Task No: YY86731

Guidance Document for Performance Measurement of Highway Structures

Part A: Framework for Performance Measurement

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Acknowledgements

Atkins was commissioned by the Highways Agency to develop a suite of performance measures for highway structures. The commission was subsequently extended with funding from the Department for Transport to ensure the performance measures developed were also appropriate for use by Local Highway Authorities.

Two groups were set up to oversee the development of the performance measures:

Steering Group – to review progress, provide comments and guidance, and accept project deliverables.

Consultation Group – to establish the needs of a diverse range of authorities across the country, to provide feedback on the work performed, and to try and achieve a consensus across the bridge engineering community.

The composition of the two Groups is shown in the table below.

Organisation	Representative
Steering Group	
Highways Agency	Martin Potts (May 2002 to November 2003)
Highways Agency	Awtar Jandu (October 2003 onwards)
CSS	Mike Young (Suffolk)
CSS	Dr Roger Cole (Lancashire)
CSS	Graham Hollett (Derbyshire)
CSS	Peter Brown (Oxfordshire)
Consultation Group	
Highways Agency	Martin Potts (May 2002 to November 2003)
Highways Agency	Awtar Jandu (October 2003 onwards)
CSS	Mike Young (reporting to CSS Bridges Group)
Department for Transport	Ian Holmes & Andrew Oldland
Welsh Assembly Government	John Collins
Scottish Executive	Raymund Johnston
Northern Ireland Office	Ronnie Wilson
Network Rail	Lenny Aristodemou & Alan Dray
Transport for London	Dana Skelly
London Underground	Brian Thorne
LoBEG	Richard McFarlane & David Yeoell

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1. Introduction

1.1 Performance Measures for Highway Structures

This document describes the framework for, and overall context of, performance measurement. The performance measures are contained within one guidance document that contains five stand alone parts:

- Part A: Framework for Performance Measurement
- Part B1: Condition Performance Indicator
- Part B2: Availability Performance Indicator
- Part B3: Reliability Performance Indicator
- Part C: Measuring the Structures Backlog

Part A describes the background and the overall framework for the evaluation, interpretation and use of performance measurement in the management of highway structures.

1.2 Definitions of Performance Measures

The definitions for the four Performance Measures covered by this Guidance Document are as follows:

- **Condition PI** – A measure of the physical condition of the highway structure stock.
- **Availability PI** – A measure of the reduction in the Level of Service provided, on a highway network, due to restrictions placed on highway structures.
- **Reliability PI** – A representation of the ability of the structure stock to support traffic, and other appropriate loading, taking into account the consequence of failure.
- **Structure Backlog** – The monetary value of work required to close the gap between the actual performance provided by an asset and the current required performance.

1.3 Implementation of Highway Structure Performance Measures

Performance Measures have been developed and implemented in many Government sectors (Health, Education, Social Services) and also for roads (through the UKPMS and HAPMS systems). Experience from these sectors has shown that implementation of Performance Measures raises many issues that need to be widely discussed. As such, this set of Performance Indicators has gone through an extensive trialling and consultation period, and amendments have been made based on the feedback received.

It is envisaged that authorities will adopt this set of Performance Indicators, along side their local measures, and embed them within their asset management practices, as set out in the Code of Practice (Ref. 1).

1.4 Performance Measures and Performance Indicators

The terms *Performance Measure* and *Performance Indicator* are used in accordance with the definitions provided in the Government paper *A Framework for Performance Information* (Ref. 2). *Performance Measure* is the generic term used to cover both *Measures* and *Indicators* and these are in turn defined as:

- **Performance Measure** – measuring performance against a robust scale.
- **Performance Indicator** – a proxy used when it is not feasible to develop a clear and simple measure.

1.5 Background

Highway structures represent a significant publicly owned asset that form an integral part of the transport infrastructure and often form prominent features of the community and its heritage. Adopting the principles of Asset Management is fundamental to the effective long-term management and preservation of these assets (Ref. 1). The need to develop tools and procedures to support effective Asset Management of highway structures is widely recognised.

In 2000 the CSS report, Funding for Bridge Maintenance (Ref. 3), identified the need for a Bridge Condition Indicator that could be used to measure and monitor the condition of highway bridges. In April 2002 the CSS published Guidance Documents for Bridge Inspection Reporting (Ref. 4) and Evaluation of the Bridge Condition Indicator (BCI) (Ref. 5). However, it was widely recognised that the Condition Indicator alone would not be sufficient to measure the overall performance, or *fitness for purpose*, of a stock of highway structures and the performance of a highway authority in managing the structures stock.

In May 2002 the Highways Agency (HA) commissioned the development of a balanced set of Performance Measures for trunk road and motorway structures. The commission was subsequently extended to ensure the Performance Measures were also appropriate for use by Local Highway Authorities.

1.6 The Need for Performance Measures

In recent years there has been a growing awareness of the need for highway authorities to adopt a formal asset management approach, see the Code of Practice (Ref. 1) and the *Framework for Highway Asset Management* (Ref. 6). Performance measurement and monitoring are an integral and important component of good Asset Management.

Performance measurement plays a major role in influencing human behaviour, as "*what gets measured, gets done*", and therefore is seen as key to achieving significant improvements in performance. Performance measurement is a mechanism by which audit, review and improvement are achieved. These are fundamental elements of Asset Management and the Government's recent and

current initiatives (e.g. Best Value Legislation, Whole of Government Accounts and Gershon Efficiency) which seek to achieve continual improvement in performance through measurement, target setting and benchmarking.

By comparing Performance Measures against identified targets and goals, the strengths and weaknesses in performance can be identified. By monitoring the measures over time warnings of progressive degradation in performance can be identified so that corrective action can be taken at an early stage. Thus Performance Measures provide important inputs to the decision-making processes relating to management of existing assets.

1.7 Objectives of Highway Structure Performance Measures

Performance Measures for a structure stock should measure both the performance of the **structures management function** and the performance of the **structure stock** itself. The following are considered as the main objectives for developing Performance Measures for highway structures:

1. For external reporting (public, customer, Government) to demonstrate how well the organisation/authority is achieving its objectives with regard to structures management.

2. As part of the Modernising Government initiatives which aim to achieve continual improvement in the quality and efficiency of service delivery.

3. To provide feedback for planning and management control by identifying deteriorating trends in time to allow corrective action to be taken.

4. To compare current performance levels against target levels. Where the target levels are defined in accordance with the *Organisational Strategic Plan* and *Asset Management Plan* (see Ref. 1 for definitions of these).

5. To inform business planning and funding allocations to different functions, routes, groups of structures by type and/or geographical area; and

6. To provide a mechanism for reviewing, auditing and identifying areas for improvement at an operational level.

1.8 Interpreting Performance Measures

This Guidance Document describes four Performance Measures (Condition, Availability, Reliability and Backlog). These measures must **not** be used in isolation for decision making and/or external reporting because individually they do not capture the full performance and functionality (or *fitness for purpose*) of a structure stock.

Formal relationships between the different Performance Measures have not been developed. It is the responsibility of the bridge manager to understand, through the guidance provided, the criteria included in each Performance Measure and therefore appreciate how a change in one measure may, or may not, be reflected in the other Performance Measures.

1.9 Scope

The performance measurement Guidance Document, Parts A, B and C, is intended to:

1. Cover the main highway structure types of bridges, larger and small culverts, retaining walls, road tunnels, sign/signal gantries and high masts.

2. Recommend consistent procedures for the evaluation of highway structure Performance Measures (Condition, Availability, Reliability and Structures Backlog).

3. Provide Performance Measures that can be readily adopted and implemented by all authorities with minimal additional data collection.

4. Provide Performance Measures that are meaningful and beneficial to engineers and managers at *Operational*, *Tactical* and *Strategic* management levels.

1.10 Terminology

The following terminology is used in the performance measurement guidance documents:

- **Authority** – refers to any authority or organisation that owns/manages highway structures.

- **Tactical Sets** – groups of structures defined by similar characteristics e.g. structural form, material type, network corridor etc. The Performance Measures for Tactical Sets inform decision making (e.g. funding allocations) at the *Tactical* planning level of Asset Management.

2. Performance Measurement Framework

2.1 General

Experience of using performance measurement in different sectors has shown that, to be successful, the Performance Measures should be clearly linked to the strategic objectives of an organisation. This ensures that the effort is focused on *what really matters* and allows the organisation to demonstrate how well it is meeting its objectives. At the same time it is important to ensure that the chosen Performance Measures form a balanced set covering all the different dimensions of an organisation's function. Otherwise, effort may be focused on those aspects that are being measured and there is a danger that the remaining functions would be overlooked. In this context, the Government paper, *A Framework for Performance Information* (Ref. 2), provides guidance on the criteria and dimensions that should be considered when developing Performance Measures, some of the important considerations are summarised in Table 1.

Table 1 Dimensions for a Performance Measurement Framework

Dimension	Description
Strategic Objectives	Why the service exists and what it seeks to achieve?
Cost/Efficiency	The resources committed to the service and the efficiency with which they are turned into outputs.
Service Delivery Outcomes	How well the service is being operated in order to achieve the strategic objectives?
Quality	The quality of the service delivered, explicitly reflecting users' experience of service.
Fair Access	Ease and equality of access to services.

Apart from this high level government advice (Ref. 2) it has largely been left to the individual sectors (Health, Social Services, Education, Transport etc.) to develop and implement Performance Measures that best reflect the services they provide. It is therefore the responsibility of highway structure engineers to:

1. Identify appropriate Performance Measures for highway structures.

2. Develop the performance measurement procedures and provide guidance on how to evaluate them.

3. Describe a procedure for Performance Measure target setting.

4. Describe the Performance Management System, i.e. the process by which the information on measures should be collated and used for audit, review and continual improvement. The Performance Management System should clearly define the roles, responsibilities and procedures involved.

Important: This commission included consultation and discussions to identify the Performance Measures (point 1 above) and the development of a *Guidance Documents* (point 2 above). This document does not address points 3 and 4 above.

2.2 Performance Measurement Framework for Highway Structures

A questionnaire survey was carried out (in 2002) to determine the most important objectives and strategic functions of a wide range of UK highway authorities with regard to the management of a structures stock. Based on the feedback received and further discussions with the Steering Group and the Consultation Group, a balanced set of six Performance Measures was identified as below:

1. *Condition* as a function of severity and extent of damage. This implicitly measures aesthetics and durability and the potential impact on reliability.

2. *Availability* of the structure for use by traffic.

3. *Reliability* of the structure in supporting the traffic loading taking into account the consequences of failure.

4. *Maintenance Backlog* with a view to providing sustainable programmes of work and minimising whole life costs.

5. *Asset Value* as a function of gross replacement cost, depreciation and impairment to identify if maintenance and renewal are preserving, and if appropriate enhancing, the asset base for future generations.

6. *Cost Efficiency* in delivering maintenance and renewal work.

The framework for the six Performance Measures is shown in Figure 1. The first three (Condition, Availability and Reliability) measure the performance, or health, of the **structures stock** while the latter three (Backlog, Asset Value and Efficiency) measure the stewardship and effectiveness of the highway authority in **managing the structure stock**.

In view of the constraints on this commission and the priorities identified from the Questionnaire Survey; the Steering Group and Consultation Group decided that the following four Performance Measures should be developed as a priority under this commission:

1. Condition Performance Indicator (Ref. 1) - building upon the earlier CSS BCI work (Ref. 4 and 5).

2. Availability Performance Indicator

3. Reliability Performance Indicator

4. Structures Backlog

Guidance on Asset Valuation for highway structures can be found in the Guidance Document for Highway Infrastructure Asset Valuation (Ref. 7). At the time of publication of this document no work has been commissioned on a Cost Efficiency performance measure for highway structures.

It is proposed (in Figure 1) that the Condition and Availability PIs are reported externally because they deal with more readily understood criteria. However, the Reliability PI should not be reported externally because it is an engineering concept and may be misinterpreted by the general public.

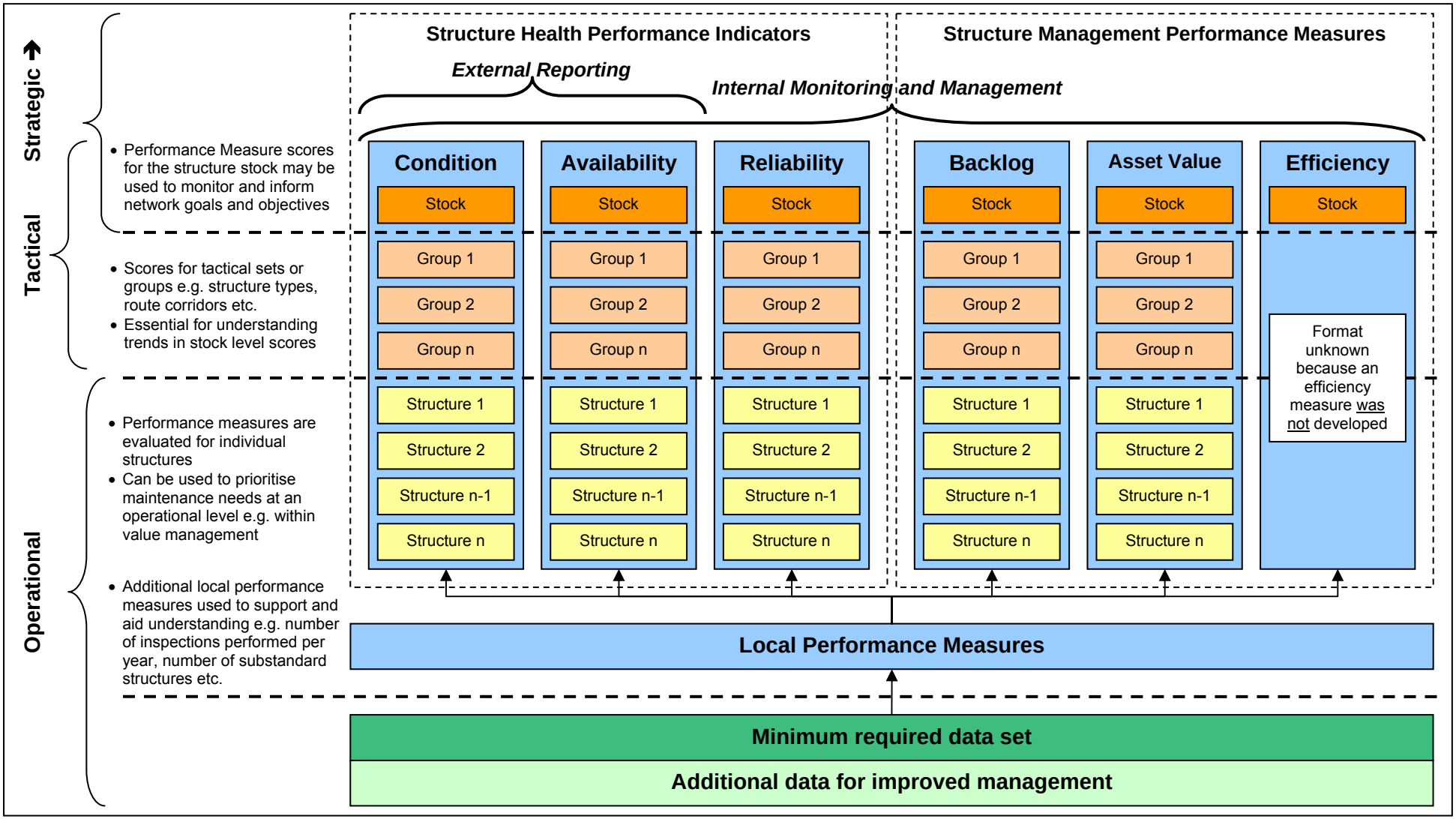

Figure 1 Performance Measurement Framework

3. Performance Measure Information

3.1 General

This section provides an overview of:

1. The boundary/assessment criteria that are used consistently in the performance measurement framework i.e.:
    a. Structure Types (Section 3.2)
    b. Route Types (Section 3.3)
    c. Vehicle Types (Section 3.4)
2. The Performance Indicator scale (Section 3.5).

3.2 Structure Types

The Performance Measures should be applied to all appropriate structure types on an authority's network. Guidance is provided in Parts B1, B2 and B3 on the structures that should be included, however authorities are recommended to check this guidance against the scope of their highway structures stock. As a minimum the structure types covered by the Performance Measures should include.

- Bridges, buried structures, subway underpasses, culverts and any other similar structures
- Sign and/or signal gantries
- High masts
- Tunnels

Suitable definitions for these structures types, and others, are provided in the Code of Practice (Ref. 1), BD62 (Ref. 8) and BD63 (Ref: 9).

3.3 Route Types

The route type hierarchy used by the Performance Measures is shown in Table 2. The Route Types enable a refined, but not overly complex, level of assessment in the performance measurement procedures.

Table 2 Route Types

Route Types
Motorway
Primary A
Other Principal Roads
Classified B and C
Unclassified U
Non-vehicular routes

3.4 Vehicle Types

The vehicle type categories defined in DMRB (Ref. 10) were used to analyse traffic. The characteristics of each vehicle type category were used to establish the economic and social impact of different restrictions types. The six vehicle categories used in the development of the performance measurement procedures were:

1. Cars
2. Light Goods Vehicles (LGV)
3. Other Goods Vehicle 1 (OGV1)
4. Other Good Vehicles 2 (OGV2)
5. Buses and coaches (PSV)
6. Emergency Vehicles (EV).

3.5 Scale for Performance Indicator Reporting

The scale for the Condition, Availability and Reliability Performance Indicators is 0 (worst performance score) to 100 (best performance score), whereas the Structures Backlog is a monetary value of the work identified on the structures stock.

The 0 to 100 scale is subdivided into six bands for ease of understanding. The six bands can be broadly interpreted as shown in Table 3.

Table 3 Performance Categories

PI Score	Generic Category Description
90 ≤ x ≤ 100	**Very Good** performance
80 ≤ x < 90	**Good** performance
65 ≤ x < 80	**Fair** performance
40 ≤ x < 65	**Poor** performance
0 ≤ x < 40	**Very Poor** performance

More detailed interpretations for each Performance Indicator are provided in the relevant part of the Guidance Document.

4. Using Performance Measures

4.1 General

Performance measures may be used to support bridge managers/engineers in a number of different ways (some of which are discussed below). For all of these the bridge manager should seek to adopt and maintain a standardised format of reporting (i.e. graphs, statistics), thereby enabling easy comparison of values from year to year.

Examples of where the highway structure Performance Measures may be used include:

1. External and internal reporting - an authority should give careful consideration as to whether or not external reporting of Performance Measures for highway structures is required, and if so who should they be reported to, e.g. all stakeholders or only those stakeholders that require or have requested them,

2. Supporting funding bids and forward work planning, i.e. Spending Reviews, Local Transport Plan or Local Implementation Plans, Asset Management Plans etc (see Section 4.2)

3. Supporting management decisions (see Section 4.3).

4.2 Supporting Funding Bids

Many authorities are required to submit bids for funding that cover the next 3 to 5 year period. The bid submission should include up-to-date Performance Measure scores that accurately reflect the current status of the stock.

It is likely that the Authority's Annual Report and/or Business Plans will only include a small number of high level scores for highway structure Performance Measures. This is to be expected given the wide range of assets and services many authorities own and manage. However, in funding/bidding submissions (e.g. Asset management Plans) more effective use should be made of the Performance Measures; in particular the high level scores should be supported by:

1. Scores for tactical sets of structures, e.g. structural type, construction form, material type, location, route etc.
2. Histograms to demonstrate the spread of scores within the stock.
3. Simple statistics to illustrate the percentage of structures in each performance category, i.e. Very Good, Good, Fair, Poor, Very Poor and Severe.
4. Projections/estimates of the impact of reduced funding levels on future Performance Measure scores.

4.3 Supporting Management Decisions

Chapter 3 of the Code of Practice (Ref. 1) sets out an asset management approach for highway structures. This includes a description of the role of Performance Measures, and how they help to link together the *Strategic*, *Tactical* and *Operational* management levels. The Performance Measures can be used to provide vital

information for business planning and management control at these three management levels within an organisation. Figure 2 provides an example of how the Performance Measures may be used to support decision making.

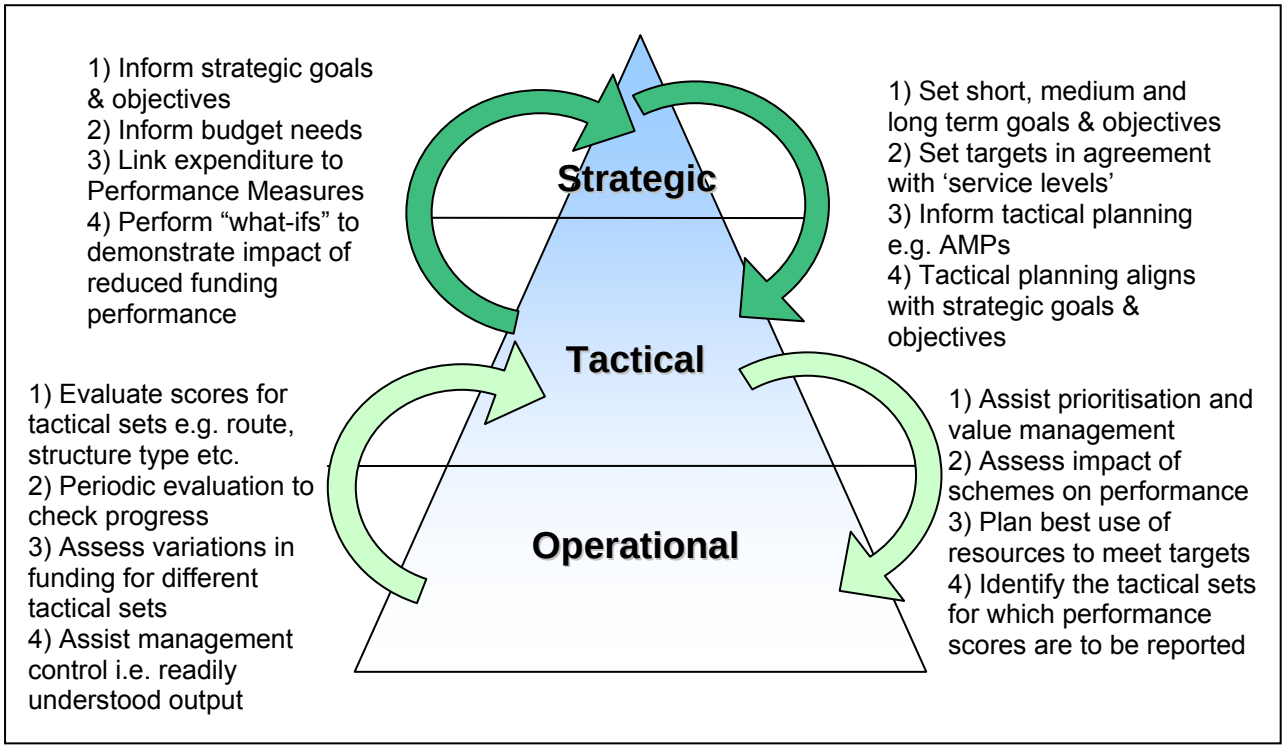

Figure 2 Performance Measurement in Structures Management

5. Implementing Performance Measures

5.1 Resource Requirements

When implementing Performance Measures an authority needs to give full consideration to the resources required. The main areas that require resource input from the authority are:

1. Data collection:
   a. Regular/cyclic data collection, e.g. General and Principal Inspections.
   b. One off data collection exercises, e.g. geometry, obstacle crossed, road carried, assessed capacity/rating etc.
2. Data entry onto a computerised system, e.g. the resources required to enter data onto an appropriate computerised system. This may include the transfer of data from paper records or from another computerised system.
3. Data management - reviewing, auditing and updating when changes to data occur, e.g. maintenance, renewal, new build, change of ownership etc.
4. Software Systems – development or purchase of appropriate software systems that assist the evaluation, analysis and manipulation of the Performance Measures and their associated data.
5. Training – in order to effectively implement and use the Performance Measures an authority's staff may require training to fully understand the measures, manage the data requirements, produce reports and link them into the management process.

It is recommended that an authority gives due consideration to implementing the above, where appropriate, as part of the evolving Asset Management practices. The associated resource requirements should be presented in the structures Asset Management Plan.

5.2 Data Requirements

The essential data required for each Performance Measure are described in Parts B1, B2, B3 and C respectively. A significant proportion of the data requirements overlap with existing data held by authorities, however if an authority identifies that a significant data collection exercise is required then they should consider:

1. A dedicated one off data collection exercise; or
2. Additional data item/s collected during General or Principal Inspections.

Where possible, an authority should give due consideration to other data requirements when compiling Performance Measure data, e.g. Asset Valuation, Risk Assessment and Management and Asset Management Plans (AMPs).

5.3 Software Systems

The ever increasing need to justify and demonstrate the benefit of highway structure expenditure has necessitated the development of a number of management tools and processes, e.g. Performance Measures, Asset Valuation, Risk Assessment, Prioritisation Systems, AMPs etc.

The large number of management tools that will become available over the next 2 to 3 years, and the associated pressures on structure owners and managers to make effective use of them, means it is essential that appropriate support software is developed, implemented and used. It is recommended that an authority considers their current situation and assess where they will need to be in the next 2 to 3 years to meet Government requirements and Asset Management needs. It is the responsibility of all authorities to fully investigate their software support options e.g.:

- Develop a bespoke system or purchase an off-the-shelf commercial package.
- Have a stand alone highway structures package, an integrated highways package or an authority wide package.
- The demands of the stock size, i.e. can expensive software packages be justified for smaller authorities.
- Joining up with other authorities to reduce the individual cost and/or risk of developing or purchasing software systems.

The Code of Practice (Ref. 1) provides further guidance on the requirements of a Bridge Management System.

6. References

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