Recommendation

# ITU-T M.3386 (01/2024)

SERIES M: Telecommunication management, including TMN and network maintenance

Telecommunications management network

# Requirements for the management of network operation cost within AI enhanced Telecom Operation and Management (AITOM) in telecommunication operational aspects

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## Recommendation ITU-T M.3386

# Requirements for the management of network operation cost within AI enhanced Telecom Operation and Management (AITOM) in telecommunication operational aspects


### Summary

Recommendation ITU-T M.3386 focuses on network operation cost management within AITOM in telecommunication operational aspects. This Recommendation provides the classification standard and functional requirements of network operation cost management.


### History *

| Edition | Recommendation | Approval | Study Group | Unique ID |
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| 1.0 | ITU-T M.3386 | 2024-01-13 | 2 | 11.1002/1000/15772 |


### Keywords

Management, network maintenance, network operation cost.


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# Recommendation ITU-T M.3386

## Requirements for the management of network operation cost within AI enhanced Telecom Operation and Management (AITOM) in telecommunication operational aspects

## 1 Scope

This Recommendation defines the framework of AI technology in network operation cost management in telecommunication network operation and maintenance, and defines the functional requirements under the AITOM standard.

## 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T M.3200] Recommendation ITU-T M.3200 (1997), *TMN management services and telecommunications managed areas: overview*.

[ITU-T Y.3101] Recommendation ITU-T Y.3101 (2018), *Requirements of the IMT-2020 network*.

## 3 Definitions

### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 artificial intelligence model** [b-ITU-T M.3080]: The model created by applying artificial intelligence (AI) technology to data to learn from.

**3.1.2 artificial intelligence pipeline** [b-ITU-T M.3080]: A set of logical nodes, each with specific functionalities, that can be combined to form an artificial intelligence (AI) application in systems of telecom operation and management.

**3.1.3 machine learning (ML)** [b-ITU-T Y.3172]: Processes that enable computational systems to understand data and gain knowledge from it without necessarily being explicitly programmed.

**3.1.4 on-site overhaul** [b-ITU-T M.3040]: A kind of on-demand preventive maintenance performed at facility site in the condition of natural disasters or major events.

**3.1.5 on-site patrol** [b-ITU-T M.3040]: A kind of routine preventive maintenance periodically performed at a facility site.

**3.1.6 on-site troubleshooting** [b-ITU-T M.3040]: A kind of corrective maintenance performed at a facility site when the quality of equipment degrades.

**3.1.7 work order** [b-ITU-T M.3382]: A ticket through which the superior department assigns a network management, operation and maintenance task to the subordinate department.

### 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1 consumable material:** All supplies used in the performance of maintenance work that are disposable after use and must be replaced regularly to continue with the performance of maintenance work.

NOTE – Some typical consumable materials are patch cord, pigtail, connectors and registered jack.

**3.2.2 maintenance support services:** Services provided by the original equipment manufacturer or provider to support the operator's maintenance work according to the maintenance contract.

NOTE – Maintenance support services include technical support in case of operational failures, regular inspection and repairing of the device, etc.

**3.2.3 network operation cost**: Human and other resources spent during the operation and maintenance of a network.

**3.2.4 spare parts**: Extra components or devices prepared in advance for replacing the ones in use according to maintenance work needs.

# 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI Artificial Intelligence

AITOM AI enhanced Telecom Operation and Management

NLP Natural Language Processing

OS Operation System

TMA Telecommunications Managed Areas

TSMS Telecommunication Smart Maintenance System

# 5 Conventions

In this Recommendation:

The keywords "**is required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The keywords "**is recommended**" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement needs not be present to claim conformance.

# 6 Overview

The application framework of AI technology in network operation cost management is a detailed application based on AITOM, focusing on the network operation cost management of telecommunication network equipment, telecommunication machine room, base station and transmission lines. This Recommendation proposes the classification of network operation cost and the framework and functional block of artificial intelligence-based network operation cost management, and describes how to use artificial intelligence to correlate network status data, business operation data and maintenance execution data to achieve real-time dynamic network operation cost decision-making and management.

# 7 Framework for the management of network operation cost within AITOM

## 7.1 Classification of network operation cost

### 7.1.1 Classification principle of network operation cost

The classification structure design of network operation cost should follow these basic principles:

1) Principle of network development consistency: Respond to network evolution and business tendencies such as IMT-2020 and cloud and have dynamic adjustment capability of classification.

2) Principle of conformity to management requirements: The setting of cost classification structure should conform to the requirements and emphasis of realistic cost analysis and control, which is easy to implement management.

3) Principle of comprehensiveness and clarity: The classification perspective and classification logic are unified, the concept of classification description is unambiguous, the classification system is comprehensive, independent and non-overlapping.

### 7.1.2 Classification framework of network operation cost

The classification of network operation costs is mainly composed of the telecommunications managed area and cost expenditure categories.

The telecommunications managed area is a set of telecommunications resources, logically and/or physically involved with the telecommunications services. According to [ITU-T M.3200] and [ITU-T Y.3101], those listed below are possible examples of telecommunications managed areas:

– Fixed broadband network;
– Radio access network;
– Core network;
– Transport network;
– Infrastructure.

The cost expenditure category is mainly subdivided from the perspective of network operation cost payment objects. It is recommended to contain the following:

– On-site patrol;
– On-site overhaul;
– On-site troubleshooting;
– Installation and acceptance testing;
– Spare parts;
– Consumable material;
– Maintenance support services.

Table 1 presents the classification framework of network operation cost.

**Table 1 – Classification framework of network operation cost**

| TMA \ Cost expenditure category | On-site patrol | On-site overhaul | On-site trouble-shooting | Installation and acceptance testing | Spare parts | Consum-able material | Mainten-ance support services | … |
|---|---|---|---|---|---|---|---|---|
| Fixed broadband network | | | | | | | | |
| Radio access network | | | | | | | | |
| Core network | | | | | | | | |
| Transport network | | | | | | | | |
| Infrastructure | | | | | | | | |
| … | | | | | | | | |

The design of network operation costs classification has applicability between different operators, which can support the flexible expansion of classified items under a unified framework. In practical applications, operators can choose a subdivision category or aggregate some subdivision categories on demand for benchmarking management to ensure consistency of calibre.

## 7.2 Functional block diagram for network operation cost within AITOM

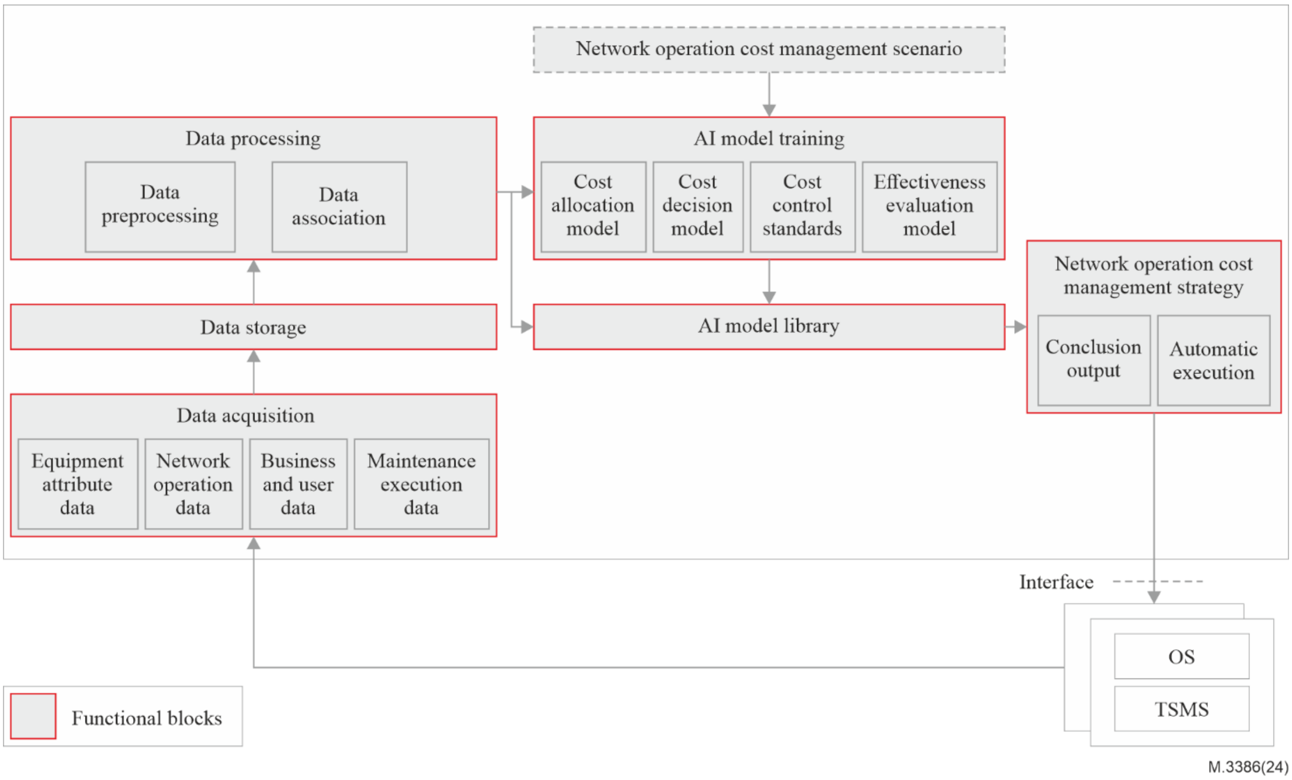



**Figure 1 – Functional block diagram for network operation cost within AITOM**

The management of network operation cost within AITOM is required to provide the following functional blocks, as shown in Figure 1:

1) Data acquisition block: This module realizes the collection of various data related to network operation cost management, including data in the process of enterprise operation and external industry and market data.

2) Data storage block: The data from the "data acquisition block" are stored, managed and updated in this module for the network operation cost management model in different scenarios to call.

3) Data processing block: Standardized processing and data association of the data collected and stored by different systems for further analysis and application. The data formed by the secondary processing also need to be included in the "data storage block".

4) AI model training block: For different network operation cost management application scenarios (such as cost configuration, cost-benefit evaluation, etc.), call the data information in the data storage block, select appropriate model tools for model algorithm training and draw conclusions.

5) AI model library block: This module mainly trains, stores and manages different network operation cost management models. After the training is completed, the AI model is put into the AI model library through capability packaging.

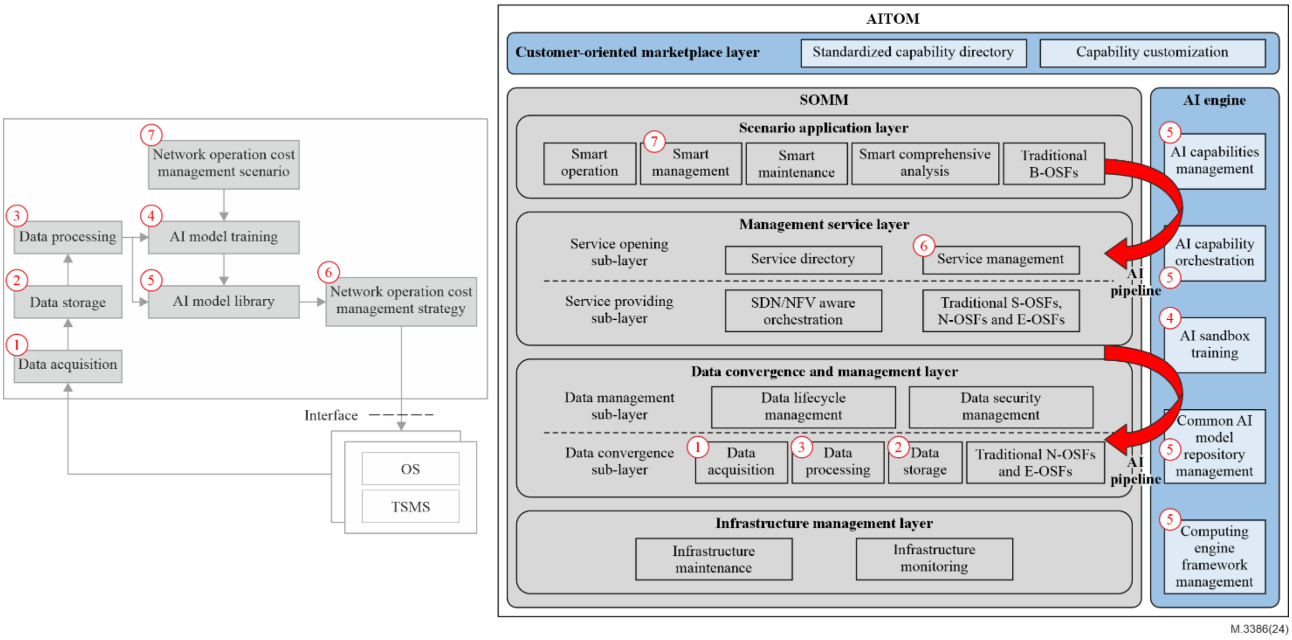
6) Network operation cost management strategy block: Based on the trained artificial intelligence model and online data, this block calls and integrates artificial intelligence models to generate artificial intelligence-based network operation cost management strategies.

7) Interface: After generating the AI-based network operation cost management strategy, the system sends commands through the interface to execute the network operation cost management strategy.

The functional requirements of each functional block for network operation cost within AITOM will be introduced in clause 8.

### 7.3 Relationship between AITOM and network operation cost management

Network operation cost management is a function class for the AITOM framework. This proposal focuses on the functional requirements of AI-based network operation cost management. The functional block diagram of AI-based network operation cost management refers to the functional framework of AITOM, and the relationship between them is shown in Figure 2.




NOTE 1 – The symbols of the red circle with a number represent the mapping relationship between the functional block diagram of AI-based network operation cost management and the AITOM framework.

**Figure 2 – Relationship between the functional block diagram of network operation cost management and the AITOM framework**

The relationship between the functional block diagram of AI-based network operation cost management and the AITOM framework in Figure 2 can be described as follows:

– The data acquisition block, data storage block and data processing block can correspond to the data aggregation and management layer of the AITOM framework. However, the data collection of this block is based on the network operation cost management scenario.

  NOTE 2 – These three blocks correspond to red circle 1, red circle 2 and red circle 3 respectively in Figure 2.

– The AI model training for network operation cost management corresponds to the AI sandbox training of the AI engine under the AITOM framework.

  NOTE 3 – This block corresponds to red circle 4 in Figure 2.

– The AI model library for network operation cost management corresponds to the AI engine's AI capability orchestration and AI capability management, general artificial intelligence model library management and computing engine framework management.

  NOTE 4 – This block corresponds to red circle 5 in Figure 2.

– The network operation cost management strategy block corresponds to the service management of the management service layer in the AITOM framework.

  NOTE 5 – This block corresponds to red circle 6 in Figure 2.

– The network operation cost management scenario corresponds to the smart management of the application layer of the AITOM framework.

  NOTE 6 – This part corresponds to red circle 7 in Figure 2.

## 8 Functional requirements of network operation cost management within AITOM

### 8.1 Functional requirements of the data acquisition block

The data that support the realization of the network operation cost management business process includes internal data (equipment attributes, network operation, maintenance execution, etc.) and external data (market unit prices, etc.). The internal data mainly come from the network management system, work order system and analysis system.

Data acquisition block is required to acquire the following data:

– Equipment attribute data: equipment type, equipment capacity, manufacturer, original value and net value of network assets, etc.

– Network operation data: installation location, network level, network access time, service bearing, resource utilization, equipment alarms, etc.

– Business and user data: business and user scale and type, user perception, user complaints, etc.

– Maintenance execution data: work order start and end time, executor, maintenance actions, maintenance labour and material input, maintenance cost accounting, etc.

NOTE – Maintenance labour refers to the personnel input to execute the maintenance work order, including the number of personnel, personnel ability attributes (general workers, technicians, etc.) and working hours.

### 8.2 Functional requirements of the data storage block

After being collected, the data needs to be stored in the data storage block, and the data storage block is required to provide the following functions:

– Support the storage of original information of different types and formats (such as data, text, voice, image, video and code instructions);

– Support the storage of process data and final analysis results;

– Support batch import and export of data.

### 8.3 Functional requirements of the data processing block

Standardize processing and secondary storage of data collected and stored by different systems for further analysis and application. The data processing block is required to provide the following functions:

Data preprocessing: Acquire historical network operation cost data (operation work order data, etc.) from the data storage module. Identify and replace the missing and wrong category labels (network type labels, etc.) in the operation work order, and improve the accuracy of classification information through natural language processing (NLP). The implementation process is as follows:

1) Work order information acquisition: Obtain the project name, project description and resource information from the work order.

2) Keyword extraction: Select part of the candidate word data as the training set, label each candidate word by expert and determine whether it is a keyword. Use the labelled training set to train the keyword classifier, and then obtain the keyword database.

3) Classification operation keyword database creation: Form a classification operation keyword database according to network categories.

4) Keyword screening: Screen keywords for new work orders, and obtain the classification and frequency of all keywords.

5) Data comparison and correction: Take the keyword category with the highest frequency as the category labels (network type labels, etc.) of the work order, and replace the missing or wrong label.

Data association: The collected data of maintenance operations, network resources, network operations, business and users can be associated in the following ways:

1) Association through device information: Other systems connect to resource systems based on resource system data.

2) Association through operation work order information: Connect other systems to the work order system based on operation system data.

After data preprocessing and data association, network maintenance cost data can be analysed according to different dimensions, including:

1) Cost expenditure category: On-site patrol, on-site overhaul, on-site troubleshooting, installation and acceptance testing, spare parts, consumable, maintenance support services, etc;

2) Telecommunications managed area: Fixed broadband network, radio access network, core network, transport network, infrastructure, etc;

3) Equipment dimension: Device manufacturer and models.

Based on the above data, the AI model can be trained according to the requirements of relevant scenarios.

### 8.4 Functional requirements of AI model training block

AI model training is applied to different network operation cost management application scenarios. It includes three stages: calling the data information in the data storage module, selecting appropriate model tools (such as mathematical statistics, decision trees, neural networks, genetic algorithms and machine learning) and drawing general rules or conclusions. The training model of the network operation cost management is required to include:

– Cost allocation model: Based on historical data of network operation cost and replaced category labels (including cost amount, network type, resource information, time, geographical location, etc.), predict the network operation costs of different types of networks or equipment within a specified period of time through machine learning, including:
  1) Equipment maintenance cost prediction: For specific types of equipment, extract the historical cost data, adopt regression models (linear/non-linear), and train the models by gradient descent, neural network or other algorithms. Predict equipment maintenance costs by the trained model.
  2) Network operation cost prediction: Identify the highest-correlated network operation cost-effectiveness indicators (such as maintenance cost/fixed assets and maintenance cost/equipment port) with maintenance cost through related algorithms (such as the decision tree algorithm), and generate cost-effectiveness models and cost estimation rules.
  3) Modification factor configuration: Modification factors include topography characteristics and maintenance labour cost level. Establish factor configuration rules based on features of different regions or telecommunications managed areas.

– Cost decision model: Based on the predicted network operation costs data of different types of networks or equipment from cost allocation model within a specified period, and generate the automatic evaluation and decision model through using the multifactor evaluation method and algorithm training such as the decision tree algorithm, to form the network operation cost management strategy in the end. Relevant evaluation factors include:
  1) Network operation cost factor: evaluate network operation cost-effectiveness;
  2) Network quality factor: evaluate network performance and alarm data;
  3) User perception factor: evaluate the user complaint rate caused by network quality reasons;
  4) User and revenue factors: evaluate the number of users and revenue;
  5) Potential risk factors: evaluate the network operating life range (calculated by the weighted operating life of various devices).

– Cost control standards: standardize the usage of various cost materials in the network maintenance process, and form cost quota standards under different geographical characteristics (such as the input of manual labour hours for each base station inspection work in plain and hilly areas).

– Effectiveness evaluation model: According to the network operation cost input of different network levels and device types, different data and methods are selected to build a differentiated effectiveness evaluation model. The construction of the evaluation model needs to cover the selection of evaluation indicator sets, the determination of data-collection time, and effectiveness evaluation algorithm rules.

### 8.5 Functional requirements of the AI model library block

After training, the AI model is put into the AI model library through capability packaging, and called according to the actual cost management requirements in the network operation and maintenance process.

### 8.6 Functional requirements of the network operation cost management strategy block

The network operation cost management strategy is required to include two modes: conclusion output and automatic execution.

– Conclusion output: The output of the model analysis results can support the decision-making suggestions of cost managers and field maintenance personnel at all levels. The decision-making suggestions must be converted into natural language and displayed on the user-side visual interface to ensure the readability of the output results.

– Automatic execution: For more mature application scenarios, it can skip manual transfer and adopt automatic execution modes, such as the automatic allocation of cloud network operation costs, and the automatic batch establishment of maintenance projects.

### 8.7 Functional requirements of the interface

After generating the AI-based network operation cost management strategy, the system sends commands through the interface to execute the network operation cost management strategy.

### 8.8 The process of network operation cost management

From the perspective of the entire lifecycle management and control of network operation costs, the management process of network operation cost includes six typical steps: cost requirements, cost decision, cost execution, cost settlement, cost evaluation and comprehensive analysis (Figure 3).

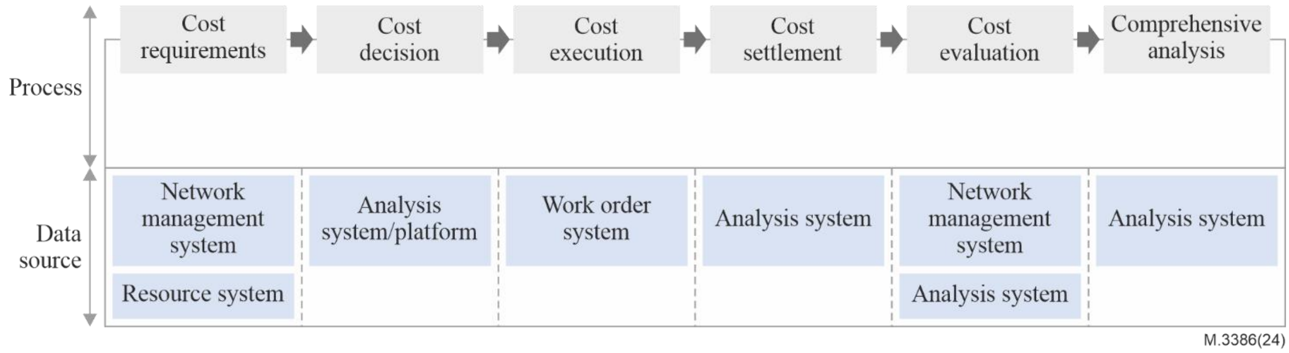



**Figure 3 – AI technology in the network operation cost management business process framework**

1) Cost requirements: The generation of service requirements is mainly based on the network operation status in the resource system and the network management system. Through the monitoring, aggregation and analysis of the real-time status of the network operation, combined with the characteristic analysis of historical network failures and machine learning, real-time warning of network failures and high-risk equipment can be realized, and a hierarchical service requirement list can be generated.

2) Cost decision: Make manual decisions or intelligent rule judgments on the maintenance requirement list, automatically generate servicing work order for the servicing requirements that need to be executed, and intelligently identify and filter similar service work orders through feature matching from historical service information, and data analysis modelling to support the accurate estimation of current cost requirements.

3) Cost execution: Through accurate matching of service demand and service cost distribution, the system can distribute work orders intelligently. At the same time, geographical positioning, image acquisition and action recognition are realized through the intelligent terminal to collect and record the execution process information, mainly including the service object, service time and service cost input.

4) Cost settlement: After the work order is closed, it is necessary to calculate the cost of the current work order. In this way, network operation cost usage is associated with maintenance equipment (or line) and maintenance work order.

5) Cost evaluation: Automatically monitor and analyse the two time points before and after maintenance, compare and analyse the state changes of equipment in the network management system and evaluate whether the operation cost investment has achieved the function of fault recovery or performance and quality improvement.

6) Comprehensive analysis: Comprehensive analysis is based on the work order execution and cost usage data pool, through data mining modelling, machine learning, etc., to form decision rules and standard scales that support the refined and intelligent management of network operation cost; for example, resource allocation quotas for different maintenance scenarios and cost allocation priority rules under resource constraints.

# Appendix I

## AI pipeline case within Network operation cost management

(This appendix does not form an integral part of this Recommendation.)

For the description of the AI pipeline in network operation cost management, refer to the description of the AI pipeline in the AITOM framework given in [b-ITU-T M.3080]. The AI pipeline has two states: development state and running state.

### I.1 AI pipeline in the development state

The AI pipeline in the development state includes the AI capability requirement analysis process based on the application scenario, the AI sandbox training process, and the AI capability scheduling and storage process. The first step is to analyse AI capability requirements based on specific network operation cost management scenarios, and frame the data and general AI models required for model training. The second step is to obtain feature data and general AI models from the data module and AI model library, and continuously carry out model training and parameter tuning. The third step is to form a mature model and input it into the AI model library for scheduling and calling. The flow chart is as follows:

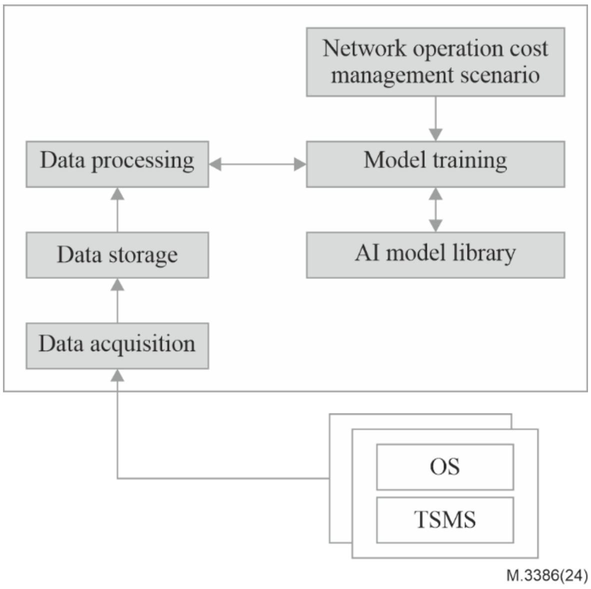



**Figure I.1 – Development state process of AI-based network operation cost management**

### I.2 AI pipeline in the operation state

The production management strategy of the AI pipeline in the running state for the cost management requirements in the actual network operation and maintenance process includes data acquisition, model invocation, strategy generation, command issuance and execution, and data return. The first step is to determine the network operation cost management AI model that needs to be invoked, according to the cost management requirements in the actual network operation and maintenance process and the data collected to support the model measurement. The second step is to generate the data for this time based on the model and data invocation, which support the demand network operation cost management strategy. In the third step, the management strategy is issued to the operating system (OS) or telecommunication smart maintenance system (TSMS) through the interface block to implement command execution. In the fourth step, the command execution action and execution result data are sent back to the data management module to continuously enrich the data accumulation and support model training and upgrade. The flow chart is shown in Figure I.2.

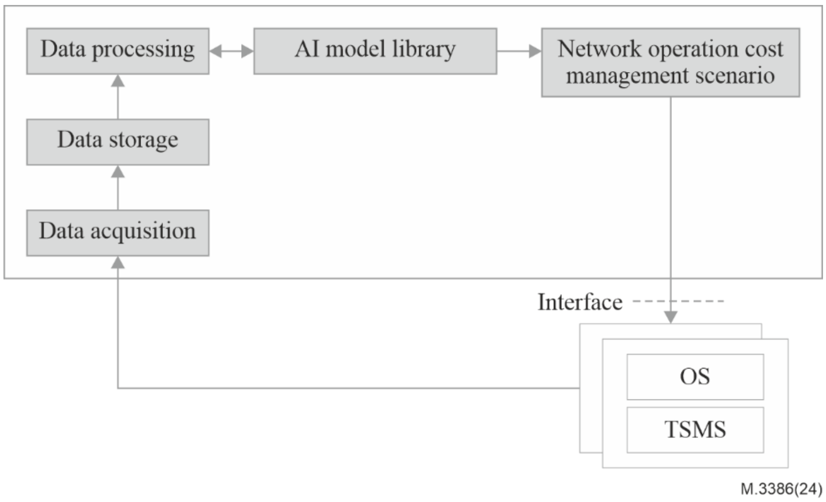



**Figure I.2 – Operational state process of AI-based network operation cost management**

# Appendix II

## AI-based network operation cost management case

(This appendix does not form an integral part of this Recommendation.)

This appendix presents two typical application cases for management of network operation cost within AITOM. One case is about the combination of cost management and fault management to maintain the stability of network operation with fewer costs. Another case is about building a cost quota database by collecting all kinds of data.

**Table II.1 – Automatically initiate scenario for network operation cost requirements**

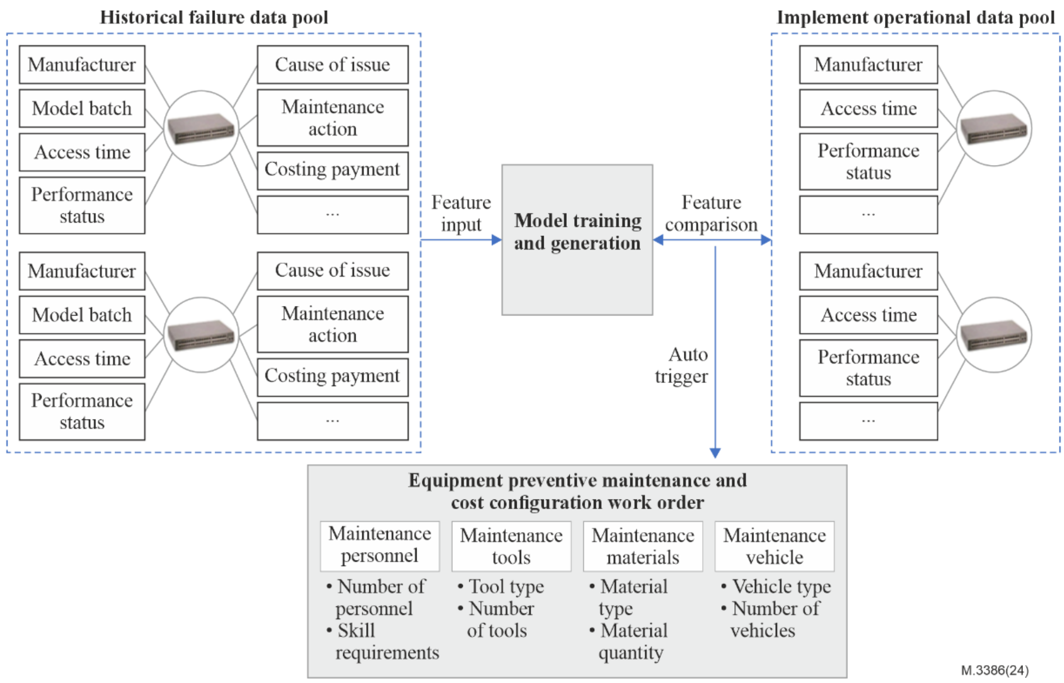
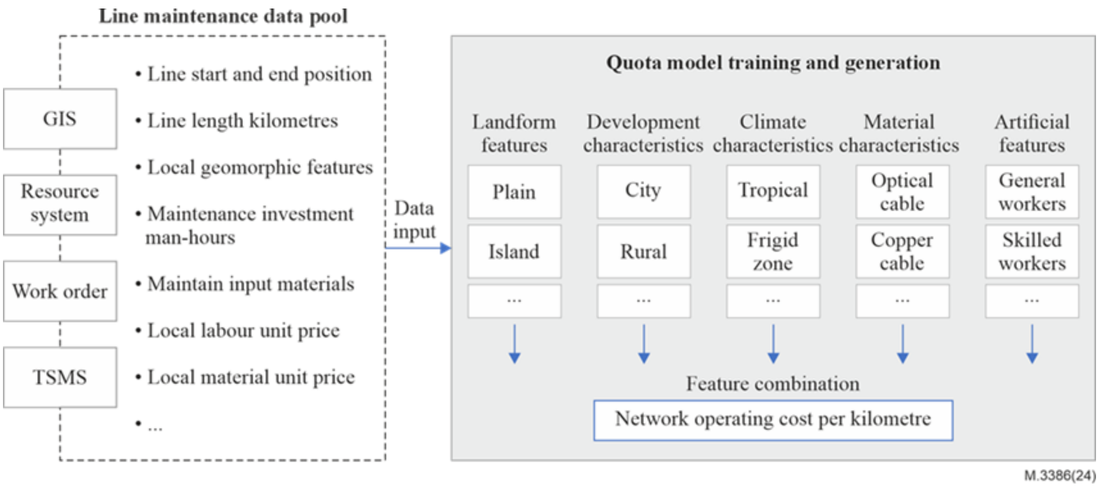
| Title | Automatic initiation of maintenance in cost requirement scenario |
|---|---|
| Description | If a telecommunication network has fault prediction and intervention capabilities before a telecommunication network fault, the risk of high cost investment caused by business interruption and large-scale faults can be eliminated with fewer network operation costs.<br>By gathering a large amount of historical fault information (such as the equipment status before the fault, the scope of the fault, the duration of the fault maintenance and the cost input), the main rules and cost-effectiveness of the fault are summarized, and the triggering rule base and maintenance priority base for preventive maintenance is formed. When the operating status of the equipment in the actual network meets the triggering rule, according to maintenance priority a preventive maintenance work order is automatically initiated and the cost of maintenance is automatically configured; see Figure II.1. |
| Figure II.1 |  |

**Table II.2 – Scenario for quota management of network operation costs**

<table>
<tr><th>Title</th><th>Quota management of network operation costs in comprehensive analysis scenario</th></tr>
<tr><td>Description</td><td>The demand for network operation costs is not only affected by the characteristics of the maintenance object (equipment, lines, etc.), but also by various regional factors (such as topography, climatic conditions and price levels) where the maintenance object is located. These regional factors cause the difficulty of maintenance and the material input in the maintenance process to be different, which ultimately affects the input amount of network operation costs.<br>Through the study of massive historical maintenance execution and cost input information, a cost quota database of different characteristic scenarios is constructed to support the precise configuration and control of network operation costs; see Figure II.2.</td></tr>
<tr><td>Figure II.2</td><td>
</td></tr>
</table>

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