Scholar Publishing Group
Kinetic Mechanical Engineering
https://doi.org/10.38007/KME.2020.010401
ISSN 2790-2676 Vol. 1, Issue 4: 1-10

Construction Machinery Product After-sales Field Based on Data Mining

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Keywords: Data Mining, Construction Machinery, Mechanical Products, After-sales Field

Abstract: With the development of the market economy and the rise of the service industry, the survival and development of enterprises have quietly undergone tremendous changes. With the change of consumers' consumption concept, consumers are more willing to choose enterprises with high-quality after-sales service quality while paying attention to product quality. Therefore, the quality of after-sales service has become a powerful factor for enterprises to maintain and expand market share. Therefore, this paper discusses the after-sale field (ASF) of construction machinery (CM) products relying on data mining (DM) technology. This paper analyzes the current situation and characteristics of the after-sales spare parts logistics of CM products, discusses the after-sales service of CM products based on DM technology, which should be tested and analyzed experimentally, and verifies that it is feasible to use sequence mining technology in the after-sales service of CM products.

1. Introduction

With the development of the market economy, low-quality products can no longer meet the needs of customers. Many enterprises put their core energy into technology and quality. While looking for customer demand intensity from the perspective of different shapes, functions, quality and performance, enterprises are also showing customers differentiated service advantages through marketing, sales and after-sales service opportunities to establish their market position and enrich their brand personality. In today's market economy environment, the competition in the ASF plays an increasingly important role in the competition between enterprises. How to improve the after-sales service of products is a topic worthy of discussion. This paper discusses the ASF of CM products based on DM technology.

The reform and opening up has brought China's door to freedom to the world. China's market

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economy has been developing at a high speed. The competition in domestic and foreign markets has become increasingly fierce. The economic ties between countries around the world have become closer and closer. The global economic integration has been highly developed. CM usually works in the open air, and CM and equipment are generally sensitive to external working temperature and humidity [1]. In the north, seasonal changes are particularly obvious. The low temperature in winter affects the normal use of equipment, and even to extend the service life of equipment, CM in many areas does not work in winter. China has a vast territory, and the seasonal conditions are different in different regions. The analysis of seasonal factors often needs to be carried out by region. As seasonal factors have a great impact on the use of equipment, the demand for spare parts is relatively large. Therefore, the ASF of CM products is particularly important [2].

This paper relies on DM to analyze and discuss the ASF of CM products. In view of the relatively weak demand forecasting management of after-sales spare parts of CM, this paper makes a specific analysis based on the actual situation of the company. At the same time, in combination with the actual characteristics of after-sales maintenance of CM and equipment, the problems in the actual operation process are analyzed and solved one by one, which not only improves the timeliness of spare parts supply and the availability of spare parts in the maintenance process, but also improves the level of after-sales service to a certain extent. Moreover, because the focus of spare parts inventory management is more prominent and more practical, the cost of spare parts inventory will be greatly reduced, and the supply channel will be smoother. The workload of spare parts demand forecasting is reduced and the efficiency is improved [3]. As an important part of the company's spare parts inventory management, spare parts demand forecasting can help the company make better inventory control decisions for spare parts required for CM and equipment maintenance in the fierce competition for after-sales maintenance services of CM and equipment, thus laying a solid foundation for the company's after-sales service and spare parts supply [4-5].

2. Analysis of ASF of CM Products

2.1. Current Situation and Characteristics Analysis of After-Sales Spare Parts Logistics of CM Products

Analysis of the basic process of after-sales spare parts logistics: There are three main sources of supply of after-sales service spare parts for CM products. There are parts manufacturing plants in China, overseas plants around the world, and a few of them are purchased from parts suppliers. The parts are uniformly distributed from the global parts distribution center to the Shanghai spare parts distribution center, and some parts are directly provided by domestic factories and parts suppliers, Parts required by domestic regional service centers are uniformly allocated by Shanghai PDC, and the process is shown in Figure 1 [6-7].

When the service dealer needs to replenish the goods, the service operation department will search for the spare parts and determine the arrival time, and submit the spare parts demand after confirming with the customer. If the warehouse can meet the spare parts demand, it will be directly delivered to the dealer. If not, the spare parts warehouse will submit the purchase plan, and the spare parts purchase department will generate a purchase order after reviewing it and submit it to the regional service center, At the same time, the enterprise command center is responsible for tracking spare parts to ensure smooth and timely procurement of spare parts [8].

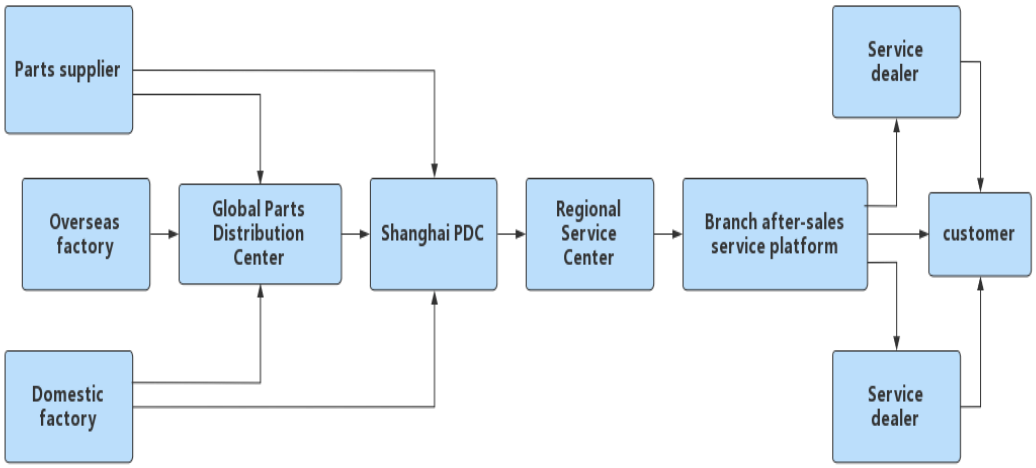


Figure 1. After sales spare parts allocation process

2.2. Influencing Factors of Spare Parts Demand Forecast of CM Products

Because the demand for spare parts of CM and equipment will only occur when the spare parts are damaged, the random probability of the demand for spare parts is relatively large, and the demand for spare parts is often not a single law. The reason is that there are many factors influencing the demand forecast of spare parts for CM and equipment [9-10]. Through in-depth analysis, it is found that the factors affecting the logistics demand for spare parts mainly include the maintenance rate of equipment, the quantity of CM and equipment in a region, the working time and intensity of equipment [11].

The maintenance rate of equipment refers to the number and frequency of equipment maintenance required in its life cycle, that is, the proportion of the number of equipment of a certain type that fails in a certain area in a year to the total number of equipment of that type in that period [12]. Generally, the frequency of maintenance is high at the initial stage of product use. On the one hand, all mechanical parts of the new equipment are in the running in period of wear, during which the spare parts have just entered the high-strength working environment, so the probability of failure is high; On the other hand, the operators of new equipment may also cause frequent failures due to improper operation and other factors. As the CM and equipment enter into normal working condition and the equipment is used and operated skillfully, the equipment can work stably for a long time. In the later period of equipment use until the equipment is scrapped, the parts of the equipment are gradually aging, the equipment maintenance rate is gradually increasing, and the demand for spare parts is also gradually increasing. For example, the working life of an excavator is about years, and the failure frequency is high in the years before and after use. Therefore, spare parts management personnel should roughly judge the maintenance rate of each equipment according to the sales time of CM and equipment, so as to make inventory production and storage for the demand of spare parts [13-14]. When the maintenance rate of a certain type of CM is the same, the greater the number of equipment in the area, the more maintenance times in the area will be, and the demand for spare parts will generally be greater.

Since the production period of the product, as the equipment is recognized by customers and more and more customers buy it, the inventory of equipment will generally increase, but in the

product recession period, with the upgrading and technical improvement of the product, the inventory of a certain type of equipment will gradually be eliminated, and the equipment that needs maintenance will continue to decrease, and the corresponding demand for spare parts will also continue to decrease [15].

It should be noted that a special forecast should be made for the demand for large-scale spare parts. For some large-scale engineering construction projects, such as the Universiade Security Project and Mawei Shipyard Project, these projects require a large number of engineering machinery and equipment, so a special forecast analysis should be made based on the construction volume of specific engineering projects. The probability of equipment needing maintenance is also closely related to the working time and intensity of the equipment. Generally, the longer the working time and the greater the working intensity of the equipment, the parts of the equipment will need to be replaced due to wear, aging and other reasons, and the more spare parts are required for maintenance [16]. Generally, the actual working time and working intensity of spare parts are difficult to be calculated quantitatively by the manufacturer of CM and equipment. Therefore, the working time of the equipment can only be calculated from the date when the equipment is sold, or the working intensity of the CM and equipment can be calculated by calculating the distance traveled by the customer's equipment according to the equipment meter. Seasonal factors are also important factors affecting the working environment of industrial machinery and equipment [17].

The influence of seasonal factors on the demand for spare parts usually has the following characteristics:

The optimization plan for the company's after-sales spare parts logistics operation: from the beginning of each spring, with the commencement of various projects, the CM and equipment will be put into use, and the demand for spare parts will reach a peak, and the demand for spare parts will increase significantly; In winter, the climate in the north is very cold. In most northern regions, such as Inner Mongolia and Heilongjiang, most of the CM and equipment are shut down every winter, and the demand for spare parts in this period is also at a low ebb; In the early winter and the former northern regions, the demand for spare parts will reach a small peak in the rush period of each project; In most regions, before the Spring Festival, due to the impact of the project duration, the demand for spare parts has increased significantly, with a small peak. Product technical factors refer to the situation that the demand for spare parts of a certain type of CM equipment or some of its spare parts will remain high due to defects in technical means. For such equipment or its required spare parts, it is necessary to timely find and report to the relevant technical departments, and at the same time, increase the demand forecast for such spare parts [18].

The above factors play a key role in the spare parts demand of CM and equipment. Therefore, these factors must be fully considered in the excessive forecast of spare parts demand, so as to make the forecast of spare parts more accurate and the inventory control can meet the customer demand to the greatest extent. However, it is a complex system engineering how to realize the comprehensive utilization of forecast influencing factors to complete the spare parts demand forecast. Because all factors cannot be fully considered, the spare parts demand forecast of the company's CM equipment is often not prepared, so the company's spare parts inventory control usually cannot cope with sudden spare parts demand.

3. After Sales Service of CM Products Based on DM Technology

3.1. Data Source of DM

DM is based on certain data. Data sources of DM generally include data in data warehouse, data

in data warehouse and data in logical data warehouse. The data warehouse construction is shown in Figure 2.

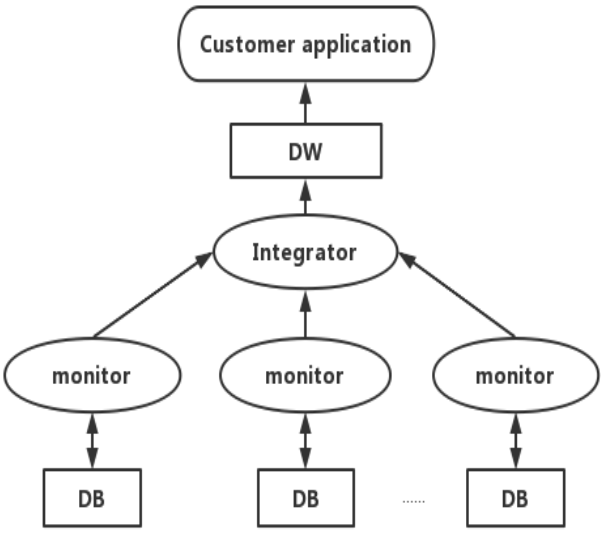


Figure 2. Data warehouse construction diagram

3.2. Data Warehouse Architecture Diagram

A complete data warehouse includes three layers of architecture, namely data acquisition layer, data storage layer, and DM layer. The architecture diagram of the data warehouse is shown in Figure 3.

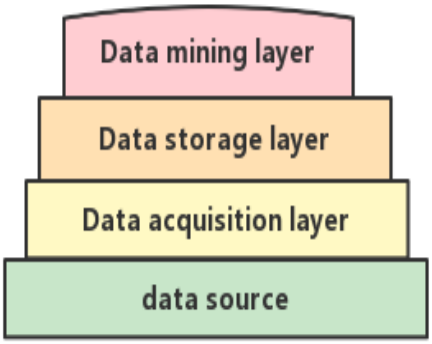


Figure 3. Data warehouse architecture diagram

3.3. DM Algorithm

If the source X and the random variable Y are not mutually independent, the receiver receives the message Y. Then, the conditional entropy K (X/Y) is used to measure the uncertainty of the

receiver about the random variable X after receiving the random variable Y. Let X correspond to the information source gi, and Y correspond to the information source hi, p (gi/hi) be the probability that x is g when Y is hi, then:

$$K(X/Y) = -\sum_{i=1}^{n}\sum_{j=1}^{n} p(x_i / y_i)\log_2 p(x_i / y_i) \tag{1}$$

The average mutual information is used to represent the amount of information about X that signal Y can provide, and T (X, Y) is used to represent:

$$T(X,Y) = K(X) - K(X/Y) \tag{2}$$

3.4. DM Based on Logical Data Warehouse

Logical data warehouse is mainly built on the basis of enterprise business database, which is not actually realized in physical implementation. Data is preloaded into the cache according to the theme, and data is organized in the cache. The purpose of DM is achieved by DM on the cached data. Therefore, this pattern solution can be defined as DM based on logical data warehouse. The implementation principle is similar to that of DM based on data warehouse. The difference is that the data of logical data warehouse is stored in cache, organized and processed in cache, and the data life cycle ends at the end of application system operation, while data warehouse can store data for a long time.

Table 1 compares data warehouse, ODS and logical data warehouse in many aspects.

Table 1. Comparison of data warehouse, ODS and logical data warehouse

Compare items	data warehouse	ODS	Logical data warehouse
Construction purpose	decision support	Real time monitoring	Decision support and monitoring
service object	Enterprise management	Business management	Enterprise management
Storage cycle	long-term	short-term	immediate
Processing frequency	Non real time	Quasi real time	Quasi real time
major function	Analysis function	Transaction processing, short-term analysis	Analysis function, short-term analysis
Technical realization	OLAP	OLAP, OLTP	OLAP, OLTP
Functional structure	focus	Relative concentration	focus
data type	Detailed data	detail data	Detailed data
Data capacity	Very large	Small	Small

4. Test and Analysis of ASF of CM Products Based on DM

4.1. Data Source Analysis

4.1.1. DM Analysis Based on "Service Station Cost Analysis"

This topic is aimed at the service inspection system of the target enterprise. The target enterprise needs to check the service stations with abnormal fluctuations in service station fees irregularly to ensure the authenticity of warranty services and reduce service costs. When identifying service stations with abnormal fluctuations in service costs, the target enterprise usually completes the selection of audit service stations through prior knowledge, which is subjective and not objective. Therefore, it is an inevitable task to find knowledge from data for the target enterprise to select audit service stations. The audit has the following characteristics.

Service station fees shall be settled monthly. So far, the target enterprise has used the information system for about years. For each service station, the monthly service cost is the settlement cycle, so there is a total of months of service cost data for the faulty parts information, and the subordinate service stations are about. If the service station cost is monitored on a monthly basis, the data is the target enterprise's cumulative time of using the information system, and the number of sample data of the service stations is calculated on a monthly basis. If the timeliness principle is followed, the sample cycle is one year, The data volume is sample data. The monitoring of the service station is required to be real-time, and the fraud of the service station can be known in time to correct the speculation of the service station, ensure the effectiveness of the service station in providing three guarantee services and reduce the service cost. It is time-varying. The service charge settlement methods of the service stations of the target enterprises may be different, and the sample data in different time periods will not guide the cost analysis of the service stations of the target enterprises.

4.1.2. DM Analysis Based on "Vehicle Type Fault Analysis"

In order to better apply the enterprise marketing concept to the whole service work of the target enterprise, the service department uses the fault code to conduct statistical analysis on the fault forms and failure modes of spare parts, find out the weak links of the product, improve and improve the product quality, and the service station needs to fill in the Fault Code when submitting the San Bao appraisal form, One of the main purposes of the target enterprise's analysis of vehicle type fault information is to find out the rules that specific vehicle types are suitable for specific regions, find out the main causes of vehicle type faults and the main suppliers of fault parts to support the enterprise's decision-making. The data has the following characteristics.

It is necessary to pay more attention to the main causes of vehicle failure, so as to analyze and improve vehicle configuration. The target enterprise tracks the product quality and timely learns whether the supplier's products have been improved over time. At the same time, the supplier feeds back the weak links of spare parts to the supplier. The supplier improves the quality of spare parts according to the weak links of spare parts fed back by the enterprise, so as to achieve the win-win goal of suppliers and automobile manufacturers. Vehicles of the same model have different fault causes and different service times in different regions. Through vehicle fault analysis, it is found that a certain model is suitable for the geographical environment of a certain region, and specific models suitable for a specific region are found from the fault information, so as to promote the sales of enterprises and improve the brand value of target enterprises.

4.2. Generation and Preparation of Experimental Data

As the after-sales service information of CM products is a business secret for enterprises, this prototype does not use real original data, but compiles a program to generate random original data to simulate experimental data for DM, and the simulated experimental data is a customer

The user table and maintenance table, other maintenance result tables and maintenance result relationship tables need to be manually set, and the data warehouse is established from the simulation experiment data. Table 3 shows the results of the sequential pattern of chunk DM.

Table 2. Result of sequence mining

Frequent sequence	Support
ABCG	0.45
BCD	0.54
FAD	0.60
DIH	0.65
FI	0.80

As the original data is analog data, it is impossible to explain the practical significance of DM results from practical applications. However, some pattern results can be found through mining programming, and it is feasible to use sequence mining technology in after-sales service of CM.

5. Conclusions

This paper analyzes and discusses the ASF of CM products based on DM technology, and finds some pattern results through mining programming. It is feasible to use sequence mining technology in the after-sale service of CM. But there are also shortcomings. Optimization of spare parts demand forecast. The demand forecast management of spare parts in CM companies is relatively weak, which brings great difficulty to the inventory control of spare parts. The subjective empirical decision-making of spare parts demand forecasting has many drawbacks, which leads to the difficulty in balancing the demand and supply of spare parts. The closer the forecast of spare parts demand is to the real demand for spare parts, the easier it is for the spare parts logistics department to prepare inventory in a limited time and quickly respond to the market and customer service needs. If some data that can be mastered, such as product life cycle and failure frequency statistics, are close to the real demand for spare parts to the greatest extent, the probability of spare parts out of stock will be greatly reduced, and the after-sales service efficiency of CM will be improved. The ASF of CM products needs further discussion.

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.

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