

ASSET MANAGEMENT ROADMAP FOR MUNICIPALITIES IN SOUTH AFRICA



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1. INTRODUCTION

We humans have achieved much in terms of living well. We have managed to acquire more comfort and convenience than any other generation in the past. We are blessed to be living in the most sophisticated and technologically advanced period in all of humanities presence on this planet. Much of our existence and comforts of life continue to depend on the services and products obtained from highly mechanised and automated industries. We have become dependent on services such as continuous supply of water, uninterrupted availability of electricity, access to various destinations via good transport infrastructure, etc. We (including the people we serve) all want to live well. More than ever, this depends on the continued integrity of physical assets. However, when these assets fail, not only is the economy under threat and not only is the provision of services interrupted, but our very survival and comforts of life threatened. As a result, the processes by which asset failure occurs and what must be done to manage them are becoming very high priorities indeed.

Since the second industrial revolution, Asset Management (AM) has changed, more so than any other management discipline. These changes are precipitated by:

- Huge increase and number of physical assets
- Advancement in technologies and techniques, more complex designs
- Greater expectations from stakeholders / customers.
- An ageing fleet of assets.
- Optimising asset performance.
- Managing information across multiple systems.
- Shorter or reduced Planning horizons.
- Increasing Operating costs and decreasing budgets: 'having to do more with less'.
- Decreasing revenue.
- An increase in the demand on Reliability and Availability.
- Reduction in Manpower and exodus of skills and tacit knowledge.
- Greater demands on Safety, increased Regulatory and Statutory compliance.

In the current context as technology evolves towards the much talked about 4th Industrial Revolution, organisations find themselves swinging like a pendulum that cannot sustain themselves propelling forward because there are numerous areas that are not working effectively across various building blocks viz. processes, people, responsibilities, departments, technology, etc. Some of these areas are:

- Capital expenditure that is based on least Capital cost being unsustainable.
- Planning and Designs that exclude the holistic approach of life cycle costing, thereby increasing OPEX costs substantially over the life of the asset.
- Incomplete asset registers; poor management of the Computerised Maintenance Management System.

- Incorrect Maintenance and Asset Management strategies, minimal or no condition/online monitoring or inspection information.
- Unstructured internal benchmarking.
- Poor monitoring and reporting, where most indicators are lagging indices.
- A lack of reliable information or data to support good decision making.
- Poorly defined End of life management plans or Refurbishment plans.
- No or inconsistent assurance being performed.

Many utilities /organisations are in ‘firefighting mode’ where they move from one crisis to another, cost is unpredictable, and one surprise failure is followed by an even bigger one. We all know that pro-actively approaching Asset Management and Maintenance Management, based on realistic robust principles is the answer. Yet many asset centric organisations continue struggling. The answer is simple – organisations need to know where to spend their resources for improvements to break the vicious cycle.

One reason why some executives appointed to manage this physical infrastructure look like the six blind men studying an elephant – (getting the parts right, while missing the whole), is their ‘tunnel vision’ of Asset Management

1.1. What is Asset Management?

Asset Management awareness and importance is becoming significant for utilities and organisations that have a value expectation from physically intensive infrastructure [1]. Asset Management is a process that guides the planning, acquisition, operation, maintenance and end of Life management (renewal and disposal) of physical assets. This enables an organisation to realise value from its assets to meet its organisational objectives. The primary objective of AM is to maximise performance (asset service delivery) and manage related risks and costs over the life cycle of the asset [1–4], as detailed Fig. 1.

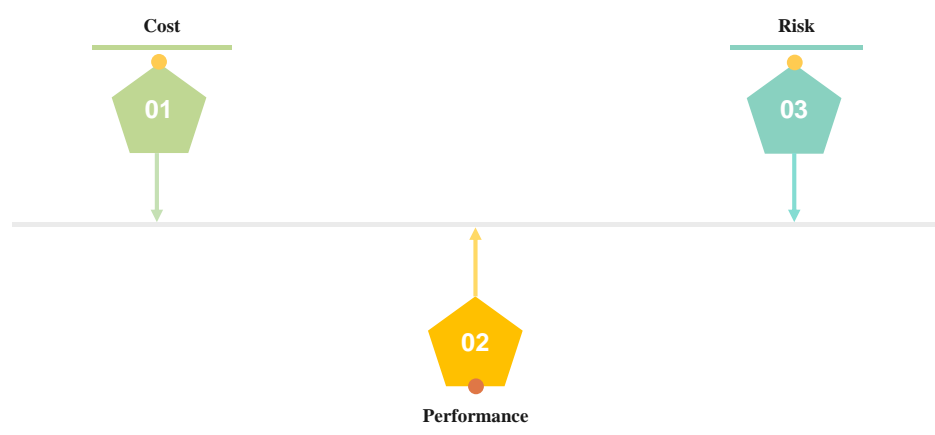


Figure 1: Presentation of the interplay between Cost, Performance and Risk.

1.2. Benefits of Asset Management

Since Asset Management is a systematic approach to investing, acquiring, maintaining and operating physical assets, in a cost-effective way, it therefore delivers benefits that are realised in the areas of forecasting, improved accountability, sustainable performance and service delivery, risk reduction and financial management.

The benefits of Asset Management can include, but are not limited to the following [5–7]:

- a) **Improved financial performance:** improving the return on investments and reducing Capex & Opex costs can be achieved, while preserving asset value and without sacrificing the short or long-term realization of organisational objectives.
- b) **Informed asset investment decisions:** enabling the organisation to improve its decision making and effectively balance costs, risks, opportunities and performance.
- c) **Managed risk:** reducing financial losses, improving health and safety, goodwill and reputation, minimizing environmental and social impact, can result in reduced liabilities such as insurance premiums, fines and penalties.
- d) **Improved services and outputs:** assuring the performance of assets can lead to improved services or products that consistently meet or exceed the expectations of customers and stakeholders.
- e) **Demonstrated social responsibility:** improving the Utilities ability to, for example, reduce emissions, conserve resources and adapt to climate change, enables it to demonstrate socially responsible and ethical business practices and stewardship.
- f) **Demonstrated compliance:** transparently conforming to legal, statutory and regulatory requirements, as well as adhering to Asset Management standards, policies and processes can enable demonstration of compliance.
- g) **Enhanced reputation:** through improved customer satisfaction, stakeholder awareness and confidence.
- h) **Improved organisational sustainability:** effectively managing short and long-term effects, expenditures and performance, can improve the sustainability of operations and the organisation.
- i) **Improved efficiency and effectiveness:** reviewing and improving processes, procedures and asset performance can improve efficiency and effectiveness, and the achievement of organisational objectives.

To realise the benefits above, Utilities would need to overcome the challenges described and foster changes with regards to Asset Management. Utilities which are asset-centric will need to embrace the principles of Asset Management and the establishment of an Asset Management system. In so doing, they will be able to overcome the pressures facing them and realise value from their assets.

1.3. What is ISO 55000?

The adoption of ISO 55000 series as the international standard enables an organisation to achieve its objectives through the effective and efficient management of its assets. ISO 55000 is the application of an asset management system which provides assurance that the AM objectives can be achieved consistently and sustainability over time [8,9]. The elements of ISO 55000 series are:

- a) **ISO 55000:2014** provides an overview of asset management, its principles and terminology, and the expected benefits of adopting asset management. It also provides the context for ISO 55001 and ISO 55002 [9].
- b) **ISO 55001:2014** provides requirements for how to operate the system within which activities are defined, organized, and managed. This International Standard specifies the requirements for the establishment, implementation, maintenance and improvement of a management system for asset management, referred to as an “asset management system” [10].

This International Standard can be used by any organisation. The organisation determines to which of its assets this International Standard applies. This International Standard is primarily intended for use by:

- i. those involved in the establishment, implementation, maintenance and improvement of an asset management system;
- ii. those involved in delivering asset management activities and service providers; and
- iii. internal and external parties to assess the organisation’s ability to meet legal, regulatory and contractual requirements as well as the organisation’s own requirements.

The order in which requirements are presented in the International Standard does not reflect their importance or imply the order in which they are to be implemented. Further guidance regarding the application of the requirements within this International Standard is provided in ISO 55002.

- c) **ISO 55002:2014** provides guidance for the application of a management system for asset management, referred to as an “asset management system”, in accordance with the requirements of ISO 55001. This International Standard [10]:
 - i. contains explanatory text necessary to clarify the requirements specified in ISO 55001 and provides examples to support implementation. It does not provide guidance for managing specific asset types;
 - ii. is intended to be used for managing physical assets in particular, but it can also be applied to other asset types;
 - iii. does not provide financial, accounting or technical guidance for managing specific asset types.
- d) For the purposes of ISO 55001, ISO 55002 and the term “asset management system” is used to refer to a management system for asset management [7].

The elements of the ISO 55000 standard are summarised as follows [5]:

- a) Context of the organisation;
 - i. Understanding the organisation and its context,
 - ii. Understanding the needs and expectations of stakeholders,
 - iii. Determining the scope of the asset management systems, and
 - iv. Asset management system.
- b) Leadership;

- i. Leadership and commitment,
 - ii. Policy, and
 - iii. Organisation roles, responsibilities and authorities.
- c) Planning;
 - (a) Actions to address risks and opportunities for the asset management system, and
 - (b) Asset management objectives and planning to achieve them.
- d) Support;
 - i. Resources,
 - ii. Competence,
 - iii. Awareness,
 - iv. Communication,
 - v. Information requirements, and
 - vi. Documented information.
- e) Operation;
 - i. Operational planning and control,
 - ii. Management of change, and
 - iii. Outsourcing.
- f) Performance evaluation;
 - i. Monitoring, measurement, analysis and evaluation,
 - ii. Internal audit, and
 - iii. Management review.
- g) Improvement.
 - i. Nonconformity and corrective action,
 - ii. Preventive action, and
 - iii. Continual improvement.

1.4. Life Cycle Stages of Asset Management

Asset life cycle stages are discrete phases of an asset throughout its whole life, from conception to final retirement and disposal. These stages are integrated and dependant on each other, just like a chain, the asset management process can only be as strong as the weakest link. This life cycle relationship is illustrated in Fig. 2. There are various aspects that are fundamental and support the AM process from inception to end. Some of them are Risk, Information, Finance, Human Resources, etc [5].

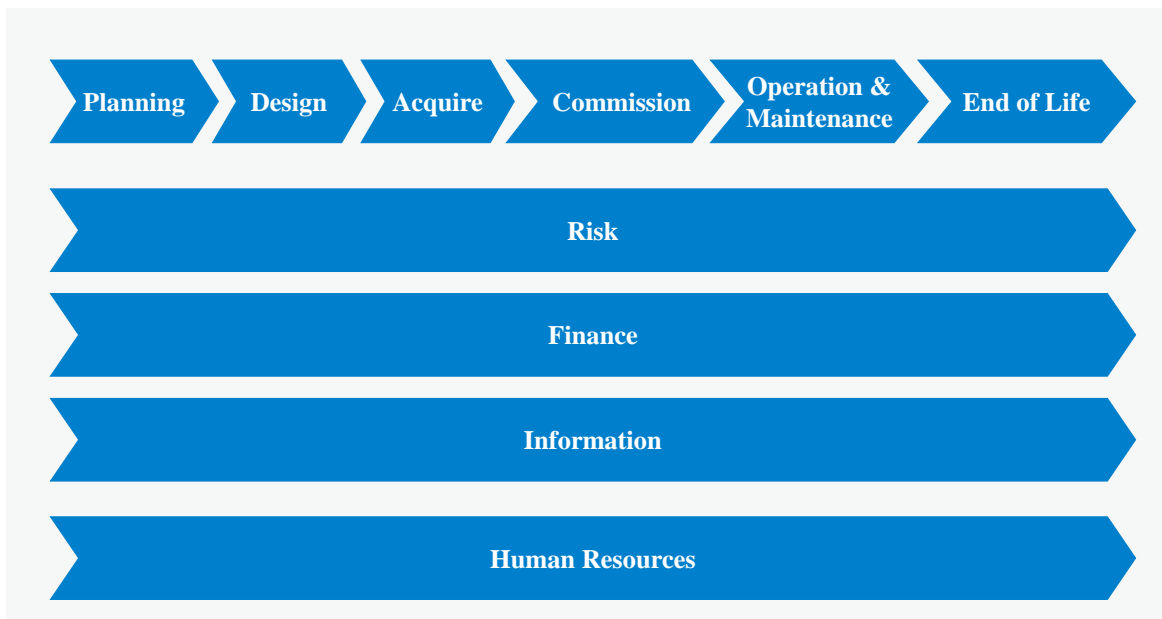


Figure 2: Life Cycle Stages of Asset Management.

1.4.1. Planning

In this stage, asset planning focuses on the integration of asset objectives in line with organisational plans. Asset planning is responsible for ensuring that the expansion of the asset system is optimally provided for to sustain the demand placed on the asset system. The asset shall be expanded at just the right time to ensure optimal investment of capital while avoiding overloading. The asset shall continue to comply with quality, reliability, statutory and regulatory, safety and environmental requirements [11]. Asset planning shall incorporate network capacity, availability, maintainability and reliability requirements, as well as the service requirements of existing and future customers. Planning shall focus on optimizing life cycle cost in line with the principles defined in the South African Grid Code. The whole life cycle cost should include creation or acquisition cost, costs for maintenance operations and cost for disposal. Capital projects shall be formally prioritised based on the risk to availability and reliability and impact on customer service. Operating and maintenance costs should underpin the prioritisation criteria. Asset planning shall be integrated between key internal and external stakeholders. NOTE The planning philosophy prescribed by the South African Transmission and Distribution Grid Codes is that of least economic impact, i.e. life cycle cost.

1.4.2. Design

Design selection includes research and application of new technologies, widely accepted design specifications and standards and application guides. Designs and standards shall incorporate the requirements from all the life cycle stages. Designs and standards shall support continual improvement in asset performance, availability, maintainability and reliability at optimised life cycle cost and minimum risk. The design and selection of new and existing technologies shall be appropriate to the organisation's current capability in terms of resources, processes and knowledge. Design shall take into account all relevant legislation.

1.4.3. Acquire

This life cycle stage includes the procurement/creation of new plant/components and equipment (based on specifications developed during the design stage), as well as the procurement of construction services. This is followed by the activities of contract management, construction and installation (or both) of the asset, and finally, quality assurance. The acquire life cycle stage is supported by the utility's commercial services and supply chain processes [11]. Commercial policies shall incorporate asset management principles and support optimised asset life cycle cost. Commercial and procurement bottlenecks shall be removed to streamline asset procurement for projects. External supply chains shall be developed and managed in accordance with the utility's requirements for the plant, equipment and professional as well as construction services. Project management and execution shall be continually improved to ensure that projects are executed on time and within budget while complying with quality, health and safety, and with environmental requirements. Service contracts with construction contractors and consultants shall be managed to ensure services are delivered on time at the right quality and within required Safety, Health, Risk, Environmental and Quality (SHREQ) parameters and within budget. Quality assurance plans shall be put in place for products as well as services to ensure compliance with the utility's standards and specifications.

1.4.4. Commission

In an asset management context, the commission phase starts when the contractor has completed the design implementation and indicates that the asset or system is ready for utilisation. Final testing of the installation is carried out, the as-built data is recorded and captured, and the maintenance and operating staff are informed about the maintenance and operating requirements of the new plant. The phase ends when the new asset is handed over to Operations and Maintenance and put into commercial operation [11]. Operational and maintenance manuals are to be stored in a technical library (manual or electronic) and shall be properly managed. All maintenance and inspection schedules shall be recorded in the Enterprise Asset Management System (EAMS). All new or refurbished/retrofitted assets (or both) shall comply with the relevant design specifications, and this shall be verified during commissioning. Commissioning tests and procedures shall be formalised and shall not unduly reduce the life time of an asset. Commissioned assets shall be formally and properly transferred to the utility's relevant operation and maintenance department, and shall be supported by the necessary production equipment and transfer of skills. As-built asset information and commissioning test results shall be captured during commissioning and the information shall be properly managed.

1.4.5. Operate and Maintain

During the operate and maintain life cycle stage, the physical asset is expected to operate within the operating envelope and perform as per its designed function. The manner in which the asset is operated and maintained directly determines the performance, reliability and life expectancy of the asset. The best performance of the asset will be experienced when the operators and maintainers work in harmony at the optimum cost. If either operations or maintenance work is given preference over the other, deterioration and poor performance will result. The effect of good management of assets during operate and maintain stage will extend expected life (refurbishment), reduce overall life cycle costs and ensure good availability and reliability [11]. The purpose of maintenance is to ensure that physical assets perform as per their design. This relationship between the purpose and performance is shown in Fig. 3. It also illustrates the purpose of refurbishment. The purpose of maintenance is to ensure that physical assets perform as per the design.

Assets shall be operated and maintained optimally to continually improve Assets availability and reliability over time. Maintenance strategies / schedules shall be determined using a Reliability

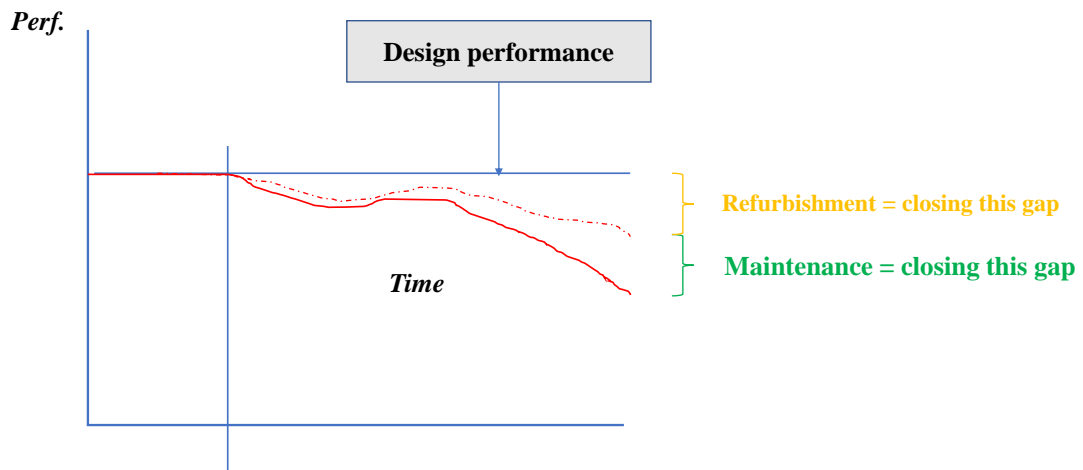


Figure 3: Relationship between the purpose of Maintenance, Refurbishment and performance over time.

Centred Maintenance (RCM) technique. Maintenance planning and scheduling shall be optimised based on reliable asset information that includes asset condition and performance data. Equipment manufacturer requirements / recommendations as well as international best practice should also be considered. Asset condition and performance shall be appropriately monitored and managed. Assets (including servitudes) shall be operated and maintained in a manner that optimises system life cycle cost with due consideration of technical risk. Spares-holding strategies shall be revised and optimised to ensure that there are sufficient spares for critical and strategic plant for failures, corrective and preventive maintenance. Asset life extension shall be executed in accordance with asset life extension plans. In evaluating the useful life of an asset even though it has exceeded its initial useful life but is still in excellent condition and can be utilised for years, should not be replaced unless economically viable, taking into account obsolescence, spares, skills, etc. The power network shall be remotely monitored and controlled through Supervisory Control and Data Acquisition. Assets shall be operated and maintained in such a manner that safety to the public and personnel can be assured. Measures shall be put into place to ensure compliance with statutory, regulatory requirements and organisational capacity to operate and maintain. This will be performed by competent personnel where the right mix of competent and motivated people are developed and retained to improve maintenance capability. Maintenance shall maximise performance of assets over their life, taking into account the trade-off required between performance, cost and risk.

1.4.6. End of life Management

In this stage, the utility is expected to develop asset replacement strategies based on the criticality and life expectancy of assets with the focus on maximising asset life and minimising total lifecycle cost. The relationship between Maintenance and End of Life management is illustrated in Fig. 4.

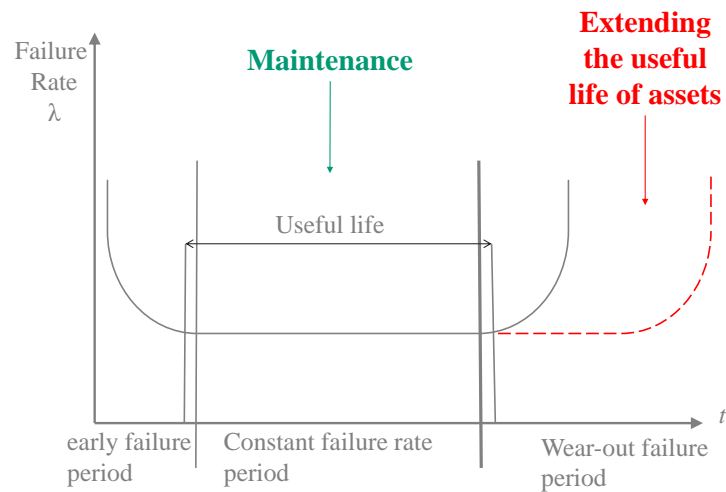


Figure 4: Relationship between Maintenance and End of Life Management.

Short-term asset replacement and retirement plans and decisions shall be based on a comprehensive asset health review and risk considerations. Retired assets shall be properly managed if retained for spares purposes. Assets shall be disposed of in an acceptable manner that complies with all health, safety, financial, statutory and regulatory and environmental issues. Investment planning shall include formal plans for asset refurbishment and replacement based on expected asset life. This life cycle stage includes the following possible actions [5–7, 11]:

- a) **Replacement:** the replacement of assets due to theft, vandalism, vehicle accident damage or for reasons other than expansion e.g. degraded performance experienced at the end of its useful life;
- b) **Retirement:** the removal of equipment from service due to expansion, but retention of the asset for strategic reasons such as spares;
- c) **Disposal:** the complete removal and disposal of an asset when it is no longer required;
- d) **Strip/harvest spares:** no longer manufactured, but required to maintain similar equipment still in service, and scrap balance of asset taken out of service;
- e) **Renewal:** works to replace existing assets with assets of equivalent capacity or performance capability; and
- f) **Refurbishment:** works to rebuild or replace parts or components of an asset, to restore it to a required functional condition and extend its useful life, which may incorporate some modification.

1.4.7. Elements Common to all the life cycle stages

Certain elements of Asset Management apply across the entire value chain or all the life cycle stages, they are briefly described as:

- a) **Information:** The management of asset information relates to the capturing and management of asset-related information to enable decision making.

b) **Risk:** The management of asset risks consists of the following main activities:

- i *Risk identification:* asset risks are identified per individual asset, per class of asset, at a system or network level and also at portfolio level;
- ii *Risk assessment:* the identified asset risks are quantified and ranked in terms of likelihood of occurrence and consequence of incident;
- iii *Risk control:* the necessary steps are identified and implemented to control the identified risks according to the utility's risk tolerance; and
- iv *Risk monitoring:* the effectiveness of risk control measures is monitored by means of inspection and audits.

NOTE: New or previously undetected risks are also identified.

c) **Finance:** The management of finance includes the following main activities:

- i *Budgeting:* annual operational budgets that include the operational costs of managing assets during the operate and maintain life cycle stage;
- ii *Accounting:* the utility's finance department shall track and report actual operational expenditure against the original budgets; and
- iii *Asset valuation:* the finance department is responsible for regularly determining the depreciated financial value of all the utility's assets as detailed in the financial asset register.

d) **Human resources:** Effective asset management requires that personnel responsible for the planning, design, construction, operation and management of assets are appropriately qualified in terms of education, training and experience. The management of human resources consists of the following main activities [12]:

- i *Requirements:* the requirements for human resources skills shall be identified as well as other resources to support asset management;
- ii *Recruitment:* the necessary human resources shall be recruited;
- iii *Training and development:* human resources shall be adequately trained and developed for their relevant roles and functions within the organisation;
- iv *Skills deployment:* human resources shall be optimally matched to the asset management functions; and
- v *Skills retention:* critical skills and experience shall be retained as far as possible.

1.5. Three levels in Asset Management Progression

There are generally three levels in the Asset Management progression of an organisation. This journey begins with the basic or core or fundamental requirements of an AM system, then progresses to the intermediate and advanced level requirements. The key elements for each level are presented from Sub-subsection 1.5.1 to 1.5.3.

1.5.1. Basic Level Asset Management

This is the starting point and foundation for all other asset management practices. At this level, it does not require data to be fully complete or highly accurate, provided that what is known is sufficient for day to day management of the assets. The organisation documents the current situation and what the gaps in processes, data, procedures, systems and knowledge are. It identifies the significance of any missing data and provides an improvement plan for progressing asset management [5]. During this phase the organisation should focus on:

- i Development and introduction of policies, procedures, business processes, etc.
- ii Standardise Emergent work process across all BU's
- iii Introduce or enhance the focus on Asset information – Know where your assets are, asset attributes, asset register.
- iv Set maintenance objectives and asset-specific strategy in-line with the organisation's strategy and engineering philosophy.
- v Standardise the application of the appropriate maintenance strategies across asset fleet
- vi Standardise Planning, Scheduling, Work execution
- vii Introduce Performance monitoring
- viii Spares management: Optimize inventory and availability of strategic spares.
- ix Quality: Design, assure, and support quality assurance processes.
- x Training: Identify training needs and ensure training is delivered.
- xi Facilitate best practice sharing through documentation, peer forums and cross-site reviews
- xii Set technical requirements for contractor performance and assure adherence to requirements
- xiii Assure mitigation of health, safety, environmental and regulatory risk.

1.5.2. Intermediate Level Asset Management

This is the name given to the phase of improved asset management practices. It is between the achievement of basic level asset management and before attainment of advanced level asset management. This phase includes all basic level asset management practices to an improved level of completeness and accuracy. The organisation introduces additional asset management practices that provide more detailed, accurate analysis and greater understanding of current and future situations [5]. During this phase the organisation should focus on improvement on the basic level requirements and:

- i Asset Health Indices
 - Condition profile
 - Age profile
 - Performance profile
- ii Influence technology decisions and development to best serve maintenance user needs

- iii Asset replacement
- iv Asset refurbishment
- v Maintenance effectiveness
- vi Support implementation and continuous improvement of standard processes and procedures.
- vii Review and assure performance and adherence to standard process.

1.5.3. Advanced Level Asset Management

This stage requires a range of key asset management practices to be implemented to a high level of accuracy, completeness and evidence that a comprehensive knowledge of current and future situations has been attained. This includes all basic and intermediate level asset management practices to a higher level of completeness and accuracy [5]. During this phase the organisation should focus on improvement on the basic level requirements, intermediate level requirements and where the focus is on amongst others:

- i Developing whole life asset management plans that take into account integration with Planning and Design
- ii Understanding the requirements between Capex and Opex
- iii Designing out maintenance
- iv Support implementation and continuous improvement of standard processes and procedures.
- v Review and assure performance and adherence to standard process.

1.6. Maintenance as a Catalyst for improvement in AM

In order to improve an organisation's maturity of asset management, the organisation needs to have clear line of sight of the current practices and a vision of the end state. Using the Maintenance infrastructure (viz, people, assets, processes, technology, etc.) AM can be introduced. This to be done thru' a change management programme. An incremental improvement in the maintenance landscape (elements that are fundamental building blocks of maintenance) is an ideal catalyst for introducing Asset Management and improving it. This is explained in Fig. 5.

Most organisations, to some extent, have a maintenance requirement and presence of the key building blocks required. As a result of this being available, the introduction and change management of AM should begin here. Remembering that Asset Management is a journey, that progresses from innocence to excellence, there is a greater chance of success by introducing and implementing in the Maintenance institution. The maintenance landscape comprises of various components; some of which are the Computerised Maintenance Management System (CMMS), Maintenance Strategies, Planning, Scheduling, Maintenance Monitoring, etc. In improving the practices of the Maintenance landscape, there are also 3 levels of maturity. The Maintenance Landscape elements and what needs to be done in each level is mapped in Fig. 6.

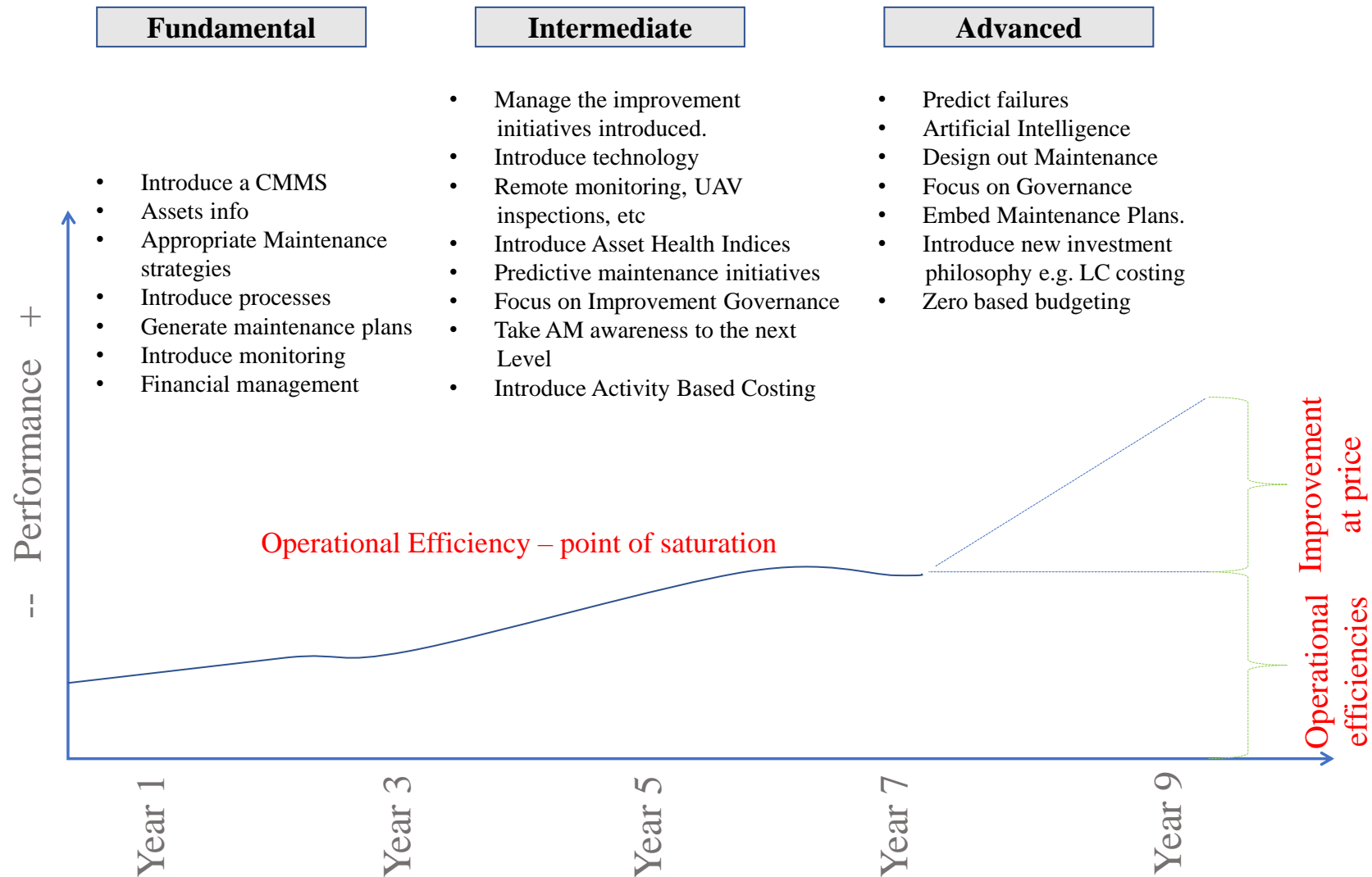


Figure 5: Well founded incremental in maintenance as a catalyst for AM.

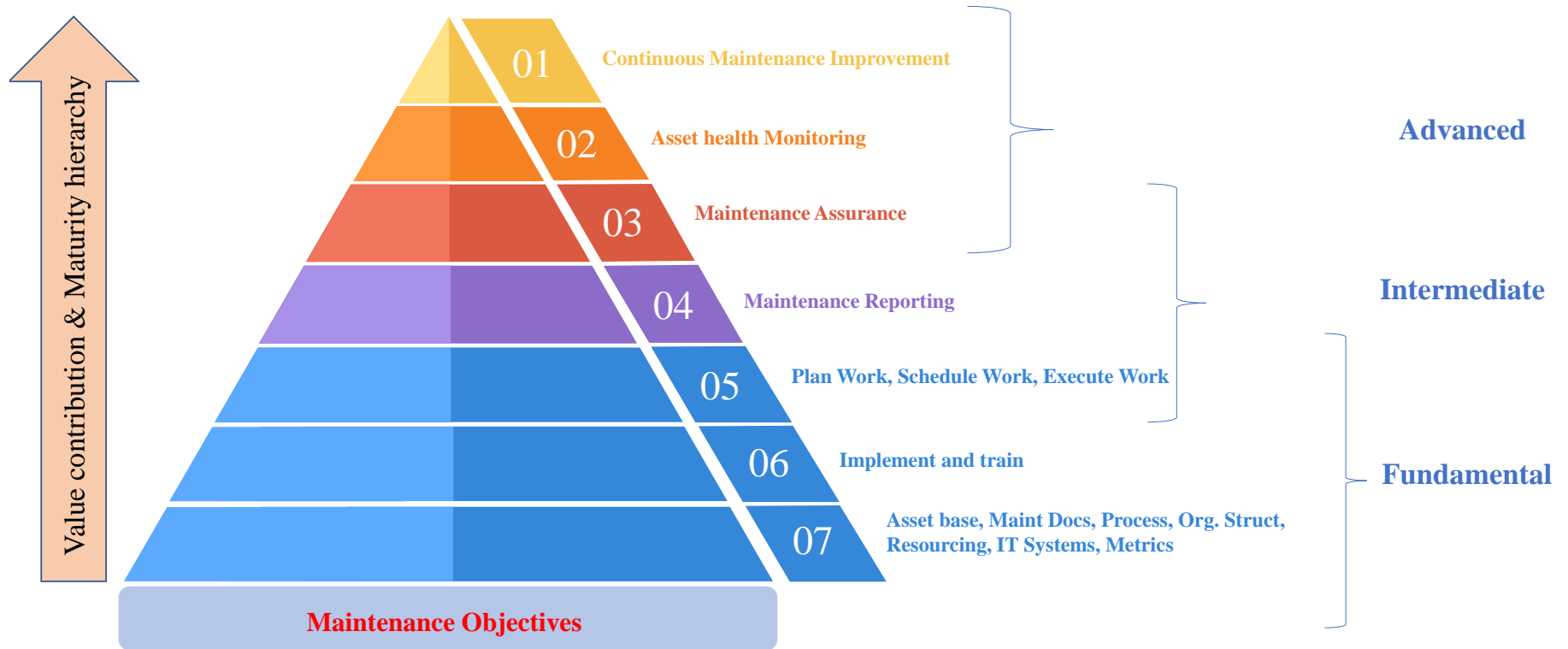


Figure 6: Maintenance landscape - prioritised and phased.

1.7. A Vision of the End State

An organisation that has most of the elements of good asset management shall have amongst others, the following aspects embedded in the Asset Management System:

- a) Well defined business processes where systems, tools, skills, training, etc. are available and embedded.
- b) A drive towards Standardisation, especially of asset information, maintenance strategies, maintenance plans, work flow, work management, KPIs, work execution, etc. These provide great leverage for AM.
- c) Asset management knowledge and purpose well understood at all levels
- d) An accurate asset register with reliable asset information.
- e) Asset risk & mitigation well defined and managed proactively
- f) Investment decisions based on:
 - i. Least economic cost
 - ii. Optimum total cost of ownership
- g) Asset acquisition (Planning, design and construction) aimed at achieving least / reduced / optimum OPEX cost
- h) Knowing where to spend resources for improvement.
 - i) Having a structured approach to directing available funds to 'where it's needed most'
 - j) Synchronised integration of different Life Cycle stages
 - k) Automated systems and tools to facilitate decision making
- l) Maintenance, Operations and End of life management proactively embedded in life of asset plans
- m) End of Life plans initiated proactively not only when assets fail.
- n) End of Life plans for assets that are:
 - i. Based on Asset Health (taking into account age, performance, obsolescence, operating context, etc.)
 - ii. Consolidated and have a view per Business Unit
 - iii. Optimised based on certain factors
 - iv. Prioritised based on certain conditions
 - v. Well-funded because plans were timeously and proactively approached
 - vi. Plans implemented timeously
- o) A situation where the organisation is NOT in 'firefighting mode' (where they move from one crisis to another, cost is unpredictable, and one surprise failure is followed by an even bigger one!)

- p) Technical performance consistently meeting and exceeding targets.
- q) Well-founded Strategic decision making
- r) Having (as a minimum) the following strategic documents
 - i. Asset Management Policy
 - ii. Strategic Asset Management Plan (SAMP) [6].

Over a period of time, moving towards full implementation of Asset Management, by following a structured process, Asset Management would evolve from innocence to excellence. If an organisation chooses to adopt the discrete Life cycle stages as the approach for improving Asset Management, then Fig. 7 presents an abridged version of a road map for the implementation of Asset Management. As the asset management system develops through its stages of maturity during the asset care journey, it is of critical importance that the mental maturity and exploiting the latent systemic abilities of the people be aligned.

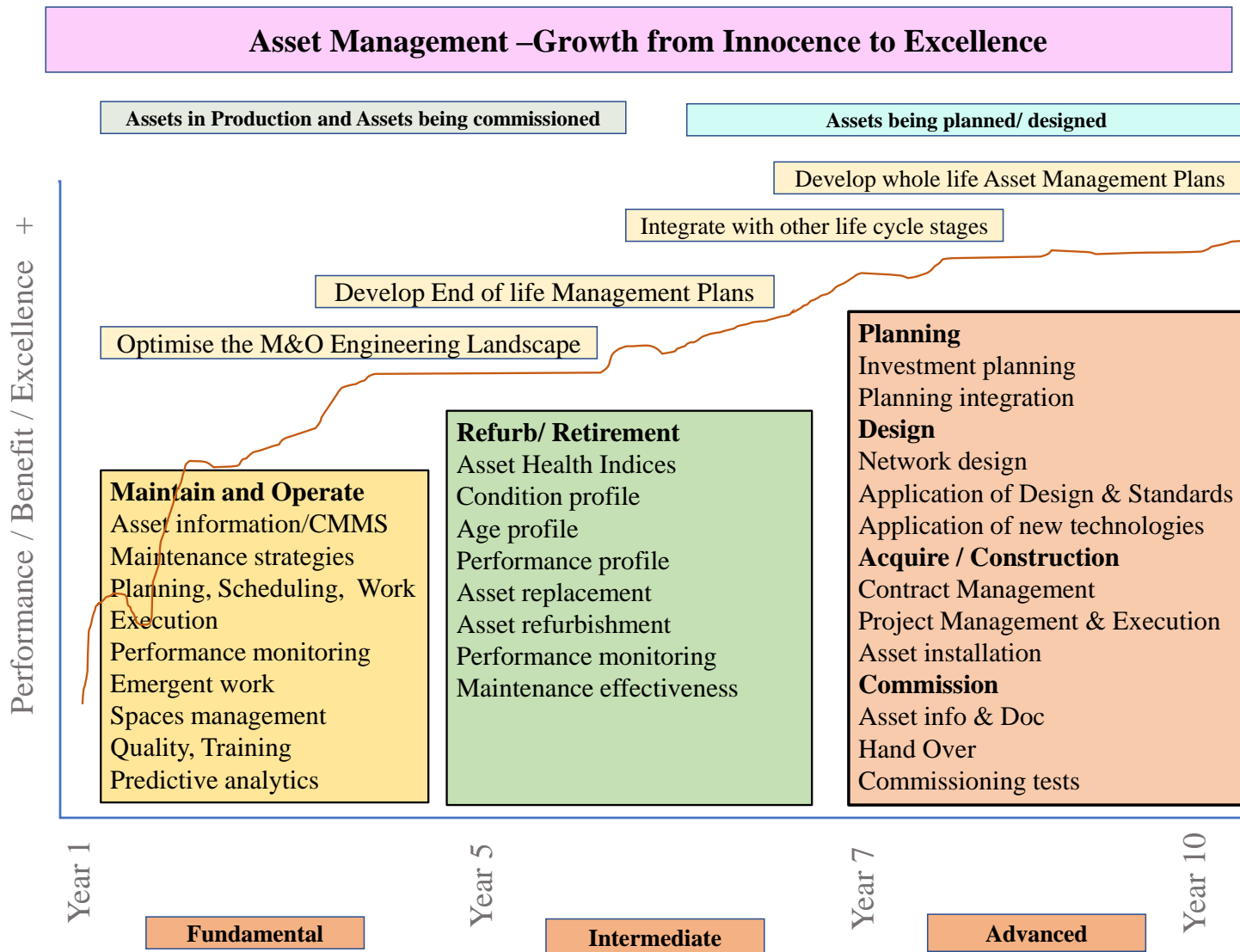


Figure 7: Abridged version of Road map AM.

1.8. Knowledge Transfer

Knowledge transfer of AM is the fundamental step for the success of AM implementation in the change management process. The interaction and outcomes of the training can be the turning point in the implementation of AM in the organisation. Careful and considered selection must take place in appointing facilitators / trainers. Asset Management awareness and understanding has to be made available to all staff. Courses need to be developed and training need to be given that target the appropriate audiences. As a minimum there should be an AM course set out in three parts viz:

- a) **Part 1 - Asset Management Innocence to Excellence** - can be 3-day course on the fundamentals of AM. The focus will be on all the introduction of AM, the essentials of the life cycle stages, awareness and some details on the ISO 55000 series. The impact and importance of the supporting infrastructure for AM viz. HR, IT, etc. Target audience – all staff, all levels, technical & non-technical staff.
- b) **Part 2 - Asset Management Innocence to Excellence** – can be 5-day course on the intermediate knowledge level of AM. The focus will be on the detail requirements of ISO 55000, ISO 55001, and ISO 55002. Target audience – all staff, all levels, technical & non-technical staff.
- c) **Part 3 - Asset Management Innocence to Excellence** can be 5-day course on the advanced level understanding of AM. The focus will be on a revision of Part 1 & Part 2. The greater detail must focus on the Financial aspects viz, Capex, Opex, Depreciation, calculation of whole life cycle costs, calculation of maintenance costs, end of life costs, costing of different options taking into account the different life cycles. Target audience – staff, operational and tactical levels of, technical & non-technical staff especially staff in the Commercial, procurement, HR, Finance, etc.

All the courses should be structured to test the theory and practical application.

1.9. Change Management Process

Application of a well-defined Change a management process cannot be overemphasised and must not be underestimated. The following are the typical eight steps in the Change Process [13]:

- a) Create a Sense of Urgency.
- b) Build a Guiding Coalition.
- c) Form a Strategic Vision and Initiatives.
- d) Enlist a Volunteer Army.
- e) Enable Action by Removing Barriers.
- f) Generate Short-Term Wins.
- g) Sustain Acceleration.
- h) Institute Change

The progression in Asset Management as changes manifest is depicted in Figure 8.

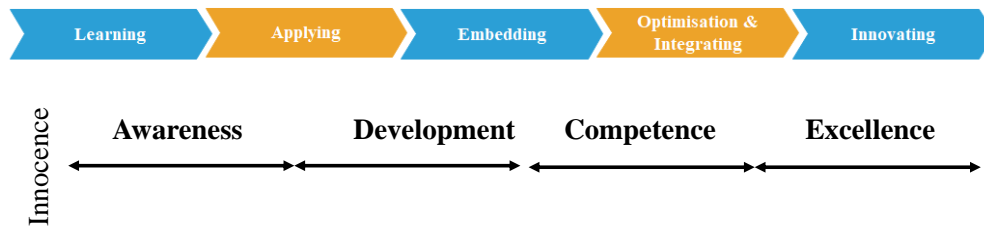


Figure 8: Progression of Asset management as changes manifest.

1.10. Benchmarking the Asset Management Maturity

Based on a set of criteria, an assessment should be done to determine this maturity level. The assessment for determining the maturity can follow either of the following approaches:

- a) **Life Cycle stages Assessment** to determine the maturity level through the Life cycle stages. Based on a set of questions, feedback is obtained from the organisation. These questions are based on the Life cycle stages.
- b) **ISO 55000 Assessment** to determine the maturity level towards ISO 55000 compliance. Based on a set of questions, feedback is obtained from the organisation. These questions are on the ISO 55000 standard.

Using ISO 55000 or the Life Cycle Stages, criteria to assess an organisation's maturity will be developed. The following is an example of the Questionnaire with reference to ISO 55000. Table 1 presents a sample questionnaire to consider for an excellent management strategy. Once the responses have been received, the outcome shall be plotted on a maturity scale.

1.11. Taking Asset Management Forward

The following are steps of how this can be taken forward.

a) **Engage with key stake holders:**

- . Engage with AMEU – obtain support for the concept, approach and names of 6 Munics to do a pilot study.
- . Engage with Head's of Dept of each of the 6 Munics – obtain support for the concept, approach and the contact person for the assessment criteria.
- . Engage with key stakeholders from each Munics – obtain support for the concept, approach and provide clarity on the assessment
- . For a broader consensus, present the position paper and share results at a forum where all or most of the key stakeholders are present.

b) **Perform assessments on the 6 sites:** Once the engagement is done, engage the Munics to provide feedback on the questionnaire of Asset Management. Jointly with the Munics, guide them thru' the assessment. Where possible on-site assessments should be done.

c) **Collate results:** On completion of the above, the information collected shall be collated and mapped against the maturity scale.

d) **Develop recommendations and engage with those Munics assessed:** The responses from the assessments will provide guidance on where the gaps are and where to introduce the improvements required. The recommendations shall be packaged according to maturity (innocence, awareness, development, competence, excellence) and at which level (Basic, Intermediate or Advanced) an organisation is.

e) **Publish outcomes:** For transparency and the advancement of this initiative to more than just the sampled Munics, the results and actions shall be made available in a constructive and non-discriminatory manner.

f) **Develop project plan for accepting Munics:** Depending on the maturity level, an improvement plan is to be developed of how the gaps can be closed. This plan must contain all the steps required to move from one level of maturity to the next. It should also identify where and what resources are required.

1.12. Governance for the Implementation of Asset Management in Municipalities

A well-designed Asset Management and Maintenance management system will give the Utilities the answers needed. The mechanics of achieving this would be directed and set in motion by an Asset Management Advisory Committee (AMAC). The role of the AMAC would serve to improve Reliability, Availability, Maintainability and Sustainability of the asset base. The AMAC would provide strategic planning & guidance with respect to development, direction, co-ordination, assurance and operations for the implementation of the outputs as determined by the Asset Management Advisory Committee. To ensure that value is realised from assets, the fundamentals of AM need to be understood and embedded into Asset Management. Amongst others the following are the proposed roles for the AMAC:

a) Establish a Terms of Reference for the AMAC;

- b) Develop a 'roadmap' for the introduction & implementation of AM;
- c) Create a programme of Work with accountabilities and time frames;
- d) Establish monitoring mechanisms on delivery of activities;
- e) Once the above has been developed, focus on the following:
 - i. Guide and support the formulation of a National, Provincial and Local Government Asset Management Policy for Electricity infrastructure.
 - ii. Develop an Asset Management implementation programme.
 - iii. Promote standardisation across all the 9 provinces and sub-sets by developing the following in a phased manner:
 - Engineer or re-engineer various process beginning with 'Maintaining the Wires' business
 - Performance monitoring
 - Conducting assurances
 - iv. Work towards standardising the Asset Management Landscape by directing the development of Asset Life Cycle management planning policies, standards, tools and practices to meet prevailing business objectives.
 - v. Support and direct applicable Asset Life Cycle management systems, ensuring interfaces with other business process systems
 - vi. Provide Asset Life Cycle management planning advice and guidance to Utilities, facilitating applicable training and development
 - vii. Develop a process for the compilation of the annual Asset Life Cycle management planning process from initiation through compilation, submission, evaluation, approval and consolidation
 - viii. Review and evaluate Asset Life Cycle planning systems to ensure submissions are complete and appropriate for intended use.
 - ix. Co-ordinate the development of a Strategic Asset Management Plan which includes an Asset Management plan per Munic, rolling up to per District, rolling up to per Province and finally for SA [14].
 - x. Providing advice for assurance that assets fulfil their required designed intent. This assurance applies to Assets, Asset Management and Asset Management systems.

2. Implementing Asset Management in Municipalities

We are on the verge of breaking thru' the 4th Industrial Revolution. From an Asset Management perspective, Munics have to yet embrace the fundamentals of what should have been in place for the 2nd Industrial Revolution. The initiative taken by the Government to 'kick-start' the economy will bring about significant changes and advancements to physical infrastructure across all the engineering disciplines such as civil, electrical, roads, water, sanitation, etc. As this unfolds, there will be a requirement for various departments to be proactive on many fronts. Improvements and sustained good service delivery will be on 'top of the agenda'. The benefits of enablers such as Reliability Centred Maintenance, predictive maintenance, advanced analytics, artificial intelligence and self-correcting algorithms will have to be introduced very shortly otherwise it will soon be history and the 'gap to close' them in the future will be unsurmountable.

As the International Society embraces ISO 55000, ISO 55000 will be the fundamental standard for Asset Management in the 4th Industrial revolution. For SA to be competitive on the Global platform, it will become important that SA takes a more proactive approach towards achieving this. This will result in improved asset maintainability, availability, reliability, operability and sustainability; better safety performance and better bottom-line results.

It must be noted that An *Asset Management System* is a framework of control, directional alignment, cross-disciplinary collaboration, optimization and continual improvement. It is not a software tool. ISO 55001 provides a very valuable structure but:

- It only defines 'what' needs to be done; not 'how' (context dependent)
- It defines 'competent' asset management; not 'best practice'
- 'Line of sight' alignment is a vital starting point

Optimization of strategies & plans is complex but very high value. The people, risk & information 'enablers' have profound impact, especially in the sustainability of the system. 'Closing the loop' is, perhaps, hardest of all *initially*, but provides the self-motivating 'engine' once started. ISO 55001 is just a checklist: the real value is found in better integration & optimization, in distilling and providing greater clarity of focus.

2.1. Roadmap Framework for the implementation of Asset Management

The BC Hydro roadmap framework was selected for asset management best practices. The objective of this roadmap is to assist Municipalities to implement asset management practices. The roadmap details the asset management practices that need to be implemented through the different levels of Asset Management maturity. It has been designed to lead one through the steps of implementing basic level asset management practices, using a modular approach. This format identifies the core components (tasks or activities that could be individually actioned) of asset management. The purpose is to make it easy to get started and to continue to make progress as time, resource and funding allow. It is also important to present each task in terms of what needs to be achieved without tying into any specific software, framework or format. This provides maximum flexibility and leaves the choice with the Municipality as to which (if any) of available systems and guidelines they might want to use to augment asset management practice. The important point is that the roadmap is a simple tool that provides a good overview and sufficient detail to implement a basic level of asset management and it is complimentary to any currently available guidelines and manuals that can give one a greater level of detail when one is ready for that [11].

There are generally three levels in the Asset Management progression. This journey begins with the basic, core or fundamental (introductory) requirements of an Asset Management system, then progresses to the intermediate and advanced level requirements. The key elements of each level are [11]:

Basic Level Asset Management: This is the starting point and foundation for all other asset management practices. At this level, it does not require data to be fully complete or highly accurate, provided that what is known is sufficient for day-to-day management of the assets. The Municipality documents the current situation and what the gaps in processes, data, procedures, systems and knowledge are. It identifies the significance of any missing data and provides an improvement plan for progressing asset management.

Intermediate Level Asset Management: This is the name given to the phase of improved asset management practices. It is between the achievement of basic level asset management and before attainment of advanced level asset management. This phase includes all basic level asset management practices to an improved level of completeness and accuracy. The Municipality introduces additional asset management practices that provide more detailed, accurate analysis and greater understanding of current and future situations.

Advanced Level Asset Management: This stage requires a range of key asset management practices to be implemented to a high level of accuracy, completeness and evidence that a comprehensive knowledge of current and future situations has been attained. This includes all basic and intermediate level asset management practices to a higher level of completeness and accuracy.

The roadmap is designed to follow-on from an assessment that needs to be done, using an assessment tool. This assessment reviews the readiness to begin implementing asset management practices.

The Guideline is then an overview of the key asset management practices needed to achieve at least a basic level of asset management implementation. It is set out in modular form so that a Municipality can choose which ever module of asset management practice they would like to take action on. At any time, the Municipality could be progressing several modules simultaneously. The modules, as listed in Fig. 9, indicate which asset management practices are essential for basic level asset management and which ones are at an intermediate level or advanced level. The modules have been colour-coded to indicate which asset management practices are essential for basic level asset management (orange) and which ones are at an intermediate level (green) or advanced level (blue). The roadmap diagram lists many Asset Management practices, arranged as separate ‘modules’ under six general category headings [5].

1. Knowing Your Assets
2. Managing the Asset Lifecycle
3. Understanding the Financial Situation
4. Decision-making
5. Knowing the Rules
6. Monitoring for Sustainability

This Roadmap currently focuses on the following asset management practice modules as detailed in Table 2 [11].

Table 2: Asset Management Practice Modules

| Parameters | Decision |
|---|---|
| 1. Knowing your asset | 1.1 Basic Asset Inventory 1.2 Identify Asset Components 1.3 Current Data, Software and Tools |
| 2. Managing asset life cycle | 2.1 Asset Condition 2.2 Level of Service 2.3 Assess Asset Renewal Alternatives (Basic) 2.4 Assess Asset Maintenance Strategies |
| 3. Understanding your financial situation | 3.1 Current Asset Investment 3.2 Current O&M Costs 3.3 Future Capital Costs 3.4 Funding Sources |
| 4. Decision-Making | 4.1 Evaluate Decision Processes 4.2 Improvement Plan and Process 4.3 Prioritized Improvement Plan |
| 5. Knowing the rules | 5.1 Strategic Goals 5.2 Legal Obligations and Standards |
| 6. Monitoring for Sustainability | 6.1 Sustainability Assessment 6.2 Co-ordinating Infrastructure Works |

| 1. Knowing your assets | 2. Managing the Asset lifecycle | 3. Understanding the financial Situation | 4. Decision making | 5. Knowing the rules | 6. Monitoring for Sustainability |
|--|---|--|--|---|---|
| 1.1 Identify asset inventory viz. Asset Type, Location, Quantity, Size, Spares & Material, Useful life, Installation & Commissioning date, Remaining Useful life | 2.1 Asset condition viz. Current condition, Condition rating, Condition monitoring, Deterioration modelling, working history tracking | 3.1 Current asset investment viz. Replacement value, Depreciated value | 4.1 Evaluate decisionmaking process viz. Current process, Desired process and gaps | 5.1 Strategic goals viz. Organisation goals & Stakeholder goals | 6.1 Sustainability assessment viz. Current state of sustainability, Desired processes, Improvement gaps |
| 1.2 Identify Asset Components | 2.2 Level of Service (LOS) viz. Current LOS, Desired LOS, Performance measures & Monitoring | 3.2 Current O&M costs viz. Historical O&M costs, Current O&M costs | 4.2 Improvement plan & processes viz. Identify tasks, Develop basic plan, Implement | 5.2 Legal obligations & Standards viz. List of requirements, Associated polices and Best practice standards | 6.2 Co-ordinating Infrastructure works viz. Identify tasks, Develop basic plan, Improvement processes |
| 1.3 Data, software & Tools viz. Asset Data (specifications), Accounting, History, Decision Tools, GIS | 2.3 Assess asset renew all alternatives viz. treatment options, Evaluation, Treatment selection, Review | 3.3 Future capital costs viz. Multi-year plans, Ops costs, Maintenance costs | 4.3 Prioritised improvement plan viz. Develop prioritisation tool/process | 5.3 Monitoring viz. State of compliance measuring compliance | 6.3 Demand management viz. Alternate strategies |
| 1.4 Data Management viz. Accuracy, Completeness, Gaps, Controls | 2.4 Assess maintenance strategies viz. Maintenance options, Evaluation, Develop strategy, Review outcome | 3.4 Funding sources viz. Multi-plans, Taxes, Revenue, Funding rules | 4.4 Collaboration/ Integration plan viz. Internal between dept, External between organisations | 5.4 Reporting viz. Compliance results, benchmarking comparisons | 6.4 Emerging technologies viz. Alternative strategies, Innovation |
| 1.5 Data Accessibility viz. Data format, Geographical links, Condition data, Financial Data, Performance data | 2.5 Life-cycle strategies viz. Operations, Maintenance, Renewal, New assets | 3.5 Future O&M costs viz. Multi-year plans, Operations costs, Maintenance costs | 4.5 Advanced decisionmaking tools & Software | 5.5 Ownership issues viz. History, Benefits, | |
| 1.6 Data, Software & Tools strategy viz. Current tools, Data management, Data accessibility, Decision tools | 2.6 Utilisation & Demand | 3.6 Maintenance liability viz. Current deferred maintenance costs, Investment strategies | 4.6 Improvement strategies | 5.6 Risk evaluation viz. Risk assessment, mitigation measures | |
| | 2.7 Optimise treatment selection | 3.7 Optimised capital plan viz. Renewal plan, Improvement plan | | 5.7 Review of goals & performance targets | |
| | 2.8 Level of service/ Cost of service reviews | | | | |
| | 2.9 optimised level of service | | | | |

Figure 9: ROADMAP Framework Diagram: : Basic level asset management (orange), Intermediate level (green), and Advanced level (blue).

2.2. Asset Management Implementation using the Roadmap

It is expected that the person or committee within the Municipality who's responsible to initiate asset management implementation, will review the current processes and data within their Municipality against the modules in the Guideline to determine for themselves which modules need to be implemented and in what priority and time-frame should they be implemented. The process of initial set up and evaluation, as detailed in Table 3, is outlined as follows [11]:

Table 3: Initial set up and evaluation

| Step | Description |
|--------|--|
| Step 1 | Identify Asset Management Champion |
| Step 2 | Create Multi-disciplinary Asset Management Team |
| Step 3 | Complete a preparedness Self-Assessment |
| Step 4 | Complete Asset Management Preparedness Tasks |
| Step 5 | Review Roadmap Framework and compare to current status to define critical gaps |
| Step 6 | Document gaps and list tasks required to improve practices |
| Step 7 | Prioritise Asset Management improvement tasks from gap assessment |
| Step 8 | Write Strategy for completing prioritised tasks |

Step 1: Identify Asset Management Champion: An Asset Management Champion is the person who will drive Asset Management in the Municipality. In some Municipality's this may be an identified role or dedicated position; however, for most it will be an existing staff member.

Step 2: Create Multi-disciplinary Asset Management Team: A multi-disciplinary team should also be set up to support the Asset Management Champion. This team will vary in size but should include representation from finance, engineering, operations and whoever approves developments. Ideally it would also include managers for each main asset group.

Step 3: Complete a preparedness Self-Assessment: A preparedness self-assessment will assist the Asset Management Team to understand if there are any issues to be resolved before they begin to develop and Asset Management Strategy.

Step 4: Complete Asset Management Preparedness Tasks: After completing a preparedness assessment, the team may identify some tasks that should be completed before they move forward. These tasks should be assigned to specific people to complete within set timelines.

Step 5: Review Roadmap Framework and compare to current status to define critical gaps: The Asset Management Team should be able to compare current practice to the Roadmap, alternatively, the review could be done as an independent audit.

Step 6: Document gaps and list tasks required to improve practices: The comparison between current practice and the Roadmap will identify gaps in Asset Management practices. A list of tasks to resolve these gaps should be documented. This will form an initial Action Plan for improving Asset Management practice.

Step 7: Prioritise Asset Management improvement tasks from gap assessment: To implement the action plan it will be necessary to have funding. Tasks in the action plan should therefore be prioritised and assigned budgets, timelines and a task manager.

Step 8: Develop Strategy for completing prioritised tasks: The Asset Management Champion and Team should use the outcomes from the above tasks to write a medium to long term strategy for implementing and improving Asset Management practice. The strategy will document the direction and focus going forward as well as the prioritised action plan and funding needs.

2.3. Description of the Asset Management Practice Modules

2.3.1. Knowing Your Assets

Basic Asset Inventory: Knowing one's assets requires that one identifies the asset inventory viz. Asset Type, Location, Quantity, Size, Spares & Material, Useful life, Installation & Commissioning date, Remaining Useful life. Creating and maintaining an Asset Inventory is sound business management. An Asset Inventory is the record of information about one's infrastructural assets. It is also called an **Asset Register**. It needs to be an itemised list of all the assets, and it must have some basic facts about each of those assets (attribute data). As a very minimum these basic facts should include:

- What type of asset is it?
- Where is it located?
- What size is it?
- What is it made of?
- How old it is?

Purpose of an Asset Inventory: The more information one knows about an asset, the easier it is to identify and respond to management issues such as:

- How long before we need to replace this asset?
- How much is this asset worth?
- How much money is spent on fixing this asset?
- Should we keep fixing it or should we replace it?
- How many assets do we have that are similar to this one?
- What is the overall state of our system?

Creating an Asset Inventory: An Asset Inventory is the foundation for building this understanding. It is where all information about the assets can be stored. This information can be used to make informed decisions about an individual asset. The collective information can also be analysed and reported on for forward planning. The first step is to collate and record what asset data one currently has. During this process identify:

- What information is missing?
- Is it important information that should be recorded?
- How important is it compared to other information gaps?

Define what needs to be known about the assets, and what information is already stored. It is more useful to do this for the Municipality rather than for individual departments. After establishing this, determine:

- What format should the asset inventory be (Excel, GIS, Financial System)
- Who should manage the inventory?
- Who should have responsibility for maintaining the accuracy and completeness of which parts

of the data?

- What information (attributes) should be stored?
- Who should have access and what type of access should they have?
- Whether it is appropriate to have more than one asset inventory or data set and how will these be controlled and connected to each other?

Identify Asset Components: All asset components listed in the inventory need key attributes recorded to manage them efficiently. Some attributes are useful for operations and others are useful for planning future work and funding needs. Other key attributes need to be known for any decision area such as age, size, material and location. Careful consideration should be given to establishing what is the most appropriate level of componentisation for each of the asset groups. Consider what one needs to know for valuation and lifecycle management of the asset. If an asset is made up of several parts, but none of these parts could be replaced independently of the others (for example if one part fails the entire asset is replaced) then there is no need to identify the separate parts; or these parts all have a similar lifespan (for example they will deteriorate at the same rate and need to be replaced at the same time) then again there seems little advantage to identify the components separately and they could be grouped together. Asset components and sub-components are parts of the overall asset or network. The way to define a component is that it is an asset or part of an asset that can be independently replaced or has a significantly different life span.

Purpose of listing Asset Components in the Inventory: Recording components of an asset as separate items in the inventory will enable one to keep inventory up to date and to manage and financially account for assets more effectively e.g. if an asset is made up of 3 components and these components have different life spans, at some stage if one of the components fails and is replaced, how does one decide if the install date of the overall asset should be updated? 1 of those 3 components is now new but the other 2 are unchanged. If the components are listed items in the inventory, this is easy. If they are not, it is difficult to show that 1 out of the 3 components has recently been replaced. Accounting for work completed is easy when asset components are itemised. When assets are not componentised, the replacement of only 1 of 3 components cannot be recorded as a replacement of the total asset. The cost of that component replacement may therefore have to be recorded as an expense cost (maintenance item) rather than a capital cost (asset renewal). This does not reflect the true nature of that cost or the true state of that asset. It is easy to use the inventory to manage the assets in a proactive manner when asset components are itemised. Reports can list components that need to be replaced in 1 year or 20 years. This will help work planning and financial planning. A list of assets requiring replacement is not as useful if the asset is comprised of 3 components and only one of the components may need replacing. Componentisation is also necessary to implement some intermediate and advanced asset management practices such as deterioration modelling and treatment option assessment.

Identifying Asset Components: There are two parameters that need to be considered for componentisation:

- Separable replacement: can parts of this asset be replaced independently of other parts
- Different lifespan: are parts of this asset likely to be replaced more or less frequently than other parts?

Current Data, Software and Tools: Documenting current data, software and tools supports effective asset management. Improvements in the quality and completeness of data will therefore increase confidence in the decisions being made about the assets. Similarly, the robustness and suitability of software systems and tools used to store, evaluate and report on asset data will also increase confidence in the quality of decision-making. The first step in making improvements to anything is to understand what one currently has. The first step to increasing confidence in decision-making about assets is to understand what they are based on. All decisions about the assets are informed by:

- Currently available data
- Outcomes from any relevant assessment systems.

Current data refers to any information that has been recorded about the assets. Information such as location and Inventory (attribute) data, Condition data; Capacity/Performance data; Valuation data; and Maintenance Cost data and work history. Software and tools refer to any systems that is in use for Storing data, Assessing/Analysing data, Prioritization, Criticality/Risk evaluation such as:

- Treatment selection
- Monitoring asset condition or performance
- Tracking financial details and performance
- Recording and reporting on faults or work history.

Importance of Current Data, Software and Tools: Understanding what information, one currently has will identify gaps – what is it that one does not know? This will clarify where improvements can be made to increase knowledge of the assets. Knowledge of the software and tools (and any type of assessment system) currently being used, helps to understand:

- How appropriate is the tool or software?
- How robust and accurate are these assessment systems?
- How should the outcomes from these systems be used?
- What confidence can be put in those outcomes?

Identifying and documenting Current Data, Software and Tools: First document what is known relating to one's department or for each department in the Municipality. This can be recorded in any way one deems suitable, however, there is an advantage in establishing a standard form to use in all departments. Once each department has a list of current data, software and tools, one should collaborate across the Municipality to identify improvements. At the very least, assistance should be sought from Financial and IT departments to look holistically at the Municipality and collate a corporate list of these. Collating and reviewing the list of current data, software and tools across the entire Municipality will more effectively identify such areas for improvement as:

- Eliminating unnecessary duplication of data
- Providing data in a more useful format
- Defining who is in the best position responsible for management of the data
- Highlighting where integration of data sets is desired
- Sharing data to those who should know about it
- Identifying more efficient ways of using current tools and software.

Data Type Groups: It is possible to group all data, software and tools into Data Type categories. It can be helpful to do this to manage the collaboration and review process more efficiently. Define names for your Data Type Groups that are appropriate to your Municipality. Suggestions include:

- Accounting/Financial/Valuation Data
- Work History/Maintenance Records
- Decision Tools (Prioritisation/Risk)
- GIS/Inventory

What to Document: As a minimum, for each department or asset group, record the following information:

- a) *Data List and Description:* List all the types of information available about the asset group and describe the content of each data set.
- b) *Data Format:* What format is the data available in, hard copy, electronic or both?

- c) *Data Systems*: What systems, tools or software applications are currently being used to analyse, record, store and manage data.
- d) *Data Location*: Where is the data stored? Is it stored in the filing room, on the corporate server or an employee's desktop computer?
- e) *Data Currency*: How up to date is the data, or when was it last updated? Provide a general approximation or estimate of when the data was last updated. Where data is updated on a regular basis, provide the frequency e.g., weekly, monthly etc.
- f) *Data Ownership*: Who is responsible for maintaining and/or updating the data? This may be a single person, group or department.
- g) *Data Accuracy and Completeness*: Provide a general overview or estimate of the quality of the data e.g., only 80% of the transformers are recorded in the asset inventory and the accuracy level for the recorded data is estimated at 60% with many default values assumed for attributes such as MVA/KVA rating, install date and manufacturer. This is just an initial estimate based on the judgement of the person who uses the data most often. The concept of assessing accuracy and completeness must be embedded in the daily routines.
- h) *Data Controls*: Provide a general description of what procedures and processes exist to manage and use the data, to update and maintain the data and to control access to the data or tools or software.
- i) *Data Backup*: Has the data been backed-up or are there other copies available should the original data be lost?

What Systems are being used?

Asset data may exist in hard copy or soft copy (electronic) format such as as-constructed (built) drawings, bills of quantities, MS Excel Spreadsheets, Financial accounting system records, Graphical Information System (GIS) data, Maintenance Management System data and proprietary software data. Generally, most Municipalities have several different methods for recording and storing data for each asset group e.g., circuit-breaker information may be recorded and stored in GIS whereas building asset information may be recorded and stored in an MS Excel spreadsheet and transportation information in a database. Depending on the Municipality's size and needs, recording and storing data on as-constructed (built) drawings and simple MS Excel spreadsheets may be entirely suitable, whereas for a large Municipality with complex assets, the use of GIS or proprietary software may be more appropriate. The sophistication of the system (or the particulars of a software tool) is not the most important consideration at a basic asset management level. The critical first step is to know what data you have, where to find it and how useful is it to inform decision making.

2.3.2. Managing the Asset Life cycle

Asset Condition: The condition of an asset component is a measure of its physical state compared to a brand-new component. It is important to know the asset condition and to track the change in condition over time. Tracking the change in condition over time will [5]:

- Provide an indicator for rate of deterioration
- Identify what type of remedial treatment is appropriate
- Help determine the best timing for a remedial treatment
- Support more accurate estimates for remaining useful life
- Indicate the most likely year that the asset will fail.

This information can be used to better predict optimal intervention treatments and future budget requirements to get the best service life out of the assets.

Not tracking condition increases the risk of sudden unexpected failures occurring. Such failures usually incur greater costs for remedial works in emergency situations compared to planned maintenance or renewal costs.

Not tracking the remaining life of an asset increases the risk of being unprepared for large unavoidable expenditures. Hence Asset condition viz. Current condition, Condition rating, Condition monitoring, Deterioration modelling, Work history tracking are critical aspects of good asset management [15].

Implementing Asset Condition Recording. There are 3 steps in asset condition recording. They are [5, 11]:

Step 1: The first step is to identify any asset condition data that is already recorded.

Step 2: The second step is to consider your assets and determine what condition data needs to be recorded. This should include updating old data if it is out of date. Determine:

- The most appropriate condition data to measure How condition data should be recorded, including what rating system to use
- How often measured data should be collected (condition monitoring interval) Who should be responsible for tracking condition data
- How the condition data should be analysed and used (deterioration modelling) How work history records should be linked to asset records How work history records can be reliably used to indicate condition.

Step 3: The third step is to implement what you have determined is the appropriate condition monitoring for your assets.

The following information needs to be determined and documented regarding assets [5, 11]:

Current Condition: This is the current condition of the asset known and must be recorded. This refers to having some measure of the current condition of your assets recorded. At a basic level of asset management condition may not be measured but may be known subjectively or there may be some holistic indicators that could be stated as an interim position until measured data becomes available. At a basic level, even the absence of complaints can be an indication that the assets are not badly damaged or at imminent failure point, or complaints could indicate that some problems exist. Where no measurements or indicators exist, the approximate age and type of material of the asset can be used as a first estimate of probable condition. At the intermediate level of asset management there would be progress towards specific measured condition values for each asset component and a formalised process for determining condition and monitoring and updating condition. At an advance component level of asset management condition data would be known or reasonably assumed from measured indicators, for every component in the asset inventory and this information would be used for predictive modelling to determine most likely fail year and most appropriate treatment intervention, including optimal time for intervention.

Condition Rating: This is the condition represented as a comparable rating score or as a description. Any condition data is better than none. However, condition assessments and inspections completed in accordance with a recognised standard and derived from a measurement are more reliable and robust than ones derived from observation. Where measured data is not available, assessments from observations using a prescribed rating manual are better than ones based only on opinion or an arbitrary rating system.

Condition Monitoring: It is important to monitor the condition of assets. Condition inspection and assessment reports provide condition information that is valid at a particular point in time. When the condition assessments are repeated, the difference in condition compared to the time between assessments becomes relevant. Over time as assessment cycles are repeated and recorded it will be possible to build up a history and observe any trend in condition viz deterioration. This is particularly useful to inform decisions about how to manage the asset most effectively and efficiently through the latter stages of its useful life.

Deterioration Modelling: It is desirable to know some past condition data so that the rate of deterioration over time can be assessed and predictions of when it will need repair or replacement can be made. As more and more condition data are collected, monitored and assessed, these predictions will become more and more accurate.

Work History Tracking: Another important source of information that indicates asset condition of assets is work history. What work (repairs, maintenance etc) have been completed on the asset component, when was it done, and how much did it cost. It is important therefore to track all work done on assets and to record this in a dataset that links work history to the specific asset component so that assessments can be done on cumulative value of maintenance versus replacement cost of the component or compared to the remaining value of an older component. This information can be set to 'flag' asset components that should be considered for replacement and will help to optimise maintenance treatment.

At a basic level of asset management, there may not be any current means to track work history in a way that is useful for asset management. Therefore, the need to implement a process would be listed as a task in the improvement plan. At an intermediate level of asset management practice, it is expected that a process for tracking work history against the relevant asset that was worked on, would be implemented and active. At an advanced level of asset management practice, it is expected that the data collected from work history would be regularly assessed and outcomes used to inform decision-making and optimisation [5].

Level of Service

Level of Service is all about understanding what is being provided by the asset and to whom. An asset owner should know about current service levels being provided and this should be recorded and tracked on a regular basis with outcomes reviewed at least annually. The level of Service is defined by the following elements [5, 11]:

- **Quantity:** expressed in terms relevant to the asset group i.e., number of breakers, number of customer connections or total length of networks
- **Location:** where are the assets, and therefore the service, located
- **Availability:** is the service available 24/7 or are there some seasonal or other conditions that limit when the service is available
- **Quality of Service:** this is a measure of the benefit that the customer receives

The information that needs to be determined and documented includes listing all the types of information available about the asset group and a description of the content of each data set viz [5, 11].

Current Levels of Service: This refers to details about the quality and reliability of the service being provided and the cost to provide that service. When determining level of service, it is important to consider where and when a service is available, how much of the service is being provided (quantity) and to what standard (quality).

Quality of Service: The measure of quality of service needs to include consideration of legislative requirements and Municipality goals as well as criteria relevant to each particular asset group. All criteria used to define the quality of service must be able to be measured so that performance achievements can be reported and tracked.

Cost of current Levels of Service: Once existing levels of service are known, the cost or service should be determined. It is important to understand the relevant service/cost relationship to ensure that the current level of service being provided is affordable and sustainable long-term. In understanding the relationship between cost of service and level of service we can identify options and consequences e.g., the level of service could be increased for a certain cost or decreased for a certain amount of savings. This allows more quantified and defensible arguments to be made regarding the asset. This increases confidence in decision outcomes.

Cost of Service scenarios / options: After the initial service/cost assessment, and in preparation for public/customer consultation, it will be necessary to identify service/cost scenarios and options. It may be prudent at this time to gain a better understanding of community expectations. This would involve consulting with key customer groups, documenting customer needs, projecting future needs, considering demand management proposals, identifying possible funding options and alternatives for provision of some services. It is a matter of choice as to which stage and to what degree customer consultation is included in the process of defining future levels of service e.g., a selection of cost/service scenarios could be developed first and then consulted on or some initial targeted consultation could be used to identify service options and then costs determined for these options and the results presented back to the wider group of customers for further consultation.

Desired Levels of Service: This refers to details about the desired quality and reliability of the service being provided and the desired cost to provide that service. What is the desired level of service to be provided? Is the Municipality providing a higher level than is necessary or is the level of service too low? Once established, a desired level of service can then be costed and whether it is feasible. Can plans be made to obtain the necessary funding or will the desired level of service have to be lowered (but still within an acceptable level) because of insufficient funding? Thus, it is somewhat of an iterative process to determine the right desired cost of service/level of service relationship for the Municipality's assets taking into consideration its financial position.

Performance Measures and Monitoring: Performance monitoring relates to comparing the actual level of service to the desired level of service. This is an essential tool for sustainability. Monitoring provides the confidence that the asset is being sustainably managed, or it alternatively alerts decision-makers to the need for change if results are demonstrating that current practices and costs are not sustainable. For performance to be monitored it first needs to be measured viz:

- Is performance of the asset monitored?
- Is there a gap between current and desired performance?
- Is there an improvement plan to increase performance?

Assess Asset Renewal Alternatives

There should always be some consideration of whether viable alternatives exist for a proposed asset renewal. Then if viable alternatives exist, which option is the most appropriate and/or cost effective for the situation. Alternative options need to be evaluated to come up with the best practical program. This may or may not be the optimum treatment in all cases, but it should be the most appropriate and effective treatment within the constraints of available funds, site conditions and local circumstances. Assessing Asset Renewal Alternatives means looking at [5–7, 11]:

- Technologies and methods to replace an asset by a method that is different to how the asset was originally installed
- Technologies and methods that do not replace the asset but are appropriate to the circumstances
- New and emerging technologies relating to asset replacement or in-place rehabilitation.
- Assessing asset renewal alternatives because there can be circumstances where it is necessary to consider an alternative treatment option for replacement of an asset e.g.:

1. Limited Funds: if there is insufficient funding to complete all the necessary asset renewal

work by traditional or expected methods it will be necessary to look at alternative options such as:

- Interim (non-renewal) treatment that will extend the life of the asset and defer the current renewal for number of years.
 - Cheaper (renewal) treatment that will replace the asset but may not last as long as the original or preferred treatment if funding had not been limited.
2. Limited Site Conditions: This relates to situations where site conditions have changed since the original asset was installed and a different construction method will now be required.

The process for assessment of alternatives for asset renewals will depend on:

- The quantum and complexity of programmed work
- Whether any treatment selection tools are already in use
- The structure of the Municipality and the responsibilities of various positions.

The following is a basic process for assessment of asset renewal alternatives:

Options: Identify viable alternatives to proposed renewal project.

Evaluate: Consult other personnel as relevant to the project. Define a process for comparing and assessing renewal options.

Selection: Determine the preferred renewal option then document the assessment and why the option is preferred.

Review: Consider process and outcomes to determine if the parameters used remain appropriate. Follow-up on the outcome of implementing preferred renewal option and document actual benefits achieved.

Assess Asset Maintenance Strategies The existence of an Asset Maintenance Strategy provides guidance to ensure all work tasks are focused on achieving the same goals. It also provides for knowledge transfer when key people retire, or staff change. An Asset Maintenance Strategy is a document that identifies [5, 11]:

- Key goals that maintenance activities seek to achieve
- Service level to be maintained
- Parameters or criteria to be used for decision-making
- Rules and standards that the activity must comply with or within which it must operate.

Without a strategy document it can be difficult to verify that:

- There are controls for maintenance activities
- Assets are being maintained in a best practice, cost effective manner
- Alignment exists between maintenance activities and Municipality goals
- Maintenance activities supports sustainability
- Decisions are being made within known parameters in a responsible manner [11].

Implement Assessing Asset Maintenance Strategies: The assessment of current maintenance strategies is part of the process for developing and keeping a maintenance strategy up to date. If the Municipality does not currently have an Asset Maintenance Strategy, then the steps to generate one are [5, 11]:

- (a) Consider (and document) how maintenance options are currently being decided and by whom
- (b) Identify and document what the maintenance goals are and any criteria or rules applying to maintenance decisions

- (c) Identify what the typical maintenance options are
- (d) Evaluate the maintenance options using the decision criteria and rules
- (e) Develop and document a maintenance strategy that defines how maintenance work is to be done to achieve the maintenance goals
- (f) Monitor maintenance activities and review overall outcomes once a year
- (g) Based on the outcome of the maintenance activities, determine if any of the decision criteria for the Maintenance Strategy should be changed.

Each asset group may have a separate strategy, or these may be combined into one strategy document. This will depend on the size and structure of the Municipality. If maintenance is managed by different people for different asset groups, then it is more appropriate to have separate strategy documents [5, 11]. The basic process for development and periodic review of an Asset Maintenance Strategy is as follows:

- Identify Maintenance Options
- Evaluate Options using Decision criteria
- Develop maintenance strategy
- Monitor and review outcomes
- Identify goals and decision criteria

Alternatively, the Municipality could apply the Reliability Centred Maintenance (RCM) methodology to develop maintenance strategies.

Maintenance as a Catalyst for improvement in asset management: To improve the maturity of asset management, the Municipality needs to have clear line of sight of the current practices and a vision of the end state. Using the Maintenance infrastructure (viz, people, assets, processes, technology, etc.) asset management can be introduced. This to be done thru' a change management programme. An incremental improvement in the maintenance landscape (elements that are fundamental building blocks of maintenance) is an ideal catalyst for introducing Asset Management and improving it, as detailed in Fig. 5.

Most Municipalities, to some extent, have a maintenance requirement and presence of the key building blocks required. As a result of this being available, the introduction and change management of asset management should begin here. Remembering that Asset Management is a journey, that progresses from innocence to excellence, there is a greater chance of success by introducing and implementing in the Maintenance institution. The maintenance landscape comprises of various components; some of which are the Computerised Maintenance Management System (CMMS), Maintenance Strategies, Planning, Scheduling, Maintenance Monitoring, etc. In improving the practices of the Maintenance landscape, there are 3 levels of maturity. The Maintenance Landscape elements and what needs to be done in each level is mapped in Fig. 6.

2.3.3. Understanding the Financial Situation

Current Asset Investment

This is an assessment of the current monetary value of the assets. Current Asset Investment is a measure of the assets value in terms of:

- What would it cost to replace the asset today (current replacement value)
- What value is the current asset considering its age (current depreciated value)?

Understanding the value of an asset helps to make good decisions about the best way to operate, maintain and plan for replacement of that asset. All measures of value are useful for asset management. Historical cost is a true and correct record of what the asset was worth when it was installed. Current replacement cost, however, is a better measure for decision making. This is because current replacement cost [5, 11]:

- Can be determined with reasonable confidence through current contracts, labour rates and suppliers' price lists
- Can be easily understood in terms of magnitude because people compare the cost to other items, they are familiar with
- Is directly comparable across all assets, which makes judgement on one asset versus another relatively easy
- Can be used along with the asset age details to determine the current depreciated value (i.e. how much the asset is worth in today's value?)

An understanding of Current Asset Investment is useful to determine [5, 11]:

- How long before we need to replace this asset
- How much should we put aside per annum to fund asset replacements
- What is the asset currently worth (depreciated value in today's value)
- Should we keep fixing it or should we replace it
- When should we replace it (from an economic point of view)
- Do we have any big financial hurdles looming up in the foreseeable future?
- Are there other options to provide this service, with or without this asset or with a different more cost-effective asset?
- Can one prove that the Municipality is sustainable?

Consideration of value is mandatory for sustainable business. The tasks that should be completed and the information that should be recorded include [5, 11]:

Calculate current replacement cost (CRC) for all asset components: To calculate credible CRC values, the essential attributes discussed in Identifying 'Asset Inventory' must be known for each component, or reasonable default assumptions and estimates made for missing data. In addition to this, a table of typical rates for current replacement cost of each type of component must be available or able to be produced. It is important to know if any valuation information exists and the date that it was relevant for. If no valuation data exists, then this needs to be completed.

Calculate current depreciated value for all asset components: Similar to 'a' above, understanding the depreciated value (or current value of aged asset) will also support good decision-making. It can be used to establish 'flags' to know when to repair and when to replace an asset component. It can also be used to trigger implementation of different treatment options.

Documentation of Assumptions and Default values: Details of all key assumptions and default values used in the calculations must be recorded and available to the people who use the cost information for planning and operational decisions.

Current OM Costs

OM stands for Operations and Maintenance. These costs are often grouped together but relate to different activities. Operational costs relate to activities that are necessary to operate the asset or to provide a service using that asset. Many operational costs cannot be assigned to a particular or specific asset as it is a function that relates to the whole network or to the service being provided. Maintenance costs however relate to the cost of actual physical repair work to a specific asset or group of assets. The physical repairs reinstate the function of the asset or assets but do not fully replace the asset, nor does it extend the life of the asset significantly beyond what was originally expected. The following is a simple guide to differentiate New Capital work, Renewal, Maintenance and Operations [5, 11]:

- Will the work add a totally new asset? If yes, then it is Capital New
- Does the work replace an existing asset or return it to near its original condition? If yes, then it is Renewal
- Does the work repair an existing asset and/or return its intended function? If yes, then it is Maintenance
- Is the work necessary for the function of the asset or part of the service provided? If yes, then it is Operations

As time progresses and assets age, the occurrence and cost of maintenance repairs for any particular asset will increase. At some point in the life of an asset it will no longer be economic to repair the physical asset and it should be replaced [11]. To get the best value for money will need tracking the maintenance costs to know when to intervene with the right type of treatment. Tracking operational costs can similarly assist in optimising operational activities. However, when operational costs are mixed with maintenance costs, the financial information is not useful for managing the asset or optimising costs. It is desirable therefore that Operational costs and maintenance costs are separately recorded, and Maintenance costs are tracked against the relevant assets on which the work was done [5].

There are many advantages and opportunities that become available when operation and maintenance costs are separated, and maintenance costs are tracked against the relevant assets. These include[5, 11]:

- Having an indication of likely condition and remaining life of an asset, based on how much maintenance work and the type of maintenance work that has been required over a period
- Understanding when it is no longer economic to continue to repair an asset and it should be programmed for replacement
- Identifying cost trends and adjusting operation and maintenance decisions and initiatives where necessary
- Being able to report on the cost of providing a particular level or standard of service and therefore being able to quantify the likely cost outcome or consequence for decisions or proposals to increase or decrease aspects of the level of service provided
- Being better able to assess the long-term liability (whole of life cost) associated with any proposal to construct new assets or approve developments. This will enable decisions related to such assets, to be made with the full knowledge of what the cost obligations for ongoing operational and maintenance will be in addition to any project construction cost

- Generally better-informed decision-making that will enable costs to be optimised.

All Municipalities will have financial records for operation and maintenance expenses. However, the current structure used for expense recording may not easily identify maintenance costs separately from operational costs. In addition to this, for some Municipalities, the definition of what is a maintenance expense versus an operational expense will not be clearly documented or widely understood. As such there is a need to collaborate with Finance Department and all other departments and work groups associated with assets across the Municipality. Together, discuss the financial information needs that each group has, and agree on the most effective cost recording structure for the Municipality. This structure then needs to be implemented along with training of personnel to differentiate between what are maintenance costs, operations costs, renewals or capital new costs [5].

It is important to provide the following information to track expenses [5, 11]:

Current and Historical Operations and Maintenance Costs: Ideally this information should be tracked for 5 years or more to identify cost trends which can be used to inform predictions of future costs. This will take time to build up if no separated historical costs are currently recorded therefore it is important to agree and implement a suitable cost structure and reporting procedures as soon as possible.

Details of maintenance expenditure recorded against relevant asset components: This breakdown of cost information may not be currently available, but procedures should be put in place to enable tracking of maintenance costs at the component level in the future. Operational costs can still be tracked at a total for the entire asset group or recorded by activity type, but maintenance costs relate to the condition and remaining life of a component therefore costs should be able to be reported by component.

Have a discussion, with supporting cost data to indicate whether current maintenance expenditure is sufficient to maintain the asset without generating or increasing deferred maintenance levels: Initially there may be insufficient information to assess this with any certainty therefore at the basic asset management level the response would have to be a comment based on the experienced judgement of a suitably qualified person. However, in time it will be possible to start comparing maintenance expenditure to asset condition. Eventually it will be possible to provide trend information and factual evidence to verify if maintenance expenditure is sufficient or whether asset condition is deteriorating.

Future Capital Costs

Future capital costs is an estimate of the most likely future funding needs. It is usually determined for at least a 20-year forecast. Capital costs refer to costs for new assets and costs for replacing existing assets as they age. Understanding likely future costs is critical for responsible and effective management. It is only by looking ahead that it is possible to gauge the long-term affordability of continuing to operate and manage the assets in the same way as we do now. Future cost forecasts also provide warning for potentially adverse financial impacts. This forewarning provides opportunity to [5, 11]:

- Make suitable preparations to cope with the situation
- Take action to reduce the likelihood of the situation occurring
- Put in place measures to reduce the extent of adverse impact.

Future cost forecasts are therefore a fundamental component of ensuring long term sustainable management of the assets. As a minimum the following details, with respect to Future Capital Costs, should be known and documented for a planning period of at least 20 years [5, 11]:

- Predicted cost for new assets (including upgrades and significant improvements as well as new assets or components)

- Predicted cost for replacement of existing assets.

Funding Sources

Funding sources refer to all the options where funding could come from and an estimate of how much that funding will be. The main funding sources for public assets will typically comprise of [5, 11]:

- Taxes
- Fees and Charges
- Reserves
- Grants
- Loans.

However, there could be a variety of other non-tax funding sources that are relevant to a Municipality. Understanding where funds come from, how they can be used and how much can be expected, is equally as important as knowing how much money needs to be spent. Both income and expense are needed to determine if [5, 11]:

- Current levels of service are affordable
- The way assets are managed is sustainable.

In addition to this, assessment of income from various funding sources will [5, 11]:

- Provide forewarning of potential cash flow problems
- Identify funding shortfalls
- Identify anomalies where reserves may be being built up for a particular purpose but are needed for a different purpose.

These circumstances may be manageable if sufficient forewarning is given and appropriate action taken. The fact that a shortfall in funds or cash flow challenges are predicted does not necessarily mean the current level of service is unsustainable. These issues may be short term issues and the overall long-term situation is affordable. Alternatively, these issues may be indicative of an escalating situation which is destined to become unaffordable. It is essential therefore that equal consideration is given to assessing future income as predicting future costs. Understanding the full financial picture sooner rather than later allows appropriate decisions to be made and action to be taken to ensure adverse financial dilemmas are avoided [5].

2.3.4. Decision-Making

Evaluate Decision Processes

Evaluate Decision Processes means to think about all the key decision areas regarding assets and services and to identify who is responsible for making these decisions, what information they use and whether there is any procedure on how they decide. This establishes what the current decision process is. After that, consideration is given to what the ideal decision process should be. This includes looking at how the decision should be made, who should be involved and what information they should have. This establishes the desired decision process. The difference between the current process and

the desired is the improvement gap. Good decision making is an important part of being efficient and sustainable. Decision processes must be fair, transparent, and robust. This is particularly true in a public organisation environment where a high level of accountability is expected. All important decision processes should therefore be documented and periodically reviewed. Reasons for evaluation and documenting decision processes are [5, 11]:

- **Identify Improvement:** Once a decision-making process is documented, it is easier to objectively see where improvements in the process can be implemented.
- **Quality Control:** Documented procedures help maintain consistency of approach over time. Consistency of approach allows comparison of results over time to track changes. It also makes the decision process more robust and defensible if challenged.
- **Business Continuity:** The basis used for making each decision (and the data inputs) are evaluated and recorded as part of documenting the decision process. This allows continuity when personnel changes inevitably occur.

Evaluating the Decision Processes Strategies

The initial evaluation of decision processes includes the following [5, 11]:

- Review and document the current decision processes
- Identify and document desired decision processes
- Document the improvement gap between current and desired processes.

Documenting a decision process means writing down who is responsible for making certain decisions, how they go about making that decision, the information that is used, the criteria that is considered, and if any assessment tools or scoring methods are used, what these systems are. To begin with, the process may simply be that personnel in charge use their judgment to make the decision based on their personal knowledge of the situation. Once recorded, the decision process can be improved as and if appropriate. This is achieved by determining the desired or ideal decision process and comparing this to the current process to identify what needs to be improved. The key objectives for desired decision processes are to ensure that [5, 11]:

- All important decisions are robust, consistent and repeatable
- Decisions are not subjective unless this is deemed appropriate
- The person accountable for a decision has all the necessary information
- Any assessment tools being used are being applied correctly and appropriately.

Accountability is an important issue when evaluating decision processes. Consider whether the person currently responsible for a decision is in the best position of knowledge to make that decision. Consider the risks associated with the decision. Determine whether appropriate risk issues are considered in the decision process or not. Understand what critical pieces of information are required for good decisions. It is then possible in a review to assess who is the best person to be responsible and accountable for the decision. In the evaluation processes it is also important to determine if there are any assessment systems, rating or scoring systems or priority ranking methods currently being used to

assist decision-makers. Are these tools appropriate and accurate? Do any of these tools or systems allow decision-makers to make fair comparisons between assets or between asset groups? Are these systems being used correctly and to their potential? Alternatively, if no tools are currently being used, should they be [5]?

Improvement Plan and Process

An Improvement Process involves reviewing current practices, determining if anything needs to be changed and developing a plan to implement changes. Generating and implementing an improvement plan is fundamental to sustainable asset management. This is because [5, 11]:

- There are always things that can be improved over time
- Parameters change, assets age, funding levels change
- Customer expectations change
- The actions taken today cause change
- In response to change it is prudent to check if the original action plan is still the most appropriate course of action.

Developing an Improvement Plan and Process: A basic process for an improvement plan is any process [5], including

- Identifies improvement tasks
- Assigns responsibility for completing the tasks
- Determines what funding is required
- Documents the tasks in a schedule for completion (Improvement Plan)
- Has a regular review cycle (typically completed at least once per year).

The process could be completed by one person, by committee or by independent review. It should be as simple or detailed as is appropriate to the Municipality, the assets and the amount of information available to base an assessment on. The process should always be documented even if this is a simple paragraph of explanation as to who, why and how often the improvement plan is reviewed and updated. Over time the Improvement Plan process should consider the results of measured performance as a means of gauging whether current practice is achieving desired results. All improvement plan processes must include consideration of long-term goals and some form of assessment as to whether any current practices need to change. The following outlines the key steps of a basic Improvement Plan process [5]:

- Understand what happens currently vs long term goals
- Identify areas of improvement to current practice
- Determine how to action the improvements
- Set a schedule of tasks with timelines
- Assign responsibility for each task

- Provide funding
- Monitor that tasks are completed to time and budget
- Review if the task has achieved desired improvement
- Consider the new improved (current) status
- Repeat process at least annually.

The initial Improvement Plan and Process may or may not include some assessment of relative priority between one task and the others. However, over time some form of prioritisation should be included in the process and used to set appropriate timing and support funding applications [5].

Prioritised Improvement Plan

The Prioritised Improvement Plan referred to is a list of tasks or actions for implementing improved asset management practices. A prioritised improvement plan consists of listing the improvement tasks in order of importance or priority. As well as being ordered by importance. Each task in a prioritised improvement plan should also have a specified budget and timeline for completion. The plan should also note against each task, the name of the person responsible for ensuring the work is completed to time and budget [5, 11].

Purpose of a Prioritised Improvement Plan: Most Municipalities will not have sufficient funding and resource to action all the desired Asset Management improvement tasks as and when they are identified. Typically, the work will be staged over a number of years with budget allocated specifically for completing planned tasks. Tasks will therefore need to be ranked to ensure the most important works are completed first. Budget allocations will need to be determined to ensure sufficient funds are allocated to complete each task. Setting timelines and assigning responsibility for completion of each task are strongly recommended to encourage successful implementation of the plan. A list of desired tasks that do not have budgets are unlikely to be completed regardless of their priority ranking. Similarly setting timelines and assigning responsibility encourages action [5, 11].

Developing a Prioritised Improvement Plan: A basic process for prioritising an improvement plan is to:

- Determine what criteria should be considered to assess importance of a task
- Establish a scoring system for the criteria
- Assess each task according to the criteria and scoring system
- Order tasks by outcome score (priority).

The process must be documented and repeatable. It should use measurable rather than subjective assessments for each criteria and be as simple or detailed as appropriate to the Municipality, the assets and the amount of information available for the assessment. The documentation of the prioritisation process should explain the criteria, how they are measured and why they were selected. Secondly it should explain the basis for and application of the scoring system. And thirdly it should identify how often the prioritisation process should be applied and when the overall process, scoring system and criteria should be reviewed. There are many options for criteria and scoring systems to use. However, it is important that a clear link can be shown between the prioritisation process and the Strategic Goals of the Municipality. This will ensure that improvement of asset management practices is consistent with the objectives of the Municipality [5].

2.3.5. Knowing the Rules

Strategic Goals

The strategic goals of the Municipality are the guiding principles for all activities of the Municipality. They are usually printed in a strategic plan document and reported on annually. It is common for strategic goals to incorporate sustainability objectives as well as social, economic, environmental and governance goals. Knowing about Strategic goals is important because everything that is done and every decision that is made within the Municipality should be in keeping with and supportive of the strategic goals. If individual departments and work groups are operating in isolation to the strategic goals, they may not be completing work that is necessary to achieve those goals. They may also be doing additional work that is not required by the strategic goals and therefore spending funds inefficiently [5, 11].

In applying the Strategic Goals to Asset Management, the first step is to be aware of what the Strategic Goals are for the Municipality. The second step is to be aware of your relevant stakeholder groups and consult on what their expectations are for management of the assets and delivery of services. The third step is to define supporting 'business level' goals. These should be written for each major asset group (i.e. Electricity, Roads, Water, etc.). The wording of these goal statements should clearly indicate how both stakeholder expectations and strategic goals can be met by management of the assets. The business level goals establish a tangible bridge between all the activities related to the assets, and the strategic goals of the Municipality. The information required to be known and documented for this task includes [5, 11]:

(a) Municipality Goals

Strategic Goals: Details of the Municipality goals and objectives relating to assets should be stated. It is very important to keep focus on the relevant high-level objectives and goals when making significant decisions about an asset. The first step toward ensuring decisions and actions are consistent with the direction and long-term strategy of the Municipality is to be aware of the Municipalities strategic goals.

Asset Group Goals: Details of the business level goals for each asset group should be stated and where known, the relationship between business (asset group) and corporate (strategic) goals documented. At a basic level of asset management practice, the connections between asset group and strategic goals may be unclear. In this case, the asset group goals (if they exist) should be stated and an improvement task identified to review these goals and define the connection to the corporate goals. This may need to include redefining the asset goal statements if necessary, so that they support the strategic goals. At an intermediate and advance level of asset management practice the connections between all of the following aspects of asset management should be clearly understood and documented:

- Strategic goals
- Stakeholder goals
- Asset group goals (business level goals)
- Levels of service
- Performance targets

(b) Stakeholder Goals

Stakeholders are the people who have an interest in the asset or the associated activity or the community or the land or natural environment that may be impacted by activities associated

with the asset group. Part of good stewardship is consultation with stakeholders prior to making significant decisions. It is therefore important to know and have an up-to-date list of who the interested parties are and their contact information. This list should be regularly reviewed (at least annually) to ensure it remains current.

Stakeholder Expectations: At a basic level of asset management practice, there may or may not exist some communication forums such as periodic interest group meetings that can be used for consultation on stakeholder (or user/community) expectations. If these exist, they should be documented and the process for communication with that group also documented. However, for many Municipalities, consultation with stakeholder occurs at a corporate level only and relative to a specific project or to strategic planning. Whatever the Municipalities means and procedure for understanding stakeholder expectations is, it should be documented. At an intermediate and advanced level of asset management practice, there would be more detail available on stakeholder expectations and there would be some level of formal on-going communication with stakeholders implemented. This may include a communication plan and documented consultation procedures, or similar documents can be referred to. These documents could be corporate level documents governing all asset groups and activities.

Legal Obligations and Standards

Legal Obligations and Standards relates to all legislation, regulation, policies, standards, and any other requirements that impact on or relate in some way to the assets or the services associated to them. Essentially, reference should be given to any document that [5, 11]:

- Sets out parameters within which the asset must be operated
- Has a requirement or condition that the asset must comply with (i.e. the ‘rules’).

These requirements can generally be grouped into legal obligations (legislation and regulation) and general standards (industry best practice, guidelines, policy).

Documenting references to Legal Obligations and Standards: Understanding the ‘rules’ within which the asset must operate is essential to being able to effectively manage legal compliance. Many asset activities and services have numerous rules from numerous sources. It can also be difficult to prove all activities are fully compliant with necessary requirements. Simply since data about what must be complied with and how it is monitored are embedded within numerous documents. Therefore, having a single collated list with reference to all relevant legislation, regulation, policies, standards and other requirements, will provide:

- A means to effectively transfer corporate knowledge on compliance when staff changes occur
- A check list for compliance auditing
- A ‘big picture’ overview to:
 - Increase understanding of the rules
 - Identify the relationship between various rules
 - Define the comparative importance of different rules
 - Select opportunities for efficiency in compliance monitoring (i.e. where one test or check being done for one rule can also be used to confirm compliance with another rule)
 - Highlight opportunities operational savings (i.e. where operational effort can be streamlined without compromising legislative compliance).

Documenting references to Legal Obligations and Standards: As with most asset management practices; the starting point is to document the current status or situation. Then as necessary and appropriate to effect improvements from that point. In the case of rules and regulations, it is possible that some personnel in some Municipalities may not be fully aware of all the requirements that apply. Therefore, the first step is to document what requirements and rules are generally known. This can be done relatively quickly by holding a meeting of relevant personnel and documenting from the shared knowledge, the requirements that each person is aware of. Most Municipalities will have people who are highly familiar with:

- The main compliance requirements
- The method of monitoring compliance
- The location of compliance results
- The current compliance status
- Any relevant historical issues.

This first list will document this corporate knowledge. Following this (if necessary), an appropriate person could be tasked with researching the documents identified from the meeting. This research would be aimed at confirming the specific clause numbers or relevant reference to be included in the collated list. Depending on the degree of corporate knowledge, the researcher may also review the document for any other requirements that may exist but were not initially noted. This process will assist in expanding the corporate knowledge and improving overall compliance and reporting. The details to be determined and recorded for this task are to provide a list of all relevant rules. This includes [5, 11]:

- a) Legal Obligations** : This refers to legal documents that impact on or relate in any way to the asset and its operation e.g. Occupational Health and Safety Act.
- b) Standards and Guidelines** : This refers to all other non-legislative or contractual rules and obligations that impact on or relate to the asset or its operation e.g., NRS Documents.
- c) Corporate Policy** : This refers to all relevant in-house policy documents that impact on or relate in any way to the physical assets, the services provided by the assets, or any activities associated with the assets. The response to this should as a minimum be a list of the policies and relevant reference number or date of policy, or the file reference for a document that holds this information.

2.3.6. Monitoring for Sustainability

Sustainability Assessment: The overall objective of Asset Management Practice is sustainability. A Sustainability Assessment is a review of whether sustainability goals are being met. This will include an assessment of current business processes and outcomes relative to sustainability goals. The sustainability goals of a Municipality are usually documented in a Sustainability Plan or Charter. They may also be incorporated into the Strategic Goals. All activities within a Municipality should be consistent with achieving sustainable outcomes [5, 11].

Purpose of a Sustainability Assessment: At a corporate level, having sustainability goals does not necessarily mean that a Municipality is sustainable. Likewise, at an asset management level, implementing sustainability programs (such as energy efficiency targets; reduction of carbon footprint; or greenhouse gas emissions etc.), does not mean the assets and services are sustainable. A Sustainability Assessment however compares the outcome of asset activities to the ideals of the Municipality's' sustainability goals. This is necessary to identify if [5, 11]:

- The sustainability goals are being met and the outcome of asset activities supports sustainability
- The business goals for management of the assets are promoting sustainability
- The sustainability goals are still appropriate and provide the right drivers
- The sustainability goals should be amended.

Implementing Sustainability Assessments: The information to be determined and documented for this task are [5, 11]:

- (a) Current Sustainability Status: Consider the following questions and complete a review of programs, procedures, and results to provide answers.
 - What processes are currently in place that contribute towards sustainability?
 - What is the current assessment of how sustainably the assets and activities are being managed?
 - What evidence is there to support this assessment of current sustainability?
 - The detail of the review and the process for assessing sustainability should be subject to on-going improvement to incrementally increase confidence in the outcomes.
- (b) Desired Processes: With consideration to the current sustainability status of the management of each asset group, identify the following:
 - What processes should be implemented to better ensure long-term sustainability?
 - What strategies are needed to manage long-term sustainability of the asset?
- (c) Improvement Gap: For this task, answer the following:
 - What is the gap between current processes contributing towards sustainability and those processes desired to ensure sustainability
 - What specific action should be taken to address the gaps identified
 - What measurements should be used to assess the level of sustainability being achieved?

The actions identified from this review of the ‘improvement gap’ will then be added to the overall improvement plan.

Co-ordinating Infrastructure Works

Co-ordinating Infrastructure Works refers to taking practical steps to try to coordinate physical works projects for the purposes of saving on total costs by combining projects where possible, reduction in overall disturbance and increased confidence in efficiency of Municipality. *Purpose of Co-ordinating Infrastructure Works:* Co-ordinating physical work programs (wherever practical), across the entire Municipality is an action that will identify opportunities to [5, 11]

- Reduce total project cost to the community by:
 - Collaborating and cost sharing on work elements
 - Eliminating duplication of work elements on different projects
 - Obtain more competitive pricing for bundled work
- Improve service standards
- Reduce disruption

- Identify innovative solutions
- Increase understanding of issues for different asset groups
- Collaborate in other service areas for increased efficiency

The expected outcomes of project/program co-ordination will also support sustainability objectives by optimising costs and reducing adverse impacts on the community [5, 11].

Implementing procedures to Co-ordinate Infrastructure Works: Some Municipalities may already have varying degrees of program co-ordination in place. Co-ordination processes could be basic or detailed depending on the needs of the Municipality and the quantity and complexity of projects. The co-ordination process could be as simple as scheduling a meeting of relevant staff once a year to review and discuss each of their physical works programs. The objective of the meeting will be to identify opportunities to co-ordinate project work, agree on actions to take and document outcomes. In other circumstances the co-ordination process may need to be more sophisticated. Where the physical works programs that need to be coordinated are large, it may be appropriate and efficient to use some database analysis [5, 11].

Another option is to use GIS spatial queries to identify projects that are in the same location. These projects can then be reported, and appropriate scheduling and co-ordination agreed between the relevant managers of the assets or projects. The first step therefore is to identify and document the current procedure for co-ordination of infrastructure works programs. Note it is important that some procedure exists. Therefore, if there is none currently, then at least the minimum requirement for an annual co-ordination meeting should be implemented. The next step is to consider if and how the co-ordination process should be improved. And if improvement is desired, what actions need to be implemented. These improvement actions can then be completed, and the co-ordination of infrastructure works undertaken. All of this should be documented. What process is appropriate and practical for the Municipality could be entirely different to what is appropriate for another Municipality. The points to consider when establishing what approach is best suited include the following [5, 11]:

- The quantum and complexity of work to be co-ordinated
- The overall quantity of assets managed by the Municipality
- Whether any co-ordination procedures or tools are already in use
- The size and structure of the Municipality
- The expected savings that co-ordination could realistically achieve
- The number of staff that will need to be involved in the co-ordination decisions.

It does not make sense to have a highly sophisticated procedure for program co-ordination, utilising advance computer software and detailed analysis if the program for physical works projects for the entire Municipality is developed by one or two persons and the quantum of work and potential cost savings and customer benefits are small. For a Municipality like this, a simple procedure requiring that at some point a meeting is held with relevant people and the opportunities to coordinate work are considered and appropriate action taken. The tasks to be completed for program co-ordination include [5, 11]:

- (a) *Identify Current Program Co-ordination:* Identify whether any degree of co-ordination of physical works projects currently occurs. If it does, describe how this co-ordination is done.

At a more advanced level of asset management practice, this would include a formal detailed procedure, evidence that this occurs, and some discussion of the successful outcomes achieved.

- (b) *Identify Process Improvements*: Consider the successful outcomes achieved from the current co-ordination procedure, or any adverse events that have occurred due to the lack of program co-ordination process. Then identify what actions need to be completed to improve program co-ordination. These actions can then be added to the overall improvement plan for managing assets.

2.4. Stakeholder Management

Asset management requires multi-level consultation and communication at different stages of implementation. It also requires on-going consultation after implementation for continuous improvement and management of change. The three main levels of Consultation are [5, 11]:

- With Council
- Within the Municipality
 - Between colleagues
 - Between Organised Labour, work groups and committees
 - Inter-departmental between heads of Departments
 - Consultation with and Reporting to Corporate Management
- With Customers and Stakeholders.

Consultation with Council

The time to start consultation with Council will vary depending on many factors specific to each Municipality. However, as a guiding principle, the sooner one consults with Council and obtain buy-in from the elected representatives the better. The counter to this is going to Council too soon with insufficient information. Ideally one should go to Council when one is able to clearly demonstrate or describe what the benefits of Asset Management Practices will be. Preferably one should be able to present at least one tangible example that is relevant to one's Municipality. After Council approval to progress implementation of asset management practices, it is important to regularly report back on progress. The Asset Management Champion needs to be committed to measuring progress in tangible ways and maintaining momentum through good communication [5, 11].

Consultation within the Municipality and Organised Labour

Consultation and collaboration should commence immediately within the Municipality and should be strongly encouraged through asset management practices. There is a particular need for Organised Labour, Finance, Engineering and other departments to work closely together on asset management practices to share different perspectives. This will improve the overall quality and robustness of decision-making, since each group manages different aspects of asset management. Much of the power of asset management to effect real change in a Municipality is in bringing together different perspectives and sharing available data [5, 11].

Consultation with Customers and Stakeholders

It is unwise except in special circumstances, to consult with customers and stakeholders until one has a good understanding of relevant critical issues such as [5]:

- The current and future financial situation, forecast for at least 20 years
- The current level of service and cost of service
- The key legislative obligations and standards that control activities

- The gap in data (i.e. what is not known at this time).

If one does not understand these, then consultation with customers will be ineffectual due to insufficient data to make decisions. It may also generate false expectations for services that cannot be delivered because they are subsequently found to be unaffordable or unsustainable [5].

3. Conclusion

Implementing asset management practices may seem like a very daunting task to Municipalities just starting on the asset management journey. The overall goal of asset management is to provide sustainable services. This requires flexibility and adaptation to changing circumstances. It is important that business decisions are made in the context of the latest information. This will ensure that they are equally applicable to the current situation and to affecting the long-term sustainable goal. In the same way therefore, it is important that all asset management practices are treated as 'live' and evolving. For it is the outcome of the asset management practices that effects and informs business decisions.

When one begins this journey, one soon realises that many of the ideas, concepts, and or tasks may already be part of one's daily operations and culture. For Municipalities wanting to embark on the asset management journey and introducing asset management practices it should be noted that creating and maintaining an Asset Inventory is sound business management. Asset data does not require data to be fully complete or highly accurate, provided that what is known is sufficient for day-to-day management of the assets. Some attribute information may not be known about the assets. Where key attributes are unknown, some assumptions or default values should be used until these can be replaced with verified data.

In Managing the Asset Lifecycle, the role of maintenance management has a much larger significance to the Municipality than just keeping assets functioning. Timely intervention with the right techniques can extend the life of the asset for a cost saving to the Municipality. Conversely, poor decisions on maintenance intervention and treatment will increase costs. When a maintenance strategy exists, and it is regularly assessed, the Municipality can have greater confidence that maintenance work is being optimised. It is important to identify and monitor maintenance outcomes to know if the current way of doing work is still appropriate. If it is not, changes can be made, and outcomes reviewed again the following year.

For renewal projects, some consideration of whether viable alternatives exist for proposed renewal projects should be undertaken. The process may be simple and only involve one or two people. Whatever the current process is and any tools or software programs (if any) used, it should be documented in a standard operating procedure. The process to assess asset renewal alternatives should be tailored to suit the Municipality, the number of renewal projects and the annual budget for renewal projects.

It should be noted that a good knowledge of asset value supports good management decisions and sound financial planning. At a basic level, the calculation can be based on relatively high-level generic unit rates. However, it is desirable even at the basic level of asset management practice to calculate and record this information at asset component level and then aggregate results into overall summaries. This will then provide the platform for progressively improving the quality of cost data as more information becomes available. At an intermediate and advanced level, it is expected that costs will not only be known with more certainty and confidence but that the systems and procedures for keeping this information current and relevant will also be fully implemented. The primary reason for tracking operations and maintenance costs is to save money. Knowledge and tracking of maintenance and operational cost is also an important input to the long-term sustainability of the assets and the services they provide. This is because to be sustainable one must find the right balance between the cost to provide a service, the level or quality of service provided and the ability of the community to pay that cost.

Good decision making is an important part of being efficient and sustainable. Decision processes must be fair, transparent and robust. This is particularly true in a public organisation environment where a high level of accountability is expected. All important decision processes should therefore be documented and periodically reviewed. In preparation for the development of an improvement plan, it is good practice to record improvement ideas and recommendations resulting from other asset

management practices e.g. many asset management practices include a review of current practice and some include a gap assessment. The outcomes of these identify improvements. Some of these improvements may be implemented as part of that process but others will just be noted. These tasks that are noted but not implemented should be included in the overall improvement plan and prioritised along with all the other improvement tasks. The improvement plan must consider all aspects of asset management practice, such as improvement in asset data, condition data, value information, management systems, decision processes and anything that will progress and enhance effective and sustainable asset management. In considering prioritisation methods and scoring systems, Municipalities are encouraged to focus on defining how important a task is to the long-term goals of the Municipality. This will avoid the trap of becoming asset focused instead of activity or service focused. The assets are used to provide a service and it is provision of the service that must take precedence. Management of the assets is then designed to fit that service provision.

The success of asset management implementation depends very strongly on multi-level consultation and communication at different stages of implementation. It requires on-going consultation after implementation for continuous improvement and management of change.

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