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Any questions in relation to this document should be referred to RISSB.

RISSB Contact details:

Head office:

Phone:	Email:	Web:
(07) 3724 0000 +61 7 3724 0000	info@rissb.com.au	www.rissb.com.au

Standard Development Manager:

Name:	Phone:	Email:
Cris Fitzhardinge	0497 919 619	cfitzhardinge@rissb.com.au

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SDM name	Cris Fitzhardinge
SDM phone	0497 919 619
SDM email	cfitzhardinge@rissb.com.au

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Objective

The objective of this Code of Practice (CoP) is to provide a consistent approach to measuring the performance of railway infrastructure in a rail corridor with primary focus on the railway track. The CoP lists performance indicators (PIs) and key performance indicators (KPIs) that may be widely adopted to manage the performance of railway infrastructure.

This CoP has been reviewed against applicable European standards such as EN 15341 and international research papers with the aim to maintain a level of consistency in performance measurement, management and reporting.

This CoP aims to achieve a high degree of harmonisation of KPIs that are identified and selected to apply.

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Section 1 Scope and general

1.1 Scope

This Code of Practice (CoP) prescribes a system for managing railway infrastructure performance within a framework of influencing factors such as safety, environmental, economic, technical and organisational aspects. Measurement practices will provide tools to improve the efficiency and effectiveness of railway infrastructure asset management.

Applying a chosen sub-set of performance indicators (PIs) from this CoP can define objectives and strategies for improving safety, environmental, economic, technical and organizational outcomes; without requiring changes to existing inspection, maintenance or regulatory regimes.

This CoP identifies a set of PIs for railway corridors or systems with the aim of providing comprehensive measures of performance and the interaction between the physical, operational and managerial aspects of the RIM.

For the purposes of this CoP, rail Infrastructure includes but is not limited to mainline operational track and selected technical structures. Rail infrastructure items that currently are excluded from the scope of this CoP are:

(a) operations related to rolling stock, train control and management;

(b) infrastructure related to buildings and other civil structures;

(c) platforms, sidings, wayside facilities, turnouts and other associated (non-mainline) track classes or categories, such as spur lines or seasonal lines;

(d) depots and maintenance facilities including special equipment and tooling;

(e) signalling other than those directly related to track maintenance activities;

(f) electrification other than the catenary system itself;

(g) low or non-revenue corridors and associated financial considerations; and

(h) interfaces associated with entering, exiting and operating in a particular rail corridor or rail network.

When using this CoP, the delineation of corridor infrastructure needs to be defined and documented. How asset renewals and life extensions of existing infrastructure will affect what is measured and concluded also warrants careful consideration. On that point however, as this CoP deals primarily with maintenance operations, such life and renewal decisions and the impact of approved capital expenditure projects normally are to be excluded from scheduled performance measures.

Within this defined scope, the core element of the data that is required for this CoP is the feedback from the asset condition. Hence, the infrastructure asset condition developed in Section 8 is based on the rail infrastructure manager's track maintenance plan (TMP). If that TMP defines measurement and reporting of asset performance, condition and remaining service life of other rail corridor infrastructure such as bridges, catenary, and associated electrification assets then these may be considered within the scope of a PI/KPI assessment, at least to the level that the TMP defines those measurement and inspection tasks.

PIs and their attribution to a set of key performance indicators (KPIs) need to be capable of being measured and recorded using existing IT and data collection infrastructure. However, where identified data acquisition and collection requirements are not available currently, those cases may be managed as discussed in Section 10.

1.2 Defined terms and abbreviations

For the purposes of this document, the following terms and definitions apply:

1.2.1

HSE
health safety and environment

1.2.2
IT
Information technology

1.2.3
key performance indicator (KPI)
quantifiable measure used to evaluate the success of an organization, employee, etc. in meeting objectives for performance

1.2.4
MTBF
mean time between failure

1.2.5
MTTR
mean time to repair

1.2.6
O&M
operations and maintenance

1.2.7
performance indicator (PI)
as a defined measure of one aspect of the business

1.2.8
RAMS
reliability, availability, maintainability and maintenance supportability

1.2.9
ROI
return on investment

1.2.10
TMP
track maintenance plan

1.2.11
TSR
temporary speed restriction

General rail industry terms and definitions are maintained in the RISSB Glossary. Refer to: https://www.rissb.com.au/products/glossary/

Section 2 Key performance indicators for railway infrastructure

2.1 Introduction

Railway traffic continues to increase in axle load and frequency with the movement of transportation from road to rail, increasing energy costs and the demand to reduce emissions.

To better manage railway infrastructure assets more effectively within business objectives, operation and maintenance activities need to be measured, analysed and monitored. PIs are to support infrastructure managers in better decision making.

As some infrastructure component assets have a long lifespan, their management needs to adopt a similarly long-term sustainment strategy. Ongoing technical and economic assessments are necessary to optimise the performance of railway infrastructure and thereby receive an appropriate return-on-investment. Long-term asset management strategies and objectives are developed to align operation and maintenance (O&M) activities and to steer them in the best direction.

These objectives need to be identified and adopted as measurable and quantitative. PIs will set a pathway to achieving a consistently high level of performance through improvements in safety, capacity and punctuality. Positive outcomes can be achieved with an optimal balance between operational performance, an agreed sustainment budget, asset life cycle cost, and no increased level of risk.

2.2 Application

Application of the CoP is expected to offer opportunities and improvements in the performance management of railway infrastructure in the following areas:

(a) Identification and adoption of a set of standardised indicators then one-for-one comparison of results and conclusions by maintenance/franchise managers.

(b) Use of standardised indicators that can enable easier comparison of maintenance and reliability performance across similar corridors/networks.

(c) Adoption of a set of company indicators and development of a scorecard by railway infrastructure management when it is based on standardised indicators.

(d) Establishment or promotion of standard calculation methods for PIs and KPIs with common language.

(e) Reduced environmental risks associated with noise and vibration transmission due to poor infrastructure performance.

(f) Use of a standard set of PIs could be made compatible with and/or incorporated into various enterprise resource planning systems and reporting arrangements of Rail Industry members.

(g) Monitoring of maintenance work that is completed to avoid failures or to identify defects that could lead to failures - including routine preventive and predictive maintenance activities and corrective work tasks identified from them.

(h) Provide a common framework to enable comparison and perhaps benchmarking of infrastructure performance outcomes and reports - among RSOs.

(i) Improve harmonisation and standardization of the management of railway infrastructure KPIs.

In relation to safety:

(j) Assist in identifying and monitoring safety critical parameters

(k) Improve failure warning - when an asset is unable to perform its required function.

In relation to financial impacts:

(l) Manage assets effectively within agreed objectives.

(m) Capture long term trends, predict future development and assist management to take the appropriate corrective actions at an early stage.

(n) Develop PIs in support of RAMS (reliability, availability, maintainability and supportability) targets.

(o) Identify using PIs and KPIs elements of rail infrastructure that display poor performance and thereby support more timely decision making about maintenance arisings, defect investigation, and replacement or investment of such assets.

(p) Ensure ONRSR requirements and compliance (www.onrsr.com.au) - as it applies to existing WHS, HSE, ENV, and Operational Safety requirements - are not affected by the development, introduction and application of this CoP.

Task management to help realise these opportunities and benefits is developed further in Section 4.

The following Sections of this CoP will present a significant set of PIs and KPIs and aim to correlate those Indicators identified in EN15341 and in referenced Australian Standards.

2.3 Overview of KPIs

KPIs are defined for infrastructure asset condition and asset management as illustrated in Figure 1. There are KPIs for each category as well as selected KPIs that relate to the condition categories and to the management categories. KPIs are comprised of PIs and these are discussed in Section 2.4

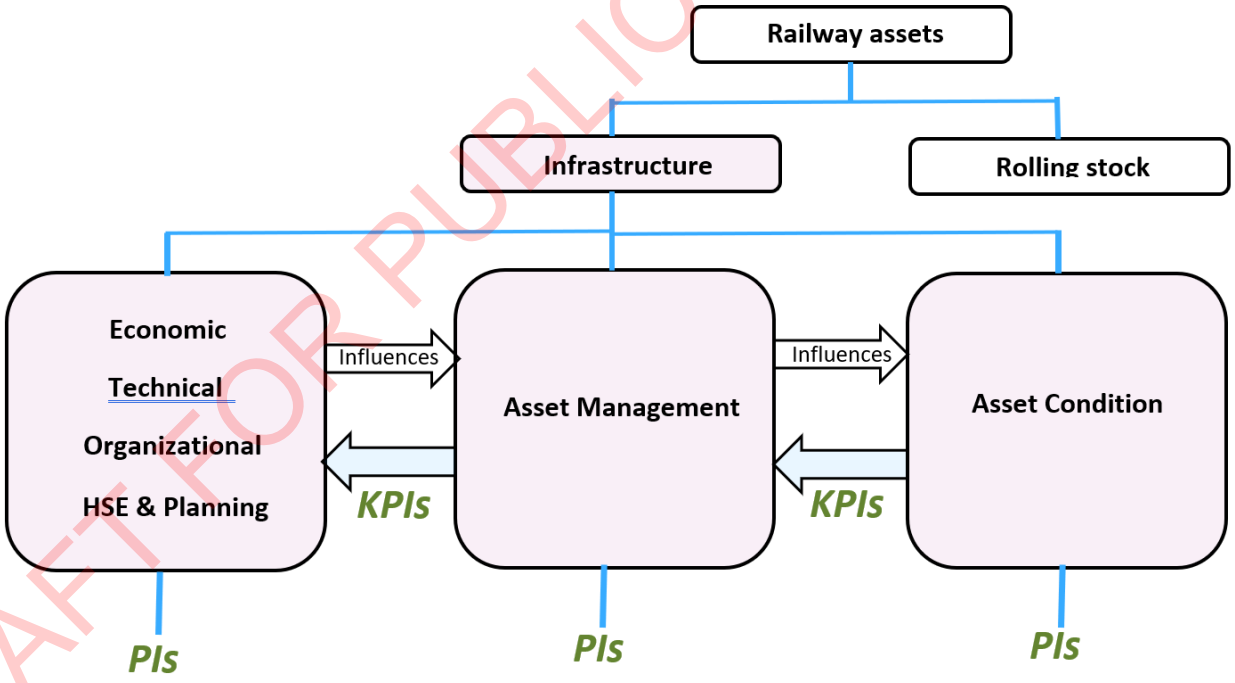

Figure 1 Overview of railway infrastructure KPI categories

A KPI needs four components to be effective:

(a) A measurable target

(b) A timeframe

(c) A data source

(d) A set frequency

2.4 Hierarchy of PI to KPI

2.4.1 Overview

As you move up the PI and KPI hierarchy, there is a higher quantity to lower quantity or simple to complex such that:

(a) The bottom layer of PIs could simply be a numerical count or percentage of some aspect of operations.

(b) Then, moving up the hierarchy, KPIs can introduce a time element or can merge PIs to factor in a supplementary data set for the asset; such as TSRs, MTBF, MTTR etc.

(c) One strategy is to trend this data over a rolling time period.

(d) The measures and values in KPIs have no reference to goals or internal target values because doing so compromises external benchmarking; i.e. they are measures of actual entities.

(e) KPIs can be further normalised for internal use to create management dashboards per Section 9.3. Doing this includes goals or internal targets and, as such, modified dashboard KPIs cannot be used for external benchmarking.

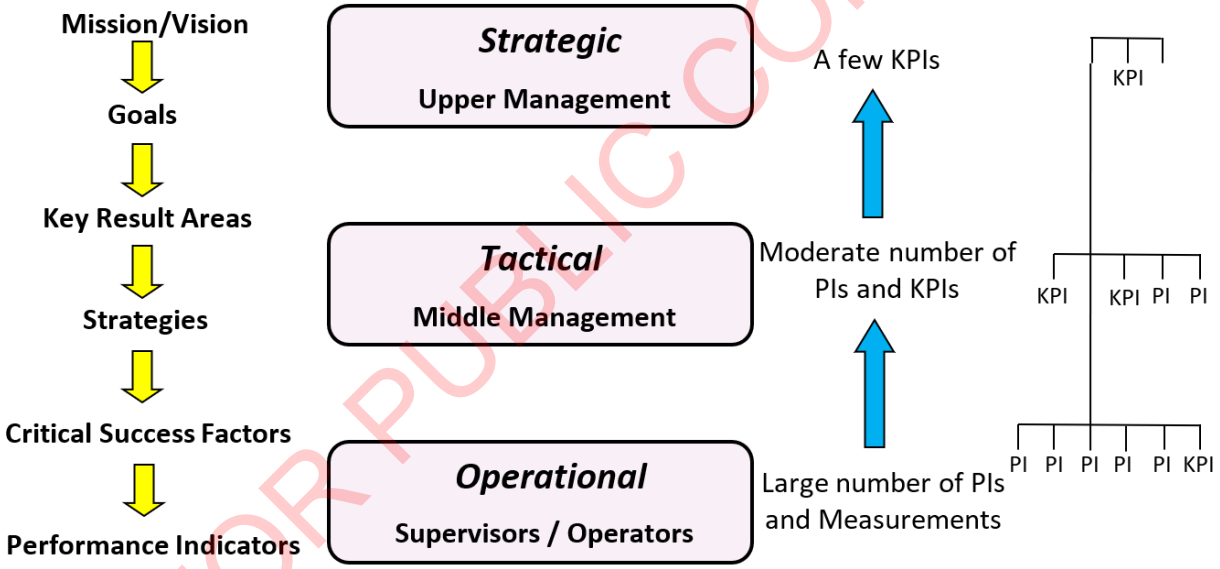

Figure 2 Goals, objectives and the aggregation of data

2.4.2 Rolling up or creating new KPIs

The RIM should select and define KPIs based on various factors, such as the number of business groups or track sections, geography, teams or organisations. These then can be merged to create one KPI set for the whole organization. The number of KPIs can be reduced by merging KPIs in the same manner that the PIs listed in Appendix A are merged to create KPIs. The chosen KPI/PI hierarchy should map to the RIM organisational structure, such as in the example below:

(a) Route Review

(b) Depot Engineer/Manager

(c) Track Engineer

(d) Section Manager

(e) Staff/Team Leader

2.4.3 Combining PIs into KPIs

KPIs are often indices with no units and when combined with a target value, they become ratios.

For example, the PIs T2 and T3 tabled below are combined to yield KT2 (see Section 5) where:

(a) T2 = Number of delay hours/number of trips, e.g., *50/500 = 10* or a mean of 10 hours per train.

(b) T3 = Number of failures affecting traffic/number of failures; e.g., *15/150 = 10%* of failures affected traffic. This PI reflects both the number of failures and the failure severity.

(c) The KPI named KT2 is simply T2 × T3, where the KPI values for a range of inputs are shown in Table 2-1.

The KPI can be used as shown or it can be compared to the target value to yield an index relative to the target. The target value is internal to the RIM and therefore not applicable to other users' benchmarking across RIMs. For the example, in Table 2-1, a target value for this Index is included and it is set to 0.9. The index is calculated based on *target/KT2* which results in an index which increases with increasing quality (as the values of T2 and/or T3 decrease).

Table 2-1 Example of PI to KPI to Index

T2	T3	KT2	Target/Index (0.9)
10	5%	0.5	1.8
10	10%	1	0.9
10	20%	2	0.45
5	5%	0.25	3.6
5	10%	0.5	1.8
5	20%	1	0.9

In this example, both PIs appear to have an equal influence on the KPI, i.e. *10 × 10%* and *5 × 20% = 1*.

KPIs should generally be referred to as a unitless measure regardless of 'from what' and how they are calculated.

Section 3 KPI frameworks and benchmarking

3.1 Overview

A KPI framework is a structured document or representation of an entity's KPIs and goals.

KPIs are selected based on the strategic goals of the organization as well as industry mandated requirements. The measures in this CoP form a common set but additional PIs and KPIs should be designed according to the RIM organization structure and grouped according to target track sections, corridors or business unit.

Although frameworks are created based on the organization's goals and strategies, presenting those frameworks typical of rail infrastructure maintenance is currently beyond the scope for this CoP. However, this section presents the basic components and illustrates how the PIs and KPIs in this CoP are structured to support these frameworks.

Figure 3 illustrates the key components of a KPI framework. Every strategy that is designed to meet specific goals is essentially a process, procedure or method with inputs and outputs. The PIs are designed to measure those inputs and outputs, and the design includes considerations to measure possible unintended results that this new process or procedural change may cause.

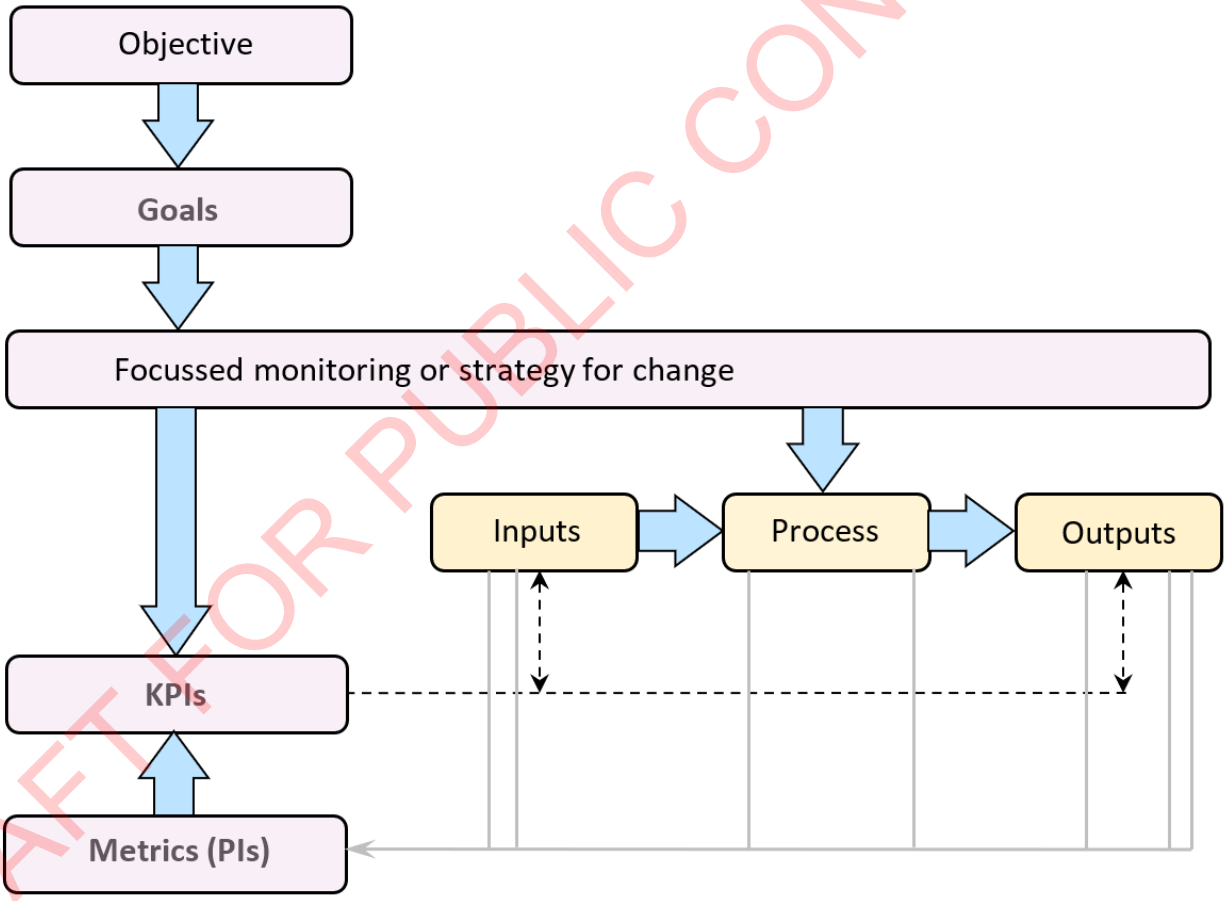

Figure 3 Components of a KPI framework

When developing a framework, it is important to identify and design additional PIs and KPIs that properly support every element of the final framework and any future planned changes or processes that will be monitored. The PIs and KPIs that are nominated in this CoP are not intended to be the complete set that are applicable to every goal/process scenario, noting that:

(a) the organizational KPIs and economic KPIs are process oriented;

(b) the technical/asset KPIs are output focussed; and

(c) the asset condition KPIs are primarily used as input indications to the organisational, technical and economic contexts.

KPIs illustrate performance as a value. The most useful method within an organization is to calculate the value relative to the goal or target value. See Section 9.2 for more details. This provides a high-level indication that is best suited for dashboard displays or other graphical representations of the KPI framework.

3.2 Benchmarking KPIs

Certain KPIs are defined to be used externally regardless of the RIM KPI framework. These benchmarking KPIs are expected to be based on the primary corridors used by RSOs and otherwise be available to those operators/managers.

The benchmarking KPIs are relevant for RSOs and are primarily in the organizational and technical asset context where results related to train delays and track quality are a focus. These key benchmarking KPIs should be clearly defined for scope and presented with no reference to a RIM goal or any KPI framework, so that they support benchmarking between RIMs.

This benchmarking KPI subset is identified as ‘Benchmark’ in Table 9-1 in Section 9.2.

Section 4 Health, safety and environmental indicators

4.1 Overview

All maintenance staff can work in stressful, dynamic and potentially hazardous conditions where the safety and well-being of all rail workers is a critical factor for consideration. HSE is especially important in the management of railway infrastructure maintenance and is legislated for compliance. Selected PIs for railway infrastructure in the HSE context of this CoP are defined herein.

4.2 Resolution and scope

The resolution of the HSE PIs, in terms of which groups of maintenance personnel are included and excluded or discretely reported, is discretionary. The user can choose to calculate one set of PIs for one or more maintenance groups but the minimum scope for the relevant KPIs should include all personnel who are engaged, employed or sub-contracted as maintenance providers in that corridor. However, including or excluding incidents affecting maintenance staff employed by sub-contracted companies is expected to be consistent with the RIMs existing policies and obligations.

The physical and natural environment in the vicinity of a rail corridor have not been defined as discrete HSE factors. For example, contamination of infrastructure, such as track and sleepers with oil, fuel and dust deposits or remediation after extreme weather events are not in the scope of this CoP. Instead, clearing of adjacent trees and undergrowth along the corridor is assumed here to be part of regular corridor maintenance along the right-of-way.

4.3 Performance indicators

Table 4-1 shows the categorised health, safety and environmental indicators.

Table 4-1 HSE Performance Indicators

Category	Indicators	Ref
Health	Maintenance personnel absenteeism	H1
	Maintenance employee turnover	H2
Safety – General	Critical track condition reports	H3
	Deaths and injuries	H4
	Accidents at level crossings	H5
	Accidents involving railway vehicles	H6
	Incidents including mishaps and potential for injury	H7
	Rail asset and site inspections performed	H8
	Hazards identified	H9
	Hazards removed	H10
Safety – Maintenance	Maintenance accidents and incidents both occurred and potential	H11

Table 4-2 HSE Key Performance Indicators

Category	Derived from Performance Indicator	Ref
Health	*H1 × H2*	KH1
Safety - General	*H3 + H4 + H5 + H6*	KH2
Safety – Maintenance	*H11/H7 × 100*	KH3

There are some PIs that are not used in the KPIs in

Table 4-2 but they are included to support KPI frameworks and additional KPIs.

4.4 Standardisation

The frequency of the reporting cadence of the HSE PIs needs to be consistent. The recommended frequency is monthly.

4.5 Definitions

The derivation of the HSE PIs in Table 4-1 are defined in Table 4-3 below. The Type column on the right-hand side of the table identifies normalised ratio as a % or a non-normalised Count value.

Table 4-3 HSE Performance Indicator Definitions

Indicator		Definition	Type
H1	Absenteeism	Maintenance personnel absenteeism hours in reporting period × 100 Maintenance personnel total hours in reporting period. Where absenteeism includes sick and excludes planned and unplanned leave.	%
H2	Turnover	Count of Maintenance personnel resigning during reporting period × 100 Total count of Maintenance personnel at end of reporting period.	%
H3	Track Safety	Count of most severe track condition events (classified as Reactive) during reporting period. See **Error! Reference source not found.** for a definition of 'Reactive'. The PIs for Asset Condition are weighted and do not include this measure as a discrete Count. Additionally, this includes ALL reported events of Reactive severity including, but not limited to, those reported by inspections.	Count
H4	Casualties	Count of deaths or injuries during reporting period. Includes rail persons if on duty & non-railway personnel on railway property. This measure can be reported separately as 'Death' and 'Injury'.	Count
H5	Accidents at crossings	Count of all accidents at crossings during reporting period. Crossings being level, pedestrian, active and passive.	Count
H6	Accidents involving rail vehicles	Count of all accidents involving rail vehicles during reporting period (which) Includes shunting and maintenance depots and all derailments.	Count
H7	Incidents	Count of all reported safety incidents during the reporting period (includes) potential for injury or property damage - including environmental incidents.	Count

Indicator		Definition	Type
H8	Rail Infrastructure & Site Inspections	Safety Inspections performed in reporting period × 100 Safety Inspections scheduled in reporting period.	%
H9	Hazards Identified	Safety Hazards Identified in report period.	Count
H10	Hazards Removed	Safety Hazards resolved in report period.	Count
H11	Maintenance incidents	Count of reported accidents and safety incidents in the report period for (only). Maintenance personnel including environmental & hazardous material events. Not limited to track maintenance.	Count

Section 5 Technical asset indicators

5.1 Overview

This category of PIs focuses on the relationship between maintenance, asset condition and actual train operations.

Asset indicators are closely related to reliability, availability, maintainability and safety (RAMS). Failure frequency and the operational impact of those failures are important considerations and so the PIs provide a degree of resolution to differentiate between reported failures that are resolved in a timely manner and those that impact train operations. Refer to AS 7640.

5.2 Resolution and scope

The PIs report on how effective maintenance is and how well the track condition meets the demands of the traffic that it supports. The PI for maintenance in this category (T5) is high level and does not differentiate between the types of maintenance. Users can create more PIs to increase the resolution of a PI to meet the requirements of their KPI framework. Users can choose the scope of operations and track that is reported but it needs to be consistent with the other PI and KPI categories in this CoP. Typically, the focus is the part of the network that is used by RSOs and connects to other railways and comprises incoming, outgoing and through traffic, but multiple sets can be used to focus on parts of the network.

Select classes of track, non-revenue track sections, seasonal branch lines and very low usage turnouts should be considered for exclusion if that is possible within the data acquisition and recording systems that provide the information for the PIs.

Refer to Section 9 for methods to translate PIs and KPIs that are intrinsically scalar in nature into ratios or indices.

5.3 Performance indicators

The subsequent tables show the asset PIs and the derivation of those PIs.

Table 5-1 Asset Performance Indicators

Category	Indicators	Ref
Scheduling	In time performance	T1
Availability	Mean train delay hours	T2
	Faults interfering with traffic	T3
	Temporary speed restrictions	T4
Maintenance	Hours faults under repair	T5
Capacity	Network utilisation. Capacity consumption (train km)	T6
Riding comfort	Track quality index (TQI) or long wave geometry	T7
Asset age	Mean age of assets	T8

Table 5-2 Asset Key Performance Indicators

Category	Derived from performance indicator	Ref
Scheduling	T1	KT1
Availability	T2 × T3 (see Section **Error! Reference source not found.** for an example)	KT2
Fault resolution	T4	KT3
Maintenance	T5	KT4
Capacity	T6	KT5
Riding comfort	T7	KT6
Asset age	T8	KT7

5.4 Standardisation

The frequency of the reporting cadence of the HSE PIs needs to be consistent. The recommended frequency is monthly.

The primary normalisation method for this category is train count to minimise the effect of variables such as traffic volume.

5.5 Definitions

The derivation of the indicators in Table 5-1 are defined in Table 5-3 below. The type column (again) identifies normalised ratio or % or a non-normalised Count.

Table 5-3 Asset Performance Indicator Definitions

Indicator		Definition	Type
T1	On Time Arrival	Number of trains arriving within 'n' minutes of scheduled time X 100 Number of train trips completed in reporting period (see NOTE 1)	%
T2	Train Delay	Total number of hours trains were delayed. Number of train trips completed in reporting period. Mean train delay hours.	Value
T3	Faults Affecting Traffic	Number of infrastructure failures that affected traffic X 100 Number of infrastructure failures (see NOTE 2)	%
T4	Temporary Speed Restrictions	Total elapsed days of all temporary speed restrictions in report period X 100 Number of days in reporting period (see NOTE 3). Includes TSRs for both planned and unplanned works.	%
T5	Maintainability	Total hours failed for Infrastructure failures X 100 Number of train trips completed in reporting period. Reactive and corrective failures only (see NOTE 4).	%
T6	Network Utilisation	Traffic volume in train km (capacity in use) X 100 Maximum network train km capacity (notional or planned capacity) (see NOTE 5).	%

Indicator		Definition	Type
T7	Riding Comfort	Track Quality Index (TQI) e.g., K/Q value or Long Wave Geometry Alternate methods include qualitative (customer survey) but a standard quantitative measure is recommended.	Ratio
T8	Age	Mean Age of Assets (rail, signals and comms, turnouts, ballast etc.)	Value

NOTE 1:
On time arrival thresholds will vary based on traffic type. The value 'n' is the railway's target threshold for on-time arrival.

NOTE 2:
The percentage of infrastructure failures that affected traffic and caused train delays. Using the value metric of delays due to infrastructure failure omits all other infrastructure failures.

NOTE 3:
Equates to the number of active temporary speed restrictions (TSRs) per reporting day.

NOTE 4:
This is total hours FAILED for reactive and corrective repairs only. This is the time between fault reporting and resolution. It is not the time on site doing the repair and is not to be confused with mean time to repair (MTTR) – i.e. because that metric has ambiguous inclusions and exclusions.

NOTE 5:
Intended for a main corridor where a nominal or target capacity is defined. Default = 100%

Section 6 Organizational indicators

6.1 Overview

Indicators for organizational effectiveness focus on the efficacy of preventive maintenance and on the availability and timeliness of maintenance in general.

6.2 Resolution and scope

The PIs report on how effective maintenance is and how well the track condition meets the demands of the traffic that it is designed to support. Users can choose the scope of operations and track that is reported but it needs to be consistent with the other PI and KPI categories in this CoP. The most effective scope is to have one set of PIs defined for all track in the network and one set of PIs defined for a focused part of the network. Typically, the focused set is the part of the network that connects to other railways and carries incoming, outgoing and through traffic.

Classes of track or non-revenue track sections, seasonal spur lines and very low usage turnouts should be considered for exclusion if that is possible within the data systems that provide the information for the PIs.

There are no specific indicators for repeat (failed) remedial maintenance events. It is assumed that these will be reported simply as additional discrete faults and reflect as increased maintenance load. Users can create PIs to capture repeat failures or failed maintenance based on their reporting system design and the requirements of their KPI Framework (Section 3.2).

6.3 Performance indicators

Table 6-1 shows organizational performance indicators.

Table 6-1 Organizational Performance Indicators

Category	Indicators	Ref
Maintenance management	Preventive and corrective maintenance	O1
	Response Time – Mean waiting time for reactive and corrective faults	O2
	Maintenance backlog of reactive and corrective faults	O3
	Maintenance on site hours	O4
	Maintenance possession overruns	O5
	Open track faults	O6
Condition Monitoring	Faults in infrastructure not identified before failure	O7
	Faults in infrastructure that have been identified	O8

Table 6-2 Organizational Key Performance Indicators

Category	Derived from performance indicator	Ref
Preventive Maintenance	Q1	KO1
Maintenance Management	$\frac{Q2 \times 100}{Q4} \times 100$	KO2
Maintenance Overruns	Q5	KO3
Maintenance Backlog	Q6	KO4
Condition Monitoring	O6/O7 × 100	KO5

6.4 Standardisation

The frequency of the reporting cadence of the HSE PIs needs to be consistent. The recommended frequency is monthly. The PIs in this category are scalar (total counts) and the key indicators in this category are all normalised as ratios. See Section 9 for methods to translate the scalar PIs into ratios or indices.

6.5 Definitions

The derivation of the indicators in Table 6-1 are defined in

Table 6-2 below. The Type column (again) identifies normalised ratio or non-normalised count.

Table 6-3 Organizational Performance Indicator Definitions

Indicator		Definition	Type
O1	Preventive Maintenance	Corrective Maintenance hours for reporting period × 100 Preventive Maintenance hours for reporting period.	%
O2	Response Time	Total hours between job creation and start of work on-site. Count of jobs. A measure of organizational effectiveness to organise and clear faults - for the reporting period. For reactive and corrective jobs only. Includes elapsed time between job logged until cleared.	Value
O3	Maintenance Backlog	Average daily number of maintenance jobs queued awaiting response. Reactive and Corrective severity only. Excludes 'as-time-permits' and low priority tasks.	Count
O4	Maintenance On Site Hours	Reactive, Corrective & Preventive on-site hrs for reporting period Excludes travel, overhead, remedial and project time (see NOTE 1).	Count
O5	Maintenance Overruns	Total number of possession overruns × 100 Total Maintenance jobs requiring possession.	%
O6	Maintenance Backlog	Total number of open Corrective and Reactive faults. Count of jobs closed for the reporting period.	%
O7	Unidentified Faults	Total number of faults reported to maintenance that were NOT scheduled due to inspections or condition monitoring for the reporting period. Excludes faults caused by external factors (see NOTE 3).	Count
O8	Identified Faults	Total number of faults reported to maintenance that were scheduled due to inspections or condition monitoring for the reporting period. Excludes faults caused by external factors (see NOTE 3).	Count

Indicator	Definition	Type

NOTE 1:
KPI KO2 factors the average number of hours of maintenance backlog each day (O2) and the daily number of jobs (O3). It combines this with the mean daily on-site maintenance hours doing all preventive and corrective work. The result is a measure of backlog as a percentage of available on-site maintenance hours.

NOTE 2:
The purpose of this KPI KO5 is to identify faults that have occurred before being identified by condition monitoring compared with those that have been identified by condition monitoring. This KPI indicates the effectiveness of the condition monitoring processes. Zero is ideal.

NOTE 3:
Reported faults in infrastructure are intended to indicate the effectiveness of asset condition processes. These differentiate between faults that were not reported by inspections and those faults that were reported by condition monitoring inspections as reactive, corrective or preventive events. There is no weighting for severity in these measures. (&) Excludes faults caused by damage from external factors such as weather and derailments.

Section 7 Economic indicators

7.1 Overview

Economic indicators are limited to maintenance costs. The focus is on infrastructure and not operations although management and overhead costs are included as part of the cost of maintenance. It is important to distinguish between corrective, preventive and other uses of maintenance resources.

Contractor costs are reported as distinct measures but their use is discretionary. They are included for RIMs who find the measure of value, however setting the value to zero doesn't affect the resultant KPIs.

Changes to the traffic volumes and tonnage will impact maintenance costs and there are PIs to normalise these costs to track km and tonne km.

Energy and other carbon related indicators are excluded from the CoP scope.

7.2 Resolution and scope

The PIs report on overall maintenance costs.

The indicators are assumed to include maintenance cost data for the same tracks or sections used for the PIs and KPIs in all categories in this CoP.

Productivity measures, maintenance detailed costing and high-resolution PIs are out scope of this CoP and these can be defined and used as required in individual KPI frameworks.

7.3 Performance indicators

Table 7-3 shows the economic performance indicators.

Table 7-1 Economic Performance Indicators

Category	Indicators	Ref
Maintenance	Maintenance management and overhead cost	E1
	Maintenance direct cost excluding contractor and overhead	E2
	Contractor cost	E3
Types	Corrective maintenance cost	E4
	Preventive maintenance cost	E5
	Cost of other activities by maintenance	E6

Table 7-2 Economic Key Performance Indicators

Category	Derived from performance indicator	Ref
Maintenance Total	*E1 + E2 + E3* Gross Tonne km	KE1
Corrective/Preventive Maintenance Prevention	*E4/E5* The ratio of maintenance that is corrective relative to preventive (see NOTE 1).	KE2
Track km maintenance	*E4 + E5* Track km	KE3

Category	Derived from performance indicator	Ref
Track tonne maintenance	*E4 + E5* Gross Tonne km	KE4

NOTE:
This KPI factors indicates the percentage of maintenance costs that are corrective relative to preventive maintenance. Assuming *E4 is 100* and *E5 is 200*, then *KE2 = 50%*. This is different than a measure of corrective maintenance costs relative to all costs which would be *100/300 = 33%.* The purpose of this measure is to identify the balance between the two measures and not the cost of one or the other because they are available as PIs E4 and E5.

7.4 Standardisation

The frequency of the creation of these economic PIs needs to be consistent. The recommended frequency (again) is monthly. The PIs in this category are scalar (total costs) and most key indicators in this category are normalised as ratios. See Section 9 for methods to translate the scalar Indicators into ratios or indices.

7.5 Definitions

The derivation of the indicators in Table 7-1 are defined in Table 7-3 below. These values are total costs and they are normalised to Track km and Tonne km in the KPIs listed in Table 7-2.

Table 7-3 Economic Performance Indicator Definitions

Indicator		Definition	Type
E1	Maintenance Overhead	Cost of Maintenance management and overheads in the reporting period. Includes training costs and current valuation of plant and infrastructure. Excludes costs of direct maintenance staff and materials used for repairs.	Value
E2	Maintenance Direct Cost	Cost of maintenance staff and material used for repairs in the reporting period. See note (a)	Value
E3	Maintenance Contract Cost	Cost of all Contracted maintenance including material in reporting period	Value
E4	Corrective Maintenance	Cost of all Corrective works and material by Maintenance staff and Contractors in reporting period. Excludes non remedial works such as renewal. See NOTE.	Value
E5	Preventive Maintenance	Cost of all Preventive works and material by Maintenance staff and Contractors in reporting period. Excludes non remedial works such as renewal. See NOTE.	Value
E6	Other Costs	Cost of activities and material by Maintenance for works in the reporting period that are neither Corrective nor Preventive (e.g., Renewals & Projects). See NOTE Not used in the CoP KPI set but included to enable total cost indicators for user defined KPIs.	Value

NOTE:
Maintenance direct cost of maintenance hours for staff includes leave loading and superannuation. However, this excludes materials and consumables.

Section 8 Asset condition indicators

8.1 Overview

There are two basic methods used to capture and evaluate asset condition. These are automated instruments and inspections that are made either visually or using instruments. In both methods, the output to the maintenance process is a logged event of varying severity. Measures from inspection machines are not standardised and different methods are used by RIMs. For this reason, all the PIs in this section are from the logged results of manual inspection, automated measuring technologies plus any reported faults by others.

The asset condition indicators are grouped by the measurement method defined in most track maintenance plans (TMP). Manual and automated inspections and their frequencies, as well as the qualitative and quantitative methods used are performed based on the rail authority's TMP. Detail on these range of potential methods and measures that are used by RIMs across the Australian and New Zealand rail industry are out of scope of this CoP but the logged results of these methods and measures can be used.

Inspection tasks and criteria for track assets are defined by the RIM to ensure that they comply to the relevant legislative, regulatory and technical requirements. Test methods that are defined in the rail authority's TMP will typically be a combination of periodic manual inspection and the output of automated on-track machines. Condition in the context of this CoP is based on a TMP that resolves to at least the following four types or severities.

Table 8-1 Condition Severities

#	Type	Description
1	Reactive	Unplanned activity on a failed or defective asset to remove a reported or inspected safety concern and restore/maintain train services (which affects train operations).
2	Corrective	Scheduled restoration required due to failures or unsatisfactory conditions detected during inspections.
3	Preventive	Scheduled regular servicing to prevent failures or further degradation.
4	Renewal	Planned activity to extend the network or renew assets due to scheduled end-of-life.

For the purposes of determining PIs, where the measure is not nominal or acceptable then it should be classified as an event of one of these four types. The method of classifying safety criticality of a measure and its service criticality usually will be defined in the rail authority's TMP. Safety critical events usually will be Type 1 (but they can be defined as a discrete new type at the user's discretion).

8.2 Resolution and scope

The resolution of the condition monitoring PIs, in terms of which tracks and sections are included and excluded or discretely reported, are defined by the user. The user can choose to calculate one set of PIs for main line track and one for the whole or parts of the network but the minimum Scope for KPIs will be all main line track. These also can be separately reported by track class. Care also should be taken when designing and defining the scope of the network to be included in the condition monitoring PIs so that the renewal type (Table 8-1) does not create statistical aberrations.

While there can be any number of subsets of PIs covering the network and that is selected by the RIM, the minimum set of Condition indicators needs to support benchmarking by RSOs traversing the network and should therefore encompass all the main line track used by RSOs.

8.3 Standardisation

8.3.1 Overview

The frequency of the creation of the condition monitoring PIs needs to be consistent. The recommended frequency for all PIs and KPIs here is monthly but the frequency of the various inspection methods used for condition monitoring will vary widely. The inspection frequency of track recording cars, ultrasonic testing, physical and manual inspections etc. will vary as defined in the applicable RIMs TMP. For this, the recommended method of normalising the condition monitoring events is:

(a) where the inspection period is less than the PI reporting period, the number of events will be the sum of all events for the reporting period;

(b) where the inspection period is greater than the PI reporting period, the events should default to the value/conduct of the most recent inspection; and

(c) where the inspection period is greater than twice the PI reporting period, the user may elect to manually remove items that have been corrected during the report period from that event count (i.e. to improve the accuracy and relevance of the measure).

The scope of the measures needs to be consistent. Hence, to ensure that the condition monitoring PIs are stable and can be related and directly compared to other indicators, as well for benchmarking purposes, all the PIs in this section are normalised and reported as a function of track kilometres. For example:

$$\frac{Events}{Track\ Kilometres}$$

8.3.2 Condition severity weighting

All PIs in this section are based on total weighted values and are not counts of identified flaws or faults. Each flaw or fault reported is assigned a value that reflects its severity. The PIs are thus the sum of those weighted values.

Factoring the criticality of detected non-conforming events is achieved by applying a weighting factor to non-conforming events based upon its type; i.e. where:

Table 8-2 Condition Severity Weighting

Weighting	Type
5	Reactive
3	Corrective
1	Preventive
0	Renewal (and/or Damage Repair if not Reactive, Corrective or Preventive)

This weighting factor can be adapted to suit. Once that factor has been chosen and implemented it should never be changed and the weighting factor should be included in KPI reports. The weighting factors are fixed and consistent with any sub-grouping of track sections or business units where these measures are used. Preferably, the weighting factors are agreed between participating RIMs.

8.4 Performance indicators

All PIs are sums of the weighted values of events per track km. See Section 8.3.

Table 8-3 Asset Condition Performance Indicators

Category	Indicators	Ref
Exceptions	Events not identified by inspections	C1
Manual inspection	Track Inspection, foot and close	C2
	Track inspection, detailed including trolley, curves, tribometry	C3
Track geometry	Track inspection and recording car, VQI/km or # events by severity	C4
Track clearance	Manual and automated inspections	C5
Rail integrity	Rail wear monitoring and NDT- including ultrasonic	C6
Catenary	Manual and automated inspections	C7

Table 8-4 Asset Condition Key Performance Indicators

Category	Derived from Performance Indicator	Ref
Track condition	*C1 + C2 + C3*	KC1
Inspection quality	*C1/C2 × 100*	KC2
Track quality	*C4 + C5 + C6 + C7 × 100*	KC3

Note that C1 through C7 as well as the KPIs KC1 to KC3 are all based on faults identified in the reporting period. Whether and how those faults are fixed during the reporting period is considered to be managed under the organizational context (Section 6).

The KPI KC1 track condition is the number of faults per track km. This is a combined measure of track faults per track km. This is expressed as a value as it is already normalised in terms of track km.

The KPI KC2 inspection quality compares faults not identified by inspections to faults that are identified by inspections. This ratio is expressed as a percentage of faults not identified to faults identified by inspection processes.

The KPI KC3 track quality combines all of the inspection methods defined in C4, C5, C6 and C7. These values are totals of incidents weighted by severity and therefore have no units. The values are however normalised by track km. This KPI primarily illustrates the overall quality of the track.

8.5 Method:

(a) Define the track and assets selected for monitoring.

(b) Identify the kilometres of track (*Tkm*) for each category.

(c) Review each PI and for the defined track assets, review reported inspections and events with non-nominal results *(E)* for the reporting period then:

  (i) Assign severity/risk weighting factor for each non-nominal event (*Ew*)

  (ii) Sum the resulting weighted events *(∑ Ew)*

(iii) Divide by the defined kilometres of track for that category *(∑Ew)/Tkm*

(iv) Multiply by 100

For example:

$$Cn = \frac{\sum Ew}{Tkm} \times 100$$

8.6 Definitions

The derivation of the indicators in Table 8-3 are defined below. The Type column identifies normalised ratio or non-normalised count.

Table 8-5 HSE Performance Indicator Definitions

Indicator		Definition	Type
C1	Exceptions	Reported events that were not identified by inspections during the reporting period. Sum of the weighted values of the exception (Reactive, Corrective, Preventive) × 100 Track km	Ratio
C2	Manual Inspection by Foot/Cab	Reported events identified by periodic foot or cab-based inspections. Sum of the weighted values of the exception (Reactive, Corrective, Preventive) × 100 Track km	Ratio
C3	Manual Inspection Detailed	Events identified by in-depth inspection including trolley, curves, tribometry, etc. Sum of the weighted values of the exception (Reactive, Corrective, Preventive) × 100 Track km	Ratio
C4	Track Geometry	Track inspection by geometry or recording car, including VQI/km. Sum of weighted values of the exception (Reactive, Corrective, Preventive) × 100 Track km inspected See NOTE 1 and NOTE 2.	Ratio
C5	Track Clearance	Results of most recent track clearance inspection, manual or automated. Sum of the weighted values of the exception (Reactive, Corrective, Preventive) × 100 Track km inspected See NOTE 1 and NOTE 2.	Ratio

Indicator		Definition	Type
C6	Rail Integrity	Results of most recent rail wear inspection, including NDT/Ultrasonic methods. Sum of the weighted values of the exception (Reactive, Corrective, Preventive) × 100 Track km inspected See NOTE 1 and NOTE 2.	Ratio
C7	Catenary	Results of most recent catenary inspections both manual and automated. Sum of the weighted values of the exception (Reactive, Corrective, Preventive) × 100 Track km inspected. See NOTE 1 and NOTE 2.	Ratio

NOTE 1:
For inspections that have frequencies greater than the reporting period, the most recent value should be used. These PIs are used in KPIs but can be individually reported and trended.

NOTE 2:
Track km for these measures should be based on the track km covered by the inspections.

Section 9 Key performance indicators

9.1 Overview

The KPIs in this CoP are defined in Section 4 to Section 8. This section summarises the KPIs and discusses additional considerations on how they can be used - both internally and for benchmarking.

A method also is presented for how the KPIs can be used to create a dashboard for the organization.

9.2 KPIs in this CoP

In Table 9-1, the column 'Norm' refers to whether this KPI is normalised and can be used for benchmarking outside of the rail organization or 'corporation'. If it is 'N', then the KPI is relevant within an organization, but it should only be used for external benchmarking where the differences are noted. For example KT7 asset age is an intrinsically scalar value and if it is normalised against some internal value, such as a target age or as a percentage of expected life then, this needs to be defined in the corresponding report.

If the measure is not normalised then, how those measures can be normalised for use in benchmarking or dashboards also is shown below where the column Type defines the KPI as a percentage, ratio or value.

The column BMark in Table 9-1 identifies the common set of benchmarking KPIs that are available to RSOs.

Table 9-1 Recommended KPI Set

Category	KPI	Type	Norm	BMark	Name	Normalisation
HSE	KH1	%	Y	N	Health	
	KH2	Value	N	N	Safety - General	Factor # personnel or tonne km or target
	KH3	%	Y	Y	Safety - Maintenance	
Asset	KT1	%	Y	Y	Scheduling	
	KT2	%	Y	Y	Availability	
	KT3	%	Y	Y	Fault resolution	
	KT4	%	Y	Y	Maintenance	
	KT5	%	Y	N	Capacity	
	KT6	Ratio	Y	Y	Riding comfort	
	KT7	Value	N	N	Asset age	
Organization	KO1	%	Y	N	Preventive maintenance	
	KO2	%	Y	N	Maintenance management	
	KO3	%	Y	N	Maintenance overruns	
	KO4	%	Y	N	Maintenance backlog	

Category	KPI	Type	Norm	BMark	Name	Normalisation
	KO5	%	Y	N	Condition monitoring	
Economic	KE1	Value	Y	N	Maintenance total cost	
	KE2	Ratio	Y	N	Maintenance prevention	
	KE3	Ratio	Y	N	Maintenance by track km	
	KE4	Ratio	Y	N	Maintenance by tonne km	
Condition	KC1	%	Y	Y	Track exceptions	
	KC2	%	Y	Y	Inspection quality	
	KC3	%	Y	Y	Track quality	

9.3 Using PIs and KPIs with target values

Most PIs and KPIs will present as numerical values or percentages and will be meaningful over time to indicate changes but they will not indicate performance relative to a target or desired value. PIs can be displayed with targets but, at line management level as well as executive levels, it can be useful if every indicator is presented relative to the corresponding strategic target (i.e. where a KPI that is lower presents as less than 1 and a KPI that is higher than target presents as greater than 1). To translate KPIs for this purpose, the KPI can be expressed as a ratio where the divisor is the target value.

For example, KE2 (Corrective/Preventive maintenance cost) can be further normalised to illustrate its value relative to the target by creating a KE2 target indicator 'KE2_Target' and presenting it as 'KE2_ Index'

For example, the following can be presented easily on a dashboard and an aspired performance report, if we assume that:

KE2 = 4.5
KE2_Target = 2.5
KE2_Index = 4.5/2.5 = 1.8

(which illustrates how much higher is it than the target value).

Alternatively, placing the target as the numerator yields a *KE2_Index = 2.5/4.5 × 100 = 55%*

This type of normalisation can be used for non-normalised KPIs such as maintenance costs and asset age.

This method is not appropriate for benchmarking between organizations by RSOs. However, it can be used in high level dashboards within an organization's management levels or between an organization's business groups, i.e. if the organization implements PIs and KPIs at or to the business group level. This normally would be defined in the organizations KPI framework where selected PIs and KPIs are defined for specific uses.

It is very important to note that if this type of normalisation of targets is adopted then any periodic changes to the KPI targets will require that the historical data be recalculated requiring the historical KPI or PI source to be retained and available.

Section 10 Data collection

The source data for the PIs and KPIs will likely be derived from different sources and may require special reporting systems or changes to existing ones to create the requisite measures.

When designing and implementing changes to enable the creation of the PIs and KPIs, the following actions are recommended:

(a) Identify the PI and KPI data sources and specify the changes to the existing reporting systems that are required to create the information that is not currently available.

(b) When the data is sourced from different systems, ensure that the reporting data periods are consistent.

(c) Review each PI and KPI data source for integrity and stability. Understand the context of the data, its inclusions and exclusions and consider how normal operational variance could affect the values and thereby still ensure statistically valid results.

(d) Where data cannot be sourced from existing data systems then consider the use of qualitative data collected via audits or questionnaires, e.g., in the case of ride quality.

(e) Beware of stale data. Where the update frequency of a data element is much longer than the reporting period then consider a means of compensating for that 'data staleness'. For example, if an inspection process identifies faults but is only repeated every 12 months, then consider maintaining a count where it is updated by subtracting the faults removed in the reporting period. However, compensating and not compensating for stale data can create artificial step changes and therefore 'whether to compensate or not' needs to be carefully considered.

(f) Consider whether new data acquisition and analysis procedures and user training may be required.

(g) Ensure that the changes in the data acquisition system and the PI/KPI reporting framework complies with regulations and standards for documentation, security, storage and retention.

(h) Consider creating an additional set of dashboard KPIs that are normalised to the specific organization's strategic targets. See Section 9 for more details.

Appendix A Required Data of this Code of Practice

Data required to support the CoP is tabled below. The data context is based on the selected reporting period and track section, business group or track class. Titles in this table are abbreviated definitions. Sections 4, 5, 6, 7 and 8 for the complete definitions.

PI	KPI	Title	Definition
H1	KH1	Absenteeism	Maintenance personnel absenteeism hours
H1	KH2	Absenteeism	Maintenance personnel total hours
H2	KH2	Turnover	Count of maintenance personnel resigning and starting
H2	KH2	Turnover	Total count of maintenance personnel at end of period
H3	KH2	Track safety	Count of track condition events classified as 'Reactive'
H4	KH2	Casualties	Count of deaths or injuries of rail and non-rail personnel on railway property
H5	KH2	Accidents X	Count of all accidents at crossings
H6	KH2	Accidents V	Count of all accidents involving rail vehicles – which includes shunting and maintenance depots, and includes all derailments
H7	KH2	Incidents ALL	Count of all reported safety incidents Including potential for injury or property damage and environmental incidents
H8	KH3	Maintenance safety	Count of all reported accidents and safety incidents Including potential for injury or property damage and environmental incidents during maintenance
T1	KT1	On time arrival	Number of trains arriving within 'n' minutes of scheduled time
T1, T2, T5	---	Train trips	Number of train trips completed
T2	KT2	Train delay	Total number of hours trains were delayed
T3	KT2	Faults traffic	Number of infrastructure failures that affected traffic
T3	----	Faults infrastructure	Number of infrastructure failures
T4	KT3	TSR	Total elapsed days of all temporary speed restrictions
T4	---	Report period	Number of days in reporting period
T5	KT4	Maintainability	Total repair hours of reactive and corrective Infrastructure failures. This is the time between fault reporting and resolution and is not MTTR
T6	KT5	Network utilisation	Traffic volume in train km (capacity in use)

PI	KPI	Title	Definition
T6	---	Network utilisation	Maximum network train km capacity (notional or planned capacity)
T7	KT6	Riding comfort	Track Quality Index (TQI) e.g., K/Q value
T8	KT7	Asset age	Mean Age of Assets
O1	KO1	Preventive maintenance	Preventive maintenance hours reported in period
O1	KO1	Corrective maintenance	Corrective maintenance hours reported in period
O2	KO2	Response time	Total number of hours between job creation and on-site response
O3	KO2	Maintenance backlog	Average daily number of maintenance jobs queued awaiting response in reporting period
O4	KO2	Maintenance hours	Total preventive and corrective hours on-site hours logged
O5	KO3	Maintenance overruns	Total number of possession overruns in reporting period
O6	KO4	Maintenance backlog	Total number of open Reactive and Corrective jobs Total number of jobs closed
O7	KO5	Fault types unknown	Total number of faults reported to maintenance that were not scheduled due to inspections or condition monitoring. Refer to the definition for details
O8	KO5	Fault types known	Total number of faults reported to maintenance that were scheduled due to inspections or condition monitoring. Refer to the definition for details
E1	KE1	Maintenance overhead	Cost of Maintenance management and overheads which includes training costs and current valuation of plant and infrastructure and excludes costs of direct maintenance staff and materials used for repairs
E2	KE1	Maintenance direct cost	Cost of maintenance staff and material used for repairs
E3	KE1	Maintenance contract cost	Cost of all contracted maintenance including material
E4	KE2	Corrective maintenance	Cost of all corrective works and material by maintenance staff and contractors. Excludes non remedial works such as renewal.

PI	KPI	Title	Definition
E5	KE2	Preventive maintenance	Cost of all preventive works and material by maintenance staff and contractors. Excludes non remedial works such as renewal
E5	KE2	Track km	Km of track being reported
E6	KE3	Other costs	Cost of activities and material by maintenance for works that are neither corrective nor preventive (e.g., renewals and projects)
E6	KE3	Gross tonne km	Gross tonne km of track being reported
C1	KC1	Exceptions	Reported events that were NOT identified by inspections during the reporting period as the sum of the weighted values of the exception (reactive, corrective, preventive) × 100
C2	KC1	Foot inspection	Sum of the weighted values of the exception (reactive, corrective, preventive) × 100 reported during routine foot/cab manual inspections
C3	KC1	Detailed inspection	Sum of the weighted values of the exception (reactive, corrective, preventive) × 100 reported during scheduled detailed manual inspections
C4	KC2	Track geometry	Sum of the weighted values of inspection exceptions, including VQI/km for the measured track km × 100 (see the definition of C4 for more details)
C5	KC2	Track clearance	Sum of the weighted values from the most recent track clearance inspection, manual or automated km for the measured track km × 100 (see the definition of C4 for more details)
C6	KC2	Rail integrity	Sum of the weighted values from the most recent rail wear inspection, including NDT/Ultrasonic methods, manual or automated km for the measured track km × 100 (see the definition of C4 for more details)
C7	KC2	Catenary	Sum of the weighted values from the most recent catenary inspection, manual or automated km for the measured track km × 100 (see the definition of C4 for more details)
C1, C2, C3		Track km	Kilometres of track inspected in C1, C2 and C3 Scope

Bibliography (Informative)

- AS 7630, *Track Classification*
- AS 7640:2024, *Rail Management*
- EN 15341:2019+A1, *Maintenance Key Performance Indicators*
- ISO 55000, *Asset Management*
- *Key Performance Indicators of Rail Freight Corridors Version 5.0 (2024)*, RailNetEurope
- *IRIS Guideline 1:2011 KPIs*, UNIFE (The European Rail Industry Association)
- *Performance Indicators of Railway Infrastructure*, International Journal of Railway Infrastructure