Innovative Application of Big Data Technology in Southwest Pipeline Information System

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Abstract. With the in-depth construction of the "digital pipeline", the full pipeline system has digitally upgraded various systems through the use of advanced information networking technologies, such as the Internet of Things and mobile Internet, and gradually realized production automation, unattended operation valve room, flat management of the labor organizations architecture, digital pipeline construction has entered the stage of operation management and maintenance. However, the traditional manual maintenance and passive maintenance methods cannot satisfy the needs. It is urgently necessary to rationally plan, develop, and optimize the pipeline support system, and to use the big data technology to establish standardized and unified pipeline Internet of things protection system specifications and to create efficient intelligent management platform. The purpose is to achieve standardized, scientific, intelligent, and high-efficient pipeline operation and maintenance.

Keywords: Digital pipeline · Big data · Management · Intelligent

1 Introduction

With the continuous construction and development of digital pipeline system, the full pipeline system has digitally upgraded various systems through the use of advanced information networking technologies such as the Internet of Things and mobile

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Internet, and gradually realized production automation, unattended operation valve room, flat management of the labor organizations architecture, digital pipeline construction has entered the stage of operation management and maintenance. “30% rely on construction, 70% rely on operation and maintenance”. Organized operation and maintenance is the key to the longevity of the wisdom pipeline, is one of the cores of the smart pipeline project, and is the key to the benefit of smart pipeline [1]. This is a very complicated system project. The objectives of the pipeline security system cover a wide area, many complex objects, a large number of equipment types, and a large quantity; there are many suppliers and data sources. The protection is faced with many problems such as how to make advance warning, information support and resource allocation, and afterward summarizing experiences. The traditional manual maintenance and passive maintenance methods cannot satisfy the demand of people, and there is an urgent need to re-plan, develop, and optimize pipeline operation and maintenance systems, establish a standardized pipeline internet of things protection system and create an efficient intelligent pipeline operation and maintenance system.

2 Status Analysis of Pipeline Information System

Long-distance pipelines are the main medium for the transportation of important energy materials in the country; it is an important strategic channel for energy import and export; it is also a major oil and gas livelihood channel for each city. It is particularly important to ensure the stability and safety of pipeline systems. Because the pipeline system is spread all over the country, the battlefield is more extensive than the oil fields, and the complex terrains such as mountains and rivers are more prominent, the temperature and environment are also more varied, and the operating risk factor is higher [2].

This document is aimed at the information maintenance service of CNPC Southwest Pipeline Company, covering the maintenance of communication, information, security and other services in Yunnan, Guangxi, Sichuan, Chongqing, Gansu, and other provinces, municipalities, and autonomous regions. Nearly 9000 km of pipeline covers more than 100 stations and nearly 200 valve rooms of the full course [3].

For the operation and maintenance projects, there are more than ten kinds of systems: optical transmission systems, industrial television systems, automation systems. IT has a large number data: more than 100 stations, nearly 200 valve rooms, more than 500 cabinets, and 8525 devices. The system has many suppliers. Each system is supplied by the way of tender, so the suppliers are different and the quality is uneven. In the process of operation and maintenance, the role of the company is complex, involving many professionals, and the assessment data is inaccurate. The vendor’s after-sales services are uneven. For the operation and maintenance methods, the operation and maintenance processes are complicated and the management efficiency is low. The geological environment is harsh, and the safety risk is high. Most of the pipelines are sparsely populated in mountainous areas. The roads are rugged, and people are extremely inconvenient to access. Natural disasters such as mudslides, landslides, and rockfalls often occur. Natural disasters within a year are no less than dozens of times. These contradictions have become increasingly prominent, and these problems are bound to result in low

management, operation, maintenance, scheduling, and data utilization. However, the existing traditional operation and maintenance methods are difficult to solve the above problems. In the past, a large amount of data was not used effectively but abandoned to the corners. Therefore, it is necessary to get help from a comprehensive and efficient organizational operation and maintenance management system and a software support platform. To help us streamline processes and auxiliary the analyze decisions. Therefore, we regard the data-based operation and maintenance platform as a good medicine for the longevity of the "smart pipeline". We hope to improve the safety, efficiency, and management of the operation and maintenance from both the concept and the software tools [4].

3 Data Cleaning and Reduction

To realize the improvement and transformation of management concepts, based on experience, it is certain that existing data needs to be analyzed and processed. However, due to the wide range of existing data sources, miscellaneous data, and large amounts of data, huge amounts of word and excel documents are needed. Managers simply do not know how to do, which requires data cleansing and checking of existing data. Firstly, we need to conduct detailed investigation and verification on the process flow and equipment location and establish a data dictionary for the name of the specification, equipment name, manufacturer, fault level, and fault category; increase the preparation of equipment QR code to ensure unique identification of the equipment and standard input format; then standardize the equipment account data table structure; divide the device attribute information into: location information, detailed parameters, process categories, time information, equipment all life monitoring information; and further improve the equipment life cycle monitoring and management. In the future system upgrade will be add new process focus point such as warehouse of entering and getting out, installation, scrap, calibration, and to achieve more data from details [5].

4 Data Mining and Application of Big Data Technology

Take the southwest pipeline communication operation and maintenance as a demonstration point to carry out big data analysis (Fig. 1) [6]. Through the exploration of potential influence factors from a large number of operational information, environmental information and status information, in-depth analysis of the correlation between parameters, forward-looking Evaluate the system/equipment operating conditions. We can formulate corresponding dynamic precision operation and maintenance strategies to effectively reduce the occurrence of failure rates. In order to solve problems such as guiding equipment selection, operation and maintenance technical innovation, scientific guidance organization and maintenance, and optimization of material/personnel ratios, etc, it provides new methods and new ideas.

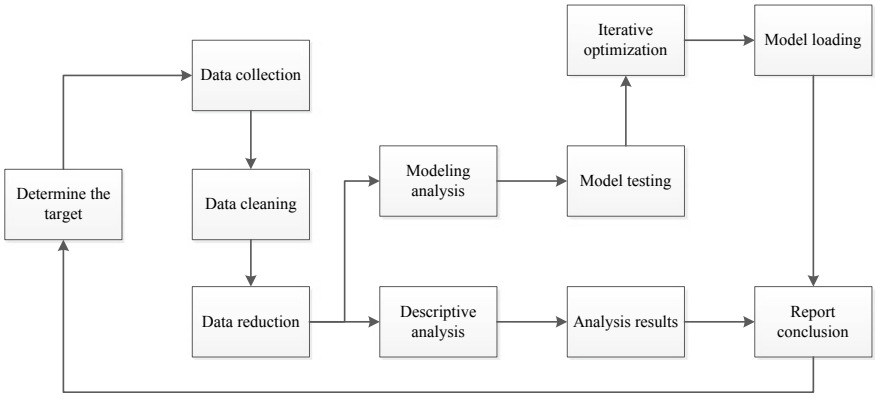

Fig. 1. Big data technology application flowchart

4.1 Realize Equipment Dynamic Evaluation System Based on Big Data Analysis

Based on the equipment evaluation system and dynamic allocation mechanism of big data analysis, a big data calculation model is established by collecting equipment attribute information and analyzing and filtering various types of data, and the equipment score is calculated. Then, mathematic analysis algorithms such as variance and weighting algorithms are used to establish a device scoring mechanism. The mechanism, based on the location and importance of the equipment, is used to dynamically allocate equipment. At present, the standards of equipment used have been initially formed to dynamically allocate two management levels, three regional levels, and six evaluation levels. Further, it can improve system operation and maintenance stability [7].

4.2 Data Mining to Realize Process Reengineering

In the past operation and maintenance are empirical, random, and basically do not involve the control of process, or simply send a single work send—complete. There are many kinds of text descriptions from received feedback, it is difficult to be used. We used the clustering algorithm of big data to classify each trouble ticket and trouble result and then returned to guide the maintenance operation plan. We have two process lines: hidden trouble investigation and troubleshooting. On their basis, we have reconstructed 12 categories of 26 subprocesses. First of all, upgrade 10 conventional general-purpose operation and maintenance projects that have been running for many years to 105 detailed projects, and then the computer continue to learn and adjust based on data from one to two years or even longer, and the machines slowly form Learning ability, intelligent guidance operation and maintenance work [8].

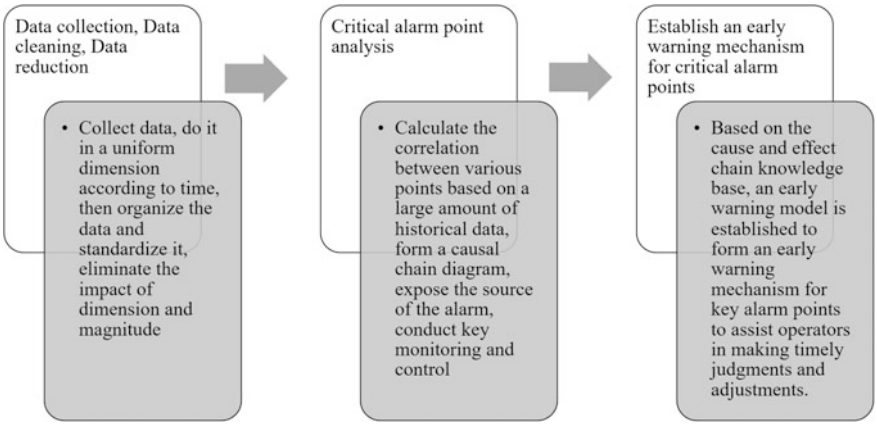

Fig. 2. Application of big data technology in fault processing

4.3 Visualized Big Data Helps to Cultivate a Multi-special Talent

In the past, one operation and maintenance person only can responsible for one profession work, so we need to train a lot of professionals. Nowadays, one person has to be responsible for multiple professions, and the demand for compound talents is increasing (Fig. 2) [9]. Management system platform includes eight types of systems, more than 500 cabinets, more than 1600 pieces of network topology, 8525 devices, 160,000 operational and maintenance data. We can take the ports of the equipment itself and the upstream and downstream visualizations (Fig. 3). Intelligent recommendation systems rely on big data methods, it can support decision-making and standard operations. VR virtual-reality training system make operation and maintenance visual operating, with the help of remote expert guidance, Operation and maintenance personnel can get started quickly and efficiently.

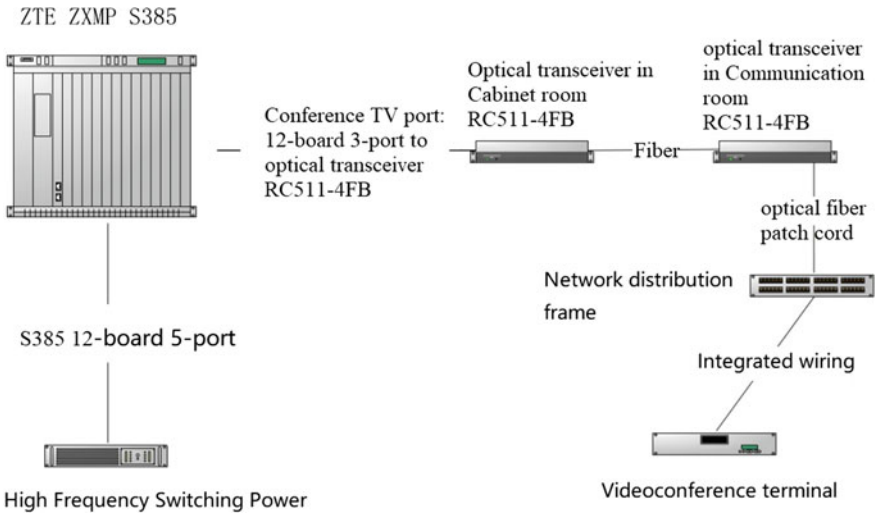

Fig. 3. Partial visualization of communication equipment and lines

We use a station as an example. Its subhealth is due to problems in the optical communication system. We can only obtain the result (Fig. 4) by directly retrieving the traditional data related to optical communications. We can't get valid conclusions because the data is not regular.

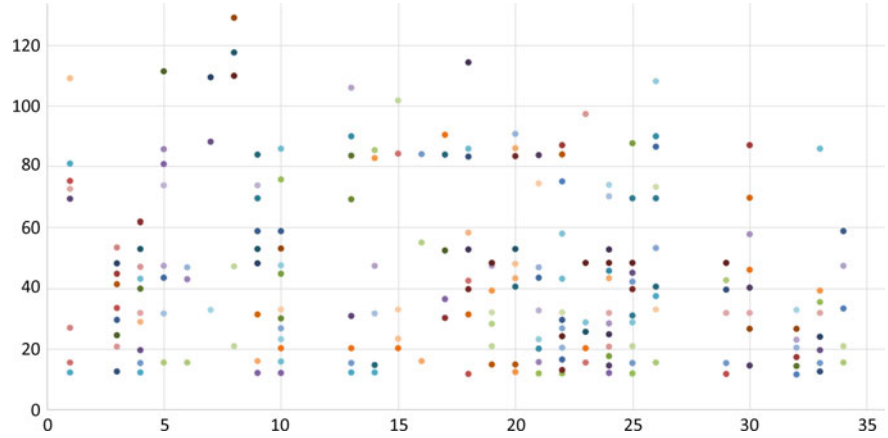

Fig. 4. Optical data of a station

Through the model improvement analysis, the system can give a direct result. The system proposes 8 rectifications; among them, it has 4 at the interruption point, and 4 large loss points. According to the results, we repair the first 80 km, and the quality of communication was greatly improved, while the latter two problem points are in other maintenance companies, we have also sent the proposal later to them. According to the rectification data, the system also gives the main reason for optical cable malfunction and gives corresponding rectification suggestions.

5 Summary

After two years of constant exploration and innovation, through the application of big data and data mining-related technologies, various types of idle data and scattered data have been effectively used, and it has achieved some certain results. An intelligent operation and maintenance management system for pipeline systems has been initially established [10]. We have preliminary realized the intelligent management of people, events, and things in the operation and maintenance process, realized intelligent classification and auxiliary decision-making of malfunction, and ensured the stable operation of the pipeline communication system. Next, we will combine real-time data of various types of equipment and further optimize the analysis model, develop the prediction model, and improve the accuracy of fault prediction and judgment, so as to better serve the smart pipeline.

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