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Research Article

Coordinated Development of Urban Intelligent Transportation Data System and Supply Chain Management

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With the development of the urban economy, the number of people using various means of transportation is also increasing, resulting in a huge workload of the traffic data system and prone to errors. Supply chain management can formulate a reasonable production plan according to the comprehensive information data generated by the supply chain management system, such as market demand analysis, purchasing demand analysis, and supplier assessment and evaluation. Therefore, this paper proposes the coordinated development of urban intelligent transportation data system and supply chain management, so as to improve the overall efficiency of the logistics system and the level of customer service. This paper aims to study the importance and advantages of the coordinated development of urban intelligent transportation data system and supply chain management. As can be seen from the data in Table 2, the percentage of people using a car increased by 18.2% in 2015, and by 2020, the percentage of people using a car increased by 36.9%. As shown in Figure 10, the traditional urban traffic data management system has the disadvantages of large amount of data and various and complex data types. Among them, the percentage of large amount of data is between 70% and 75%, and the percentage of diverse and complex data is between 62% and 68%. It can be seen that the number of people using cars is increasing, resulting in an increasing workload for the transportation system. On this basis, the intelligent traffic data system should be used to solve this problem and the coordinated development of the intelligent traffic data system and supply chain management can achieve a win-win situation.

1. Introduction

With the rapid increase in the number of motor vehicles, traffic problems have gradually become a worldwide problem. In order to solve traffic problems efficiently and reliably, all countries vigorously develop intelligent transportation systems. Intelligent transportation system is a system that collects and processes traffic information and monitors traffic conditions through modern technology. Traffic data with different structures and complex sources are often stored in intelligent transportation systems. These traffic data contain the inherent laws of the traffic system. Efficient and accurate analysis of traffic data and rational use play a critical role in improving traffic safety and minimizing traffic congestion. The supply chain management system may manage information, logistics, and capital in a fully integrated manner, allowing for coordination and integration.

Transportation plays an important role in urban life, and it is also an important factor restricting urban economic growth and the improvement of residents' living standards. Whether it is to facilitate people's lives or promote social and economic development, high-quality urban transportation is very important. With the rapid development of urbanization, the number of cars is also increasing. People suffer from traffic jams while enjoying the convenience of cars. Urban traffic quality is related to people's tourism efficiency and life happiness index.

The innovation of this paper is as follows: (1) The theoretical knowledge of intelligent transportation data system and supply chain management is introduced, and data mining is used to analyze how data mining plays a role in the research on the coordinated development of intelligent transportation data system and supply chain management. (2) The advantages of the intelligent traffic data system are analyzed in detail, and it is found through experiments that the intelligent traffic data system based on data mining can handle the work better.

2. Related Work

With the rapid development of the economy, the society is also making continuous progress. Liu Yi found that, in a smart city, the intelligent transportation system is very important, and it can make the lives of residents more convenient. The massive data of the Internet of Things can improve the happiness index. Although the scholar put forward his own point of view, there is no specific data to support [1]. Shaukat N found that the use of fossil fuels in transportation became less and less with the advent of hybrid vehicles. Hybrid electric vehicles are not only environmentally friendly, but also inexpensive; therefore, it is necessary to explore and solve these problems. He found electric vehicle batteries to be a promising solution that would help store excess energy and feed it back to the main grid during periods of high demand, which would save energy. The scholar proposed a solution to the problem but did not verify the practicability of the method [2]. Lin J discovered that public vehicle systems can improve traffic efficiency and vehicle occupancy rate, so he proposed an edge computing-based public vehicle system. In vehicle control systems, it not only improves traffic efficiency and vehicle occupancy rate, but also improves traffic efficiency by making travelers more and more satisfied. Although the scholar proposed that edge computing can be applied to public vehicle systems, there is no experimental object to prove the reliability of the experiment [3]. Babar M discovered that a large number of smart devices or objects are connected to each other, expanding the scale of the digital world. Due to the rapid increase in the novelty and number of embedded devices, IoT has become central to transportation system considerations. At the heart of citizens' quality of life is intelligent transportation. In vehicle control systems, this entails the employment of devices and sensors. He presented a big data analytics-based intelligent transportation system architecture. The scholar only proposed an intelligent transportation system architecture using big data analysis and did not specifically describe the usage and characteristics of the architecture [4]. The main purpose of Samarayake is to conduct research on the development of a conceptual framework for supply chains. He developed an integrated framework to integrate components in the supply chain. This framework can provide an integrated approach to the implementation of components but also allows flexibility. The framework proposed by this scholar has not been used in real life, and there is no example to illustrate, so the practicability of the framework has not been confirmed [5]. Rajeev A found that the increasing demand for products and their consumption puts pressure on supply chains, and industrial production brings serious pollution and environmental disasters. To address this problem he proposes a conceptual framework for classifying various problems. Although the scholar proposed a framework, the various factors were not explained or classified [6]. Vanalle RM found that the impact of manufacturing activities on the environment is receiving increasing attention. Manufacturers have taken green supply chain management very seriously to reduce environmental pollution and improve work efficiency at the same time. He explores the pressures observed in automotive supply chain suppliers, using least squares structural equation modeling to process the data. But the scholar did not describe how to use the least squares structural equation model to process the data [7]. Tiwari S found that big data analytics can play a big role in supply chain management. In the current competitive environment, a large amount of work data has brought many challenges to the workers in the supply chain; he did not mention how to play a role [8].

3. Concepts of Intelligent Transportation Data System and Supply Chain Management

Only by analyzing and summarizing massive data can data mining technology be fully utilized [9]. Data mining technology integrates data and then filters useful data to improve people's work efficiency [10]. The application of intelligent transportation is shown in Figure 1.

As shown in Figure 1, from the perspective of the urban traffic management department, millions of traffic flow data and vehicle activity data can be obtained every day using traffic detection devices such as induction coils, radar, GPS, and high-speed cameras [11].

The use of cars is no longer a luxury, and more and more people are buying cars. This paper investigates the number of people who bought cars from 2011 to 2018, as shown in Figure 2.

As shown in Figure 2: The number of selected vehicle trips in 2011 was 56.42 million, and the number of selected vehicle trips in 2018 was 356.73 million, an increase of 300.31 million. More and more people choose to drive for short-term travel and urban life. The continuous increase in the number of people and vehicles and the saturation of urban roads have caused a lot of trouble, reducing people's travel efficiency and also causing the loss of economic benefits and the decline of life [12].

The word "supply chain management" refers to the process of reducing the cost of a supply chain's operation, from purchasing to fulfilling the final client's full process into a single process with the appropriate information system computer management technology [13]. The application of intelligent transportation system (ITS) in supply chain management (SCM) system can improve the efficiency of traffic management, as shown in Figure 3.

As shown in Figure 3: In addition to the establishment of relatively complete urban highway transportation system infrastructure, the infrastructure of each enterprise in the supply chain must also create conditions for information synchronization at each stage of the supply chain [14], but also a traffic information service and an important basic support for road control. In order to reflect the situation of road traffic in real time, we must first be able to mine the data information of traffic flow in time and analyze it accurately [15], as shown in Figure 4.

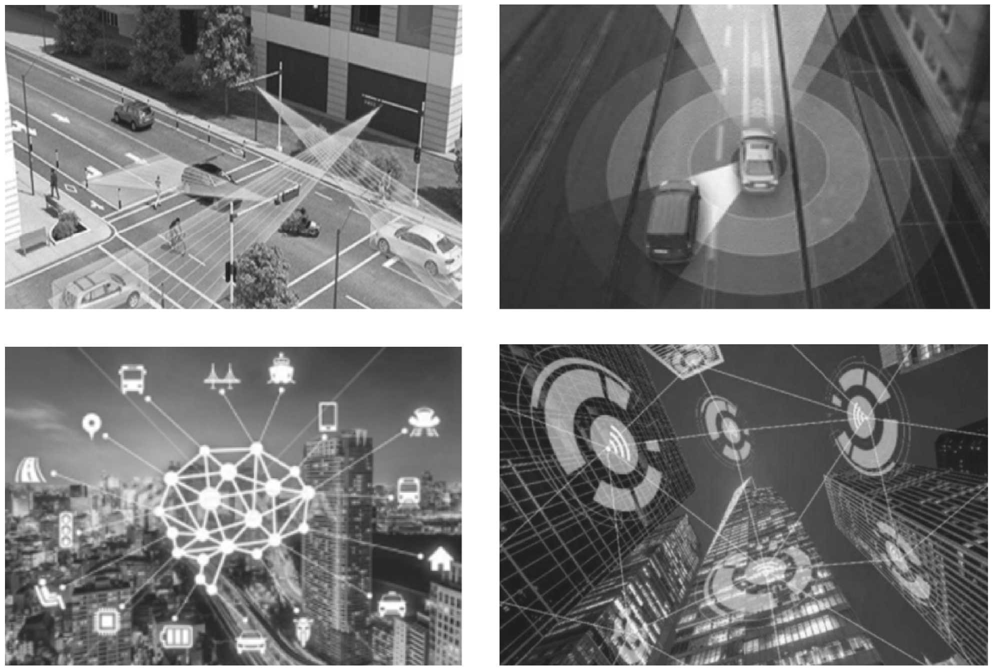

Figure 1: Applications of intelligent transportation.

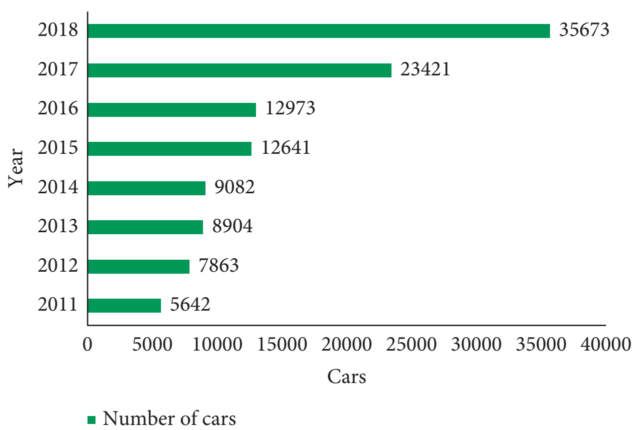

Figure 2: The number of people who bought a car, 2011–2018.

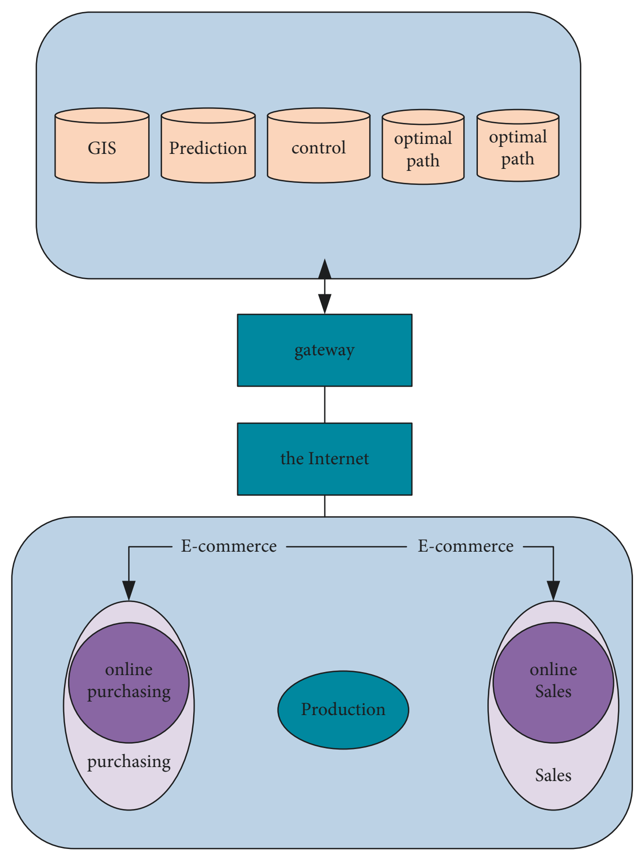

Figure 3: Schematic diagram of the system structure for the coordinated development of urban ITS and SCM.

As shown in Figure 4: The primary problem facing the current traffic is that as time goes by, more and more traffic data are generated, and its types are also more and more difficult to identify.

The timely and effective collection and utilization of these traffic big data can find the reasons for the existence of urban traffic congestion, which can solve targeted problems, lay a foundation for the smooth traffic, and provide detailed information for the decision-making of government departments [16]. As the main data analysis technology, data mining technology plays an important role in effectively collecting traffic data, as shown in Figure 5.

As shown in Figure 5: The main advantage of an intelligent transportation system lies in the timely and efficient processing of information. The gathering, processing, and analysis of data are among the main functions. It can make better use of current traffic infrastructure, reducing traffic congestion and pollution, ensuring traffic safety, and increasing transportation efficiency. To increase the utilization efficiency of traffic resources and reduce traffic congestion, the construction

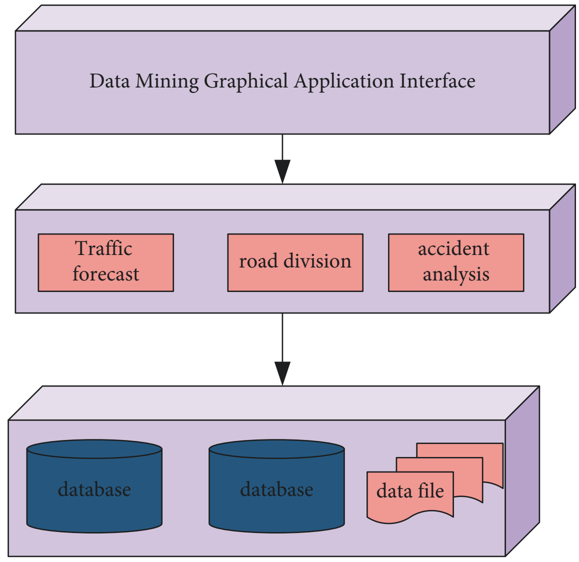

Figure 4: Architecture of intelligent transportation data mining application platform.

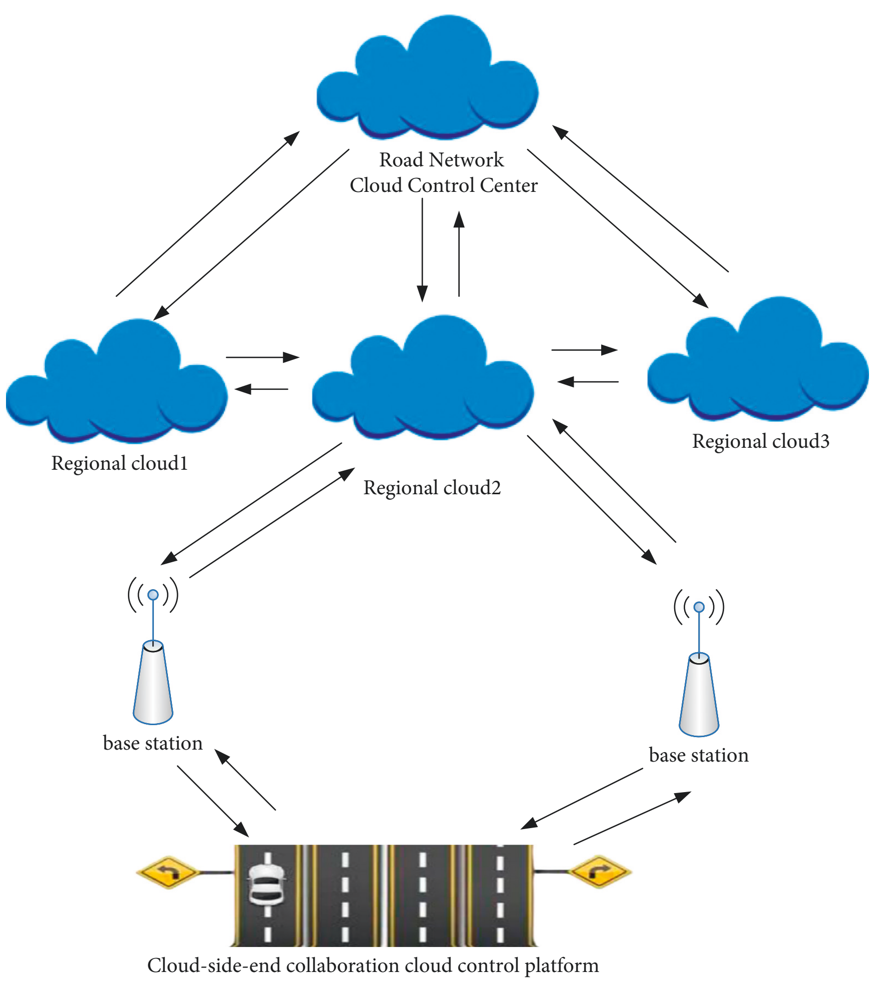

Figure 5: Structure diagram of collected traffic data.

of a comprehensive intelligent transportation system is critical [17].

4. Data Mining Algorithm Applied in Intelligent Transportation System

4.1. BP Neural Network Prediction Model. This structure is simple to understand, the calculating function is powerful, and it is simple to implement [18]. One of the most extensively used neural network models is the BP neural network, which is a multilayer feedforward network trained using the error backpropagation technique. A vast number of input-output pattern mapping associations can be learned and stored by a BP network. Its structure is shown in Figure 6.

As shown in Figure 6, each layer of the BP neural network comprises an endless number of nodes, and each node represents a neuron [19].

The following components make up the three-layer BP network learning process.

4.1.1. Input Mode Forward Propagation. The process of learning convergence is also the forward propagation process of the input pattern. Set the input vector to A_k; then there is

$$A_k = a_1^k, a_2^k, \ldots, a_n^k. \tag{1}$$

In (1), set the desired output vector as B_k, which is

$$B_k = b_1^k, b_2^k, \ldots, b_q^k. \tag{2}$$

In equation (2), $k = 1, 2, \ldots, n$; n is the logarithm of the learning mode, calculated as S_j as

$$S_j = \sum_{i=1}^{n} w_{ij} a_i - \theta_j. \tag{3}$$

It is

$$f(a) = \frac{1}{1 + \exp(-a)}. \tag{4}$$

4.1.2. Backpropagation of Output Error. If these data are wrong or contradict expectations, the network needs to be modified. Calibration errors are usually caused by collision-caused stream corruption and read and write offsets, and this is a calibration error [20]. Output layer correction error:

$$d_t^k = \left(b_t^k - c_t^k\right) f\left(o_t^k\right). \tag{5}$$

The correction error equation is

$$e_j^k = \left(\sum_{i=1}^{q} w_{ij} d_t^k\right) f\left(s_j^k\right). \tag{6}$$

The traffic data prediction research in this paper uses the BP neural network, and the gradient descent method applied in it requires the activation function to have continuous derivatives, and the activation function belongs to a linear

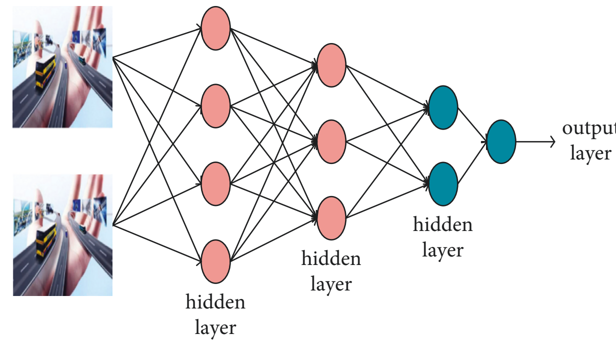

Figure 6: BP neural network.

function [21, 22]. Gradient descent is a popular first-order optimization approach for addressing unconstrained optimization problems. It is one of the simplest and most well-known methods. In addition, the input traffic data structure of this study is complex. When processing complex data, it is necessary to complete the approximation of higher-order functions, and an appropriate nonlinear function should be used as the activation function. Therefore, the final use of this research is the nonlinear function sigmoid function [23, 24]. It is

$$f(a) = \frac{1}{1 + e^{-a}} - 1, \quad -1 < f(a) < 1. \tag{7}$$

In the optimization process of the traffic data prediction neural network, it will be applied to the derivative function $1/1 + e^{-a}$ of the bipolar S function, and the derivative function of the bipolar S function is

$$f(a) = \frac{2\alpha e^{-e}}{\left(1 + e^{-a}\right)^2}. \tag{8}$$

The daily activity period $(1 + e^{-a})^2$ of human beings is roughly fixed, and the vehicle base in the traffic system is large, and the instantaneous change of traffic conditions has little effect on the overall traffic conditions at a fixed period of time every day. Especially after being classified according to the cycle, it can be considered that the vehicle changes in the same period of any Monday in the short term will basically fluctuate within a small range [25].

Taking historical vehicle speed data as input data and predicting vehicle speed in each period as output data, a neural network is established [26, 27]. Among them, a_i is the speed of a certain fixed road section in a certain period of a certain day, and b is the corresponding output predicted value. The prediction equation is as follows:

$$b = G(a_i, \theta). \tag{9}$$

When the neural network is in the learning state, it is necessary to give the neural network a certain initial value, which is a process of optimizing the network by using the objective function. After learning to obtain a stable neural network that meets the actual needs, it can enter the working state of the neural network.

4.2. Cluster Analysis Algorithm (K-Means Algorithm). The clustering method first regards each classification object as a separate class and then selects a pair of classification objects in turn according to the principle of the smallest distance and forms a new class. In this section, an aggregation-based approach is required to segment the traffic data stream; therefore, the K-means clustering algorithm is chosen as the basic algorithm.

K-means algorithm is shown in Figure 7.

As shown in Figure 7: Traffic flow is divided into two peak periods: morning peak and evening peak. In order to improve work efficiency, clustering is required to classify traffic.

The K-means is suitable for processing large-scale datasets and is very efficient and scalable. The K-means algorithm uses distance as a similarity evaluation metric and the farther the two objects, the lower the similarity.

The main task of the data preprocessing step is to standardize the vehicle speed data. Calculate the average absolute deviation S_f, and the absolute deviation is calculated as

$$S_f = \frac{\left(\left|a^{1f} - m_f\right|\right) + \left(\left|a^{2f} - m_f\right|\right) + \cdots + \left(\left|a^{nf} - m_f\right|\right)}{n}, \quad (10)$$

here, $a^{1f}, \ldots, a^{nf}$ is the n-dimensional quantity of the vehicle speed, and the average value of f is 2 m_f as the transformation standard. If calculating the normalized measure of vehicle speed divided by traffic period, it can refer to

$$Z_{if} = \frac{\left(a^{if} - mf\right)}{S_f}. \quad (11)$$

The choice of the number of classifications K in the clustering algorithm has a significant impact on the clustering results. The selection of the K initial cluster center points determines the final clustering result. The criterion for judging the current clustering performance uses the squared difference distance. J of the distances from the object to its cluster centroid is shown in

$$J = \max\sum_{i=1}^{k}\sum_{a\in c_i} di\ st\left(c_i, a\right)^2. \quad (12)$$

The principle of object division is determined by the distance between the object to be classified and the center of each group.

4.3. Support Vector Machine Algorithm for Traffic Congestion Events. Support Vector Machines (SVM) are suitable for classification problems. It mainly searches for the best big data-based urban intelligent bus management system algorithm among the load types of the model based on limited sample information.

The basic principle of SVM is to complete data classification by finding the optimal hyperplane, for example, as shown in Figure 8.

As shown in Figure 8: On a two-dimensional plane, there are two types of samples, orange triangles and green circles, denoted by H1 and H2, respectively. It can be seen that the data in this example is linearly separable, and the straight line in the middle is its hyperplane, which can completely separate the two types of samples.

When classifying data, it is necessary to measure the quality of the current solution by the classification interval or other good indicators. Among them, a represents the sample vector. Bring the sample data point into $g(a)$; if it is greater than 0, it is considered to be class H1; if it is less than 0, it is class H2.

A hyperplane in a two-dimensional plane can be represented by a linear function such as

$$g(a) = wa + b. \quad (13)$$

When classifying, the computer consists of a vector (a_i, b_i) and a label for each sample, as in

$$D_i = (a_i, b_i). \quad (14)$$

Therefore, the interval from a sample point to a certain hyperplane is as follows:

$$\delta_i = b_i\left(wa_i + b\right). \quad (15)$$

If a sample belongs to this category, according to (15), b_i and $wa_i + b$ results are both greater than 0 or less than 0. Normalize w and b and replace them with $w/\|w\|$ and $b/\|w\|$, respectively; then the interval becomes

$$\delta_i = \frac{1}{\|w\|}\left|g\left(a_i\right)\right|. \quad (16)$$

But the above process is to solve the classification problem; what this paper needs is to complete the prediction problem of traffic data. Support Vector Machine Regression (SVR) is an algorithm developed on the basis of SVM, as shown in Figure 9.

As shown in Figure 9: Support vector machine regression is to find a smooth curve $f(a)$ by training the sample data, so that more training samples can be included in the region formed between $f(a) + w$ and $f(a) - w$. In the M-dimensional feature space, the classification hyperplane or approximation function is constructed as follows:

$$f(a) = \sum_{i=1}^{m} w\varphi(a) + b. \quad (17)$$

Among them, the input sample is transformed by φ, and the insensitive loss function is defined as follows:

$$L_w\left(a_i, b_i, f\right) = \max\left\{0, \left|b_i - f\left(a_i\right)\right| - w\right\}. \quad (18)$$

After processing the original traffic flow data, the Euclidean distance is used to measure the similarity search and matching. The Euclidean distance is defined as follows: Assuming that the speeds of the two modes PX_1 and PX_2 are v_1 and v_2, respectively, and the flow rates are f_1 and f_2, respectively, then the distance between the two modes is

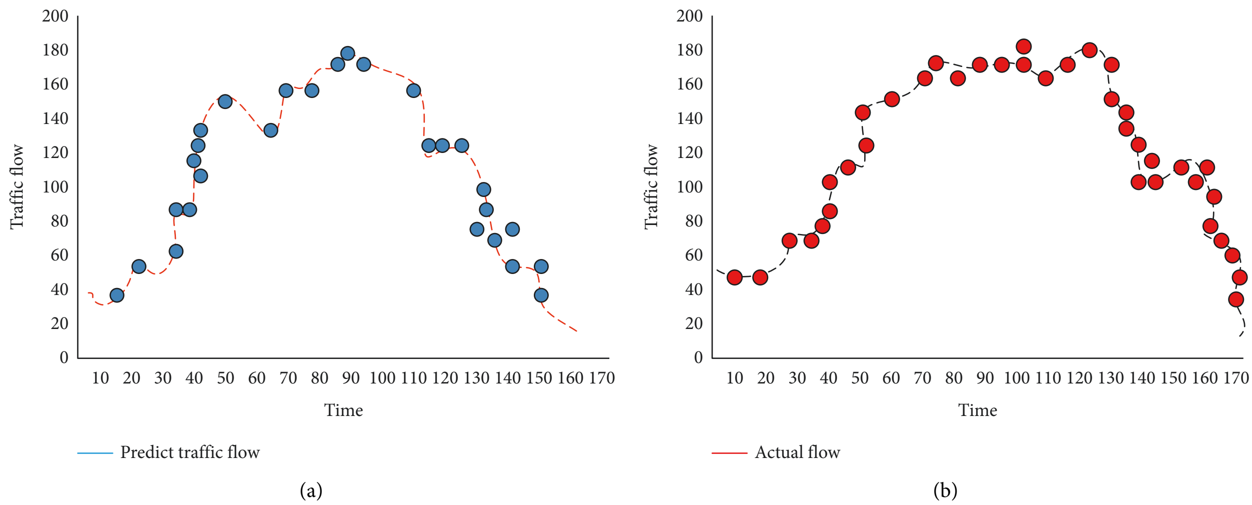

Figure 7: Statistical graph of predicted and actual traffic flow by K-means algorithm. (a) Prediction of traffic flow by K-means algorithm. (b) Actual flow of traffic.

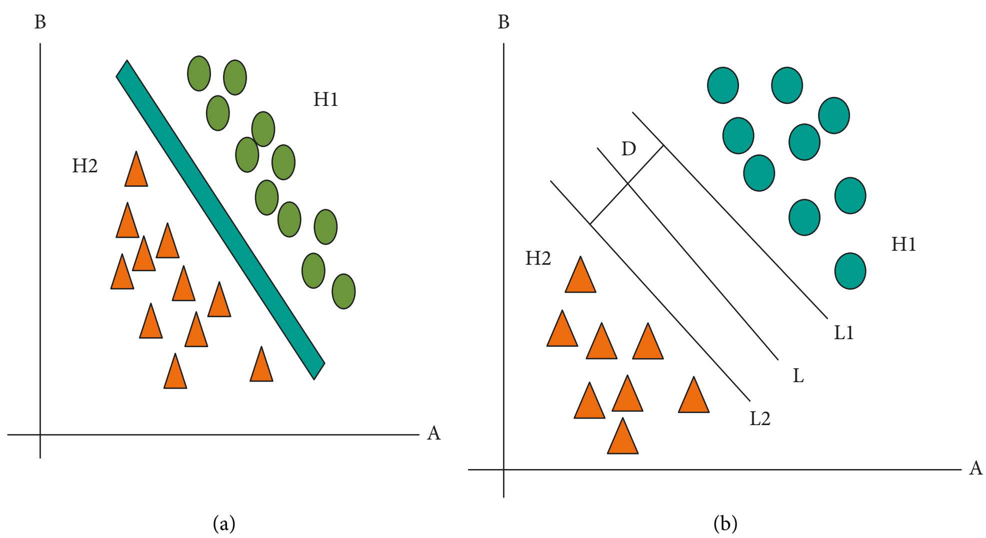

Figure 8: The basic principle of SVM is to find the optimal hyperplane by (a) basic principle of SVM; (b) optimal hyperplane.

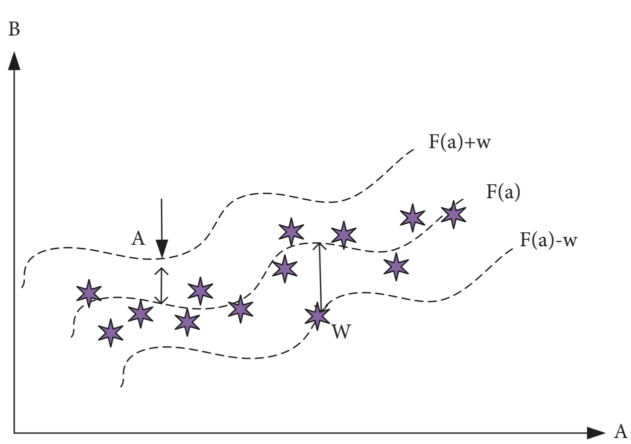

Figure 9: Support vector machine regression.

$$D(PX_1, PX_2) = \sqrt{w_1 (v_1, v_2)^2 + w_2 (f_1 - f_2)^2}. \quad (19)$$

At present, the methods used to test the accuracy of the prediction results of the algorithm model include average error (AE). The comparison of several algorithms is shown in Table 1.

As shown in Table 1: The sensitivity of the average error is 56%, the working efficiency is 43%, and the working error is 0.35, while the sensitivity of the root mean square error is 72%, the working efficiency is 67%, and the working error is 0.16. The square root error is more advantageous. It can reflect the effect of the algorithm well, so this method is adopted in this paper. During the detection process, traffic flow data and all data in the pattern are recorded.

The predicted value is A_1, the number of samples is n, and the calculation equation of the root mean square error (RMSE) is

Table 1: Comparison table of 3 algorithms.

Algorithm	Sensitivity (%)	Work efficiency (%)	Error rate
AE	56	43	0.35
MSE	59	46	0.32
RMSE	72	67	0.16

$$\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{n} \left(A_i - A_1\right)^2}{n}}. \quad (20)$$

To sum up, it can be seen that the parallel machine learning algorithm maintains a consistent prediction effect, and the neural network shows better performance in processing large-scale data.

5. Experiment and Analysis of Intelligent Transportation Data System and Supply Chain Management

5.1. Experiment and Analysis of the Characteristics of the Intelligent Traffic Data System. After decades of sustained high-speed and stable development of China's economy, the development of road transportation has been greatly promoted, which makes road traffic one of the main economic entities. For a long time to come, transportation will be adjusted with the rapid economic development and the development of other industries. In recent years, the construction of basic software and hardware facilities for road traffic has continued to increase, and the number of motor vehicles has increased exponentially. In addition, the number of trips on traffic roads is also increasing, and large-scale traffic projects have been put into construction, such as railways, subways, and light rail transits, resulting in increasing traffic congestion in key urban areas, and the number of traffic accidents has always been high.

This paper analyzes the growth rate of population, the growth rate of automobiles, and the traffic accidents from 2015 to 2020, as shown in Table 2 and 3.

Table 2: Population growth rate and vehicle growth rate, 2015–2020.

Year	Population growth rate (%)	Car growth rate (%)
2015	12.5	18.2
2016	13.6	23.5
2017	16.9	25.2
2018	21.3	27.0
2019	23.6	33.7
2020	23.2	36.9

Table 3: Traffic accidents and fatalities from 2015 to 2020.

Year	Number of security incidents	Percentage	Mortality rate (%)
2015	6532	15	2
2016	7898	19	3.5
2017	8096	21	4.9
2018	15672	24	9
2019	16790	29	10
2020	267845	35	11.6

As shown in Table 2 and 3: the number of traffic incidents in 2015 was 6532, accounting for 15%, and the fatality rate caused by traffic accidents was 2%; the number of traffic incidents in 2020 is 267,845, accounting for 35%, and the fatality rate due to traffic accidents is 10%. The percentage of traffic accidents increased by 20%, and the fatality rate increased by 8%. As a result, traffic accidents are increasing.

This paper compares the management of traffic data using traditional technologies and intelligent transportation systems, as shown in Figure 10.

As shown in Figure 10: There are many types of urban traffic big data, and it is difficult to manage, process, and analyze it in a short time using traditional technologies. Its specific characteristics are as follows: First: the amount of data is huge. The structured data obtained from the urban traffic management department reaches more than 100 GB every day. If it includes media data such as road surveillance videos and mobile phone photos, the amount of data is even greater. And the volume of data imported from related industries and domains, social networks, and public services will be even greater. Second: There are various types of data. From the perspective of data sources, in addition to the data of the transportation industry, there are other data that may affect the transportation industry such as meteorology, environment, and population. Regarding data types, it is divided into structured data and unstructured data.

The characteristics of intelligent transportation data through data mining are as follows:

(1) Rich in value. The big data of urban traffic has rich value. According to scientific analysis, people can obtain necessary traffic information in real time and accurately, so traffic management departments can provide powerful data analysis for emergency decision-making. Intelligent traffic data systems can not only maintain social stability, but also reduce economic losses.

(2) It has obvious timeliness. Decisions such as traffic management and urban planning focus more on the analysis of the latest data. That is to say, there are far fewer historical data references to determine traffic management and city planning than recent data. Among them, the percentage of rich value is 76%–80%, and the percentage with obvious timeliness is 71%–73%. It can be seen that the intelligent traffic data system has more advantages.

5.2. Experiment and Analysis of the Combination of Intelligent Transportation Data System and Supply Chain Management. This paper compares the benefits, customer service levels, and work efficiency of the entire logistics system after applying the intelligent transportation system in the supply chain management system, as shown in Table 4.

As shown in Table 4, after the supply chain management system is applied to the intelligent transportation system, the overall efficiency of the logistics system, customer service level, and work efficiency have been improved.

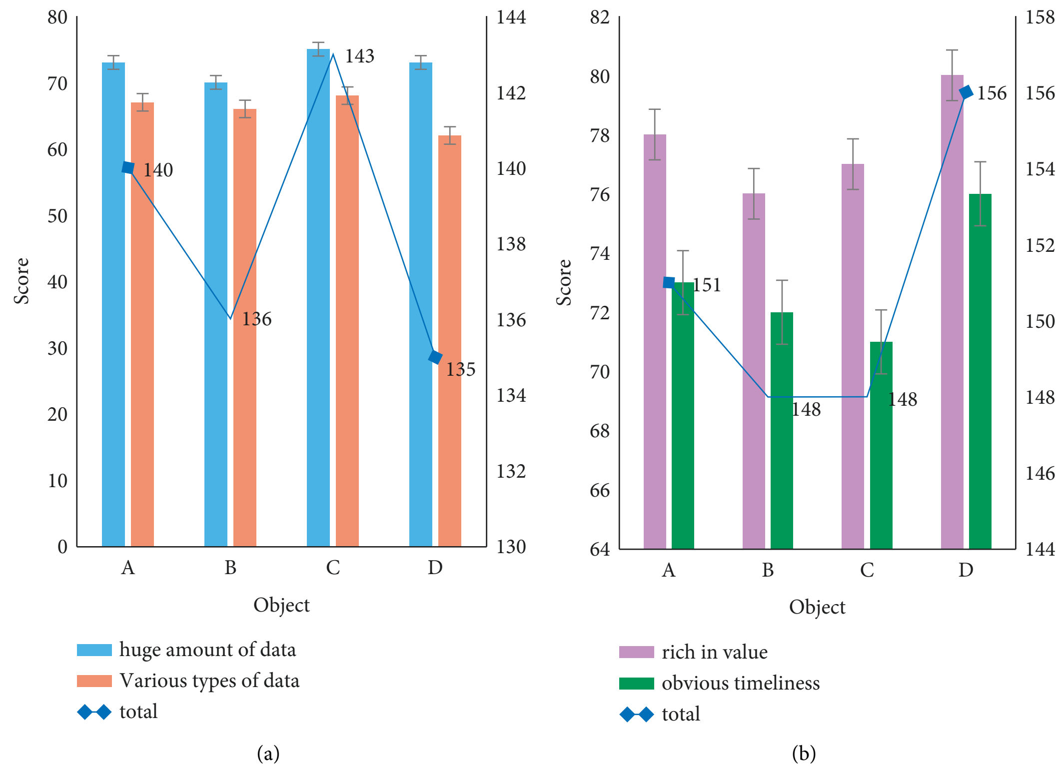

Figure 10: Traditional technologies and intelligent transportation systems manage traffic data. (a) Characteristics of traditional technologies in traffic management. (b) Characteristics of intelligent transportation systems in traffic management.

Table 4: Efficiency after ITS application in supply chain management system.

Analysis object	The benefits of the logistics system (%)	Customer service level (%)	Work efficiency (%)
Single supply chain management	45	51	49
Single intelligent transportation system	42	53	50
Combining the two	78	89	86

6. Discussion

This paper analyzes how to research the coordinated development of urban intelligent transportation data system and supply chain management based on data mining, expounds the related concepts of intelligent transportation data system and supply chain management, and studies the relevant theories of data mining. It explores the importance of the coordinated development of urban intelligent transportation data systems and supply chain management and discusses the role of urban intelligent transportation data systems through survey methods. Finally, it takes the integration of data mining in the coordinated development of urban intelligent transportation data system and supply chain management as an example to analyze the relationship between them.

This paper also makes reasonable use of neural network and cluster analysis. With the widening application of neural network and cluster analysis, its importance has gradually become prominent; many scholars have begun to combine neural network with data mining. Neural networks can effectively predict the information of the traffic data system to get the results people want. Finally, we learned that the coordinated development of urban intelligent transportation data system and supply chain management is of great significance. Through experimental analysis, this paper shows that, with the rapid development of urban economy, the application of urban intelligent traffic data system can greatly improve work efficiency. The coordinated development of urban intelligent transportation data system and supply chain management has improved the efficiency of logistics work and promoted the economic development of enterprises.

7. Conclusions

With the economic development in recent years, cities have become more and more prosperous, but this has also led to more and more congested traffic roads, which has brought difficulties to the processing of traffic data. In this context, this paper proposes an intelligent traffic data system and the coordinated development with supply chain management, which not only greatly improves the work efficiency in traffic management, but also reduces traffic accidents. This paper provides a clear description around the basic concepts of ITS and supply chain management. It proposes data mining technology based on the need to process a large amount of data in the traffic system. In the method part, based on data mining, the function of neural network and cluster analysis in traffic data processing is introduced in detail. In the experimental analysis, the traffic accidents that occurred in recent years are analyzed, which reflects the importance of the application of the intelligent traffic data system. In the experiment, not only the shortcomings of traditional traffic data processing methods, but also the advantages of intelligent traffic data systems are analyzed. Finally, the application of intelligent transportation system in supply chain management system is summarized, and it is found that the coordinated development of intelligent transportation data and supply chain management is of great significance to the transportation industry.

Data Availability

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

Conflicts of Interest

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

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