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Statistical Analysis of Minor Highway Maintenance Costs

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Abstract: *Minor maintenance and upkeep of highways is an important step in maintaining their good condition, which is of great significance in ensuring traffic safety, improving road service life, and improving service levels. The aim of this study is to analyse the cost of minor repairs and maintenance of ordinary national and provincial trunk highways, and to provide decision-making support and resource allocation suggestions for highway management departments. Through detailed statistical analysis of daily maintenance costs and minor repair project expenses, the impact of different types, traffic flow, and geographical locations of highways on maintenance costs was revealed. Research has found that road maintenance, bridge maintenance, and tunnel maintenance are the most expensive projects, while preventive maintenance and the promotion of new technologies and materials can effectively reduce maintenance costs. Therefore, this article proposes cost control measures such as constructing a cost allocation system, implementing dynamic adjustment strategies, strengthening preventive maintenance efforts, and promoting new technologies and materials, which can help highway management departments to have a more comprehensive understanding of the composition and distribution of highway minor maintenance costs, optimize maintenance resource allocation, improve maintenance efficiency and quality, and provide useful references for the sustainable development of highways. At the same time, this study also provides a reference basis for the development of more effective maintenance plans for ordinary national and provincial trunk highways, which is of great significance for the management and optimization of small maintenance costs for highways.*

Keywords: *Highway, Minor Repair and Maintenance, Cost Management*

1. Introduction

As an important part of modern transportation, highway plays a vital role in the development of social economy and the convenience of people's life. However, as road use increases and time goes on, road wear and damage become increasingly apparent. In order to maintain the good condition of the road, improve the traffic safety and extend the service life of the road, the minor repair and maintenance of the road has become an indispensable link. Highway minor repair and maintenance belong to the daily maintenance of highway, which is the frequent daily operation of highway components (including ancillary facilities) every year, including the cleaning of pavement and other parts; repair of minor damage and sporadic replacement of facilities; grass cutting and branch pruning, snow and ice removal in winter; and emergency treatment for restoring occasionally interrupted traffic. Therefore, a lot of human, material and financial resources are needed, so it is important to conduct statistical analysis of its cost [1]. The purpose of this paper is to make statistical analysis of small highway maintenance cost and provide decision support and resource allocation suggestions for highway management departments. By collecting the data related to highway minor repair and maintenance, including material cost, labor cost, equipment cost, etc., the cost of different types of highway is analyzed statistically, and the influence of highway type, traffic flow, geographical location and other factors on the maintenance cost is discussed. Through this study, we will be able to understand the composition and distribution of highway minor repair and maintenance costs, and provide reasonable resource allocation suggestions for the highway management department. At the same time, we can also reveal the influence degree of road type, traffic flow and geographical location on the maintenance cost, and provide reference for making more effective for ordinary national and provincial trunk highway maintenance plans. Although some studies have been conducted on the cost of minor highway maintenance, there are still some problems and deficiencies. Therefore, the purpose

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of this paper is to fill the gap in the analysis of highway maintenance costs, provide more comprehensive and accurate cost statistical analysis results for highway management departments, and provide useful reference and guidance for the management and optimization of highway maintenance costs.

2. General National and Provincial Trunk Highway Minor Repair and Maintenance Cost Standard

Highway minor repair maintenance fee includes daily maintenance cost and minor maintenance project cost two parts. Daily maintenance costs mainly based on labor cost and small machine usage, mainly including subgrade, pavement, road, bridge, tunnel, culvert, guardrail, greening and garbage disposal, according to different road conditions, according to the specified maintenance times, combined with mandatory maintenance time requirements; minor maintenance costs mainly for labor cost, material cost, repair cost, through road repair, subgrade reinforcement and marking, to avoid the expansion of various diseases and extend the service life of highway.

2.1 Daily Maintenance Expenses

In the daily road maintenance and management, the allocation of various funds is based on detailed data analysis and actual needs. As the foundation of the road, the roadbed needs 2,500 yuan per kilometer per year, covering the shoulder, slope, drainage facilities and other aspects of the renovation and cleaning work. Road maintenance is based on 50 kilometers, the annual cost of 5000 yuan per kilometer, and adjusted according to the increase of mileage; the cost of specific areas is still floating, thus reflecting the importance of road cleaning, water removal and damage treatment [2].

The maintenance cost of bridge and tunnel is calculated according to meters and year. Considering the complexity and safety requirements of bridge and tunnel structure, the assigned cost is used for bridge deck cleaning, drainage facilities maintenance, tunnel lighting and other aspects. At the same time, the tunnel electricity fee is calculated according to the actual cost, reflecting the concept of fine management. However, although the maintenance cost of culverts, guardrail and greening is relatively low, it plays an irreplaceable role in road safety and beautification of the environment. The annual cost of 500 yuan per culvert, 3 yuan per meter of guardrail and 400 yuan per kilometer can keep the facilities clean and intact.

The operating funds, road and shift funds and inspection funds of the service area are also set based on the actual needs and data analysis. The cost of small equipment and safety production are special costs to improve the maintenance efficiency and quality, as well as to ensure the safety of maintenance personnel. The cost of special railway lines is fixed at 378,000 yuan per year, of which 70% of the maintenance funds are borne, that is, 264,600 yuan. This cost reflects the comprehensiveness and complexity of road maintenance work.

2.2 Minor Repair Project Funds

The minor repair project adopts the combination of independent arrangement of county section and bureau measurement, and pays more attention to data-driven and fine management. In the county section, the independent arranged part of the maintenance mileage as the base, according to the standard of 1200 yuan/km year, to effectively ensure the implementation of the minor repair tasks. Specifically, the funds will be mainly used for key projects such as replacement of milestones and 100 meters of piles, repair of damaged ditches and cover plates, replanting and renewal of crossing piles and related warning facilities, repair of kerbs and so on. At the same time, the maintenance of facilities in roads and service areas, and the renewal of structures along the road, such as Bridges, culverts and tunnels, are also included [3]. In addition, it also includes the repair of road markings, the repair of local damage to the guardrail and the treatment of small pavement diseases, comprehensively covering all aspects of the road minor repair project.

According to the above standards, the total amount of annual maintenance funds is 16,551,497 million yuan. Among them, the highway daily maintenance funds occupy the main part, reaching 15,416,461 million yuan, while the funds of the county section of the minor repair project are 1,135,036 million yuan. The cost allocation not only reflects the great importance to the daily maintenance work, but also successfully carries out the tasks of the minor repair project. Through clear fund allocation and specific data support, the road maintenance work can be carried out more

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efficiently, to ensure the safety and smooth flow of the road, improve the quality of the maintenance work, and provide a more solid foundation for the road maintenance in the future.

3. Statistics of Minor Repair and Maintenance Costs of Ordinary National and Provincial Trunk Highways

3.1 Daily Maintenance Expenses

Table 1: Daily maintenance expenses

order number	project name	unit	quantity	unit-price	Amount (YUAN)	remarks
one	upkeep cost	Kms · years	945.863	38754	36656304	
1	Subgrade maintenance	Kms · years	945.863	3000	2837589	
2	Road maintenance	Kms · years	945.863	9000	8512767	
3	bridge maintenance	Rice year	19793	100	1979300	
4	Special inspection of Bridges	Rice year	19793	30	593790	Check at 10%
5	Tunnel civil maintenance	Rice year	12512	150	1876800	
6	Tunnel mechanical and electrical maintenance	Rice year	11592	30	347760	
7	Tunnel electricity charges	Rice year	11592	200	2318400	
8	Special inspection of tunnel	Rice year	12512	30	375360	Check at 10%
9	Culvert maintenance	Tao · years	1525	1000	1525000	
10	guardrail maintenance	Rice year	313641	12	3763692	
11	Green management and protection	Kms · years	945.863	1000	945863	
12	Service area management and protection fee	In the year	11	100000	1100000	
13	Parking area management and protection fee	In the year	17	50000	850000	
14	Operation fee of road class	In the year	54	50000	2700000	
15	Road class heating fee	In the year	54	20000	1080000	
16	Road class inspection fee	Kms · years	945.863	2000	1891726	
17	County section inspection fee	Kms · years	945.863	1500	1418795	
18	Small machine maintenance	Kms · years	945.863	1000	945863	
19	Maintenance of environmental protection costs	Each county section	35062704.5	3%	1051881	Garbage removal and disposal, etc
20	Safety production costs	Yuan · years	36114585.64	1.50%	541719	

The daily maintenance expenses table of ordinary national and provincial trunk highways shows the comprehensiveness and refinement of maintenance work. The total amount of road maintenance funds is 36,656,304 yuan, which is distributed in 20 specific projects, highlighting the complexity and diversity of road maintenance. Among them, roadbed, pavement and bridge, as the core part, occupy a significant proportion; especially the road maintenance cost is as high as 8,512,767 yuan, highlighting its key role in ensuring driving safety and comfort. Due to its particularity, tunnel maintenance includes civil engineering, mechanical and electrical engineering and electricity charges. The high electricity cost indicates the importance of energy efficiency management and energy conservation and emission reduction, is shown in Table 1.

In terms of safety, the significant investment of guardrail maintenance shows the degree of attention to traffic safety, and the establishment of safety production fee further emphasizes the principle of safety first. In addition, the cost of service areas and parking areas also accounts for a certain

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proportion, reflecting the provision of quality services for passing vehicles. As a grass-roots maintenance unit, the cost of operation, heating and inspection provides a strong guarantee for the efficient implementation of highway maintenance. At the same time, the establishment of maintenance and environmental protection fees, also reflects the importance of environmental protection, can be specially used for environmental protection work such as garbage collection and transportation. And the maintenance cost of small equipment, although not outstanding in a single item, but its role in ensuring the continuity of maintenance work cannot be ignored, is shown in Table 2.

3.2 Daily Minor Repair Expenses

Table 2: Daily minor repair expenses

order number	project name	unit	quantity	unit-price	Amount (YUAN)
two	Minor repair costs	Kms · years	945.863	34626	32751851
1	Road disease treatment	Kms · years	945.863	9000	8512767
2	Subgrade minor repair	Kms · years	945.863	4000	3783452
3	Bridge repair	Rice year	19793	100	1979300
4	Tunnel minor repair	Rice year	12512	200	2502400
5	Drainage facilities minor repair	Kms · years	945.863	1000	945863
6	Minor repair of protective structures	Kms · years	945.863	1000	945863
7	Security facilities minor repair	Rice year	313641	20	6272820
8	Greening and planting	Kms · years	945.863	1000	945863
9	Road class maintenance	In the year	54	15000	810000
10	Sign maintenance	Kms · years	945.863	1000	945863
11	Fill the marking line	Kms · years	945.863	5400	5107660.2

4. Control Measures for Highway Minor Repair and Maintenance Costs

4.1 Construct a Cost Distribution System

In the construction of this system, we should first focus on the subgrade, pavement, bridge, tunnel and other important components of the highway. As the cornerstone and skeleton of the highway, its integrity is directly related to the overall performance and safety of the highway. For the subgrade part, attention should be paid to its stability and drainage performance, evaluating whether there are hidden dangers such as settlement and landslide, as well as the difficulty and cost of handling the hidden dangers. For the road surface part, attention should be paid to its smoothness and wear resistance, to assess whether there are cracks, pits and other damage, as well as the repair methods and costs of these damage. For Bridges and tunnels, due to their complex structure and difficult maintenance, it is necessary to carry out more in-depth structural evaluation, clarify the focus and difficulties of maintenance, as well as the corresponding cost budget.

After the completion of the evaluation of each part of the highway, combined with the actual use and maintenance objectives of the highway, a set of scientific and economic cost budget plan is developed, fully taking into account the traffic volume, service life, regional environment and other factors of the highway, as well as the cyclical and urgent characteristics of the maintenance work. By accurately measuring the cost requirements of each maintenance project, an overall cost budget is obtained to provide sufficient financial guarantee for the follow-up maintenance work.

It is not enough to only develop a cost budget, but also to be properly allocated to each conservation project. In the process of distribution, follow the principle of "highlighting key points and taking into account general", and give priority to the maintenance projects that have great impact on highway safety and performance, such as bridge reinforcement, tunnel maintenance, etc. We should not ignore the road surface cleaning, greening maintenance and other seemingly small but related to the overall image of the highway maintenance projects, reasonably allocate the cost budget, to ensure that each maintenance project can get due attention and input. This paper establishes a set of sound supervision and management mechanism, including regular inspection and evaluation of maintenance projects,

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real-time monitoring and auditing of cost usage, and long-term tracking and feedback of maintenance effects. Through this mechanism, this paper can find and solve the problems and deficiencies in the maintenance work in time, and constantly optimize and improve the cost budget and distribution system, so as to promote the development of highway maintenance work to a higher level [4].

4.2 Implement the Dynamic Adjustment Strategy

The occurrence of minor repair and maintenance costs occurs throughout all the stages of daily maintenance, and the implementation of the dynamic adjustment strategy requires the establishment of a set of efficient information collection and feedback mechanism. Based on regular road condition detection, traffic flow statistics and maintenance effect evaluation, accurately grasp the actual situation and demand changes of each section of the highway. While ensuring that the current maintenance needs are met, we should also focus on the long-term development of the highway to ensure that the adjustment of the cost budget and allocation plan does not deviate from the long-term maintenance goals. When formulating and adjusting the cost budget, multiple factors including the overall condition of the highway, the service life, the future growth trend of traffic volume and so on. Dynamic adjustment does not mean frequent, irregular changes. Instead, it should be an orderly and proper adjustment process. Before each adjustment, full demonstration and approval should be carried out to realize the scientific and reasonable adjustment. The adjusted cost budget and allocation plan should also be publicized and explained to relevant departments and the public in a timely manner to enhance transparency and credibility.

4.3 Strengthen Preventive Conservation Efforts

Preventive maintenance is a kind of active maintenance strategy, it according to the condition of the road surface, planned to take preventive measures to maintain the road, change the past passive situation after the road damage, with the best economy. In the whole road use cycle, 3-4 times of preventive maintenance, can save the maintenance cost of 45% -50%, is conducive to reducing the maintenance cost. In the road life cycle theory, the performance of a qualified road is reduced by 40% before 75% of the service life. This stage is called the preventive maintenance stage. If the maintenance is not maintained in time during this stage, the performance will decrease by 40% in the next 12% of the service life time. Therefore, when the road surface is still in good use condition, preventive maintenance measures should be taken to prevent the sharp decline of the road surface condition in time, which can not only obtain a longer road service life, maintain a better road service level, but also produce good social and economic benefits.

4.4 Promote New Technologies and New Materials

In terms of promoting new technologies, focus should be placed on technologies that can significantly improve maintenance efficiency and quality. For example, through the integration of advanced sensors, control system and data analysis algorithm, the intelligent maintenance equipment can realize the real-time monitoring and accurate maintenance of highway conditions, greatly improving the pertinencies and efficiency of maintenance. For another example, nondestructive testing technology can accurately assess the internal damage and remaining life of the highway without damaging the structure, and provide strong support for maintenance decisions.

In the promotion of new materials, priority should be given to those materials with superior performance, environmental protection, durable and reasonable cost, to ensure that the road surface is smooth, smooth and intact facilities in the most economical way. For example, high-performance concrete, new asphalt mixture and other pavement materials, with higher strength and durability, can effectively extend the service life of the highway. At the same time, these new materials are often more convenient and efficient in the construction process, which helps to reduce the maintenance costs [5].

5. Conclusion

Highway minor repair and maintenance is the key link to maintain the road in good condition, improve traffic safety and extend the service life. This paper analyzes the composition and distribution of the daily maintenance and minor repair project costs through the statistical analysis of the minor repair and maintenance costs of the ordinary national and provincial trunk roads. [6-7] In order to effectively manage the maintenance costs, the management measures, such as constructing the cost

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allocation system, implementing the dynamic adjustment strategy, strengthening the preventive efforts, and promoting new technologies and new materials, are proposed to improve the maintenance efficiency and quality, reduce the maintenance cost, and provide decision support and resource allocation suggestions for the highway management department. Through scientific and reasonable cost management and optimization, this paper can better maintain the safety and smooth flow of expressways, and make positive contributions to social and economic development and the convenience of people's lives [8].

References

[1] Li Yuhuan, Shi Xiaoli, Gao Nan. Analysis on performance improvement of highway minor maintenance based on DEA. Foreign Highway, 2023, 43 (02): 253-258.
[2] Lu Yuduo. Study on maintenance cost control of K35-K93 section of National Highway X. Lanzhou Jiaotong University, 2023.
[3] Yang Jihua, Shi Xiaoli, Gao Nan, Lei Qiaoyu. Calculation of minor repair and maintenance cost of expressway subgrade assets. Transportation World, 2023, (09): 129-132.
[4] Liang Zhipeng, Guo Jing, Liu Danhui. The impact of the policy of replacing business tax with value-added tax and protecting the blue sky on road maintenance cost. Highway and Transportation in Inner Mongolia, 2023, (01): 10-13.
[5] Li Xufeng, Cheng Gaoli, Luo Yaqiong, Shi Xiaoli. Forecdiction of highway minor repair works based on time series analysis. Transportation Technology, 2022, (06): 16-19 + 35.
[6] Sharaf A A. Analysis of highway routine maintenance costs. Energy Consumption. 2024.
[7] Shoucun Hu, Haibin Zhao, Jianghui Ji. Statistical Analysis on the Number of Discoveries and Discovery Scenarios of Near-Earth Asteroids. Chinese Astronomy and Astrophysics, 2023.
[8] Turan F K, Tosun Z. Sustainable development of art industry and a statistical analysis of the factors that influence the gallery prices of contemporary artworks. Sustainable Development, 2023. DOI:10.1002/sd.2484.