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Specification for Rural Road Asset Management Performance

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Acronyms/Abbreviations

AFCAP - Africa Community Access Programme

CVI - Coarse Visual Inspection

IQL -- Information quality level

IRAP - Integrated Rural Accessibility Planning

ORN - Overseas Road Note

PAS - Publically Available Specification

RAI – Rural Access Index

SSA - Sub Saharan Africa

URCI – Un-surfaced Road Condition Index

Table of Contents

Abstract

In the 1990s a number of countries within Sub-Saharan Africa (SSA), encouraged by donor organizations, introduced various road sector reforms including the development of road funds and semi-autonomous road authorities (Heggie and Vickers, 1998). Despite significant challenges, the reforms are regarded as being at least partially successful in the recognition of the benefits of commercial management practices, reducing under-funding of maintenance, partial arrest of declines in the quality of road networks and, the efficiency and effectiveness of road management services (Pinard, 2012).

The benefits of the reforms however, have been almost exclusively associated with strategic road networks. Far less progress has been made with respect to rural road networks, where the benefits from investment are less tangible but still significant. This can be attributed to a number of interrelated reasons including political factors (e.g. preference for new construction over maintenance), insufficient road maintenance budgets, lack of a maintenance culture, institutional arrangements, lack of a suitable means of motivating a strong case for funds for maintenance and ineffective rural road asset management.

To address this, the Africa Community Access Programme (AFCAP) is funding a major research and capacity building project to achieve economic and social benefits for local communities in rural areas through improved road asset management. This will incorporate a structured process, which utilizes peer review, so that meaningful advances in road asset management can be locally driven and improvement in rural road network performance realised. Part of this project is to develop a road administration specification which can be used as a self-assessment tool by rural road administrations. The objective of this paper is to describe a draft of one aspect of this specification, namely that associated with road asset management, so that that stakeholders and practitioners can comment on its practicality and usefulness. The specification incorporates road asset management performance criteria developed by a panel of experts utilizing guidelines suggested in various documents including BSI ISO 55000 (2014) and the International Infrastructure Management Manual (IAMM, 2011). The performance criteria are associated with: sectoral efficiency; institutional effectiveness; life cycle processes; asset management support systems; data; asset management plans; and maintenance benefit outcomes and; network condition. For a

road administration, each performance criterion can be compared against a benchmark to target improvements in asset management. The relevance of the proposed approach to SSA countries will be tested during a conference workshop and thereafter further developed to include measures associated with all four building blocks of commercialised road management.

1 Introduction

The importance of road maintenance for economic and social development, as well as for the preservation of investment in road infrastructure, has been recognized for over 40 years (Heggie and Vickers, 1998). Nevertheless most road administrations worldwide continue to under-invest in road maintenance. Recognising this to be a significant barrier to poverty reduction in many countries, policy in the 1990s within Sub-Saharan Africa (SSA), driven by donor organizations and others, gradually introduced a commercialized approach to road management. This resulted in major road sector reforms including the development of road funds and semi-autonomous road authorities (Heggie and Vickers, 1998). Although there have been significant challenges, the reforms where they have taken place, are regarded as being at least partially successful in amongst other aspects: the recognition of the benefits of commercial management practices; reducing under-funding of maintenance; partial arrest of declines in the quality of trunk road networks, and; the efficiency and effectiveness of the road management services provided by road authorities (Pinard, 2012).

Nevertheless the benefits from the road sectors reforms in SSA, where they have accrued, have been almost exclusively associated with strategic road networks. Far less progress has been made with respect to rural road networks, where the benefits from investment in maintenance are less tangible but equally significant. This can be attributed to a number of reasons including political preference for new construction over maintenance, insufficient road maintenance budgets, the lack of a suitable means of motivating a strong case arguing for funds for rural maintenance where social benefits are significant, institutional memory loss, inappropriate institutional arrangements and ineffective rural road asset management practices.

1.1 Objectives

To address the lack of progress in the management of rural roads in SSA, the Africa Community Access Programme (AFCAP) is funding a major research and capacity building project to achieve economic and social benefits for local communities in rural areas through improved road management. This will incorporate a structured process, which utilizes peer review, so that meaningful and measureable improvements in road management can be locally driven and improvement in rural road network performance can be realised.

A part of the project is to develop a framework for road administration performance measurement which can be used by SSA rural road administrations to undertake a self assessment of their capacity and performance with respect to the rural road infrastructure.

This paper addresses one component of the framework, namely the development of a performance specification for rural road asset management.

2 Road administration performance

It is recognised that the development and performance of road administrations are on inter-dependent external factors, internal institutional arrangements and the capacity of the organisation (Brooks et al., 1989; Robinson, 2008, and Pinard et al, These are summarised in

Table 1. Brooks et al. (1989), in a study of institutional development of several road organisations, found that performance in one of these areas cannot be wholly effective without adequate performance in the others. Their study postulated that the inability to sustain advances in road management practices in the road administrations they considered, can be associated with an over emphasis of improving technical capability without due consideration of the requirements of the supporting institutional capability and the external environment.

Table 1: External and Internal Factors affecting road administration performance (Robinson, 2008)

Factor	Components
Technical: ability to undertake physical or engineering activities	• Availability and use of data and systems, materials and supplies, plant and equipment • Capability to undertake required technical operations • Controls and audit • Access to research and information
Institutional: organisational and managerial arrangements, finance, human resources	• Powers of the administration, mission and objectives, roes of staff • Finance and resource management • Organisation and management (including the implementation of policy, organizational and administrative structures, strategic planning, programing and project preparation, and the management of on-going operations, stakeholders and suppliers) • Human resources, including the size & composition of the work force, training and career development, remuneration and incentives.
External: factors which the organisation has no direct control over, but which may constrain the way in which the organisation operates.	• Physical environment • Legal and regulatory framework • Socio-cultural background of the human environment in which the organisation operates • Macro economy and national resources available • Government employment policies • Relationships with other institutions

Brooks et al. (1989) suggested that a hierarchical relationship (see Figure 1) could be developed linking the three inter-dependent factors. Accordingly, they advocated that the foundation of administration's ability to make sustainable improvements to road management is associated with the external factors, which need to be addressed adequately before institutional arrangements are dealt with satisfactorily, and these in-turn need to be sufficient before technical capability is developed. Pinard et al. (2016) proposes the decomposition of these building blocks further and argues that the political environment is a particularly strong influential factor in the SSA region.

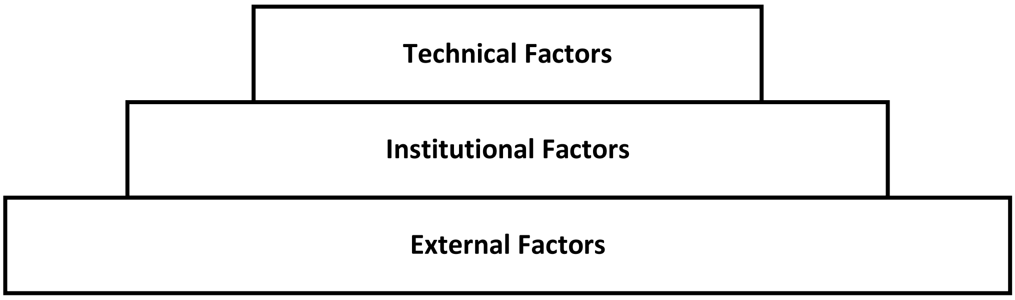

Figure 1: Brooks pyramid of factors affecting road organizational change (Robinson, 2012)

3 Commercialised road management

The commericalised road management approach first proposed by Heggie and Vickers (1998) and adopted by a number of countries within SSA proposes four main building blocks to ensure sound management and stable financing of roads.

These building blocks are (Heggie and Vickers, 1998):

- Assigning responsibility
- Creating ownership
- Ensuring secure and stable financing
- Introducing sound business practices

Although there have been significant challenges in introducing commercialisation practices to the road sector in SSA, the process has been considered to be beneficial in for the trunk road networks in many countries, through (Pinard, 2012):

1. Reducing under-funding of maintenance
2. Arresting partially declines in the quality of trunk road networks
3. Improving the efficiency and effectiveness of the road management services provided by road authorities.

The specification for rural road administration performance developed as part of the research programme mentioned herein builds on work described by Pinard (2012 and 2015) and Pinard et al. (2016), which formulated a road commercialisation management assessment methodology based on Heggie and Vickers approach (1998). This specification also utilizes asset management performance based guidelines suggested in BSI ISO 55000: Asset Management Series (2014) and its predecessor PAS 55-1/2 (2008).

This paper describes one part of the specification, namely a framework which can be used to assess road administration performance with respect to asset management as part of a sound business approach (cf. building block 4 above).

4 Road asset management

4.1 Methodology

The proposed framework for assessing asset management is based on BSI ISO 55000 (2014) and IAMM (2011), suitably refined so that the associated measures of performance are appropriate to the rural roads context. These measures of performance are to do with:

- Life cycle processes
- Information systems used to support asset management
- Data requirement for informed decisions
- Asset management plans
- Organisational / human resource issues
- Benefit outcomes from maintenance, including measures of maintenance performance.

The robustness of the overall framework and its relevance to SSA countries will be further tested during a workshop to be held at the conference, using appropriate structured communication techniques. The findings from the workshop will be used to refine further the rural road management specification to meet the needs of local rural road authorities.

4.2 Road asset management definitions

A variety of organisations have defined asset management in general and road asset management in particular. Two useful ones for the consideration of a rural road asset management specification are those given by the British Standards Institution in its

Publically Available Specification (PAS 55) (BSI, 2004) on the management of all types of asset, and that defined in the International Asset Management Manual (IAMM, 2011).

PAS 55 defines asset management as (BSI, 2004):

“Systematic and co-ordinated activities and practices through which an organisation optimally manages its physical assets, and their associated performance, risk and expenditures over their life-cycle for the purposes of achieving its organisational strategic plan.”

Accordingly PAS 55 describes a holistic approach which recognises the linkages between asset management activities and practices, the performance of the assets and the strategic plan of the organisation (e.g. the road administration).

IAMM (2011) also recognises the need to associate asset management with performance and business practices, but perhaps gives more emphasis to the stakeholder and considers sustainability in its description of the objective of asset management:

“The objective of asset management is to meet a required level of service, in the most cost effective manner, through the management of the asset for present and future customers”.

From these definitions it is clear that a road asset management specification needs to consider

- The policy of the road administration (which in turn should consider government policy), customer needs through defined levels of service for road assets
- The resources (physical and human), processes and tools required (and available) to monitor and meet these levels of service, and
- Mechanisms for planning for the future and dealing with unexpected impacts on the road infrastructure.

4.3 Basic and advanced asset management

Road asset management can be considered in terms of basic and advanced activities. Basic road asset management is associated with meeting minimum statutory obligations and organisational requirements for financial planning and reporting and requires (Robinson, 2008):

- Identifying levels of service (which should be linked to policy)
- Predicting demand (i.e. levels of non vehicular and vehicular traffic and associated axle loads)
- Assessing condition and monitoring performance
- Maintenance and its management
- Financial management
- Preparing an asset management plan (for incremental improvement)

Advanced asset management builds on basic asset management and aims to optimise activities and programmes to realise levels of service. The advanced approach therefore requires a refined approach which incorporates a more sophisticated analysis of current and future asset condition and performance, considering total transport life-cycle costs, customer expectations, the environment, current and future demand, risks, treatment options and asset value among others. Accordingly, advanced asset management may be seen to require more detailed datasets with a higher degree of granularity than basic asset management. In addition to the basic requirements mentioned above, advance asset management also requires (IAMM, 2011 and Robinson, 2008):

- Failure mode analysis
- Risk assessment and management
- Demand management
- Optimised decision making (including consideration of social, political, environmental and economic costs)
- Valuation

For rural road asset management it may be considered sufficient for a road administration to seek to achieve some level of basic asset management since the costs required to achieve higher levels of asset management may not be warranted nor the funds available.

4.4 Asset management and business processes

Rural road asset management considers the physical road infrastructure and it therefore needs to be framed within the context of the road administration's wider activities (see above). It should support and be consistent with the administration's management systems for human, knowledge, financial and intangible resources. Road asset management policies and strategies for rural roads should therefore be a holistic component of the administration's corporate policies and strategies.

Accordingly, rural road asset management should be fully integrated within the road administration's management activities and should provide a mechanism for realising the administration's goals in the context of rural road infrastructure (Robinson, 2008).

4.5 Three levels of road asset management

Road asset management can be seen to operate at three levels (Robinson, 2008):

- Strategic (planning)
- Tactical (programming) and,
- Operational (preparation and operations management).

Figure 2 shows how a road administration's policy and strategy can be realised at the three levels of management, together with:

- The associated management activities
- The information systems that may be used to support these activities
- The associated data requirements and,
- The physical works and other operational activities which realise the management aspects.

4.5.1 Strategic level management

At the strategic level of management the road administration's vision and mission are expressed in the corporate plan as part of strategic planning activities. These can be supported by strategic, or network level, planning tools which utilize summary data to determine, for example, current and future funding requirements to achieve the administration's vision associated with its road infrastructure.

4.5.2 Tactical level management

Vision and mission statements need to be translated to objectives and performance indicators at the tactical level of management and are expressed via a business plan. The associated road asset management activities can be supported using network to project level tools, using data at an appropriate level, which help to manage the process of ensuring that strategic targets for road network performance are realised at the operational level.

A useful means, used herein, to select the appropriate level of data detail to be used for road management is the World Bank's concept of Information quality levels (IQLs) (Patterson and Scullion, 1990). The concept is described further below[ii].

4.5.3 Operational level management

In terms of policy, operational management is associated with defining standards and intervention levels for road asset condition. Strategies are developed, by using these to assess road asset condition at the project level via an operational plan supported by project level management tools which make use of detailed comprehensive data sets to plan physical maintenance, renewal and development work activities.

5 The specification

IAMM (2011) defines 17 asset management activities which considered together enable holistic asset management. For each management activity IAMM (2011) introduces the concept of a Maturity Index by which an organisation's level of asset management can be assessed according to one of four levels, "minimum", "core", "intermediate (defined as "mature" herein) and "advanced". The maturity index, taking into consideration the definitions of basic and advance road asset management above, has been refined herein and used as a framework to develop a tailored specification for rural road asset management. The guidelines described in IAMM (2011) have been adapted for rural roads using a variety of sources including three Overseas Road Notes (ORNs), namely ORN 1 (TRRL, 1987), ORN 7 (TRL, 1988) and ORN 20 (TRL, 2003). Other references used for this purpose include Robinson (2008), and Eaton and Beaucham (1992). The framework is presented in Table 2 below. All four levels of maturity are shown in Table 2, however it is likely that a rural road administration could reasonably be expected to reach the "core" level. A number of activities defined in IAMM (2011) have not been included for simplification.

Various terminologies have been used in

Table 1 and these have been explained via notes in the text following Table 2.

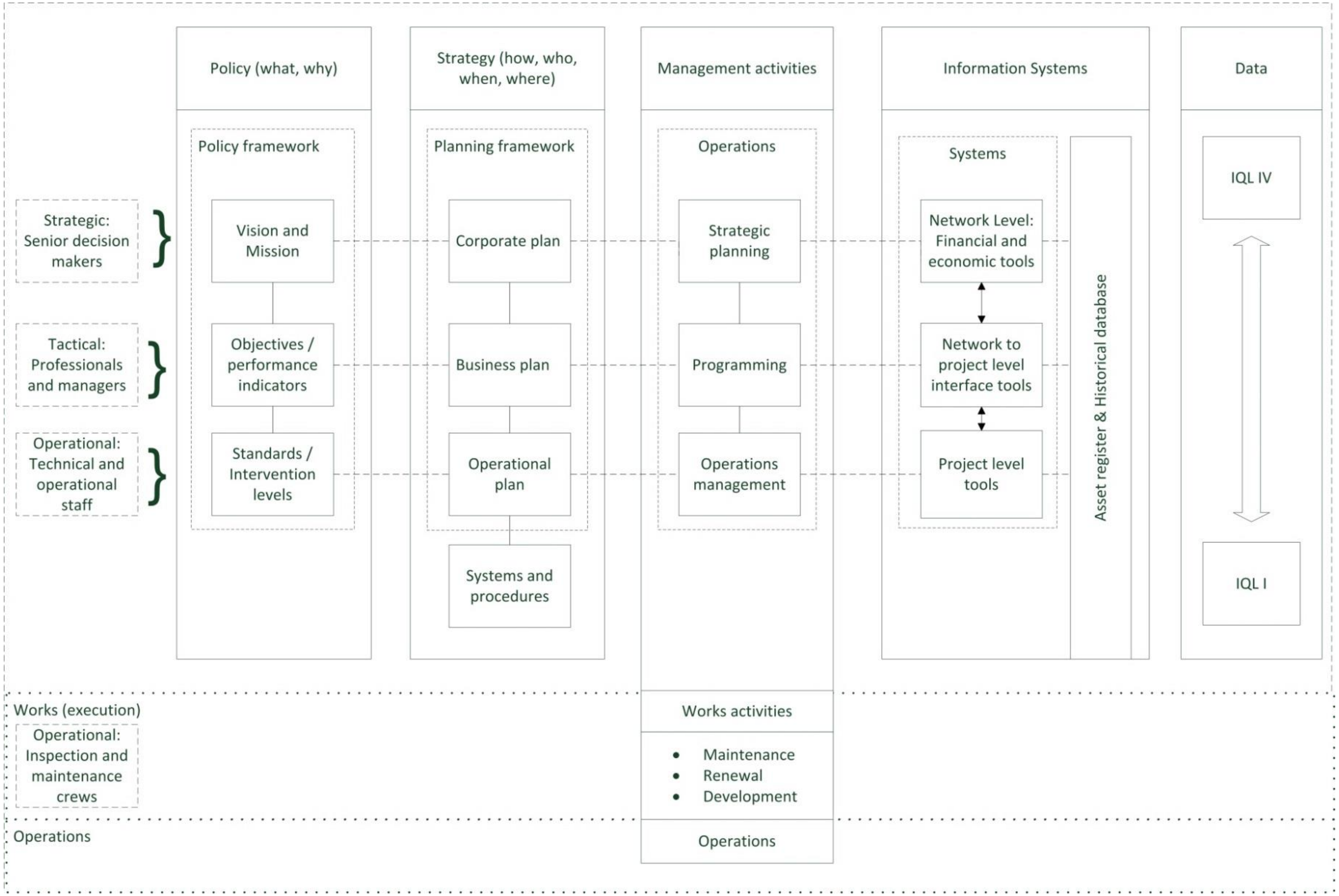

Figure 2: Road asset management framework (adapted from Robinson, 2008)

Table 2: Rural Road Asset Management Specification (adapted from IAMM, 2011)

		Level of maturity			
Item (IAMM refn). [1]	**Component**	**Minimum**	**Core**	**Mature**	**Advanced**
1 (2.1)	**AM Policy Development**	Informal expression of road administration expectations regarding Asset Management (AM) Policy	Defined policy statements for all significant AM activities including: Operations, maintenance (incl. inspections), renewal, development (constructions) and disposal (decommissioning). Clear linkages to road administration goals Policy supported by high level action plans with defined responsibilities for delivery.	AM Policy and Strategy reviewed and adopted annually by an executive team. Expectations of each activity area defined with detailed action plans, resources, responsibilities and time frames.	AM Policy and Strategy fully integrated into the road organisation's business processes and subject to annual audit, review and updating procedures.
2 (2.2)	**Levels of service and performance management**	Contribution of the road network to road administration's objectives defined. Basic levels of service with respect to World Bank's Rural Access Index (RAI)[i] have been defined. Data collected and used at Information Quality Level (IQL) IV[ii]	Customers defined and requirements informally understood Levels of service and associated performance measures for: RAI Road Condition Index RCI (for engineered earth, gravel and sealed roads; e.g. % of roads above a threshold) (See item 5) Annual reporting against performance targets for RAI and RCI (Data collected and used at IQL III)	Customers' needs analysed Costs to deliver alternative key levels of service assessed. Customers are consulted on RAI and RCI levels of service and options.	Levels of service consultation strategy developed and implemented. Technical and customer levels of service are integral to decision making and business planning.
3 (2.3)	**Demand Forecasting**	Basic forecast of traffic demand (vehicles per day) on a route basis (i.e. roads between centres of population), based on a moving-observer count method measuring traffic, experienced staff predictions, with consideration of known past demand trends and likely future growth patterns. IQL IV	Traffic demand to be broken down in terms of heavy vehicles/ non-heavy vehicles. Forecasts based on traffic counts carried out within the last 5 years and on robust projection of a primary demand factor (e.g. GDP, changes in land use). Data collected and used at IQL III	Traffic demand forecasts on a section basis and based on mathematical analysis of historical trends and primary demand factors (country GDP and significant changes in land use within road catchment). data collected and used at IQL II	As for "mature" plus risk assessment of different demand scenarios. Data collected and used at IQL I
4 (2.4)	**Asset Register Data**	Basic road inventory system consisting of: Basic network referencing system based on the basis of routes (i.e.	As for Minimum plus: Referencing system has greater granularity on the basis of carriageway sections which have homogenous characteristics (1 km	As for Core plus: Referencing system based on sub-sections (homogenous sections of 200 m lengths) Item inventory records soil, gravel and	As for Core plus: GPS based referencing system. Probabilistic deterioration models for carriageway, bridges and culverts.

[1] IAMM – Reference to relevant section in the Infrastructure Asset Management Manual (IAMM, 2011)

		length of road between centres of population, to the nearest km) Item inventory recording basic road surface type (earth, gravel or sealed) by Route and length within each Route(to nearest km) Number and location of bridges (referenced in terms of the Route) Information stored in a spreadsheet May be based on broad assumptions or incomplete data (data reliability "D", see [iii]). The concept of data confidence[iii] (reliability and accuracy) has been developed and is used to classify data. IQL IV data	lengths) with respect to traffic, construction type (earth, gravel, sealed), environment (rainfall, vertical profile) Road classification system in place (e.g. A, B, E roads) Expected service life of basic asset types known (to the nearest year) Replacement cost of principal assets known (carriageway (including shoulders), bridges, culverts, drains) Data collected and used at IQL III	seal types (e.g. cinder gravel, Otta seal). Established system of systematic and documented road condition data collection in place for all principal assets (see Item 5) on a sub-section basis. Traffic survey on the basis of Routes every 5 yrs, updated as described in Item 3. High level of confidence in inventory and condition data for principal assets (carriageway, bridges, culverts, drains) data Data to IQL II-III	Information on maintenance / renewal history (type and cost) / construction records Complete database for principal assets; minimal assumption for non-principal assets IQL I data
5 (2.5)	**Asset Condition Assessment**	Condition assessment at route level via visual inspection. Data reported in terms of good, fair, poor. Assessment required for carriageway and bridges Pavement strength to be inferred from visual assessment condition data. Senior / experienced staff judgement to decide good, fair and poor levels for each principal asset type Data collected and used at IQL IV	Condition assessment programme in place for principal assets (carriageway, shoulders, bridges, culverts, side drains) by homogenous Section asset group. Based on Coarse Visual Inspection (CVI)[iv], via windscreen survey in a slow moving vehicle for sealed roads. Unsealed Road Condition Index (URCI)[v] for engineered earth & gravel roads For gravel roads, gravel loss is estimated from historical records Summary pavement strength index (1 to 5) determined from construction records. Frequency of inspection determined as a function of road classification (see item 4). Assets to be ranked on a scale of 1 (= poor)	All inspections to be on a sub-section basis. Frequency of all surveys to be associated with road classification (see item 4). Windscreen survey of all earth and gravel roads following routine maintenance (visual survey at IQL-II/III) to determine condition as follows: Earth & gravel roads, as for "Core". For gravel roads, measurement of gravel loss Detailed Visual Inspection (DVI)[vi] of sealed roads. Carriageway deflection using non-destructive methods to determine summary data for individual pavement layers (via e.g. Falling Weight Deflectometer (FWD), Benkleman beam),	As for Mature, with the following modifications Earth and roads, as for "Mature" but also to include measurement of roughness (IRI) Sealed roads as for "Mature", but also to include roughness (IRI) and deflection measurements to obtain detailed data for individual pavement layers (FWD,). Frequency of condition measurement to be determined as a function of road class and pavement design life. In addition to general visual inspection of bridges and culverts, routine major inspections should take place every 3 years (or following floods). These should provide more detailed reports (IQL 1) of bridge and culvert condition.

			to 5 (= good). Ratings to be based on defined standards (e.g. ORN1 (TRL, 1987)). Data management standards and process documented. Programme for data improvement developed. Data collected and used at IQL III	or via field shear test (e.g. Cone Penetrometer) Inspection of shoulder condition (rating 1 to 5) Shoulder condition (rating of 1 to 5) Routine general visual inspection of bridges and culverts annually (following ORN 7 (TRL, 1988)) to determine provision of drainage/blockage, condition of surface, parapets, railings and guard rails, expansion joints (if they occur), main beams, girders, trusses and bracings, abutments, wing walls and retaining walls. Embankments and fill in front of embankments should also be inspected. Visual side drain integrity (rating 1 to 5). All inspection frequencies to be determined as a function of road classification or traffic. Data management processes fully integrated into business processes Data validation processes in place Data collected and used at IQL II-III	Reviews of programme suitability carried out every 3-5 years. Data collected and used at IQL I
6(3.1)	**Decision Making**	AM decisions based mainly on staff judgement and agreed road administration priorities	For major projects and programmes formal decision making techniques, based on multi-criteria analysis (i.e. consideration of economic, social and environmental costs and benefits) are used for: Upgrading the road network Carriageway reconstruction schemes	Formal decision making and prioritisation techniques are applied to all maintenance (see item 9) and capital principal asset programmes within each main budget category. Principal assumptions and estimates are tested for sensitivity to results	As for Mature, however the framework allows for maintenance, renewal and upgrading projects to be optimised across all activity areas. Formal risk based sensitivity analysis is carried out.
7(3.2)	**Operational Planning**	Operational responses to emergency related closure of roads or bridges resulting from traffics accidents or force majeure are understood by road administration staff, but plans may not be well documented and are mainly	As for basic. Emergency response plan is developed for closure of principal assets. Demand management is considered for road sections where overloading is a problem. The needs of stakeholders are considered in	Emergency response plan is updated every 3 years. Safety of infrastructure in relation to traffic assessed, including black spot analysis, remedial works design and layout and traffic management measures.	Operational plans analysed, tested and improved every 3 years. Formal debriefs to appropriate staff occur after severe damage to road (e.g. washout) or bridge (e.g. traffic strike)

		reactive in nature. Planning of day to day maintenance undertaken. Traffic is measured for some routes by is not routinely analysed.	scheduling of day to day maintenance activities. Asset utilization (traffic) is measured on a Section basis	Planning of day to day maintenance is optimised in terms of the availability and use of resources. Environmental impact of roads assessed including noise pollution and chemical pollution in surface water running from roads Asset utilization is measured for roads and bridges on a sub-section basis	Optimization of day to day planning of maintenance considers availability of resources and impacts on road users Asset utilization efficiency (traffic divided by capacity) is analysed annually for all principal assets. Road use costs are assessed and for a variety of road users Operational programmes are analysed using cost-benefit analysis techniques
8 (3.3)	**Maintenance Planning**	An understanding of how asset functions relate to organizational objectives. Compliant with legislation and regulations Maintenance records kept	Maintenance prioritized according to road classification and safety requirements Asset condition used to identify and prioritize maintenance of principal assets in danger of collapse (primarily bridges and culverts). Strategy for routine maintenance of assets established Earth & gravel roads (grading) Sealed roads (patching and crack sealing) Culverts (cleaning & debris removal) Side drains (cleaning & debris removal) Strategy for periodic maintenance of gravel (grading) & sealed roads (re-sealing) and bridges developed. Maintenance objectives with respect to principal assets established and measured	Periodic maintenance interventional levels for strengthening of sealed roads to be determined by cost benefit analysis as a function of traffic levels, construction type and environment (rainfall, longitudinal gradient) Maintenance prioritisation a function of traffic levels and weighted level of defectiveness Major failure modes of all principal assets understood Maintenance planning software implemented	Periodic maintenance interventional levels for gravel roads (regrading) and sealed roads (resealing) established by multi-criteria analysis , which considers economic, social and environmental costs and benefits, as a function of traffic levels, construction type and environment (see for example Integrated Rural Accessibility Planning[vii] in Road Note 20) Multi criteria analysis used to prioritise maintenance of principal assets Root cause analysis for major recurring faults in principal assets Procurement models fully explored
9 (3.4)	**Capital Works Planning**	Schedule of proposed capital projects (and costs) in place based on staff judgement of future requirements, taking into consideration government policy and political drivers.	Projects have been identified using information from a wide range of sources including operational staff, estimates of service lives (see item 4), traffic demand modelling and accident analysis (see item 7). Capital projects for the next 2-5 years are fully scoped and costs estimated	As for "Core", plus formal options analysis has been carried out for projects in the 3-5 year planning horizon. Major capital projects for the next 10 years identified and broad multi-criteria socio-political-economic benefit estimates have been carried out.	Long term capital investment programmes are developed using advanced decision making techniques.
10 (3.5)	**Financial and Funding Strategies**	10 year financial forecasts based on extrapolation of past trends and broad assumptions about the	10+ yr financial forecasts based on current Asset management plan (AMP) outputs	10+ yr financial forecasts based on current comprehensive AMPs with reasoned supporting assumptions	10+ yr financial forecasts based on current comprehensive advanced AMPs with detailed supporting assumptions

		future.	Significant assumptions are specific and well reasoned. Expenditure captured at a level suitable for strategic AM planning	Expenditure captured at a level suitable for tactical AM programming Financial modelling provides sensitivity analysis by principal homogenous asset group for expenditure as a function of the provision of level of service (RAI and ride quality (IRI))	and high confidence in accuracy Advance financial modelling provides sensitivity analysis, demonstrable whole life costing and cost analysis for level of service options (RAI and ride quality (IRI)).
11 (4.1)	**AM Teams**	AM allocated to one or two dedicated members of staff who have appropriate experience.	Coordination of different AM roles across the road administration occurs through a Steering Group or Committee (see Figure 1) AM training occurs for primary staff The executive team have considered options for AM functions and structures.	All staff in the organisation understand their roles in AM, it is defined in their job descriptions, and they receive appropriate training. Dedicated roles prescribed for strategic AM planning (senior decision makers), tactical AM planning (professionals and managers) and operational (technical & operational staff) (see Figure 2).	A formal AM capacity building programme is in place and routinely monitored. AM structure (see Figure 2) has been formally reviewed
12 (4.2)	**AM Plans**	Plan contains basic information on assets, service levels, planned works and financial forecasts (5-10 yrs and future improvements. Data collected and used at IQL IV	As for Minimum plus executive summary, description of services and principal assets, top down condition and performance description, future demand forecasts, description of AM processes; 10 year financial forecast, 2 year AM improvement plan Data collected and used at IQL III-IV	As for Core, plus analysis of asset condition and performance trends (past/ future), effective road user engagement in setting levels of service. Data collected and used at IQL II-III	As for Mature, plus evidence of programmes driven by comprehensive ODM techniques and level of service / cost trade off analysis. Improvement programmes largely complete with focus on ongoing maintenance of current practice. Data collected and used at IQL I-II
13 (4.3)	**Information Systems**	Asset register in place which can record core attributes of principal assets as described under item 4.1 Data to IQL IV	Asset register in place which can record attributes of principal assets as described under item 4.2 Road user request tracking and planned maintenance functionality enabled System enables manual reports for valuation, renewal forecasting Compatible with data to IQL III	More automated analysis reporting on a wider range of information including as described under item 4.3 Key operations, scheduled maintenance prioritised, backlog maintenance requirements, unplanned maintenance and condition and performance information held. Data collected and used at IQL II	Strategic planning, programming, preparation and operations management functionality fully integrated. Economic, financial, principal asset and road user service systems fully integrated all advanced AM functions are enabled.
14 (4.4)	**Service Delivery Mechanisms**	Service delivery roles clearly allocated (internal and external) generally following historic approaches.	As for basic plus .	Internal service level agreements in place with internal service providers. Contracting approaches reviewed to identify best delivery mechanism Tendering/ contracting policy in place Competitive tendering practices applied	All potential service delivery mechanisms reviewed and formal analysis carried out Risks, benefits and costs of various outsourcing options are considered, including contracting out of management and maintenance of roads.

6 Concluding remarks

A research project based in Sub-Saharan Africa, the initial stages of which have been described in this and a companion paper (Geddes and Gongera, 2016), is seeking to stimulate the improved asset management within rural road authorities in SSA. It is evident from past studies in the region, and elsewhere, that a number of factors need to be considered in order for rural road administrations to effect sustainable and effective change to their approaches to asset management. These may broadly be categorized into three inter-related areas, namely external factors, institutional arrangements and technical aspects. Commercialised road management, consisting of four elements associated with defining responsibility, ensuring ownership and promoting effective business practices, has been advocated as a means of providing an appropriate environment for such change (Heggie and Vickers, 1998; Pinard et al., 2016). This paper has described the development of a framework which can be used to measure the maturity of a rural road administration with respect to the later aspect, that of effective road asset management. By means of a workshop at this conference and wider stakeholder consultation the framework will be further refined and thereafter incorporated within a holistic approach which considers measures associated with all four building blocks of commercialised road management (see Pinard et al. (2016). Thereafter the approach and its benefits will be trialled in a number of rural road administrations within the region.

7 References

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Definitions of Terminology given in Table **2**

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[i] **Rural Access Index**

Rural Access Index (RAI) was developed by the World Bank and measures the rural population who live within 2 km (20-25 minutes of walking time) from an all season road as a proportion of the total rural population. It is designed to be a metric which demonstrates (and quantifies) the vital importance of access in poverty reduction, and was developed to inform policies and strategies so that development considers the needs, equitably, of the rural population (Roberts et al., 2004).

[ii] **Information Quality Levels**

The concept of Information quality levels (IQLs) was introduced by the World Bank to assist with determining the appropriate level of data detail to be used for road management. The IQL concept recognises that the level of data required for management depends on the management function for which it will be used. As the management process moves from strategic planning through programming and preparation to operations the resolution of the data required increases, albeit the extent of its network coverage decreases. Accordingly, the IQL concept defines the appropriate quality of the information that each management activity requires (Patterson and Scullion, 1990). Such an approach provides a framework for the collection and use of appropriate data in a consistent manner and helps to ensure that only the required amount of data is obtained to make appropriate decisions for a particular level of management (Robinson, 2008). Table 3 describes the four IQLs and the associated data collection characteristics.

Table 3: Information Quality Levels (after Robinson, 2008)

Information quality level (IQL)	Description	Data collection
IQL – I	• Most detailed and comprehensive • Mainly used for research programmes	• Short lengths or isolated samples measured using specialised equipment • Tends to be slow

IQL – II	• Detailed
	• Typically used for
	  o Project design
	  o Supervision
	  o testing
		• Limited lengths using semi-automated methods
		• Full network coverage is possible using advanced automation at high speed

IQL – III	• Summary details and categorised or aggregated values
	• Typically used for
	  ○ Programming and budget preparation
	  ○ Preliminary design
		• Full coverage of network using high-speed low-accuracy, semi-automated methods
		• Network sampled manually at slow speed
		• Processed from other data

IQL - IV	• Most summary coarse
	• Typically used for
	  ○ Strategic planning
	  ○ Network statistics
		• Full coverage of network using
		• Manual (windshield survey at medium speed
		• Low accuracy, semi automated methods
		• Processed form other data

[iii] **Data Confidence**

A data confidence grading system such as that described in the IAMM and shown in Table 4 can be used to describe data accuracy and confidence (IAMM, 2011).

Table 4: Information Quality Levels (IAMM, 2011)

Confidence Grade	Description
A Highly reliable	Data based on sound records, procedure, investigations and analysis, documented properly and recognised as the best method of assessment. Method of data capture fully repeatable and reproducible. Dataset complete and estimated to be accurate ±2%
B Reliable	Data based on sound records, procedure, investigations and analysis, documented properly but has minor shortcomings, for example some data is old, some documentation is missing and/or reliance is placed on unconfirmed reports or some extrapolation. Method(s) of data capture are repeatable and reproducible. Dataset is complete and estimated to be accurate ±25%
C. Uncertain	Data based on sound records, procedure, investigations and analysis which are incomplete or unsupported, or extrapolated from a limited sample for which grade A or grade b data are available. Dataset is substantially completed but up to 50% is extrapolated data and accuracy is estimated ±40%
D Very uncertain	Data based on unconfirmed verbal reports and/or cursory inspection and analysis. Datasets may not be fully complete and most data is estimated or extrapolated. Accuracy ±40%
E Unknown	None or very little data held.

[iv] **Coarse Visual Inspection (CVI)**

The Coarse Visual Inspection (CVI) is a UK Pavement Management System (UKPMS) defined inspection procedure for road pavement surfaces (UKPMS, 2008a). The procedure is designed to be undertaken from a slow moving vehicle and records visual information associated with the length defect edge defects, kerb defects, off-carriageway defects, longitudinal and transverse joint defectiveness (where appropriate), lane length defects carriageway, major cracking, rutting, count defects transverse cracks and transverse joint defectiveness.

[v] **Unsurfaced Road Condition Index (URCI)**
The URCI is based on the visual assessment of seven distress types which commonly occur on unsurfaced roads (Eaton and Beaucham, 1992). It has been developed by the U.S. Army Corps of Engineers as means to assess the overall condition of unsurfaced roads, determine maintenance and renewal requirements and prioritise road sections requiring treatment. The distress types considered, measured using a low, medium, high rating, are:

- The road cross section (in terms of water ponding on the road surface)
- Drainage (in terms of water and vegetation in side drains)
- Corrugation (as a function of the depth of corrugation)
- Dust (in relation to an estimate of the severity of dust cloud thrown up by a passing vehicle)
- Potholes (in terms of depth and diameter)
- Ruts (as a function of the depth of ruts)
- Loose aggregates (the size and volume of loose aggregates occurring on carriageway and shoulder)

[vi] **Detailed Visual Inspection (DVI)**
The UKPMS Detailed Visual Inspection (DVI) records measured areas or lengths for a wider range of more closely defined defects (than for CVI), aggregated within short sub-sections. The DVI is intended to be used where more detailed information is required to support and validate treatment decisions and scheme identification. Distress types considered include wheel track cracking, carriageway cracking, chip loss, fretting, fatting, subsidence, rutting, transverse/ reflection cracking, edge deterioration, block deterioration, joint deterioration and seal deterioration (UKPMS, 2009b).

[vii] **Integrated Rural Accessibility Planning (IRAP)**
IRAP is a planning tool which can be used to prioritise rural investment by taking into account the requirements of rural households (TRL, 2003). Such needs include access to facilities such as health services, markets, water supply, schools etc. One aspect of IRAP, the prioritization procedure can be used to prioritise rural road maintenance expenditure and is a function of socio-economic benefit (determined from a simple rating system) by the costs of the road scheme.