Intelligent Highway Maintenance Management Technology Based on Internet and Big Data

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Abstract: Driven by the social and economic development, the construction center of our country has gradually shifted to the transportation facilities. Through the construction of traffic facilities, not only can the development of society be promoted, but also people's daily travel can be more convenient, and then people's living standard can be further improved. During the construction of traffic facilities, highway maintenance management is essential. However, there are some problems in the process of highway maintenance management, which affect the effect of maintenance management. Therefore, relevant staff members need to take corresponding solutions to the existing problems to optimize the situation of highway maintenance management. As far as the current social development is concerned, Internet and big data are two common types of technologies, which are widely used in all walks of life. This paper mainly analyzes and discusses the specific situation of highway maintenance management under the background of Internet and big data.

1. Introduction

As far as China's highway maintenance and management is concerned, there are many problems, such as problems in management system, management technology and management personnel. These problems hinder the implementation of highway maintenance and management measures and weaken the effect of maintenance and management. Under such circumstances, the staff need to combine the problems existing in the maintenance management, the specific content of the maintenance management and the development characteristics of the times, and adopt some new technologies to complete the maintenance management of highways, so as to optimize the specific situation of the maintenance management of highways [1]. Under the background of Internet and

big data, the maintenance and management of highways should not only update the traditional management measures, but also introduce some advanced measures, so that the maintenance and management of highways can be guaranteed [2].

2. The Problems Existing in China's Highway Maintenance Management

2.1. The Problem of Maintenance Management System

There are three levels of management systems in China's highway maintenance management, the first is the highway administration, the second is the highway management sub-bureau, and the last is the highway section management [3]. Under the effect of this management system, China's highway maintenance management has made great progress, and the main responsibilities of these management are basically concentrated in relevant government departments and professional management organizations, as shown in Figure 1. Under the influence of this management mode, the highway maintenance management has gradually entered a "Buddhist system" state, which is not only reflected in the weak sense of competition, but also in the low work efficiency, resulting in difficulties and problems in the highway maintenance management [4].
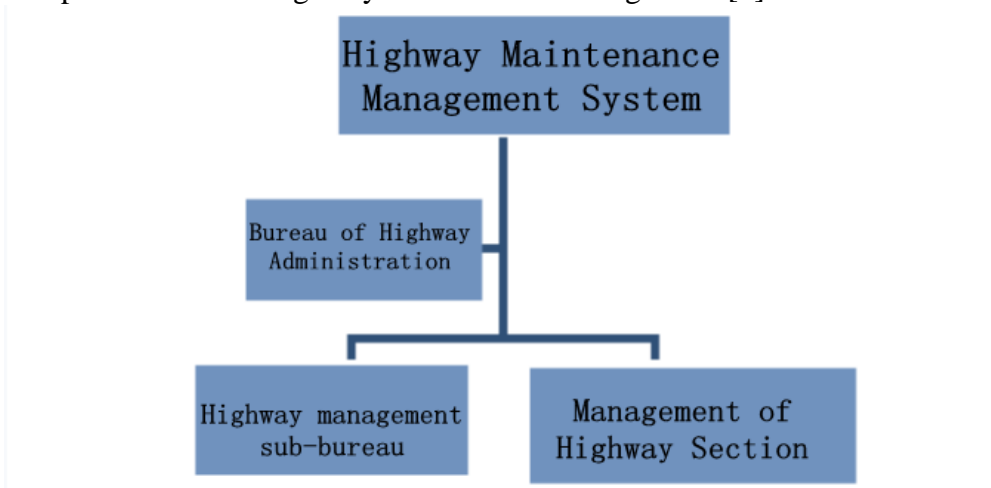
Figure 1. Highway maintenance management system

2.2. Problems of Maintenance Management Technology

Under the influence of social development, highway maintenance management has gradually turned to modern management, and various mechanized and scientific methods are constantly improving their own level, which makes highway maintenance management change from the original manual, miniaturization and simplification into an intelligent, large-scale and diversified comprehensive form, as shown in Figure 2 [5].
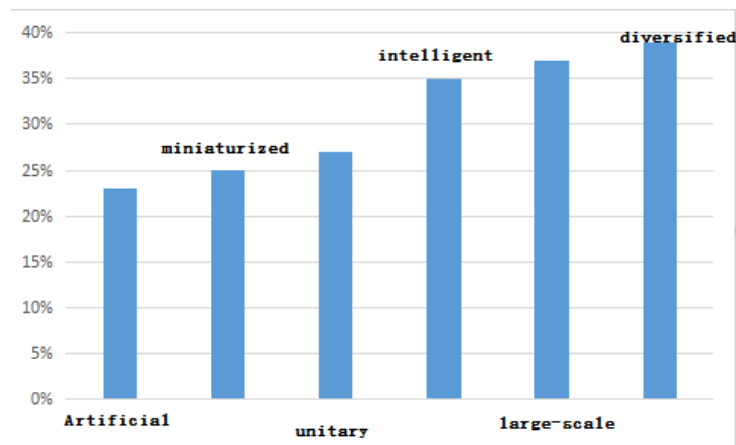
Figure 2. Comprehensive form transformation of highway maintenance management

Through the combination of professional technical equipment, it can effectively reduce the intensity of staff, strengthen the effect of highway maintenance management, and make the process of highway maintenance management more concise and convenient [6]. Under this application trend, the update of highway maintenance management technology has become a key point, but most of the technology updates slowly, and even some technologies follow the traditional form, which makes the highway maintenance management have big problems and limitations [7].

3. Smart Highway Maintenance Management under the Background of Internet and Big Data

3.1. Improve the Level of Highway Maintenance Management through Big Data

As far as big data is concerned, this is an integral part of artificial intelligence, and it can also be a machine learning method. Therefore, prediction is the core element in big data, that is to say, big data predicts the occurrence of unknown events by mathematical calculation [8]. When carrying out highway maintenance management, relevant responsible personnel and some experts will make decisions on specific measures, but this decision may be biased. In this case, the combination of big data can play an auxiliary role in decision-making to a certain extent [9]. Therefore, under some specific conditions, the use of big data technology can improve the level of highway maintenance management [10].

In addition to the improvement of this level, big data technology can also strengthen the early warning ability of highway maintenance management [11]. In recent years, in the highway maintenance management, the staff often find that the highway is in a dangerous state during the patrol or inspection [12]. One of the reasons for this phenomenon is that the staff's collection of highway-related data is seriously lagging behind, which leads to the data not being updated in time. In this regard, through the combination of big data technology, the staff can complete the integration, processing and analysis of a number of data, so that the effectiveness of data analysis can be realized to a certain extent, and the early warning ability of highway maintenance management can be enhanced [13].

3.2. Integrating the Data of Highway Maintenance Management through Big Data

In the process of highway maintenance management, there are three problems in the integration of data. The first is the independence of internal data, and the differences between different management systems are strong, which makes the data between systems in a state of mutual independence; The second is the independence of external data, which means that the relevant data

of highway maintenance management will be handed over to the transportation department on a yearly basis, which makes the circulation between data weak, resulting in the independence of data [14]; The third is the independence of horizontal data, which means that the data of highway maintenance management between horizontal provinces and cities can't be interacted, which makes the data connection between these provinces and cities weak, which makes the data independence more obvious, as shown in Figure 3.
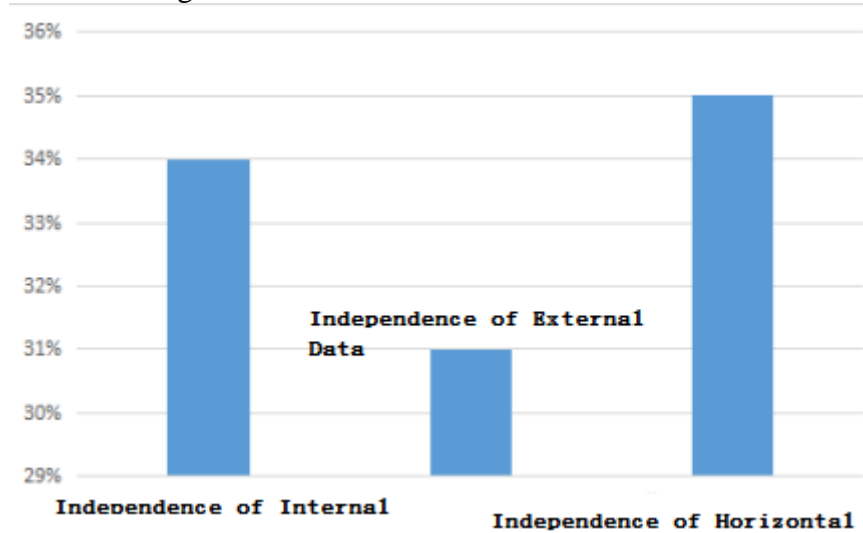

Figure 3. Road maintenance management data integration

Table 1. Evaluation standard grade of pavement maintenance

Evaluation grade	Excellent	Good	Medium	Secondary	Poor
IRI (m/km)	$\leqslant$2.3	>2.3,$\leqslant$3.5	>3.5,$\leqslant$4.3	>4.3,$\leqslant$5.0	>5.0
RQI	$\geqslant$90	$\geqslant$80,<90	$\geqslant$70,<80	$\geqslant$60,<70	<60
RD (mm)	$\leqslant$5	>5,$\leqslant$10	>10,$\leqslant$15	>15,$\leqslant$20	>20
RDI	$\geqslant$90	$\geqslant$80,<90	$\geqslant$70,<80	$\geqslant$60,<70	<60
DR (%)	$\leqslant$0.4	>0.4,$\leqslant$2.0	>2.0,$\leqslant$5.5	>5.5,$\leqslant$11.0	>11.0
PCI	$\geqslant$90	$\geqslant$80,<90	$\geqslant$70,<80	$\geqslant$60,<70	<60

According to the standard grade of highway pavement maintenance evaluation (see Table 1), the combination of the Internet and big data is particularly important in this case. When integrating internal data, it is necessary to aggregate the data between different systems, so that the source of data can be expanded. For example, the integration of data between highway monitoring system and highway management system can visually present the traffic situation of vehicles on the highway. When integrating external data, it can be realized through the construction of highway maintenance management information network, which can strengthen the circulation of data and make the decision of maintenance management more objective [15]. When horizontal data integration is carried out, it can be realized by the way of highway monitoring data transmission, so that the highway data information between neighboring provinces and cities can be interacted, and then the rationality of vehicle driving on the highway can be ensured [16]..

3.3. Discussion on Highway Maintenance Management through Big Data

Under the background of Internet and big data, data information is very important. Therefore, it is an inevitable measure to strengthen the relevant data information in highway maintenance

management, which can not only realize the flow of data information, but also fully display the role of data information, as shown in Figure 4. The strengthening of highway maintenance management data information is mainly reflected in two aspects:
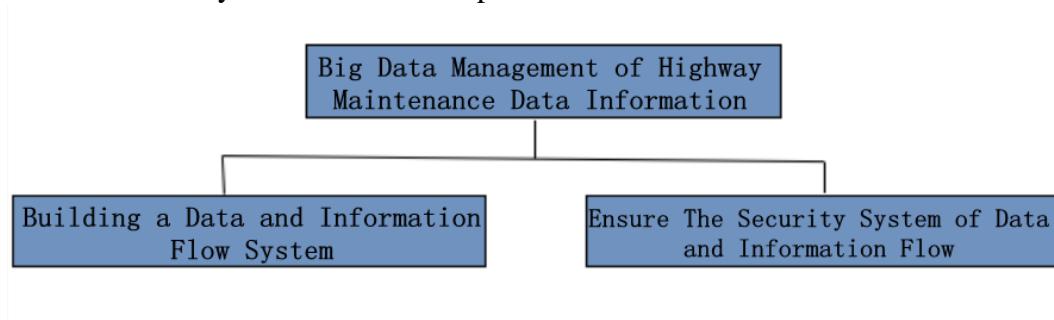

Figure 4. Construction of big data highway maintenance management system

First, build a system of data information flow. The construction of information flow system is directly related to the cooperation of relevant government departments. In this system, the standards, principles and some elements of information flow can be specified, so that the sharing of data information can be realized to a great extent, and information leakage will not occur at the same time [17]. For example, in the process of highway maintenance and management, modified data and testing data can be circulated in an open way, while some highway facilities data and highway positioning data are circulated in a privileged way.

Second, ensure the safety of data and information flow. In the era of Internet and big data, the security of data information is a key point, so relevant staff need to ensure the security of this information in the process of data circulation, so that the practicality of information can be guaranteed [18]. To ensure the security of data information flow, taking responsibility is a major direction, which can not only strengthen the safety awareness of staff, but also cultivate the responsibility awareness of information users.

3.4. Building a System of Highway Maintenance Management through Big Data

In the current social development, the application of big data technology in highway maintenance management can build a corresponding monitoring system for highway maintenance management [19]. The establishment of this system can play a strong role in promoting highway maintenance management, and it can also make highway maintenance management tend to be perfect. Through the construction of this detection system, it can have two effects on highway maintenance management. The first is to strengthen the improvement of highway maintenance management's own road network construction, such as the construction of responsibility and right consciousness, the vertical and horizontal aspects of road network construction, etc. The second is to strengthen the collection of highway maintenance management data information (Figure 5), such as the collection of different grade highway information [20]. In this case, the staff can effectively call the corresponding data information according to the actual situation.
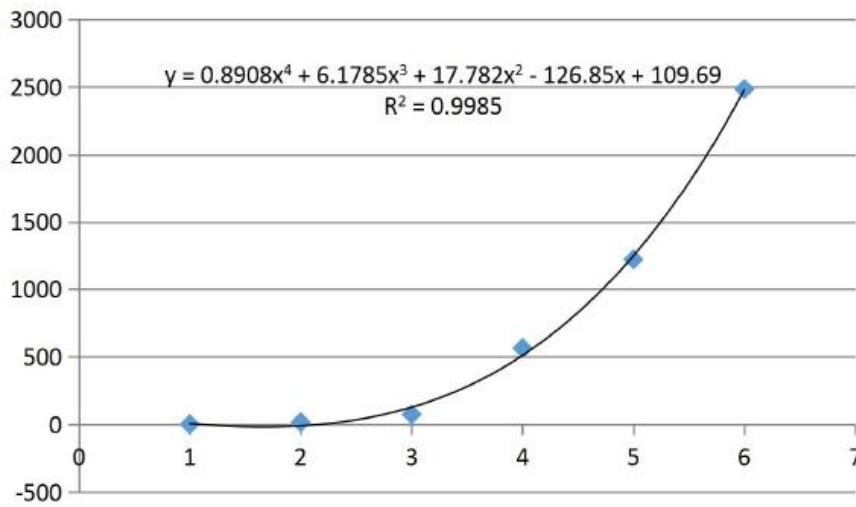
The chart shows the equation $y = 0.8908x^4 + 6.1785x^3 + 17.782x^2 - 126.85x + 109.69$ with $R^2 = 0.9985$.

Figure 5. Statistics of maintenance costs of an expressway in recent 6 years after operation

In addition to the above two aspects, the construction of the monitoring system can also monitor and track the real-time state of the road operation, and this aspect can be used as a decision-making aid. With the help of big data technology, workers can monitor the running status of different grades of highways, and can also collect the monitoring information on the network platform of highway maintenance management. Under such circumstances, the maintenance and management of highways can be shared [21]. In view of this, on the whole, the construction of highway maintenance management monitoring system can promote the highway maintenance management to be scientific and precise to a great extent [22].

3.5. Prevention of Highway Maintenance Management through Big Data

When carrying out highway maintenance management, the preventive maintenance of the highway is a more important content [23]. This aspect refers to ensuring the running state of the highway without changing its own structure and carrying capacity, so as to prolong the service life and service time of the highway. In this kind of preventive maintenance, it is a kind of maintenance mode with "protection" as the mainstay. Through the combination of this mode, the systematic function of the highway itself can be improved, and then the usability of the highway can be guaranteed [24]. As far as highway preventive maintenance is concerned, the combination and application of big data technology play an important role, which can not only make the implementation of preventive maintenance measures more timely, but also greatly reduce the waste of resources [25].

With the help of the Internet and big data, the preventive maintenance and management of highways can combine various factors, such as disease factors, disaster factors and natural factors, so that the staff can take corresponding preventive measures in time according to these situations, thus preventing the possibility of large-scale disasters on highways. Through the implementation of preventive maintenance measures, not only can the effect of highway maintenance management be strengthened, but also the loss of funds in the process of highway maintenance management can be weakened, and then the effect of highway maintenance management can be greatly improved [26].

4. Concluding Remarks

To sum up, under the background of Internet and big data, highway maintenance management needs to integrate various information, such as management innovation, management coordination,

management intelligence, management sharing, etc., which can greatly promote the overall situation of highway maintenance management. As far as highway maintenance management is concerned, this paper mainly analyzes five improvement measures, namely, improvement of maintenance management level with the help of big data, integration of maintenance management data, discussion of maintenance management methods, construction of maintenance management system and improvement of maintenance management prevention. The application of these five measures can not only strengthen the effect of highway maintenance management, but also make the highway maintenance management tend to be intelligent, accurate and developed.

Funding

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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