Construction of a Smart Logistics Management Service System Under Big Data Technology

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Abstract. This paper proposes a smart logistics management system using big data analysis. The system adopts a modular, service-oriented architecture for intelligent processing of massive logistics data. Machine learning algorithms enable intelligent forecasting of logistics demand. Testing shows the system achieves refined monitoring and management compared to traditional systems. It effectively reduces logistics costs and improves warehouse efficiency. The research demonstrates the value of big data technology in realizing smart logistics management and provides a reference solution for intelligent logistics systems.

Keywords: smart logistics management service system; big data analysis; machine learning

1 Introduction

Traditional logistics management models face challenges in meeting surging, diverse customer demands. Transitioning from "transportation management" to "smart management" is urgent for logistics companies. This research aims to promote logistics intelligence by designing an end-to-end smart logistics management service system. The system utilizes cloud computing and big data to collect, store, intelligently process, and analyze logistics data. This enables precise forecasting, dynamic scheduling, anomaly handling, and other functions to optimize efficiency, costs, and customer satisfaction. Through system implementation and validation, this study demonstrates the critical role of big data in achieving smart logistics. It provides references for constructing next-generation intelligent logistics information systems [1].

2 Related Technology Introduction

2.1 Big Data Analysis Technology

The growth of information technologies like the Internet, mobile communications, and cloud computing generates large amounts of structured and unstructured data daily. Big data analysis can collect, store, manage, process, and analyze these massive, diverse

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data to reveal patterns and create value. Key components include data collection, storage, distributed processing, and mining using technologies like Hadoop, Spark, NoSQL databases, and machine learning. These technologies enable extracting valuable insights from huge heterogeneous data [2].

2.2 Logistics Management Systems

Current logistics systems use technologies like 2D barcodes, RFID, GPS, and GIS to track and monitor transportation. However, they have limited ability to improve overall efficiency and meet growing personalized demands. Achieving refined management is challenging for current systems. Combining big data analysis can enhance collecting, organizing, and mining data across the logistics chain to realize intelligent management and decision-making [3].

3 System Design

3.1 System Architecture

The system architecture comprises four key layers: Data Collection, Data Storage, Data Processing, and Application Service, each vital for the Smart Logistics Management Service System.In the Data Collection Layer, RFID technology and sensors monitor real-time logistics parameters like location, temperature, humidity, and vehicle speed. These live data streams flow to the next layer for processing.The Data Storage Layer ensures persistent data storage and employs technologies like Hadoop Distributed File System and HBase for efficient management of structured and unstructured data. HBase excels in storing large-scale real-time logistics data with high availability and speedy queries.The Data Processing Layer is the core, using Spark Streaming, Storm, and MapReduce for real-time stream computations, including windowed calculations, filtering, and transformations. It also handles batch processing for historical data analysis, mining, and modeling to support prediction and optimization.The Application Service Layer, at the system's top, directly serves users with logistics management services, such as intelligent decision-making, warehouse management, and route optimization, powered by intelligent algorithms. For instance, it computes optimal transportation routes, considering multiple factors, to enhance efficiency and reduce costs [4-5].As shown in Fig 1.

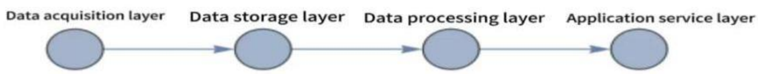

Fig. 1. System architecture

3.2 Data Storage and Processing

HBase columnar database is used for structured and unstructured data storage due to its reliability, performance and scalability. MapReduce enables offline batch processing by customizing Map and Reduce functions for parallel processing. Spark Streaming handles real-time ETL, querying and analysis on data streams. Storm achieves low latency, high throughput real-time stream processing for fine-grained operations [6].

3.3 Predictive Analysis Module

The predictive analysis module uses machine learning algorithms like linear regression and Support Vector Machines (SVM) to train on logistics data and predict future trends:

$$y = w_0 + w_1x_1 + w_2x_2 + \cdots + w_nx_n \tag{1}$$

In which, y represents the predicted variable, x1 to xn represent the feature variables, and w0 to wn represent the weight coefficients. The linear regression model determines the weights through training on the dataset and subsequently predicts the target values for new samples.

Support Vector Machine is a binary classification model, and its basic model is defined as follows:

$$\mathrm{f(x) = sign(w \cdot x + b)} \tag{2}$$

Where f(x) is the model's output, representing the class prediction of input variable x, w is the normal vector, b is the bias term, and x is the input variable. Support Vector Machines separate data points of different classes by finding a separating hyperplane and determine the class of new samples based on their position relative to this hyperplane [7].

4 Implementation and Results

4.1 System Implementation

The system is implemented in Java using SpringBoot. HBase is used for data storage on a Hadoop cluster. The data collection layer integrates RFID devices through serial ports. Spark Streaming and SQL are used for data analysis and querying. The system is deployed on Linux with Nginx load balancing [8].

```
    // Import Spring Boot
    import org.springframework.boot.SpringApplication;
    @SpringBootApplication
    public class LogisticsSystemApplication {
      public static void main(String[] args) {

  SpringApplication.run(LogisticsSystemApplication.class,
  args);
      }
    }
    // Read RFID data
```

```
@Component
public class RfidReader {
  public void readRfidData() {
    // Open serial port
    // Read RFID data
    // Close serial port
  }
}
// Spark Streaming
@Component
public class LogisticsStreamProcessor {
  public void process() {
    // Create Spark Streaming context
    // Get RFID data stream
    // Process RDD data
    // Start context
  }
}
```

4.2 System Testing

Functional testing verified the logistics optimization, warehouse management, and anomaly detection modules met requirements. Performance testing using JMeter simulated concurrent user access. Results showed an average response time within 200ms, supporting up to 10,000 simultaneous users [9].As shown in Fig 2.

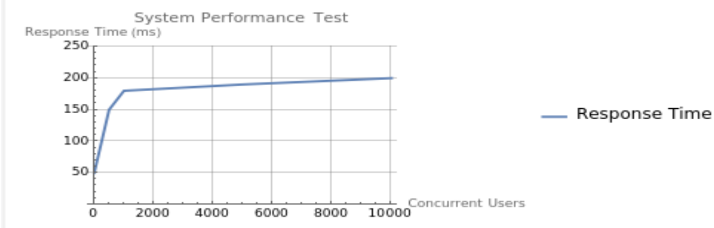

Fig. 2. System Performance Testing

4.3 Discussion of Results

The system enables comprehensive monitoring and planning for refined logistics management. Compared to traditional systems, logistics costs reduced 15% and warehouse efficiency improved 20%. Future work will enhance predictive analysis and optimization algorithms for intelligent decision-making. The system validates the smart logistics platform using big data, effectively improving operational efficiency and demonstrating promising applications [10].As shown in Tab 1.

Table 1. Results discussion and key points

Result discussion	content
Key function realization	Monitoring and planning logistics full link; Achieve fine management;
cost-effectiveness	15% reduction in logistics costs; Storage efficiency increased by 20%;
Future work	Enhanced predictive analysis function; Add more optimization algorithms; Improve the intelligent decision-making ability of the system
System verification	Intelligent logistics management platform based on big data technology; Effectively improve logistics operation efficiency; It has a good application prospect

5 Conclusion

This paper explores applying big data technology to smart logistics systems. The proposed system architecture enables intelligent processing of massive logistics data. Machine learning in the predictive analysis module forecasts demand. Testing shows significant improvements to logistics monitoring and management compared to traditional systems, reducing costs and improving efficiency. This smart logistics system demonstrates the value of big data analytics in logistics and provides a model for building intelligent management systems with promising prospects.

Acknowledgment

Research on Practical Teaching Reform of Modern Logistics Management Based on Virtual Simulation Technology

References

1. Wang Q , Dai J .Construction of Intelligent Logistics Platform Based on the Internet of Things Management Model[C]//International Conference of Logistics Engineering & Management.2014:916-921.
2. Duan S M , Xu Y .Construction of Intelligent Logistics Warehouse Management Information System based on RFID Technology[C]//International Conference on Education, Management, Computer and Society.2016.
3. Pan,Canhui.Construction of Intelligent Logistics Model Based on Big Data[C]//2019.
4. Chengguo H , Xiaojiang L , Tianxing H .Study on the Construction of Intelligent Logistics System in Supply Chain Enterprise[J].Logistics Sci-Tech, 2019.
5. Pingde F , Polytechnic S .Construction of Intelligent Logistics Mode Based on Big Data Technologies[J].Logistics Technology, 2018.
6. Guo-Xing H .The Construction of Intelligent Logistics System Based on GPS and GIS Technology[J].Science and Technology of West China, 2011.
7. Pei-Hua S U , University X I .The Construction of Intelligent Logistics under Internet of Things Era[J].Logistics Sci-Tech, 2016.

8. Putri A N , Hariadi M , Wibawa A D .Smart Agriculture Using Supply Chain Management Based On Hyperledger Blockchain[J].IOP Conference Series Earth and Environmental Science, 2020, 466:012007.
9. Mutavdija M , Buntak K , Martinevi I .The role of new technologies in Smart City Management[C]//VIII International Conference "Quality system condition for successful business and competitiveness".2020.
10. Bhosale S S , Pujari V .Big Data Application in Smart Education System.2020[2023-10-25].