Demand Forecasting Solution Contributing to Components Inventory Repair Optimization

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Abstract

The optimization of spare parts inventories is an issue that is commonly found in the manufacturing industry. NEC Fielding, who are the subsidiary of the NEC Group and manage the maintenance business, also have similar concerns, because traditional statistical techniques have had limited accuracy in predicting the future demand for repair parts. The company therefore has decided to adopt NEC's big data analysis technology "heterogeneous mixture learning." This has enabled them to forecast demands with high accuracy. They have thereby succeeding in reducing by about 20% the inventory of the high-rotation parts that occupy a large share of the spare parts shipments. As the stockout risk is also estimated, this approach has allowed the company to challenge a more thorough optimization of the inventory. This paper describes the spare parts demand forecasting procedures performed at NEC Fielding by using the heterogeneous mixture learning engine and includes discussion of its resulting effects.

Keywords

Big data utilization, heterogeneous mixture learning analysis technology, spare parts inventory optimization, elimination of dependency on individual skills

1. Introduction

Spare parts refers to the component parts prepared to enable instant servicing and recovery in case of a failure of a product such as a PC, server or printer. In the case of the printer for example, the paper feed roller and printed circuit boards are included.

Through long years of activities in support of production innovation, NEC Fielding have already taken appropriate measures aimed at inventory optimization and there has seemed to be almost no room for further improvement. Nevertheless, the company has continued the pursuit of further inventory optimization and it has consequently become aware of the big data analysis technology. Hoping that this would lead to more measures for inventory optimization, the company started demonstration and verification experiments using actual data in December 2013.

The demonstration experiment has led to improvements of 20% on average for the accuracy of high-rotation spare parts demand forecasts. This performance corresponds to an inventory reduction of some millions of yen, and a reduction in the risk of stock-out is also estimated. To benefit from these results as early as possible, the company started to apply the technology in actual business environments in October 2014.

Aiming at deploying spare parts demand forecasting by using the big data analysis technology to benefit other NEC customers, the company is currently able to market a satisfactory solution to this issue that is now being implemented.

2. Outline and Issues of NEC Fielding EC Businesses

NEC Fielding sets "ALPARTS Kawasaki" in the city of Kawasaki, Kanagawa Prefecture, Japan, as the central warehouse and deploys spare parts stations in about 200 locations all over Japan. The spare parts are delivered from "ALPARTS Kawasaki" to spare parts stations located nationwide via the logistics network designed by NEC Fielding.

The parts stations keep in stock only the frequently shipped parts while the central warehouse covers all spare parts. As a result, "ALPARTS Kawasaki" has a massive inventory, which may be as large as 140,000 spare parts items.

"ALPARTS Kawasaki" executes centralized control of spare part logistics including nationwide delivery, warehouse operation and procurement. However, as the number of handled products increases every year together with the number of parts and the inventory value, it is becoming difficult to optimize the inventory system while maintaining the service quality. It was in order to resolve this issue that the company introduced spare parts demand forecasting by utilizing the big data analysis technology.

3. Outline and Features of the Spare Parts Demand Forecast Technology

Forecasting spare parts demand at high accuracy cannot be expected with a simple forecast model, because it consists of various factors. These include the parts shipment data, the number of products in operation and the number of months elapsed since the launch of the products.

The spare parts demand forecasting solution described herein utilizes NEC's big data analysis technology called the "heterogeneous mixture learning analysis technology." The spare parts shipment data or achievement data that seems to have a certain causal relationship with the shipment trend is input. Then the heterogeneous mixture learning solution automatically categorizes the data into groups and generates forecasting formulae for the categorized data groups and implements highly accurate demand forecasting (**Fig. 1**).

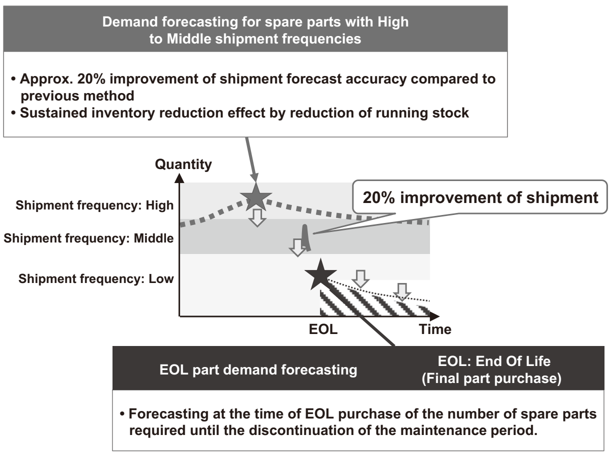

Fig. 1 Spare parts demand forecasting solution.

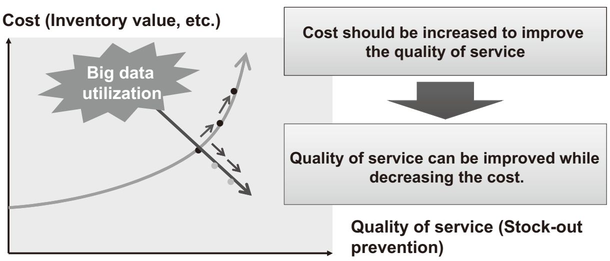

Fig. 2 Relationship between quality of service and cost.

This procedure reduces the risk of stock-out (missing parts) and thereby contributes to the improvement of cash flow and a reduction in the associated expenses.

It has hitherto been necessary to increase cost if an improvement in the quality of service* provided for customers is sought. However, by utilizing the big data analysis technology, we have succeeded in setting a course for reducing the cost while also improving the quality of the service (**Fig. 2**).

4. Utilization of the Heterogeneous Mixture Learning Technology

When forecasting the demand for parts that have an extremely wide range of types, such as in the case of spare parts, the most often used forecasting method has been to categorize parts manually into several groups with similar demand characteristics and then to forecast the demand of each group.

The reason for the above is that the data for multiple parts with similar demand trends can improve the forecast accuracy more than the one for an individual part or for all parts.

Nevertheless, due to the extreme difficulty of manually categorizing tens of thousands of parts types into appropriate groups, it has not been at all easy for the traditional method to forecast demand with high accuracy.

The heterogeneous mixture learning technology employs unique algorithms to categorize parts into appropriate groups and to derive an optimum forecast model according to the properties of each group, even when the parts extend over a very wide range of types.

The authors have conducted a demonstration experiment of the present technology on about 10,000 types of parts that are more frequently shipped. This was done by obtaining the related data, including the monthly shipment data of the past 14 months, the number of products in operation, and the number of months elapsed since the launch.

As a result, it was found that the inventory can be reduced by about 20% compared to that of the period before the introduction of the present technology. In the monetary context, the reduction effect is a few million yen per year. The point to be specially noted is that the demand of parts that has been hard to forecast due to seasonal fluctuations may now be forecast with high accuracy.

In the past, the demand for parts has been forecast by focusing on forecasting faults. Since spare parts are needed in case of troubles, it had been thought that shipments could be assessed naturally by forecasting the likelihood of product faults. However, the result of the experiment discussed above showed that parts shipments are determined by assorted multiple factors. Meanwhile, heterogeneous mixture learning has succeeded in accomplishing highly accurate forecasting by quickly searching and discovering the optimum data groupings. It has thereby been possible to devise models from an infinite

* Quality of service: Definition of the specific quality level of maintenance services, for example reducing the customer visit time to no more than two hours.

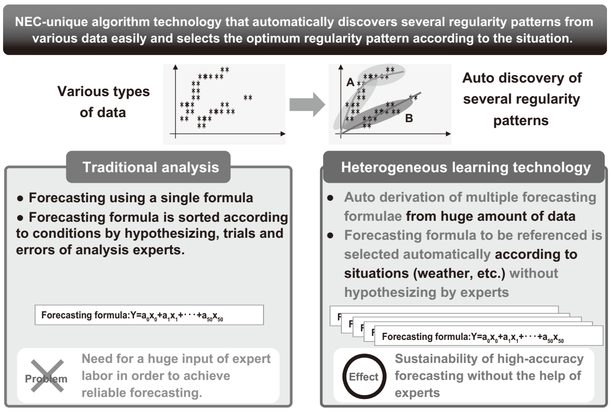

Fig. 3 Advancement of forecasting.

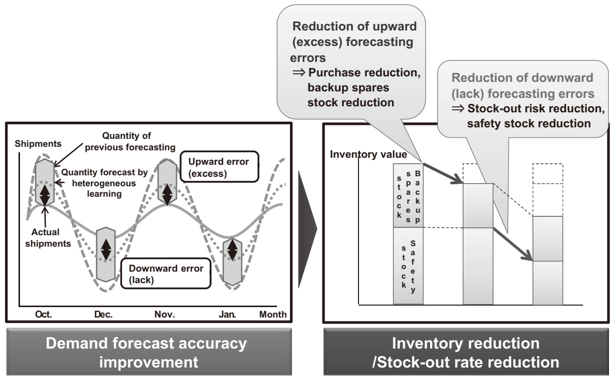

Fig. 4 Inventory optimization by forecast accuracy improvement.

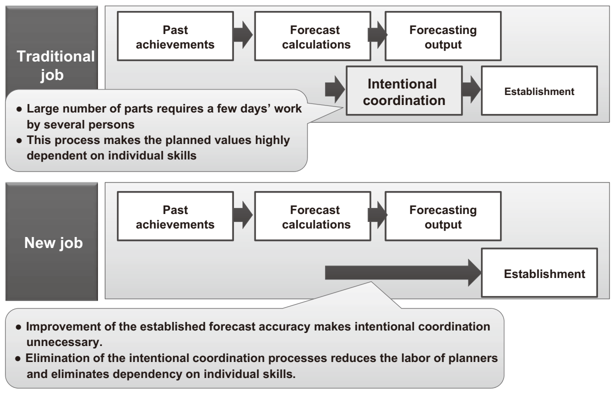

Fig. 5 Labor reduction by improving the forecast accuracy.

number of combinations that vary depending on the number of groups in which the data is categorized, the method of data grouping and on the forecast models that vary depending on the group (**Fig. 3**).

5. Introduction Advantages

(1) Optimization of inventory

The graph on the left of **Fig. 4** shows a comparison of the error rates of the demand forecasting accuracy of the traditional forecasting and of the big data analysis-based forecasting. It shows that the demand forecasting using the heterogeneous mixture learning technology achieves the higher accuracy.

The graph on the right of Fig. 4 shows that the accuracy improvements obtained by reducing "excess" (upward) forecasting errors, contributes to a reduction in the parts purchase and moving stock (inventory for meeting demands). Accuracy is also improved by reducing the "lack" forecasting errors, which contributes to a reduction in the risks of stock-out and safety stock (inventory for avoiding stock-out). This data means that the forecast accuracy is improved by reducing forecasting errors for both the "excess" and "lack" (downward) inventories. Such a strategy simultaneously enables both inventory reduction and the avoidance of a risk of stock-out.

(2) Labor reduction of man-hours

Traditionally demand forecasting applied the quantity adjustment based on the experience of the person in charge, to the forecast data in order to further improve the forecast accuracy. Utilization of the big data analysis technology makes it possible to reduce the labor for the quantity adjustment and also to plan standards by eliminating the dependency on individual skills and experience (**Fig. 5**).

(3) Automation of the ordering procedures

When the highly accurate results of demand forecasting are output at the planning stage, it becomes possible to automatically project orders by considering the stock quantities, the parts shipments scheduled for future deliveries and the inventory levels. Such procedures may be implemented by linking with existing customer systems or by combining solutions such as for spare parts replenishment planning.

6. Future Applications and Their Deployment at NEC Fielding

NEC Fielding introduced the present solution based on their verification results. It is thereby enabled to improve the demand forecast accuracy of frequently shipped parts. In order to disseminate the effects of the solution it is currently expanding the targets of all service parts and it is also taking measures for further accuracy improvements (**Fig. 6**). The company is planning to widen the achieved effects and values via the implementation of these measures.

Now that the automation of associated works is nearly complete, it will soon be possible to achieve all of the hoped for cost reduction, job efficiency improvements and automation. The company also expects to benefit from the labor saved via

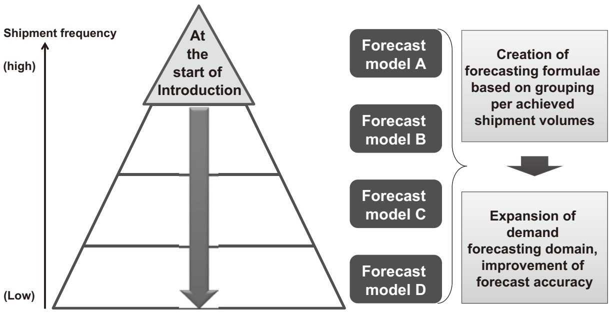

Fig. 6 Expansion of demand forecasting targets, improvement of forecast accuracy.

the efficiency improvements by developing new jobs with high added values.

7. Conclusion

The present targets of demand forecasting are limited only to the parts with a large number of shipments, however, it is planned to expand these gradually so that all of the 140,000 types of inventory parts will be covered in the future. Furthermore, it is also planned to examine the application of big data based analyses to the EOL (End Of Life) service parts before discontinuation of production. This is because it would serve for forecasting the number of parts to be purchased up until the discontinuation of maintenance.

NEC Fielding expects that the expertise and actual achievements of these activities will enable the company to provide suitable parts management services that is one of our maintenance businesses and commissioned by our customers such as manufacturers, etc. These services include recommendations based on demand forecasting and measures for cost reduction with high accuracy and high added values.

The results obtained above have led the NEC Group to start providing the "Service Parts Demand Forecasting Solution" in April 2015, which is mainly oriented toward the manufacturing industries.

This consists of a service that learns the data held by each customer using the big data analysis technology (heterogeneous mixture learning technology) and automatically generates a spare parts demand forecast formula. This means that the results and accuracy of forecasting varies depending on the type, quantity and data granularity of each customer and it is therefore recommended to conduct a demonstration experiment using the customer data and to verify the feasibility and effects before introducing the service. This makes possible step-by-step introduction by beginning the service from a small start with a low initial investment and subsequently creating a larger system according to the results achieved.

This solution is not only applicable to IT-related parts, but also it is expected to bring about important effects such as inventory optimization, cash flow improvement and associated expense reduction for parts stocked by enterprises in various industries. These include the industrial machinery, air conditioner and medical instrument manufacturing industries.

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