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Guidelines for the Application of Asset Management in Railway Infrastructure Organisations





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1 Introduction

Asset management is a term usually associated with the financial sector but is rapidly gaining influence in organisations responsible for infrastructure networks, such as electricity and gas transmission and distribution, water, and transport. There is particular interest in the application of asset management principles to the management of railway networks, where the cost and performance of the infrastructure are of national significance.

Asset management for the railway infrastructure is fundamentally about delivering the outputs valued by customers, funders and other key stakeholders, in a sustainable way, for the lowest whole life cost. While it may be considered to be an evolution of traditional approaches to managing large scale infrastructures, it does have three distinguishing features.

- 1. It explicitly focuses maintenance, renewal and enhancement activities on delivering sustainable outputs valued by customers and funding providers at the lowest whole-life cost, as opposed to prioritising work predominantly according to condition
- 2. It provides an integrating mechanism that crosses boundaries – between organisational functions and asset disciplines, and where relevant, between the infrastructure manager and contracting organisations
- 3. It places a greater emphasis on evidence-based decision making, using knowledge of how assets degrade and fail to optimise maintenance and renewal interventions. The potential benefits from applying an asset management approach are numerous and significant. They include the creation of a ‘line of sight’ between strategy and implementation, the capability to deliver the same level of sustainable performance with reduced volumes of work, and the demonstration to external stakeholders that activities are being undertaken at the lowest whole life cost.

One of the main barriers to introducing an asset management regime has been a lack of clarity, and therefore consensus about what asset management really means i.e. how should it be interpreted and what are the necessary practical steps for its implementation. This document has been produced to promote a consistent asset management approach to railway infrastructures, primarily in order to help organizations develop their own methods, and to compare their progress both with other railways and with other asset intensive organisations.

2 Scope of this document

The document is structured around eight key steps which provide high level guidelines for designing, implementing and sustaining a comprehensive asset management system. The guidelines are consistent with good practice specified in recognised approaches, such as PAS 55-1:2008¹, the IIM² and the approach of the U.S Highways Agency³.

In particular an explicit linkage is established between the asset management framework specified in this document and the more generic framework in PAS 55 (see Appendix A). The linkage is provided for two reasons:

- It allows the asset management approach in this document to adopt terminology commonly used in a railway context while remaining consistent with generic good practice.
- It enables the tools and products built around PAS 55, such as the Institute of Asset Management (IAM) Assessment Methodology, the IAM Competencies Framework, and the Asset Register Guidelines, to be referenced to the framework in this document.

The eight key steps referred to above are as follows:

STEP 1	Definition of asset management
STEP 2	Scope of asset management
STEP 3	Asset Management Policy
STEP 4	Asset Management Strategy
STEP 5	Asset Management Framework
STEP 6	Specification: Core decisions and activities
STEP 7	Specification: Enabling mechanisms
STEP 8	Specification: Reviewing mechanisms

Each of these steps is discussed in turn in the following sections. The level of detail provided is intended to help managers specify the main building blocks of an asset management system; it is not intended to be prescriptive about the detail that these building blocks should contain. More importantly, this document shows how the building blocks fit together to produce an overall asset management system.

1 Asset Management Part 1: Specification for the optimized management of physical assets, 2008

2 International Infrastructure Management Manual, 2006

3 Asset Management Overview, Federal Highways Administration. U.S. Department of Transportation, FWHA-IF-08-008

3 Definition of asset management (Step 1)

There are numerous definitions of asset management being used in different sectors and in different countries. The majority are slightly different expressions of the same basic concept, based around optimizing asset performance to deliver business objectives at the minimum whole-life cost.

The most widely quoted definition is provided in PAS 55-1, which has been adopted in this work. The definition is as follows, with the key words highlighted:

*Systematic and coordinated activities and practices through which an organization **optimally** manages its **assets** and their associated **performance, risks and expenditures** over their lifecycle for the purpose of delivering the organization's **business objectives**.*

The definition is used below to help define the scope of asset management and to inform the Asset Management Policy, Strategy and Framework.

4 Scope of asset management (Step 2)

The two main categories that determine the scope of asset management are:

- The scope of the physical assets to which the asset management process applies.
- The decisions, processes and activities that link the high level strategy for the infrastructure to the physical work that is undertaken on the ground.

These are discussed in turn below.

4.1 Scope of assets

The scope of assets included in the asset management system is at the discretion of each organization. In order to promote consistency among railway organizations, the definition of scope has been made consistent with previous EC Directives, the most relevant being the European Commission 5th Framework Programme, IMPROVERAIL, Deliverable D3 “Benchmarking exercise in railway infrastructure management” as referenced in the UIC Lasting Infrastructure Cost Benchmark (LICB) project.

LICB defines the Railway Infrastructure as consisting of the following items, assuming they form part of the permanent way, including sidings, but excluding lines situated within railway repair workshops, depots or locomotive sheds, and private branch lines or sidings:

- Ground area
- Track and track bed etc.
- Engineering structures: bridges, culverts and other overpasses, tunnels etc.
- Level crossings, including appliances to ensure the safety of road traffic;
- Superstructure, in particular: rails, grooved rails; sleepers, small fittings for the permanent way, ballast; points, crossings.
- Access way for passengers and goods, including access by road;
- Safety, signalling and telecommunications installations on the open track, in stations and in marshalling yards etc.
- Lighting installations for traffic and safety purposes
- Plant for transforming and carrying electric power for train haulage: sub-stations, supply cables between sub-stations and contact wires, catenaries.



4.2 Scope of asset management decisions and activities

For asset intensive organizations, including railway infrastructure companies, the scope of asset management includes the majority of major decisions and activities that the organization undertakes. The scope of these decisions and activities fall into two main categories.

- All decisions and activities relating to maintaining, renewing and enhancing the infrastructure. These extend from high level strategy for the railway infrastructure through to the delivery of work and the provision of train paths.
- In addition to including all aspects of maintaining, renewing and enhancing the railway infrastructure, the scope of asset management includes the operation of the network, including capacity planning and timetabling.

5 Asset Management Policy (Step 3)

The objective of the Asset Management Policy is to provide a high level statement of intent by the organisation's senior management, demonstrating commitment to the adoption of asset management principles and showing the role of the asset management system in delivering the organisation's objectives.

The Asset Management Policy is conventionally a short document (circa 2 pages) that can be communicated to staff, customers and stakeholders. The policy sets out:

- The organisation's vision for the railway
- The role of asset management in delivering this vision
- The core principles underpinning the asset management system e.g. commitment to minimum whole life costs, sustainability etc.
- How the asset management system will be implemented and its implications for customers and stakeholders.



6 Asset Management Strategy (Step 4)

The Asset Management Strategy defines the organisation's medium to long term approach to asset management. It has two main objectives:

- Firstly it should define how the infrastructure is required to perform in order to deliver the asset management contribution to achieving the vision of the railway. These requirements are defined in terms of the infrastructure outputs that impact directly on customers, funders and other key stakeholders. These outputs should include service frequency, train performance, the safety of passengers, workers and members of the public, and the environmental impact from changing and operating the infrastructure.
- Secondly, it should set out how the asset management system will be implemented. This includes defining the major components of an asset management system in the form of an asset management framework. The Asset Management Strategy sets target levels and timescales for improving and sustaining the capability for each component of the framework. It should also explain how the organisational design will support the implementation of asset management and define the interfaces with other parts of the organisation and with external parties.

7 Asset Management Framework (Step 5)

The Asset Management Framework should identify the key components of the asset management system. These fall into three categories:

Core decisions and activities: The spine of the asset management framework defines the decisions and activities that link strategy to the delivery of work, including both work on the infrastructure and the operation of the network.

Enabling mechanisms: The effectiveness of the core decisions and activities are dependent on many support mechanisms such as asset information, life-cycle costing tools, competencies and business processes.

Reviewing mechanisms: Reviewing mechanisms are required to monitor and improve the effectiveness of the asset management regime in delivering sustainable infrastructure outputs for the level of committed funds. They provide the feedback loop for the continuous improvement of the asset management system.

The key components of these three categories, which comprise the Asset Management Framework are illustrated in Figure 1. The framework is arranged to represent the flow of decisions from strategic to tactical. The upper components represent the specification of the network and route requirements, predominantly from a customer and funder perspective.

The framework then splits into an asset component and an operational component, representing the way in which most railway infrastructure companies are organized. The bottom components of the framework represent the execution of work on the infrastructure and the day to day operation of the network.

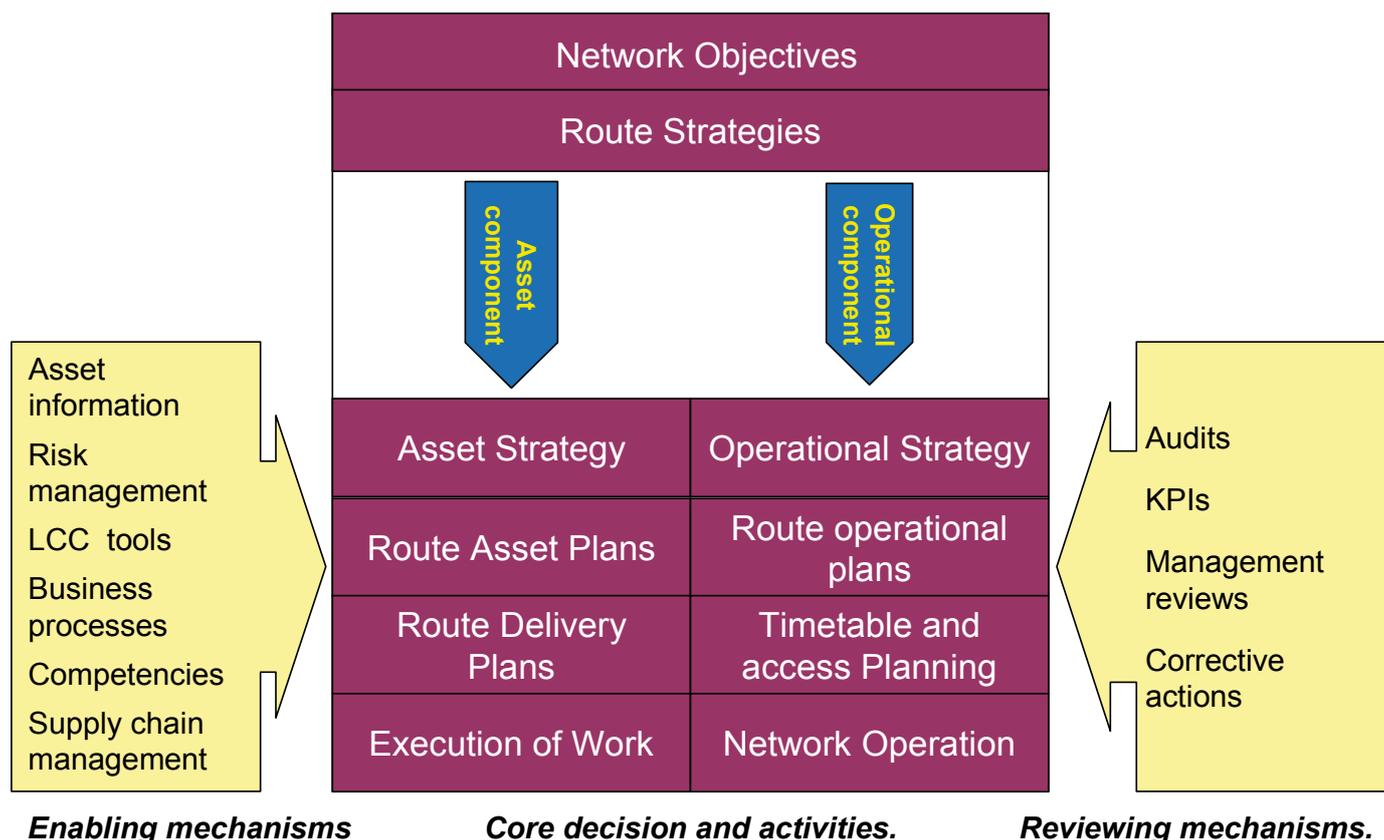


Figure 1: Asset Management Framework

The components of the framework are structured in a Plan – Do – Enable - Review arrangement, consistent with PAS 55. The Plan – Do components are contained within the core decisions and activities. The Enable and Review components support and monitor the core decisions and activities and are shown on the left and right respectively.

The specification for each of the components of the Asset Management Framework is provided in the following three sections.

8 Specification: Core decisions and activities (Step 6)

8.1 Network Objectives

Network Objectives define the high level requirements for the railway from the perspective of the customers i.e. train and freight operators, and funders, usually the government. They provide the vision for the type of railway that the country wants and the willingness to pay for it. They should provide clarification on traffic growth, and targets for network punctuality, safety and sustainability. They should also include a specification of the level of funding available to maintain the core railway and to deliver any required enhancements.

8.2 Route Strategies

Route Strategies should provide the specification of route level targets, funding and constraints covering a period of at least five years, consistent with the Network Objectives. Route Strategies should recognize the differentiation of the network and allocate priorities according to the assessed importance of each route. As a minimum, Route Strategies should translate the network objectives to route level and include additional specification on factors particular to the given Route e.g.

- Route capability
- Route capacity
- Route availability, including the route access regime
- Traffic
 - Number of trains
 - Vehicle characteristics
 - Line speed
- Route infrastructure performance (punctuality, safety, environmental impact)
- Passenger flows
- External factors e.g. 3rd party activities
- Route budgets

The Route Strategies should set output targets and budgets for a defined train service pattern. This sets the requirements for the infrastructure and therefore the targets to be achieved by the maintenance, renewal and enhancement decisions (asset strategies) discussed below.

In some countries the Route Strategy will be derived from negotiations with relevant train operating companies or local government.

8.3 Asset Strategies

The primary objective of the asset strategies is to optimize decisions on inspecting, maintaining, renewing and enhancing the infrastructure such that the route outputs are delivered at the minimum whole life cost.

The asset strategies should specify the following:

- Inspection regime (preventative / reactive monitoring)
- Maintenance and renewal intervention criteria
 - When to intervene e.g. condition thresholds
 - How to intervene e.g. type of new equipment, length of renewals, clustering of work
- Equipment obsolescence assumptions
- Technical strategy
- Redundancy
- Cost of inspection, maintenance and renewal

The Route Asset Strategies should provide demonstrable evidence that these decisions deliver the required outputs from the Route Strategies for the lowest whole life cost. The specification of the intervention criteria in the asset strategies represents the pivotal link between the customer/funder requirements of the railway infrastructure and the planning and delivery of work. More than any other component of the framework, the asset strategies are the major determinant of the cost and sustainable performance of the infrastructure.

8.4 Route Asset Plans

Asset Plans specify the location specific enhancement activities, renewal workbanks e.g. replacement of a life-expired section of track, and the maintenance regime e.g. type and frequency of maintenance task. The workbanks and maintenance regime are usually specified as the tactical component of the plans, in which the longer-term elements are typically derived from modeling tools. The proposed content of the Route Asset Plans listed below is comprehensive but not exhaustive:

- Overview of the route section
- Condition and performance trends
- Work history
- Route condition and performance targets
- Selection of the appropriate asset strategy to deliver the route targets
- Maintenance and renewal work volumes and costs resulting from application of the asset strategy
- Assessment of the risks to the plan delivering its objectives

The plans should provide a specification for the delivery functions. They should also provide assurance to senior management and external stakeholders, such as regulators and governments, that the costs are justified and that the infrastructure outputs will be delivered in a sustainable way.

8.5 Route Delivery Plans

Route Delivery Plans should translate the work specified in the Route Asset Plans into a detailed plan for execution. The Route Delivery Plans should:

- Optimize the delivery of maintenance, renewal and enhancements, grouping work spatially and combining work to be delivered at the same time
- Provide a detailed design for construction projects
- Confirm the availability and source of funding
- Agree the delivery programme with customers and stakeholders
- Align the delivery programme with the local track access regime and the delivery capability of suppliers.

8.6 Execution of Work

The final element in the asset leg is the delivery of work. This should include the following:

- Mobilization of the project team, the scheduling of resources and booking of possessions
- The provision of tools, facilities and equipment.
- Construction, testing and commissioning
- Hand back of work
- Updates to asset registers and cost management systems as a result of changes to the infrastructure.

8.7 Operating Strategy

The scope operating strategy has two main components:

- the operation and control of the rail network
- the optimization of the access regime.

The operational strategy specifies the requirements for the future configuration of the infrastructure, for example the number of signaling centers and the degree of automation. It also specifies the required level of train service capacity and the high level requirements for the production of a robust timetable. The operating strategy also specifies the arrangements for providing access to the network in order to allow maintenance and renewal work to be undertaken.

8.8 Route Operation Plans

Route operational planning is the process that translates train and freight operator requirements for running service on the network into detailed plans for the provision of safe and reliable train paths. It involves detailed capacity planning, typically over a ten year horizon. The overall capacity of a route is determined by the intervals between trains, as permitted by the signaling system, with a contingency built in to allow for perturbation. The route operation plans also include the arrangements for access to undertake work on the infrastructure. The production of the route operation plans takes account of the trade off between the number of trains operated and the level of performance delivered.

8.9 Timetabling and access planning

The timetabling process comprises a number of phases which typically includes:

- an initial phase during which track access arrangements (possessions) are prepared
- a drafting phase in which the infrastructure manager and the train operators collaborate to produce a draft timetable, often based on a number of automatically generated timetable scenarios
- a finalization phase to refine the content and make final decisions on the timetable content, usually involving manual alterations to the selected scenario.

In parallel and in iteration with the production of the timetable, an annual access (possession) plan is produced.

Following the production of the annual timetable, it is frequently necessary to make short term amendments to the timetable, to meet particular commercial and operational needs, in particular to schedule paths for freight trains.

8.10 Network Operation

Operational delivery is concerned with the provision of safe and reliable train paths in accordance with the detailed production plan referenced above and the recovery response following incidents on the network.

Network management is the real time process that monitors and controls the movement of trains. As incidents occur, the network management function controls and manages the problem. It is therefore crucial for minimizing delay per incident, which has a major impact on train punctuality.

9 Specification: Enabling mechanisms (Step 7)

9.1 Asset information

Fit for purpose asset information is essential for developing the appropriate asset strategies and for producing and implementing work and operational plans. The scope of asset information is defined by the requirements of the components of the Asset Management Framework in Figure 1, the core of which should include:

- Asset type / location
- Installation date
- Capability
- Condition
- Failure history and impact of performance/safety
- Maintenance and renewal history and plans
- Unit costs of maintenance and renewal
- Diagrams specifying the 'as-built' configuration of the railway infrastructure

The approach to the management of asset information should, as a minimum, address the following issues:

- Specification of information requirements linked to business processes
- Design and implementation of a system for integrating asset information and making it accessible to internal and external users
- Implementation of a process for maintaining asset information to an appropriate level of quality (completeness, timeliness, accuracy).

9.2 LCC tools

Lifecycle costing (LCC) tools should support the optimization of decisions on maintaining and renewing infrastructure assets. They should also provide the basis for route and/or network forecasts of work volumes, costs and outputs.

The tools should embody a good understanding of how assets degrade and fail, for example with age or usage, and how the degradation or failure impacts on train service and the safety of passengers, workers and members of the problems. The tools should also be able to model different maintenance and renewal options to provide decision makers with funding and output choices.

9.3 Risk management

Decisions and plans for renewing, maintaining and operating the railway infrastructure should be robust against uncertainties in assumptions and hazards or other events that may occur.

Risk management should provide an effective mechanism for identifying threats to asset management objectives, for assessing their impact and for identifying appropriate mitigating measures. Techniques developed for managing safety risk e.g. the ALARP framework, should be extended and applied to provide an integrated approach covering, for example, train performance, financial risks, environmental impact etc.

The risk management process should address both strategic and operational risks within a single framework. This requires the integration of the top-down and bottom-up identification, evaluation and control of all major risks relating to the infrastructure.

9.4 Business processes

Business capabilities are commonly defined as comprising processes, people, technology and information. The complexity of managing the railway infrastructure places significant demand on clear processes being defined to underpin and link the components of the Asset Management Framework in Figure 1.

Business processes should be developed in order to:

- Define the inputs and outputs for each of the asset management components
- Provide the key steps in translating the inputs to outputs
- Identify the 'suppliers' of the 'inputs' and the 'customers' for the 'outputs'.

A key output from process development should be the assignment of key accountabilities and responsibilities, using for example a RACI structure (Responsible, Accountable, Consult, Inform). The process framework should also inform the design of the organizational structure. The business processes provide the key means of embedding asset management in the business. A clear communication strategy should therefore be integrated with process development and implementation.

9.5 Competencies

Asset management competencies represent the skills, aptitudes and behaviours required by individuals and teams. The competence requirements provide direction to the recruitment and development of staff including assessments, training and deployment. A structured

approach should be used to identify, assess and develop asset management competencies. A good reference is the IAM Competency Framework, which is specific to asset management and identifies seven key roles:

- Policy development
- Strategy development
- Asset management planning
- Implementation of asset management plans
- Asset management capability development
- Risk management and performance improvement
- Asset knowledge management

Each of these roles is broken down, firstly into competence units e.g. 'Apply whole life costing principles' and then into a small set of competence elements e.g. 'Identify whole-life costing models'.

9.6 Supply chain management

Railway infrastructure organizations have diverse arrangements for the work that is carried out internally or outsourced to contractors.

Management of the supply chain is key to the effective delivery of work on the infrastructure and the control of

costs. Supply chain management should address:

- The scope of potential activities for outsourced processes and activities
- The business case for outsourcing work versus retaining in-house - 'Make versus Buy'
- The interfaces with internal processes and activities, including the accountabilities and responsibilities for managing the outsourced processes and activities
- The flows of information between the infrastructure manager and the contractor.

10 Specification: Reviewing mechanisms (Step 8)

The purpose of the reviewing part of the Asset Management Framework in Figure 1 is to identify the components that are required to monitor the effectiveness of the core decisions and activities and to identify and implement corrective or improvement actions where required.



10.1 Audits

A systematic programme of audits should be implemented in order to confirm that:

- The major components of the asset management system have been implemented and are being maintained
- The target levels of capability for each component are being achieved
- Asset management standards are being complied with.

The audit regime should be risk based, focussing on areas where gaps in the asset management or non-compliances have a material effect on business objectives.

10.2 Key Performance Indicators (KPIs)

A comprehensive suite of key performance indicators should be implemented in order to:

- Provide a measure of how effective each component of the asset management system is being implemented, for example the delivery of work plans aligned to the asset strategies
- Provide measurements of the impact of the implementation of asset management system on

the performance of the infrastructure, for example condition, failures, capability, service impact, costs etc.

The measures should be selected to provide leading and lagging indicators and to provide insight into the impacts of strategic decisions and their tactical implementation.

10.3 Management reviews

The outputs from the audit regime, measurements of key performance indicators and other sources of feedback should be reviewed regularly by management in order to:

- Identify gaps in the implementation of the asset management system
- Identify the root causes of deviations in key performance indicators from target values
- Confirm that the implementation of the asset management is driving sustainable performance and costs.

The outputs from management reviews should be a combination of improving the short term performance of the infrastructure where required, or longer term improvements in the components of the asset management framework, including changes to the framework itself.

10.4 Corrective actions

A process for managing corrective actions arising from management reviews and other sources should be implemented to remove non-compliances, address short term improvements in the performance of the infrastructure, and deliver longer term continuous improvement in the asset management system.

The benefits from implementing corrective actions should exceed their costs. The actions should be planned and coordinated with mitigating actions deriving from the risk management process.



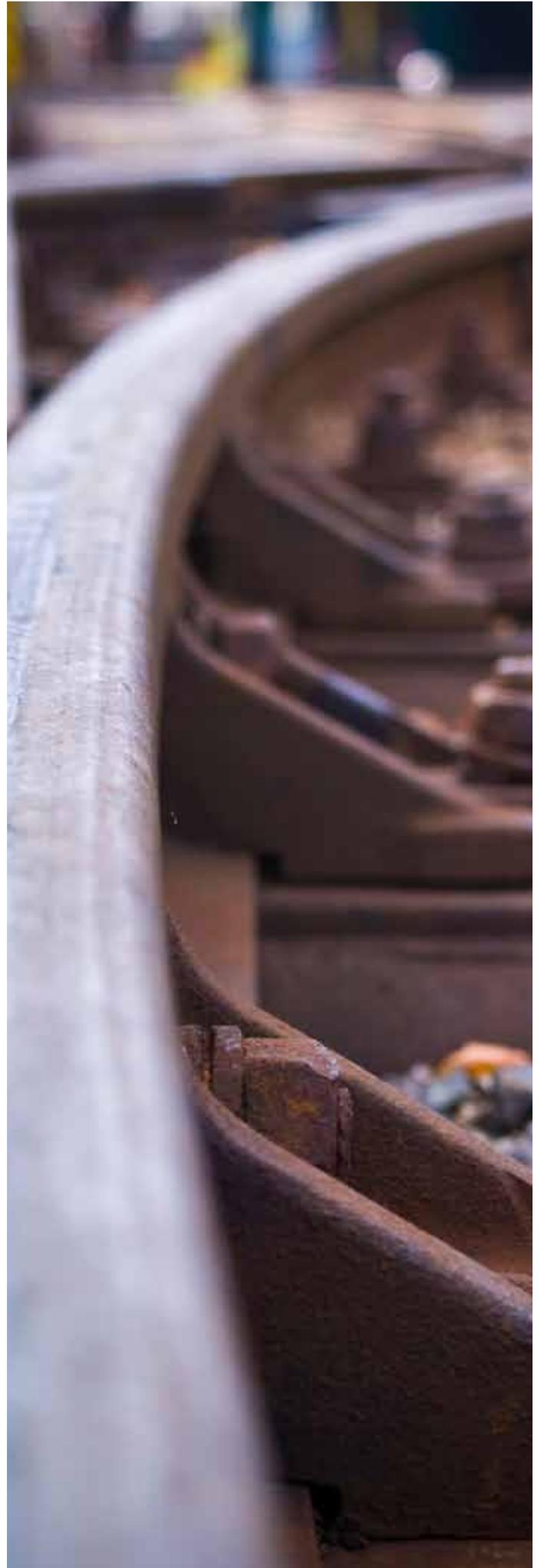
11 Conclusions

The guidelines provided in this document are based on the experience of the infrastructure managers that are represented on the UIC Asset Management Working Group, taking account of current and emerging good practice outside the railway.

The Asset Management Framework, around which the guidelines have been constructed, has been found to be applicable to all of the group members and therefore should be relevant to all railway infrastructure organizations.

The guidelines are high level but nonetheless comprehensive. The guidelines will enable infrastructure managers to determine whether they have all the components of an asset management system in place. This could be the case even if the term asset management is not recognized within the organization. More importantly, the guidelines may be used to test whether the components of the framework are aligned and the interfaces between them optimized. Based on the experience of the AMWG group members, the joining up of core decisions and activities and the provision of effective support and monitoring, provides the major opportunity for improvement.

In addition to supporting internal improvements, a common Asset Management Framework may also underpin comparisons between railway infrastructure companies. This includes both the comparison of asset management processes and systems and the comparison of Key Performance Indicators relating to infrastructure outputs and costs. A key objective of the UIC AMWG is to establish the minimum whole-life cost to deliver a given level of infrastructure output. The comparison of KPIs and the link back to the components of the Asset Management Framework is intended to identify transferable good practice, which is the basis for achieving this objective.



Annex A

Correspondence between PAS 55-1:2008 and the UIC Asset Management Framework.

PAS 55 has a management system structure comprising 22 components (Figure 6, Page xiii). These components are compared below with the Asset Management Framework provided in this document, indicating a high degree of correspondence. A comment field is provided where the correspondence requires explanation.

PAS 55-1:2008 (see Figure 6, Page xiii)	UIC AM Framework	Comments
4.2 Asset management policy	5. Asset Management Policy	
4.3.1 Asset management strategy	6. Asset Management Strategy	
4.3.2 Asset management objectives	6. Asset Management Strategy 8.1 Network Objectives 8.2 Route Strategies	
4.3.3 Asset management plans	8.4 Route Asset Plans 8.8 Route Operational Plans	
4.3.4 Contingency planning	8.9 Network Operation 9.3 Risk Management	
4.4.1 Structure, authority and responsibilities	9.4 Business Processes	Business Processes assign key responsibilities and accountabilities.
4.4.2 Outsourcing of asset management activities	9.6 Supply Chain Framework	
4.4.3 Training, awareness and competence	9.5 Competencies	
4.4.4 Communication, participation and consultation	5. Asset Management Policy 9.4 Business Processes	High level communication if provided by the AM Policy. The communications strategy is part of the business process development.
4.4.5 Asset management system documentation	9.1 Asset Information	
4.4.6 Information management	9.1 Asset Information	
4.4.7 Risk management	9.3 Risk Management	
4.4.8 Legal and other requirements	5. Asset Management Policy	
4.4.9 Management of change	9.4 Business Processes	
4.5.1 Life cycle activities	8.3 Asset Strategies	
4.5.2 Tools, facilities and equipment	8.4 Route delivery plans 8.6 Execution of Work	
4.6.1 Performance and condition monitoring	10.2 Key Performance Indicators	
4.6.2 Investigation of asset related failures, incidents and non conformities	10.3 Management Reviews	
4.6.3 Evaluation of compliance	10.1 Audit	
4.6.4 Audit	10.1 Audit	
4.6.5 Improvement actions	10.4 Corrective Actions	
4.6.6 Records		Mandatory requirement to keep records not considered necessary in guidance document



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