Scholar Publishing Group
Kinetic Mechanical Engineering
https://doi.org/10.38007/KME.2021.020205
ISSN 2790-2676 Vol. 2, Issue 2: 36-44

Effective Method of Railway Construction Machinery Management Integrated with Cloud Computing

Diana Mads*

KEMRI Wellcome Trust Res Programme, Kilifi, Kenya

**corresponding author*

Keywords: Cloud Computing, Railway Construction, Construction Machinery, Management Systems

Abstract: The railway large road maintenance machinery is to be cut by broken glass track automatically starts a way, dial a way and tamping maintenance railway line highly automatic large road maintenance machinery, which is widely used in our country railway works system. This paper mainly studies the effective method of railway construction machinery management integrated with cloud computing. In this paper, the railway construction machinery management information platform as the research object, relying on the actual project, on the basis of the study of its characteristics combined with the theory of cloud computing, a railway engineering information platform based on cloud computing. The field experiment verifies that the system runs stably and reliably, and the data collection is real-time and accurate. It can be widely used in the current construction machinery management system, which solves the shortcomings of traditional construction machinery management and improves the quality and efficiency of the project.

1. Introduction

Since 1980s, our country began to introduce a large scale maintenance machinery from abroad. After continuous development for more than 30 years, our railway is equipped with more than 5000 sets of large type of maintenance machinery equipment. Citing technology and remarkable achievements of independent innovation for many years [1]. Through manufacturing technology introduction and absorption, mechanical main suitable model has been implemented in the current railway are the localization, a project has covered the main railway lines, rail and tunnel mechanical cleaning sieve, lines and rail tamping, line with a frantic jumble cosmetic and stability, rail grinding and a series of form a complete set of equipment, a variety of diseases on different lines to realize effective governance, Compared with traditional public works units, the operation quality and efficiency are greatly improved [2]. With the continuous expansion of the road network in China, the pressure on the maintenance of lines continues to increase, the number of large road maintenance machinery equipment also continues to grow, so that the overall equipment technology level and application level of Chinese railway large road maintenance machinery has gradually entered the world advanced ranks [3]. With the continuous improvement of the application level of large-scale road maintenance machinery, exploring a set of safety system suitable for the management of large-scale railway road maintenance machinery has become a new topic [4].

After more than a century of development, railway has become an indispensable part of the transportation plate [5]. Japanese and European railways developed earlier. Compared with the last century, the ideas, methods and methods of railway safety management in developed countries have been greatly changed. With the establishment of the safety management system and promotion, these countries on railway safety management thoughts, the successful application of modern safety management system and railway safety management, in the management of outstanding system safety concept, affecting the safety of person, machine, environment, pipe and other factors all include, take the comprehensive management and scheduling systems [6-7]. In the process of safety management, always strengthen the construction of railway safety laws and regulations, the implementation of management law; At the same time, the research and development and application of advanced driving safety monitoring equipment are strengthened through scientific and technological progress. With the continuous development of digital network technology and communication technology, remote centralized management and scientific analysis of safety information in the transportation process can be realized [8-9]. At present, the large maintenance road machinery in China is established by the corresponding railway bureau of machinery section unified management, responsible for the application, maintenance and overhaul of equipment, adhering to the traditional management mode of railway system. The operation of large-scale railway road maintenance machinery is field operation, and the operating environment changes frequently. At the same time, due to unfavorable factors such as the low education level of operators, the opening of V-shaped skylights, bad weather, and the frequent replacement of outsourced construction teams, the inevitability and contingency of safety management determine the difficulty and complexity of safety production: Inevitability means that the law of accident statistics shows that long-term management is out of control, a large number of hidden dangers exist, and the final result will inevitably lead to an increase in the probability of accidents. However, the time, place and consequences of accidents are unforeseeable, which is also a prominent manifestation of contingency, so it is difficult to prevent accidents [10].

Based on cloud computing technology research to establish a set of suitable for enterprises in our country are the machinery and safety management system, effect a radical cure in our country are the machinery enterprise security management difficult, disorderly, some problems, after the implementation is engaged in the management, make management to advance management, change passive to active, realization of accident prevention in advance, the radical problems of safety management from the source, Establish a long-term safety management mechanism.

2. Railway Machinery Management System Based on Cloud Computing

2.1. Cloud Computing and Key Technologies

As an emerging computing model, cloud computing has attracted widespread attention since it was published. The so-called cloud computing is a distributed computing capability provided by the network [11-12]. The initial purpose of cloud computing is to improve students' experience in network development. Since it was first proposed, cloud computing has become one of the fastest developing technologies in the computer field, and the general trend of development is defined as more openness, integration and intercommunication [13].

Cloud computing has three service modes, namely Iaas (infrastructure as a service), Paas (platform as a service) and Saas (Software as a service) [14].

Iaas service is located at the lowest level of cloud computing service, which is required by most small and medium-sized enterprises to provide the hardware and the most basic software resources to each user in a service mode. This layer provides users with the service of renting computing resources, which is developed in response to the development requirements of most small and medium enterprises in enterprises. Users can install the operating system and other software according to their own needs, and do not need to own their own data centers and hardware equipment, thus avoiding the maintenance of hardware equipment [15].

Paas platform is based on Iaas service. This platform is managed by a third party, which is not directly connected with ordinary users, but directly connected with technical personnel. This service layer is a form of software service. Although this platform is managed by a third party, users can use the public applications provided by it to build the required applications on this platform and enjoy the management rights. Platform services serve developers when developing software, which is a very beneficial thing for developers, who do not need to worry about the configuration of software development anymore, and devote themselves to software development, which shortens the software update cycle and improves work efficiency [16].

Saas services are the highest level of cloud computing platform services. Network users do not need to have a variety of software and hardware facilities, nor do they need to hire network maintenance personnel, which is not only convenient but also saves resources [17].

The development and parallelization of data in the cloud platform are generally processed using the Hadoop platform. Hadoop platform is composed of Hadoop distributed file system (HDFS) and MapReduce computing model. These two modules are only the core content, in addition to Common, Hive, Avro and other sub-projects [18].

Hadoop is an open source distributed computing framework in cloud computing platform, which is researched and developed by Apache. It has only been a decade since Hadoop was proposed and applied, but the development of Hadoop has been beyond imagination. Within a short period of time, Hadoop has been deeply involved in all fields of big data, and has been applied in search engine, fault monitoring, data mining and other fields, with low running cost and strong capacity expansion. High computing efficiency is the main feature of Hadoop platform.

MapRaduce is a distributed processing framework for device maintenance data in Hadoop. MapRaduce model generally adopts the idea of "divide and conquer" to deal with large-scale data sets. All the large-scale data to be processed are divided into many small data blocks, and all the small data blocks are processed by map() function in parallel to output new results.

HDFS is a distributed file system that can process large amounts of data and run on a common infrastructure, much like a file storage system in a computer. The HDFS system architecture uses the Master/Slave architecture. The system consists of name nodes (NameNode), data nodes (DataNode), and clients. The NameNode and DataNode are the primary and secondary nodes of the system respectively. The primary and secondary nodes run on common commercial computers using Linux operating system in the form of Java programs.

2.2. Railway Construction Machinery Information Management Cloud Platform Architecture

The system is implemented based on the Industrial Internet of Things platform, including edge layer, IaaS infrastructure service layer, PaaS platform service layer and SaaS application service layer.

Edge layer: Use ubiquitous sensing technology to collect and gather information of multi-source devices, heterogeneous systems, operating environment, people and other elements in real time and efficiently, build a set of equipment access and edge data processing that can be compatible and converted into multiple protocols, and realize industrial data interconnection, interoperability and operation.

Iaas layer: Based on virtualization, distributed storage, parallel computing, and load scheduling technologies, the Iaas layer implements pooling management of computer resources, such as network, computing, and storage, flexibly allocates resources based on requirements, and ensures the security and isolation of resource usage to provide users with complete cloud infrastructure services.

PaaS layer: provides services at the application layer, such as device management, resource management, operation and maintenance management, and security authentication, simplifying application platform establishment.

SaaS layer: According to the actual needs of the owners, it provides service-oriented customized operation and maintenance application services, and other applications can be built on the basis of PaaS.

Online monitoring is based on OPC UA for high-speed data channel information exchange, with data acquisition, direct digital control, human-computer interaction, monitoring and management functions. Based on the cloud platform, unified data collection, business processing and distributed control of heterogeneous data are realized, and unified data services are provided to the business layer, so as to achieve the purpose of visual management and control of equipment, intelligent management of equipment and automatic control of production.

Service system A processing system for O&M services such as scheduling and management based on RabbitMQ. Service system data is closely related and analyzed and processed in a centralized manner. Through channel isolation, the data acquisition channel and the service channel do not affect each other, and the system coupling is reduced. On the other hand, the remote service client verifies the data of the two channels.

Service scheduling: The Web server obtains user operations for service scheduling and uses RabbitMQ message queue middleware for message production and consumption. The message queue server uses Redis for real-time data persistence.

3. Field Testing

In this paper, field tests are carried out to further verify the application of the system, mainly observing the operation of the hardware deployment in the field environment and testing its functions. In the first part of this section, the tester checks real-time logs and calls services on the site through the management platform, communicates with the field construction machinery operators about the operation of construction machinery, and observes the real-time data situation. The other is to analyze and compare the actual data recorded in the field, the data saved in the background database and the local data saved in the cloud box to analyze the consistency of the data and verify whether the expected goal can be achieved. In this section, the test environment is the actual construction environment. The field view is open, and there is electromagnetic interference from large electromechanical equipment, but there is no strong interference source.

First of all, in the experimental pilot, after installing hardware for the construction machinery, it will enter the system guidance and wait for it to enter the stable state. After logging in to the management platform on site, it will observe the situation of site deployment and communication.

The management platform is used to invoke cloud services and adjust cloud configuration parameters. You can view detailed information about the device ID, message type, IP address, message subject, Qos, message timestamp, and message details by viewing logs on site.

In order to test the effect of data monitoring in the field, it is necessary to compare the field records with the data reported in the database after completing the field real-time test to obtain the deviation of monitoring data. In the database data extraction, can get a variety of construction machinery, each time period, monitoring data, including the construction machinery categories of road roller, bulldozer, excavator, administrative vehicles, etc.

The following formula is used for system testing:

$$DDE = TDFT / (TDFC + TDFT) \times 100\% \tag{1}$$

Where, TDFT= all defects found in the test process, TDFC= all defects found by the customer.

$$DRE = (TDCT / TDFT) \times 100\% \tag{2}$$

Where, TDCT= all defects modified during the test, and TDFT= all defects found during the test.

4. Test Implementation Effect

4.1. Oil Quantity Monitoring

In order to carry out accurate quantitative analysis, the field refueling record is taken as the standard to compare the refueling quantity data. The deviation between the collected remaining oil quantity and the actual refueling quantity recorded manually in the field during the same period is mainly observed, and the conclusion is drawn.

Table 1. Comparison between field record and monitoring data of bulldozer oil volume

	1	2	3	4	5
Actual refueling quantity(L)	273.14	160.42	332.89	217.45	229.72
Monitoring refueling quantity(L)	272.58	160.94	333.56	215.87	228.32

As shown in Table 1, Figure 1 and Figure 2, the measured values of refueling volume of the three construction machinery vehicles are compared with the actual data. As can be seen from the above chart data, the combined deviation of refueling record is 1.65L. The oil tank volume of all kinds of construction machinery is inconsistent, the accuracy of the oil level sensor is affected by temperature, and the deviation of the performance of all kinds of construction machinery is also different. In the later application, regular calibration is needed to ensure the monitoring accuracy.

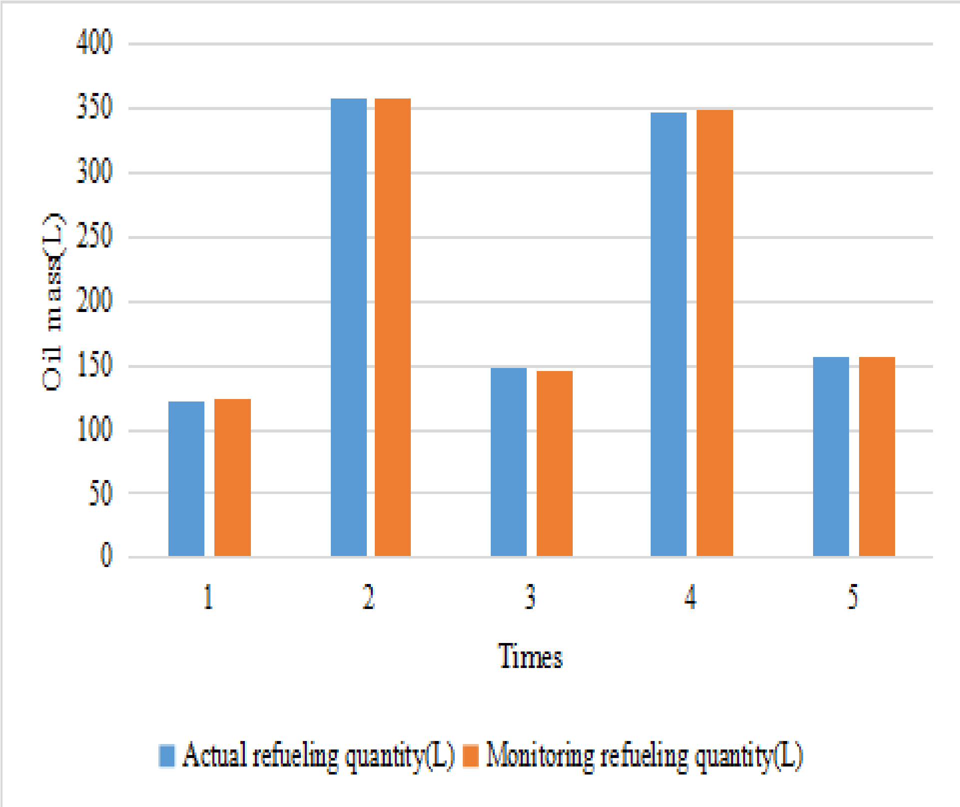

Figure 1. Comparison of excavator refueling volume data

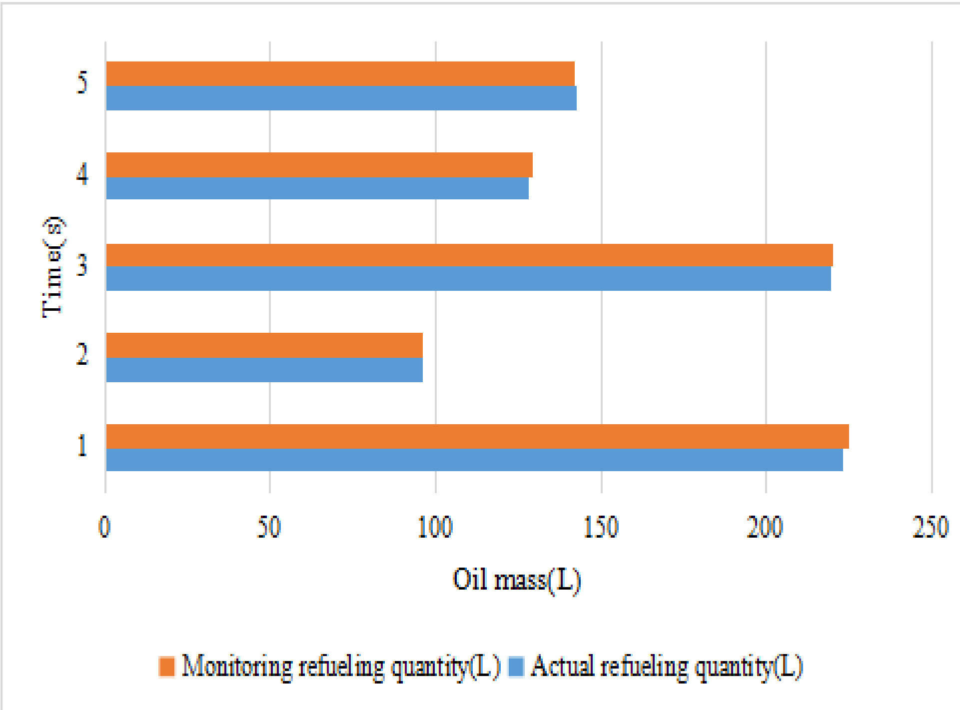

Figure 2. Comparison of tanker volume data of loading vehicles

4.2. Monitoring Running Status

By comparing the length of each state time period of the running state monitoring data, the accuracy of the running state monitoring of various construction machinery can be obtained. The following results are obtained through statistics, as shown in Table 2.

Table 2. Construction machinery three kinds of running state judgment accuracy

	Accuracy at rest	Idle speed accuracy	Accuracy of operation
Loader	97.53%	91.38%	98.12%
Excavator	94.58%	88.92%	92.07%
Bulldozer	97.61%	91.43%	95.87%

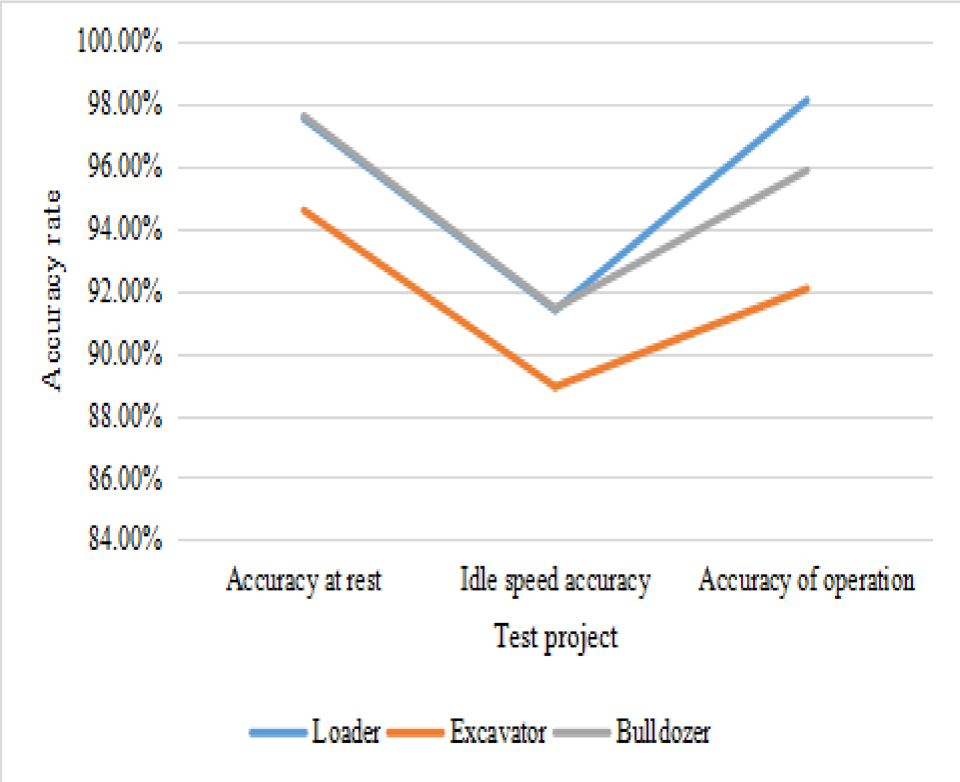

Figure 3. Three kinds of construction machinery different running state judgment accuracy statistics

As shown in FIG. 3, the comprehensive average accuracy of all kinds of construction machinery running state monitoring is 94.17%, which meets the monitoring requirements.

5. Conclusion

In this paper, through analyzing the current situation of railway engineering machinery operations, combined with the development of cloud computing technology, put forward the development of the railway engineering machinery remote operational system design project, from the user, information, and the Angle of the functions and operational performance, analyzes the functions of the system of high speed railway hoisting machinery remote operational requirements, remote operations on the basis of research the key technology of system design, development and implementation. System overall business requirements, but there are still some need to be improved in the process of practical application and extension, specific job prospect is as follows: the function of the Web management system has to meet basic demand, but in material management needs further supplement and improvement of the material can be combined with the project information for effective management of material to provide users with multi-dimensional functions of management.

Funding

This article is not supported by any foundation.

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.

References

[1] Rainer, Horn W, Blum E H. Effect of land-use management systems on coupled physical and mechanical, chemical and biological soil processes: how can we maintain and predict soil properties and functions? Frontiers of Agricultural Science and Engineering, 2020, v.7(03):17-19. https://doi.org/10.15302/J-FASE-2020334

[2] Thakur S S, Narang M K, Chandel R. Studies on Straw Management Techniques Using Paddy-Straw Chopper Cum Spreader Along With Various Tillage Practices and Subsequent Effect of Various Sowing Techniques on Wheat Yield and Economics. Agricultural mechanization in Asia, Africa and Latin America, 2018, 49(3):50-65.

[3] Tripathi V, Saraswat S, Gautam G D. Improvement in shop floor management using ANN coupled with VSM: A case study. Proceedings of the Institution of Mechanical Engineers, Part C. Journal of mechanical engineering science, 2021(10):236. https://doi.org/10.1177/09544062211062062

[4] Ajay, Kumar, Yadav. Safety Management of Mining Machinery. The Indian mining & engineering journal, 2018, 57(8):13-16.

[5] Buklagin D S, Goltyapin V Y. Digitalization of crop production: development trends. IOP Conference Series: Earth and Environmental Science, 2021, 723(3):032021 (12pp).

[6] Seerangurayar T, Shridar B, Kavitha R, et al. Performance Evaluation of Power Weeders for Paddy Cultivation in South India. Agricultural mechanization in Asia, Africa and Latin America, 2017, 48(4):76-81.

[7] Nasirian A, Abbasi B, Cheng T C E, et al. Multiskilled Workforce Planning: A Case from the Construction Industry. Journal of construction engineering and management, 2021(5):148.https://doi.org/10.1061/(ASCE)CO.1943-7862.0002279

[8] Colin, Granger. BNSF Railway announces 2017 capital expenditure plan. Machinery Market, 2017(TN.6063):29-29.
[9] Yildirim M S. A Management System for Autonomous Shuttle Freight Train Service in Shared Railway Corridors. International Journal of Civil Engineering, 2021(3):20. https://doi.org/10.1007/s40999-021-00663-3
[10] Ajay, Kumar, Yadav. Safety Management of Mining Machinery. The Indian mining & engineering journal, 2018, 57(8):13-16.
[11] Fehis S, Nouali O, Kechadi M T. Encryption key management as a trusted security as a service for cloud computing. International Journal of Security and Networks, 2021(3):16. https://doi.org/10.1504/IJSN.2021.117865
[12] Shingade R, Marimuthu K, Nagaraja R A, et al. Healthcare Products Management and System Analysis in Cloud Computing Environment (Salesforce). Advances in computational sciences and technology, 2017, 10(9):2823-2834.
[13] Shrestha R. Research on 3D Printing Resource cloud Platform Technology based on dynamic Service Composition. Journal of Physics: Conference Series, 2021, 1798(1):012047 (6pp). https://doi.org/10.1088/1742-6596/1798/1/012047
[14] Alshareef H N, Dan G. Using Twitter and the mobile cloud for delivering medical help in emergencies. Concurrency Practice & Experience, 2017, 29(24):e4151.1-e4151.12. https://doi.org/10.1002/cpe.4151
[15] Rashid A, Chaturvedi A. Cloud computing characteristics and services: a brief review. International Journal of Computer Sciences and Engineering, 2019, 7(2): 421-426. https://doi.org/10.26438/ijcse/v7i2.421426
[16] Askarizade Haghighi M, Maeen M, Haghparast M. An energy-efficient dynamic resource management approach based on clustering and meta-heuristic algorithms in cloud computing IaaS platforms. Wireless Personal Communications, 2019, 104(4): 1367-1391. https://doi.org/10.1007/s11277-018-6089-3
[17] Luo Y. RETRACTED ARTICLE: Environmental cost control of coal industry based on cloud computing and machine learning. Arabian Journal of Geosciences, 2021, 14(12): 1-16. https://doi.org/10.1007/s12517-021-07411-w
[18] Poniszewska-Maranda A, Matusiak R, Kryvinska N, et al. A real-time service system in the cloud. Journal of Ambient Intelligence and Humanized Computing, 2020, 11(3): 961-977. https://doi.org/10.1007/s12652-019-01203-7