

# Chapter 28

## Performance, Audit, and Review

**Abstract** The aim of this chapter is to introduce and to give examples of indicators of asset performance and to discuss auditing and review of the asset management system itself. *Outcomes* After reading this chapter you will be aware of the role of performance indicators and of some of the factors to consider in creating and applying them. You will have available some examples of performance indicators in specific applications. You will be aware of the need for audit of the asset management system and the requirement for review of the system to ensure its continuing effectiveness.

### 28.1 Key Performance Indicators<sup>1,2</sup>

Key performance indicators are measurable quantities which are intended to show the extent to which a system is meeting the expectations which are placed on it. Performance indicators assist with:

- Providing a high-level indication of how well activities are being managed.
- Highlighting areas that need attention.

Performance indicators are used to measure the performance achievements of systems. They show how well an asset, or system of assets is meeting its stated purpose. They will usually relate to defined *levels of service*. They are therefore a valuable guideline for users, customers, and senior management in assessing and comparing performance across time periods and across comparable systems.

A range of performance measures suited to public works organizations is listed in the International Infrastructure Management Manual Sect. 2.2.3. Indicators may be linked to payments or to penalties in performance contracts. Responsibilities

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<sup>1</sup> ISO 55001 Clause 6.2.1 Asset management objectives: “The organization shall establish asset management objectives...”

<sup>2</sup> ISO 55002 Clause 9.1.1.3. “A set of performance indicators should be developed to measure asset management activity and its outcomes.”

for nonconformance and constraints on performance need to be recognized in creating these contracts. At the operational level, performance indicators are useful to managers as rapid pointers to how a system is performing and as an indication of areas of strength and weakness.

Performance indicators should ideally be designed so that they do not affect the behavior of participants, other than in motivating genuine performance improvements. In practice, performance indicators can have a motivating or demotivating effect depending on how they affect particular people or groups. If maintenance work done while machinery is idle for operational reasons creates “unavailability” which counts against maintenance, then the maintenance opportunity will not be taken. If the cost of tires is charged to the operations budget, operators will have more motivation to drive carefully than if the cost comes out of the maintenance budget. Service providers can indulge in what is known as ‘*pencil whipping*’, which means making moves designed specifically to meet or beat the indicator. For example, a performance indicator on completed repair tasks may be circumvented by closing off one job ahead of a deadline and then starting up another job to finish the remaining work. Thus the danger of a performance indicator is that persons assessed on the basis of an indicator will work to the indicator, but not necessarily for the good of the systems as a whole.

Performance measures are subject to random variation, and to decide formally whether a variation is significant or not, statistical analysis, or at least, an awareness of statistical principles is needed.

Some examples of indicators are given in the following sections.

### ***28.1.1 Railway System Indicators***

In a railway system, some indicators are:

- % of planned train-kilometers delivered per month
- % of services no more than 5 min late
- Passenger-minutes late
- Train cancelations %
- Train-minutes late

### ***28.1.2 Water Supply System Indicators***

In a water supply system, performance is measured by such factors as reliability of supply, water quality, water pressure, frequency of burst water mains, sewer collapses, leaks and flooding, and response times and time to fix problems. Target levels of service for these parameters are set and performance is measured against them.

The severity of incidents can vary considerably and a severity rating should be established. The rating will also serve to indicate priority in addressing problems at any particular point in time. Examples of high severity events for a water authority are as follows:

- Sewer discharge or overflow
- Missing sewer access lid
- Sewage entering drain or watercourse
- Personal injury or significant health risk
- Damage to buildings or sensitive environments

### ***28.1.3 Electricity Transmission or Distribution***

Indicators of performance are:

- Outages frequency
- Outages duration
- System-minutes lost
- Voltage drops

The system-minutes lost is calculated by dividing the number of megawatt-minutes lost in a period by the average megawatt rating in the period. For example, if 40,000 megawatt-minutes were lost in a period, in a system that averaged 5,000 megawatts, the number of system-minutes lost would be 8.

Outages can be split into those which are “planned” and those which are “unplanned”. Planned outages occur when parts of the network are closed for refurbishment, upgrading, or replacement and customers are warned in advance of the intended shut down. The performance of the network is judged mainly on keeping the extent of unplanned outages to a low level.

### ***28.1.4 Trucks***

Examples of indicators are,

- Truck utilization.
- Numbers of used and unused trucks.
- Payload by weight, volume, and value.
- Distance traveled.
- Value per truck-day.
- Comparison with a base line.

It is important to distinguish between maintenance indicators and operations indicators.

## 28.2 Overall Equipment Effectiveness

$$\text{Overall Equipment Effectiveness} = \text{Availability} \times \text{Utilization} \times \text{Quality}$$

It is important to identify the sources of shortfalls. Availability may be high, but utilization poor, due to a range of factors, such as shortage of operators, shortage of materials, poor operational planning, and lack of demand. Similarly, the problems may lie in the quality area.

## 28.3 Maintenance-Related Performance Indicators

The following are some examples of items which can be used as a basis for performance indicators.

- a. Plant availability to be high
- b. Maintenance backlog in terms of numbers of work orders and total work load.
- c. Budgetary performance, actual versus planned maintenance costs
- d. Compliance with weekly maintenance plan, % of activities completed
- e. Response to approved work requests by numbers and times.
- f. Planned and scheduled hours as a % of total maintenance hours.
- g. Regulatory conformance as audited
- h. Unplanned downtime to be low
- i. Occupational Safety and Health injuries to be minimal
- j. Preventive Maintenance, Predictive Maintenance, and Condition-Based Maintenance hours as a % of all maintenance hours to be high
- k. Breakdown Maintenance Hours as a % of All Maintenance Hours to be low
- l. Production losses due to maintenance to be low
- m. Maintenance costs as a % of turnover
- n. Maintenance costs as a % of plant replacement value
- o. Work Orders Reworked/Total Work Orders
- p. Maintenance overtime/Total company overtime to be less than 5 %
- q. Inventory service level, % items met from stock.
- r. Inventory turnover to be 2–3 times/year
- s. Training, proportion of employees/year receiving training to be more than 40 %
- t. Expenditure on employees training to be more than 4 % of payroll
- u. Store investment as a % of plant replacement value
- v. Contractor costs as a % of maintenance costs
- w. Maintenance labor utilization to be high, but not so high that response to urgent jobs is inhibited.

## 28.4 Audit of the Asset Management System<sup>3</sup>

An audit is a process of checking a system to see whether the specified processes are being correctly followed and that the records in the system reflect the real assets and real events. Audits of the asset management system are required from time to time.

The results from an audit should form a basis for correcting any errors, omissions, or nonconformities. They can also form a basis for improvements in the system. Personnel working within the system should be encouraged to propose potential improvements.

Specific audit checks will include:

- Asset condition, availability, and suitability for purpose
- Compatibility of physical assets and the asset register
- Configuration management
- Stock taking
- Risk analysis and management status

## 28.5 Management Review<sup>4</sup>

A management review is a process of evaluating the asset management system to check its suitability and effectiveness in relation to the aims of asset management. Management reviews should be carried out from time to time.

Reviews should consider whether changes are needed in the asset management system, taking into account asset developments and the results of asset audits. Developments can include changes in the numbers or types of assets supported, technical and regulatory changes, and the performance of assets relative to key indicators.

Reviews may result in changes to resources, staffing, information systems, and roles and responsibilities of personnel. Reports of reviews should be retained for follow-up purposes.

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<sup>3</sup> ISO 55001 Clause 9.2 Internal audit: “The organization shall conduct internal audits...”

<sup>4</sup> ISO 55001 Clause 9.3 Management Review: “Top management shall review the organization’s asset management system at ... intervals...”