should guide to reduce the labor intensity of drivers and improve the efficiency at the same time.

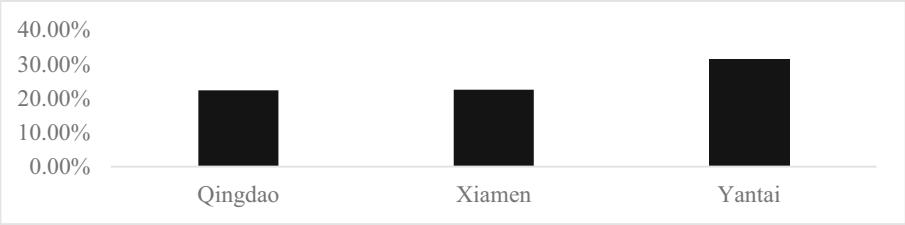

Fig. 4. Comparison of non-passenger working hours in different cities

6.2 Setting of Regulation Parameters

6.2.1 Annual Average Passenger Carrying Speed

In order to give consideration to the efficiency of enterprise transportation organization and the safety of driving, consider the construction objectives of transit metropolis and transit network optimization, and avoid reducing the average speed to increase the passenger carrying time and affecting the service quality, combined with the historical speed data of Yantai urban transit lines, this regulation takes 23 km/h as the regulation.

6.2.2 Ratio of Non-passenger Working Hours to Total Working Hours

Due to the shortage of manpower, the current scheduling efficiency is too low, resulting in long non passenger time. Therefore, while the driver's salary level is close to other cities, the work efficiency should also be gradually close to other cities. With reference to the proportion of other cities, the regulation value is 22.5%.

6.2.3 Reference Wage Benchmark

The average wage of non-private enterprises in cities and towns is chosen as the reference wage.

6.2.4 Department of Wage Growth Control

Design the salary growth control method which is linked with the operating cost control and service quality assessment results of public transport enterprises. When the performance appraisal results of public transport enterprise service quality are excellent, the adjustment coefficient of wage growth is 1.2; when the performance appraisal results of public transport enterprise service quality are qualified, the adjustment coefficient of wage growth is 1; when the performance appraisal results of public transport enterprise service quality are unqualified, the adjustment coefficient of wage growth is 0.

6.2.5 Parameter Setting Considering the Standard Working Hours and Salary Level of Drivers

The following factors should be considered when determining the annual standard working hours per capita and the driver's salary level:

①From the perspective of sustainable and stable development of the industry, the average wage of drivers should not be lower than the average local social wage;

②According to the industry standard, the annual standard working hours are recommended to be 1880–2432 h, and the value should be 1920 h; the wage coefficient should be 115–130% of the average social wage; according to Yantai's 2018 standard, that is, under the 1920 h working intensity, the driver's wage level should be 88%–105% of the average non private urban wage;

③According to the recommended value of work intensity of industry standard, the wage level of drivers in the same type of cities is compared horizontally. The average wage of bus drivers in Yantai is 1920 h, which only accounts for about 65% of the average wage of Urban Non private employees. There is still a big gap between the average wage of Yantai bus drivers and that of other cities (90%).

Based on the above factors, several sets of wage levels are designed as follows:

Among them, under the intensity of 1–3:1920 working hours (3844 approved), the wage level reaches the medium high level in other cities, that is, 96% of the average wage of Urban Non private employees on duty; 2432 h, 122% of the wage level, 2300 h and 115% of the wage level, which is actually different forms of the same total wage; the ratio of the total driver's salary to the average level of the previous three years It rose more than 129 per cent.

Scheme 4–6: under the intensity of 1920 working hours (authorized number of 3844 people), the wage level reaches the medium low level of other cities, that is, 88% of the average wage of Urban Non private employees; 2432 h, 111.5% of the wage level, 2300 h, 105% of the wage level are actually different forms of the same total wage; the total wage of drivers is higher than the average level of the previous three years More than 118% (Table 1).

Table 1. Different schemes of driver wage level and labor intensity parameter setting

		Annual standard working hours	**Approval of number of pilots**	**Ratio to the urban non-private sector in that year**	**Ratio to actual total wage**	
	The actual situation	3268	2506	112.00%		
Close to the average level of drivers in other cities	Option 1	1920	3844	96.00%	129%	
	Option 2	2432	3035	122.00%		
	Option 3	2300	3209	115.00%		
Close to the lower limit of industry standards	Option 4	1920	3844	88.00%	118%	

(*continued*)

Table 1. (*continued*)

		Annual standard working hours	Approval of number of pilots	Ratio to the urban non-private sector in that year	Ratio to actual total wage	
	The actual situation	3268	2506	112.00%		
	Option 5	2432	3035	111.50%		
	Option 6	2300	3209	105.00%		Recommended scheme√

After considering the financial affordability, the relevant provisions of the labor law, the need for sustainable development of the industry and the relatively acceptable number, the regulation recommended scheme 6: 2300 h of standard working hours in the whole year. When the performance appraisal is qualified, the ratio of the driver's wage level to the social non private wage of that year is 105%.

6.3 Regulation Method of Bus Driver's Total Wage

In summary, the formula for regulating the total wages of drivers in Yantai is as follows:

$$JZ = JR \times JG = \left[\frac{\frac{ZL}{S(23\text{Km/h})}}{\frac{1-f(22.5\%)}{Rt(2300\text{ hour})}} \right] \times [W \times (1 + Rg \times b) \times (1 + a)] \tag{5}$$

where, the same letters and values are given above.

The regulation method of bus driver's total salary has been applied to the regulation method of bus cost in the implementation plan of Yantai municipal government's purchase of public transport services, which is used for the budget and approval of Yantai's bus operation cost and service purchase cost from 2021 to 2023.

7 Concluding Remarks

At present, this regulation method has been applied in Yantai, and the application effect is good, which ensures the labor intensity and wage level of front-line drivers. In fact, for the regulation of bus operation cost, the total salary of drivers is only one of the labor costs. In addition, there are other labor costs such as management auxiliary personnel and wage expenses. In addition to labor costs, major cost items such as fuel and power consumption, warranty fees, tire fees, depreciation of fixed assets, leasing fees, insurance premiums and accident losses also need to be regulated by comprehensive design methods and parameters on the premise of considering labor intensity, work efficiency, financial affordability and other factors.

For the purchase of public transport services, cost regulation is only a basis to determine the rationality of the purchase of services. In addition, service standards, service quality assessment, ticket system and fare dynamic adjustment are also needed to maximize the efficiency of the use of funds for the purchase of services.

For a city's public transport, the government's purchase of public transport services is only an incentive way for self-improvement within the industry. In addition, no matter the priority development of public transport, the promotion of attraction, or the construction of transit city, it is neither the responsibility of the industry management department nor the task of one stage in the implementation period of the system, but a comprehensive, long-term and systematic project. It is a long-term task for all cities.

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