

Accumulation and Active Use of Facility Information for Repair and Maintenance Services

Keywords Advanced maintenance and inspection services, Facility information, Analysis, Evaluation, e-Faln

Abstract

To maintain longer operation facility life, “maintenance and inspection” activity is vital in the repair and maintenance service that diagnoses signs of equipment anomaly and manages the facility. This can happen, however, only if obtained reports, information, maintenance, and inspection records are properly managed and utilized.

To quickly confirm collected issues and trends, it is important to convert maintenance and inspection records into electronic data. e-Faln facility information management system systematically manages various information and documentation related to a facility and supports the improvement and efficiency of a series of repair and maintenance service work by accumulating and utilizing information. At the same time, information is analyzed and evaluated, and for proper preventive maintenance, risks and costs are minimized. Effective information is provided to help prolong operation life of the facility and make decisions on partial renewal of the facility. In doing so, it contributes to the optimization and high added value of overall repair and maintenance services.

1 Preface

As many facilities supplied to our customers, including substation equipment, are aging, and various problems, such as outages and insufficient capacity due to deterioration over time, are likely. For prevention, it is important to continuously maintain an appropriate repair and maintenance facility management system. Preventive maintenance is required to analyze maintenance and inspection services in taking proactive measures. In order to properly maintain a facility, information on the configuration and specifications of the customer’s facility is systematically stored and managed, and maintenance and inspection service information is added for analysis, evaluation, diagnosis, preventive maintenance, and facility renewal. In this paper, we will introduce the facility information management system e-Faln and the function of data mining (utilizing accumulated data), which we built as one of the tools to support repair and maintenance service.

2 Overview of e-Faln

Fig. 1 shows the sharing and use of informa-

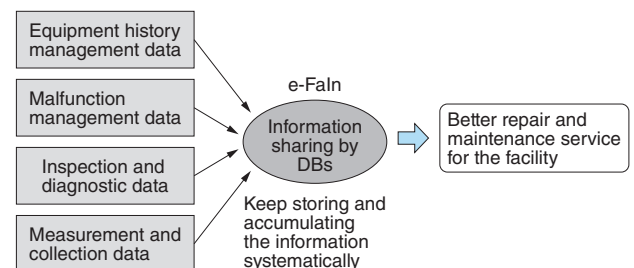


Fig. 1 Sharing and Use of Information

Facility information is an accumulation of the basic information relating to facilities and equipment plus a variety of information about repair and maintenance service history. These information and data are actively used for repair and maintenance service.

tion. This system collects information obtained during daily inspection service based on the system configuration information of various facilities, and systematically stores and organizes it in a Database (DB). For facility management service, reliable information such as analysis and evaluation using repair and maintenance service information of these facilities and equipment, accurate judgment of anomaly data, detection of signs of failure, maintenance planning, extension of facility operation life, and propos-

al of equipment replacement time is provided.

In addition, when an inquiry from a customer or information of a malfunction is received, it is possible to respond promptly by referring to the facility/equipment configuration and information/maintenance history. In this way, it is a system aimed at supporting the entire repair and maintenance service works.

2.1 Background

Our repair and maintenance service Business Unit (BU) has a nationwide service network in Japan and manages individual information on each customer facility for each service hub. In recent years, with the progress of Information Technology (IT), the spread of network technology has made it possible to digitize and share information, thus centralized management in DB has become possible. Information related to facility and equipment that leads to maintenance or diagnosis matters is stored in a DB at each service hub to be shared, and utilized. As a result, detailed facility maintenance services can be provided.

2.2 Necessity of Facility Information Management

Fig. 2 shows the necessity of facility information management. Facility maintenance is similar to a medical examination in that, at the time of a medical examination, diagnosis and treatment are performed by referring to information already written in

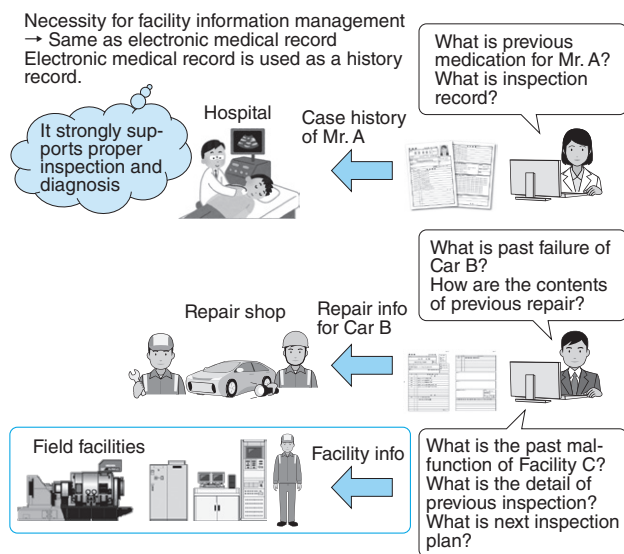


Fig. 2 Necessity of Facility Information Management

Facility information is equivalent to a medical record used for diagnosis at a hospital.

the medical record. Similarly, when repairing a car in a repair shop, the shop refers to its past maintenance details and performs the repair work needed. For facility maintenance service, we refer to the facility information and maintenance history corresponding to its previous records and perform the repair and maintenance service works required. Without equipment information, accurate facility repair and maintenance service works cannot be performed properly. The priorities of facility information management are as follows:

- (1) Facility management service work and repair and maintenance service works are very closely related.
- (2) Information management is required to carry out repair and maintenance service works.
- (3) Facility information management is required for facility management service works.
- (4) Facility management system is required for information management when the amount of information is large.
- (5) Information that can be analyzed is required for condition diagnosis and repair and maintenance service.

2.3 Functional Overview

2.3.1 Information Content

Fig. 3 shows the data structure. To manage the status of the equipment maintenance, various basic facility information on the equipment is accessed.

- (1) Information of customer, facility, and equipment
Detailed information on installed equipment and information that identifies the equipment (customer name, equipment name, and equipment classification)
- (2) Information of replacement part
Information on replacement parts for each device, on and inspection (part name, model, location of use, replacement period, and replacement record)
- (3) Information of failure repair, inspection, and machine history
Implementation details of inspection, failure repair, repair, expansion, and modification for equipment
- (4) Information of diagnostic measurement
Periodic measurement values performed during inspection (follow-up data)
- (5) Information of maintenance plan
Inspection items and cycles for each device

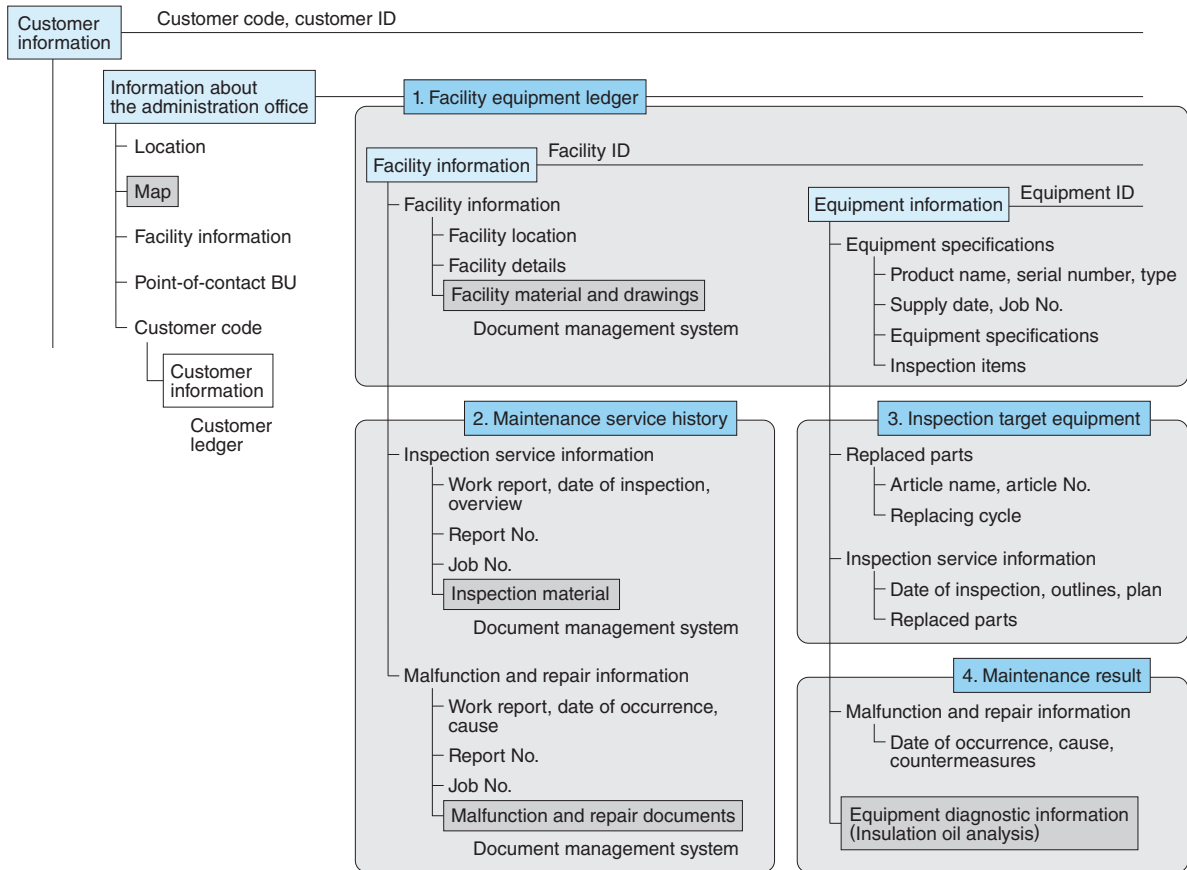


Fig. 3 Data Structure

Data of the facility information management system are managed in a hierarchical structure with customer information at its top.

linked with device data

(6) Information of related materials

Management of numerous documents such as work reports, drawings, technical materials

2.3.2 Visualization of Information

Fig. 4 shows an example of a form output. It outputs the accumulated information in various forms.

(1) Facility inspection history list

Inspection history of the facility to be inspected

(2) List of the facility malfunction and repair history

Details of malfunction and repair work

(3) Usage record of products used for emergency trouble-shooting work

List of products used for emergency trouble-shooting work

(4) Replacement parts list

Replacement parts information and replacement plan table

(5) List of inspection service work items

Contents of inspection service work

(6) Replacement part replacement cycle standard list

Fig. 4 Example of Form Output

Accumulated information is edited and outputted in a variety of formats.

Replacement cycle standard value

(7) Maintenance service work plan table

Maintenance service work implementation schedule

2.3.3 Information Analysis

It outputs the accumulated data using the export function and analyzes it. It graphs the data

and uses it for trend analysis management. Fig. 5 shows the information analysis screen.

2.4 Linking with Other DBs Such as Document Management DB

It links and refers to the accumulated information of other DBs in addition to the facility information DB. Fig. 6 shows the reference to each DB.

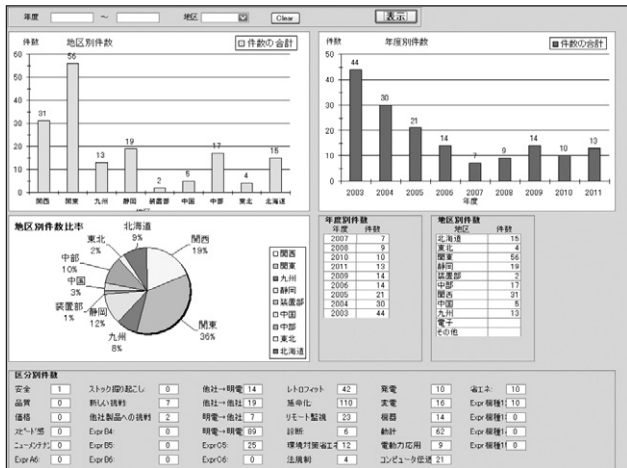


Fig. 5 Information Analysis Screen

Accumulated data are outputted and put into graphs using a BI tool for the purpose of analysis.

2.4.1 Malfunction Information Reception Management System

It records the content of the malfunction report from the customer and transmit the obtained information to the parties concerned by e-mail. In addition, the progress is traced by recording the trouble-shooting status (results). Furthermore, it links with e-Faln as reception information. Fig. 7 shows the configuration of the malfunction information reception management system.

- (1) Record of malfunction information reception
 - It records when, from whom, and what kind of information
- (2) Sending the information to on-site field service engineer in charge

Contact is made by e-mail for trouble-shooting. (It outputs a work instruction.)

- (3) Trouble-shooting information (update management)

- (a) Electronic files of the related documents
- (b) Trouble-shooting progress information

It manages the start of trouble-shooting work and the time of completion.

- (c) Registration of data for facility information – malfunction and repair information

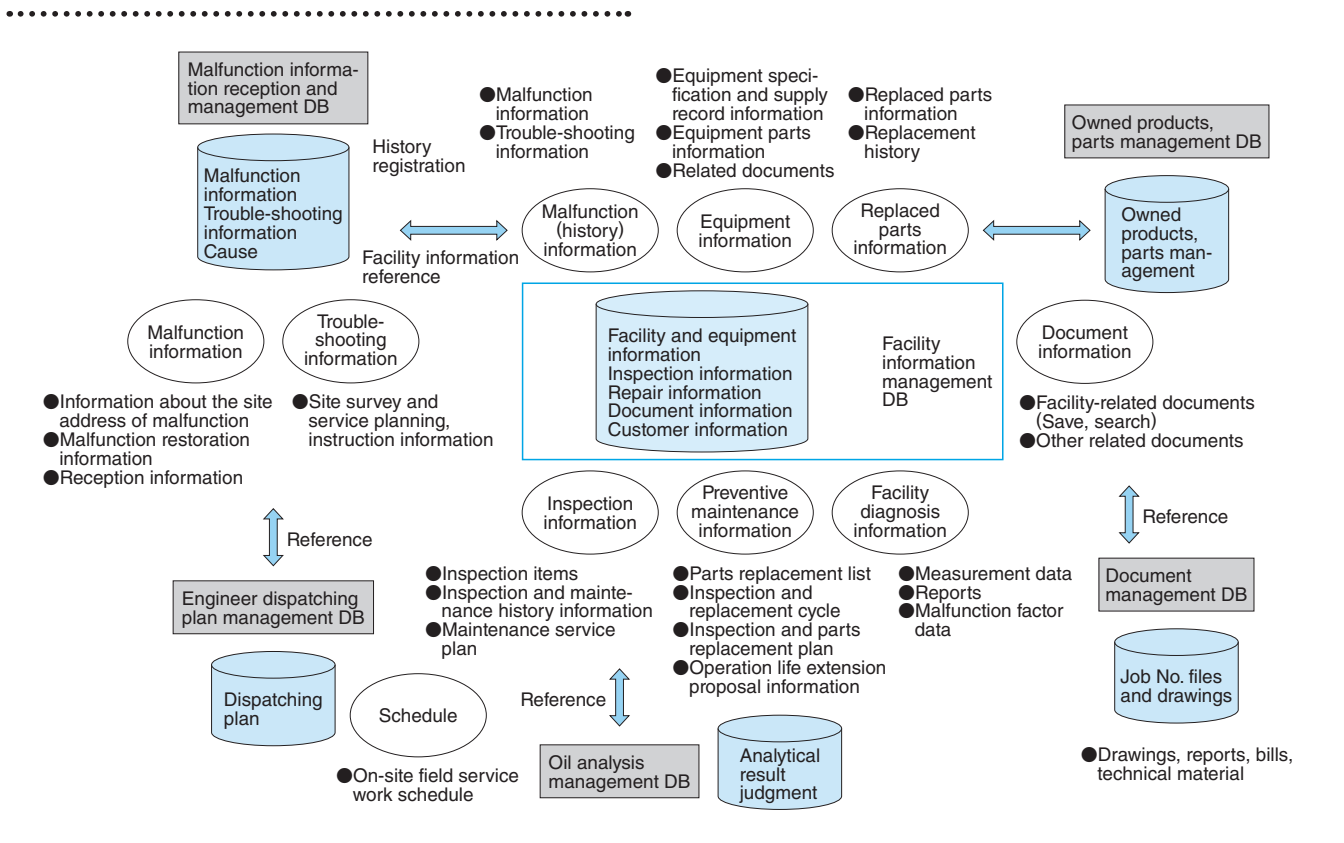


Fig. 6 Reference to Each DB

In relation to maintenance and inspection service work, accumulation and coordination of various DB information and information linking of various DBs are shown.

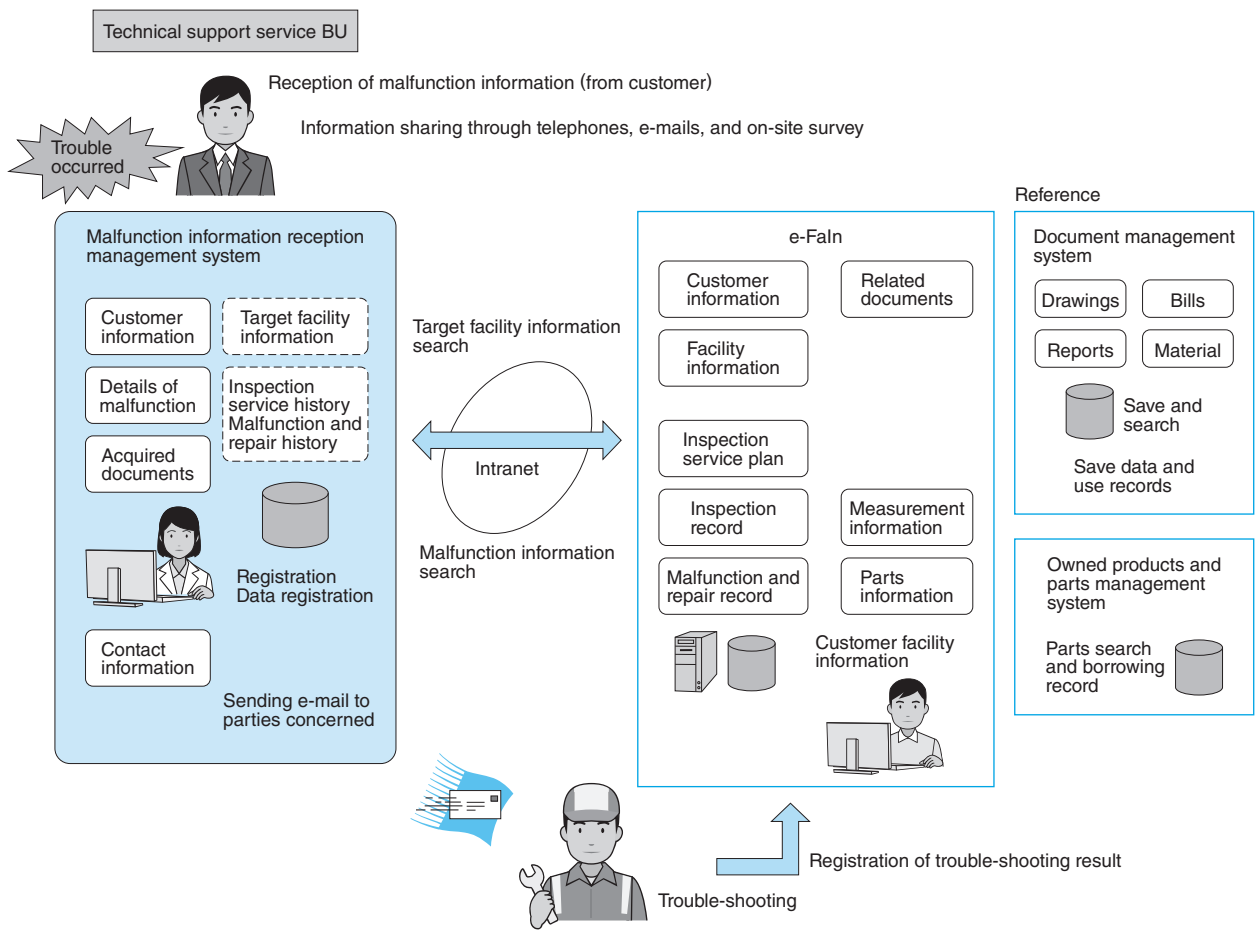


Fig. 7 Configuration of Malfunction Information Reception Management System

Contents of customer's malfunction-related contact are recorded to control the result of trouble-shooting.

Fig. 8 Form Screen of Malfunction Information Reception Management System

Based on accumulated information, transmittal sheets of the repair service request sheet (contents of request) are sent to the dispatched field-service engineer(s) or the contract service provider as a means of information communication.

Fig. 8 shows the form screen of the malfunction information reception management system.

Fig. 9 Screen of Field Service Engineer Dispatching Schedule

Field service engineer dispatching schedule is registered and referred within the scope of districts, bases, and related BUs.

2.4.2 Field Service Engineer Dispatching Plan Management

After receiving malfunction information, it is registered in the field service engineer dispatching plan. The schedule of field service engineers within the applicable districts, bases, and departments are referred to and registered. **Fig. 9** shows the screen

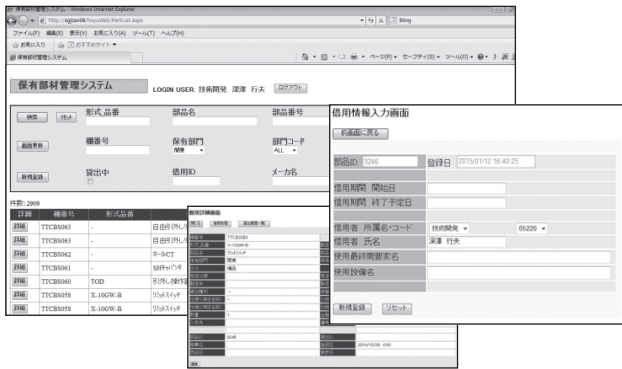


Fig. 10 Screen of Required Products or Parts Search and Borrowing Application

Required products or parts search and borrowing application screen are shown. This searches the owned products, parts, and materials via the Web.

of the field service engineer dispatching schedule.

2.4.3 Owned Products, Parts and Materials Management System

Fig. 10 shows the screen of the required products or parts search and borrowing application. It manages products, parts or materials necessary for urgent trouble-shooting work.

(1) Parts search

Searches for the presence or absence of parts

(2) Lending management

Sharing products necessary for emergency trouble shooting work

(3) Parts management function

Usage status of parts necessary for urgent trouble-shooting work

2.4.4 Document Management System

The data such as reports, drawings, materials, inspection implementation records, work records related to the target facility as electronic files is shown and can be referred to as the facility information management DB. **Fig. 11** shows the linkage between document management DB and facility information management DB.

2.4.5 Oil Analysis Management System

The information obtained from the request for analysis to the completion of analysis in insulating oil analysis is recorded. In addition, various evaluations based on the result information are performed and past analysis data, and the analysis result report are outputted. **Fig. 12** shows the screen of the oil analysis management system.

2.4.6 Active Use of Data

While various inspections are carried out daily, accumulated data already examined are actively and effectively utilized. Functions of this system are

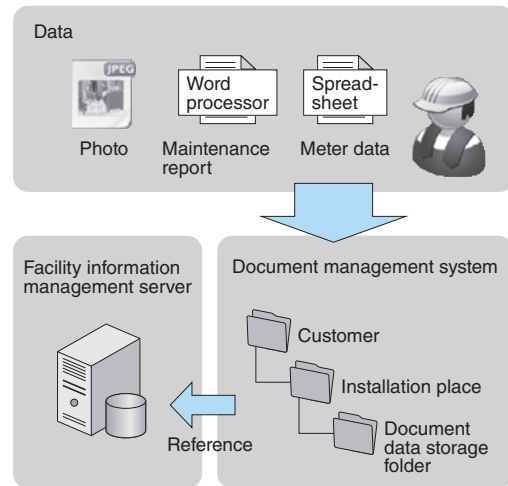


Fig. 11 Linkage between Document Management DB and Facility Information Management DB

Flows of document data storage and management data reference are shown.

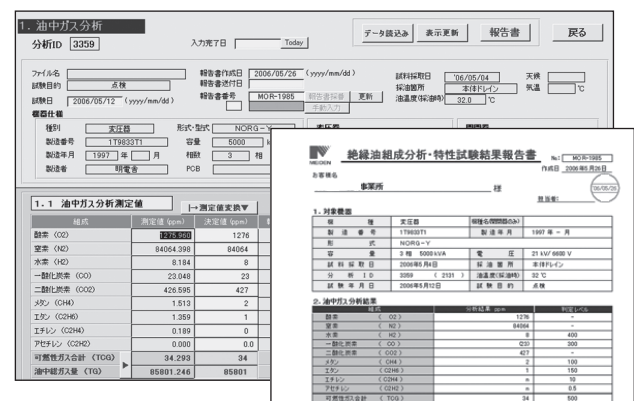


Fig. 12 Screen of Oil Analysis Management System

Functions for storage, evaluation, and judgment of the result of oil analysis are shown.

designed to support proper management of anomaly data, detection of failure signs, and proposal of maintenance service plans.

(1) Risk evaluation table drafting tool (**Fig. 13**)

The basic information of the risk evaluation table, which is part of facility information, can be outputted from files so that the information output is analyzed by using the risk evaluation table drafting tool. The output of the risk evaluation result is then generated.

(2) Trouble-shooting flow drafting tool (**Fig. 14**)

Information of field service work report accumulated in files of facility information DB is outputted and analyzed by using trouble-shooting flow drafting tool in order to generate an output of a past failure flow.

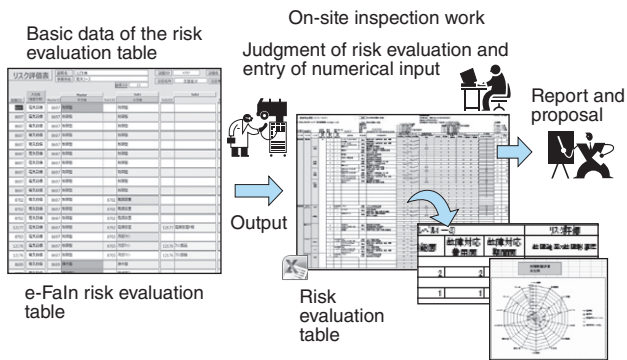


Fig. 13 Risk Evaluation Table Drafting Tool

Tools for drafting a facility risk evaluation table are shown based on the registered information of the facility acquired from inspection service processes.

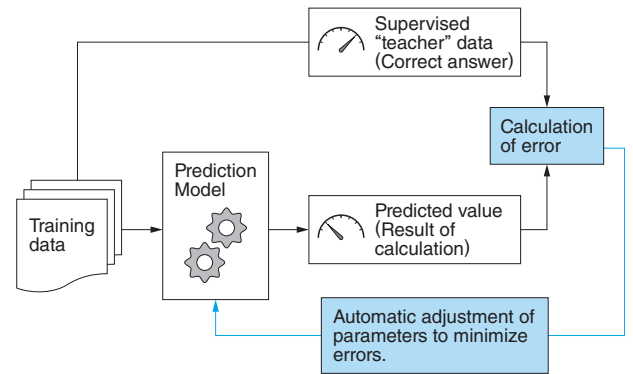


Fig. 15 Process of Prediction Model Making by Machine Learning

Using machine learning technology, we make and apply prediction judgment models, such as judgment and evaluation criteria.

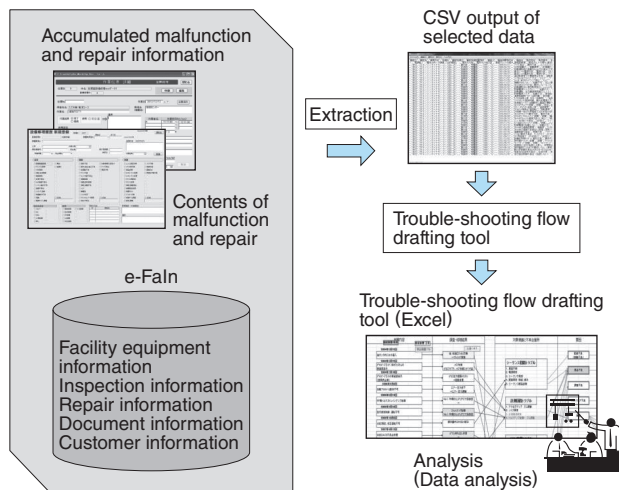


Fig. 14 Trouble-Shooting Flow Drafting Tool

The CVS files, where information of the on-site service work report is gathered, are outputted from the accumulated facility information, and the malfunction is illustrated.

3 Future Prospects

To establish and utilize the DBs, it is critical to maintain and update the data continuously, in addition to the initial building of database. By interlinking with other DBs, the volume of information can be expanded so that the system operation is extended to enable the related business units (BUs) to use this system in regular ongoing business.

In addition, since there are various target facilities and equipment, it is important to establish effective diagnostic technology for each case, including analysis technology using statistical methods. It is also important to accurately select the diagnostic data and inspection data to be accumu-

lated and monitored. For analyzing data, we will work on creating a prediction model for making judgments by applying AI technology such as machine learning, so that we can predict failures. Fig. 15 shows the process of a prediction model making by machine learning.

4 Postscript

Facility maintenance service has a wide scope of work such as commissioning, inspection, repair, adjustment, modification, expansion, and partial renewal work. It is, therefore, important to systematically manage various data and information that can be used for each work. This system utilizes various information about the target facility to support a series of reasonable and efficient repair and maintenance service works. At the same time, while minimizing risks and costs, it provides effective information useful for prolonging the operational life of a facility and making decisions on partial renewal, and aims to support the optimization and high added value of overall repair and maintenance service works.

Going forward, we will continue to improve this system so that it will be a more effective system to provide optimal maintenance services for the longer operational life of a facility.

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