

The Maintenance Framework

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English Version



GFMAM

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& Asset Management

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The Global Forum on Maintenance and Asset Management

The Global Forum on Maintenance and Asset Management (GFMAM) has been established with the aim of sharing collaboratively advancements, knowledge and standards in Maintenance and Asset Management.

The members of GFMAM (at the time of issue of this document) are:

- Asset Management Council (AMCouncil), Australia;
- Associação Brasileira de Manutenção e Gestão de Ativos (ABRAMAN), Brazil;
- European Federation of National Maintenance Societies (EFNMS), Europe;
- French Institute of Asset Management and Infrastructures (IFRAMI), France;
- Gulf Society of Maintenance Professionals (GSMP), Arabian Gulf Region;
- Iberoamerican Federation on Maintenance (FIM), South America;
- Institute of Asset Management (IAM), UK
- Japan Institute of Plant Maintenance (JIPM), Japan
- Plant Engineering and Maintenance Association of Canada (PEMAC), Canada
- The Society for Maintenance and Reliability Professionals (SMRP), USA.
- The Southern African Asset Management Association (SAAMA), South Africa

The enduring objectives of the GFMAM are:

- 1) To bring together, promote and strengthen the maintenance and asset management community worldwide
- 2) To support the establishment and development of associations or institutions whose aims are maintenance and asset management focused
- 3) To facilitate the exchange and alignment of maintenance and asset management knowledge and practices
- 4) To raise the credibility of member organizations by raising the profile of the Global Forum

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1 Introduction

1.1 Background

The Global Forum on Maintenance and Asset Management (GFMAM) has an objective of collaboratively sharing collected advancements, knowledge and standards in both maintenance and asset management. This document has been developed by an interested subset of these member organizations (indicated below in bold font) to develop a common understanding of Maintenance management and how it contributes to the delivery of business outcomes.

It has been drafted to align with the “Asset Management Landscape”, a document published by the GFMAM.

The members of GFMAM include:

- Associação das Empresas Brasileiras de Manutenção, Brazil;
- **Asset Management Council (AMC), Australia;**
- **European Federation of National Maintenance Societies (EFNMS), Europe;**
- French Institute of Asset Management and Infrastructure (IFRAMI), France
- Iberoamerican Federation on Maintenance (FIM), South America
- **Gulf Society of Maintenance Professional, Arabian Gulf Region;**
- Institute of Asset Management (IAM), U.K.;
- **Plant Engineering And Maintenance Association Of Canada (PEMAC), Canada**
- **Society for Maintenance and Reliability Professionals (SMRP), USA**
- **Southern African Asset Management Association (SAAMA.)**
- **Japan Institute of Plant Maintenance (JIPM)**

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1.2 Purpose of the Framework

The Maintenance management Framework is intended to be used by members of the GFMAM, the Maintenance and Asset Management communities to:

- Provide an overview of the discipline of maintenance management;
- Provide a structure for the building of a body of knowledge for certification schemes and qualifications in maintenance management;
- Provide a structure (and potentially the criteria) for assessing an organization’s maturity in maintenance management;
- Provide information for maintenance management knowledge requirements for assessors and auditors;

- Provide the capability to compare the products and services of the different GFMAM members related to maintenance management; and
- Provide a reference for future GFMAM projects.

1.3 Definition of Maintenance

Maintenance is a combination of all technical and administrative actions, including supervision actions, intended to retain an item in, restore it to, or replace it so that it can perform a required function.

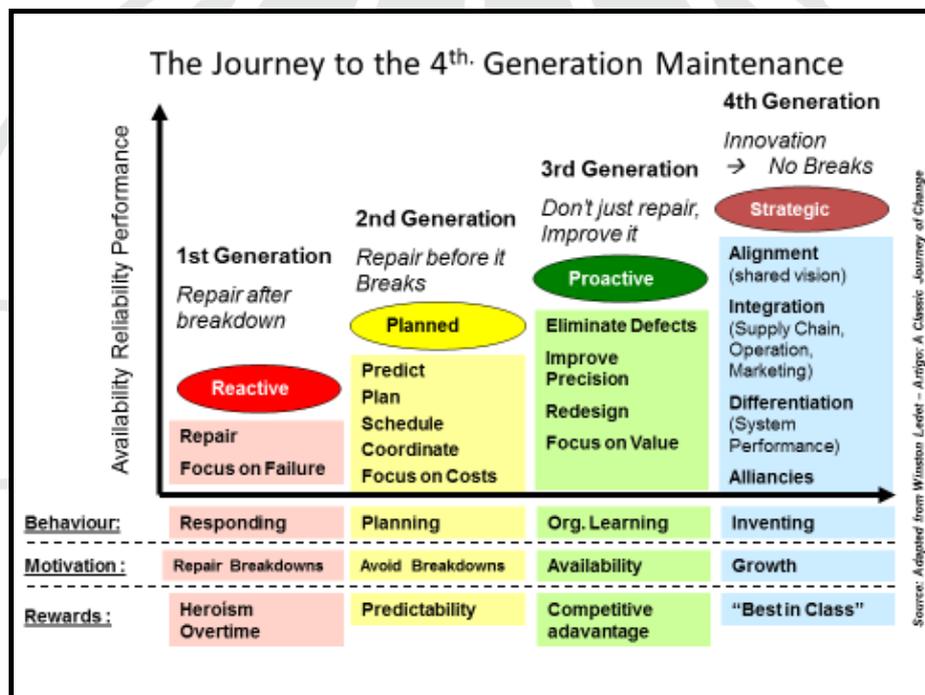
1.4 Definition of Maintenance Management

Maintenance management is the decision-making processes that align maintenance delivery activities with corporate objectives and strategies.

1.5 The Evolution of Maintenance

During the initial few decades of the industrial revolution “first generation” equipment was generally over-designed and relatively simply constructed. Maintenance was considered absolutely necessary, however maintenance management was not. Over time equipment grew in complexity and demand for safety, reliability and financial accountability increased, especially in high-risk or high-performance industries.

Figure 1: The development of maintenance management.



When the “fix equipment when it breaks” paradigm was no longer acceptable, more proactive, systematic thinking began to evolve. Preventive maintenance planning and control systems, often

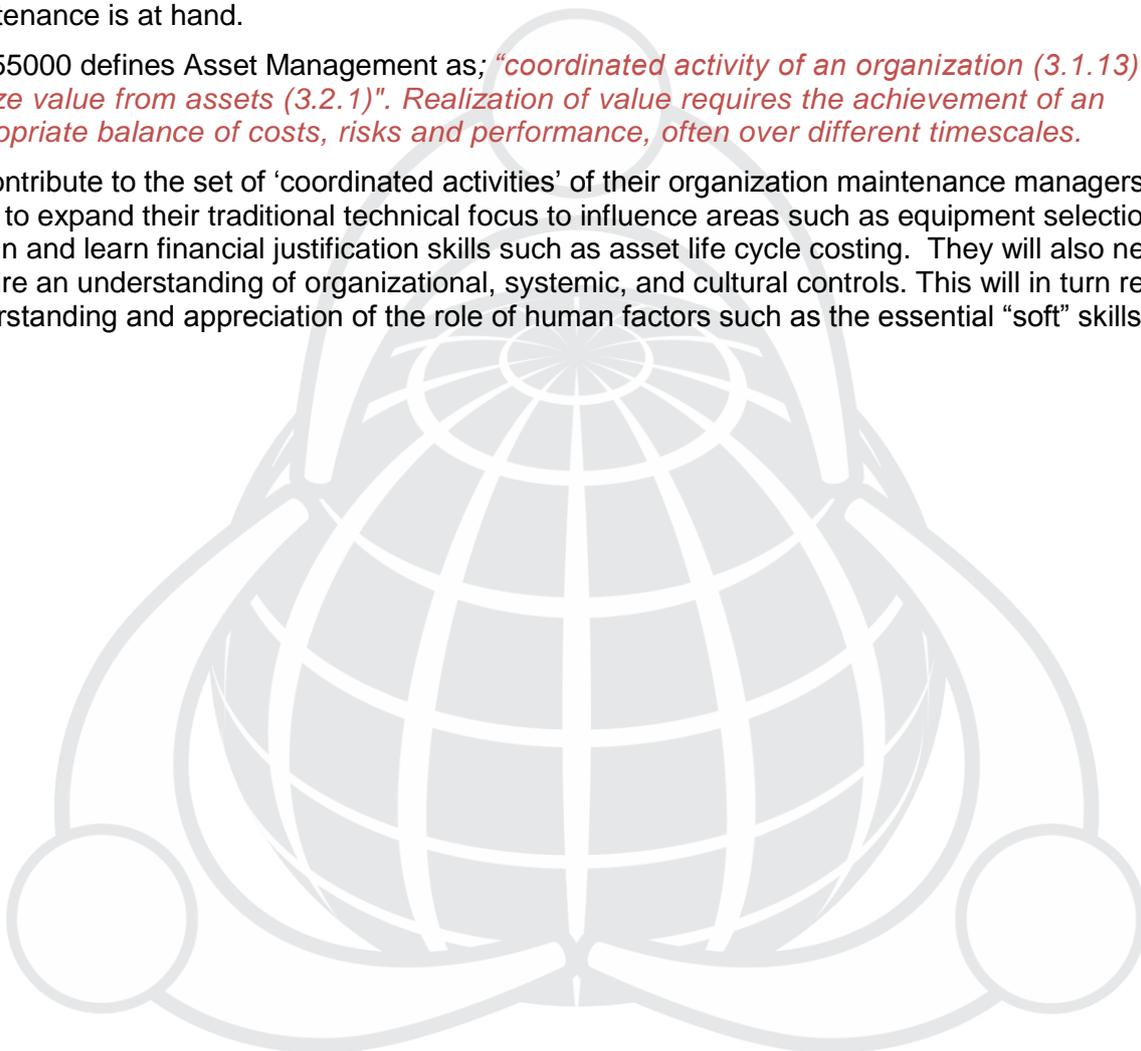
manually created and managed, enabled higher equipment availability, longer equipment life and lower maintenance and life cycle costs

The “third generation” was characterized by techniques such as “failure modes and effects analysis” and “design for reliability”. During this period technology developed substantially. It became possible, for example, to monitor the condition of equipment in real time to detect the need for repair or replacement of a critical part without invasive actions. Information and computer technology evolved so that databases of assets and their maintenance requirements could be built up to assist with the difficult task of managing the maintenance of complex systems.

With the advent of ISO 5500X suite of Asset Management standards, the fourth generation of maintenance is at hand.

ISO 55000 defines Asset Management as; *“coordinated activity of an organization (3.1.13) to realize value from assets (3.2.1)”. Realization of value requires the achievement of an appropriate balance of costs, risks and performance, often over different timescales.*

To contribute to the set of ‘coordinated activities’ of their organization maintenance managers will need to expand their traditional technical focus to influence areas such as equipment selection and design and learn financial justification skills such as asset life cycle costing. They will also need to acquire an understanding of organizational, systemic, and cultural controls. This will in turn require understanding and appreciation of the role of human factors such as the essential “soft” skills.



2 The Five Principles

This Framework document is structured as follows:

- Five Principles (Section 2)
- Seven Subject Groups (Section 3&4)

The five principles below articulate the fundamental elements of excellence that are intended to enable informed decisions and actions across an organization.

Principle 1 - Value

Disciplined execution of maintenance tasks are critical to value delivery during the 'operations and maintenance' phase of the asset life cycle.

Principle 2 - Efficiency & Effectiveness

Efficiency and effectiveness of the maintenance function are important factors to achieve minimum lifecycle costs.

Principle 3 - Integrity

Proactive management of maintenance planning and maintenance task execution contributes to the inherent safety of an operation and contributes significantly to the protection of people, property and the environment over the whole lifecycle of an asset

Principle 4 - Execution

Disciplined execution of maintenance tasks provides assurance that assets fulfill their function reliably, effectively, efficiently and will be available when required.

Principle 5 - Leadership

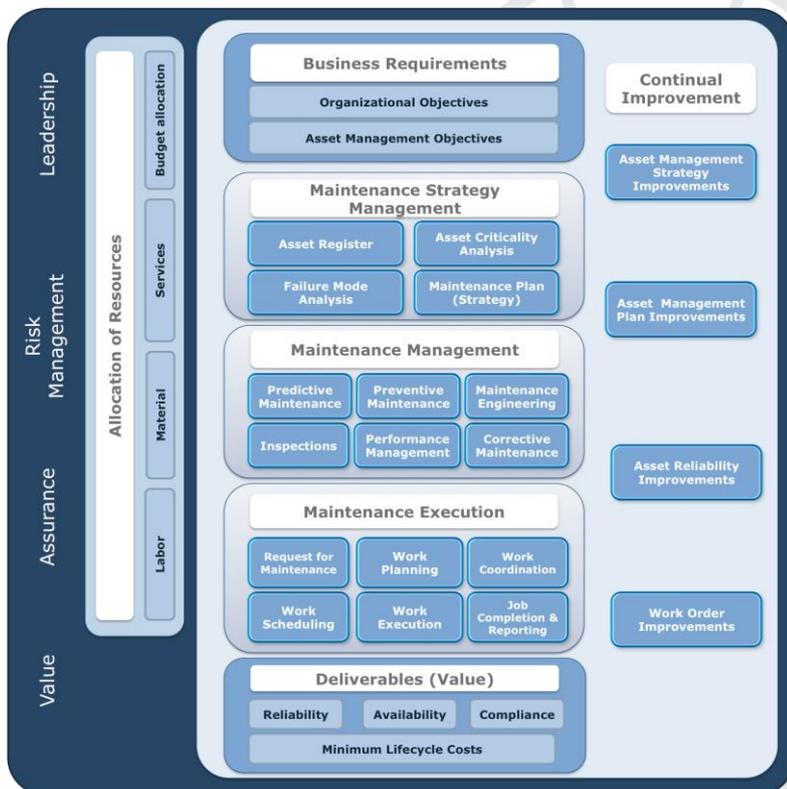
Leadership and workplace culture are determinants for continuous improvement of system performance including the performance of those tasked with managing and delivering maintenance functions.

3 The Seven Subject Groups and the Framework Diagram

The seven subject groups and related subject elements are shown in Figure 2, with each element further described and defined in subsequent sections of the document. The subject groups are:

1. Business Requirements
2. Maintenance Strategy Management
3. Maintenance management
4. Maintenance execution
5. Deliverables
6. Continual improvement
7. Allocation of resources

Figure 2 – The Maintenance Management Framework Diagram



While the diagram shows generally how the maintenance management subject groups fit in relation to each other and to the objectives of the organizational business plan, there is no one common workflow for maintenance management. The workflow depends uniquely on the organization and its environment.

Maintenance can be managed totally internally, partially internally or completely outsourced. The application of the Maintenance management Framework can therefore vary according to organizational specific circumstances.

4 Descriptions of the Subject Groups

For each of the seven Subject Groups in the framework (Business Requirements, Maintenance Strategy Management, Maintenance Management, Maintenance Execution, Deliverables, Continual Improvement, and Allocation of Resources) this section contains:

- A definition;
- A context statement;
- The artefacts that would typically be produced in relation to this subject;
- Key relationships with other subjects; and
- Any relevant standards.

4.1 Subject Group 1: Business Requirements

4.1.1 Definition

Business Requirements define what must be delivered to provide value to stakeholders, such as safety, return on investment, return on assets, return on equity and service levels.

Physical assets therefore should be considered as a means to an end. Assets are the means that the organization uses to satisfy, or meet, business requirements. Physical assets alone cannot achieve the objectives of the organizational plan. Hence asset managers and maintenance managers must also work together with other business functions.

Business requirements are often documented into an organizational strategic plan – a plan that satisfies the business stakeholders. From that plan, asset managers develop supporting plans, through which selected activities and tasks are performed on those assets. When those plans are implemented, the assets should achieve/deliver the desired revenue at the defined cost, meet the risk appetite of the organization and achieve the performance needed of them.

Physical asset maintenance activities and tasks (as documented in plans) are developed from an understanding of:

- The business needs of the organization and how those needs directly relate to the assets to be used; and
- The risks (safety, financial, environment and reputational) that are associated with the use of assets to deliver those stated needs.

4.1.2 Context

Maintenance is one of the key levers to deliver business outcomes. About two thirds of the total life cycle cost is consumed in the “Operate and Maintenance” phase of an asset. With advances in technology and maintenance awareness and related competencies, asset managers and maintenance managers working together are now well placed to relate that expenditure directly to the business need.

As a result, asset management and maintenance management is based solely on meeting business needs and requirements. It therefore concentrates on managing and mitigating the risk(s) of equipment failure. Its focal point is also on aligning and combining technical and financial management to provide equipment/assets that are “Fit for purpose”, “Safe to Use” and “Financially Sustainable” over the short and long term.

In doing so, asset management and maintenance is seen as an investment, demonstrably delivering the required return on investment and working in unison with the other business functions to achieve business needs.

4.1.3 Artefacts

The common artefacts needed to support delivery of business needs include:

- An asset management policy (required by ISO 55001);
- A strategic asset management plan (required by ISO 55001); that includes:
 - The required asset management objectives;
 - The requirements for the asset management system; and
 - The requirements for asset management plans.
- Asset management plans (required by ISO 55001) that include all the activities and tasks necessary to deliver the asset management objectives and may therefore include the approved:
 - Asset maintenance plan(s);
 - Financial plans;
 - Safety plans;
 - Regulatory plans;
 - Heritage plans;
 - Operating plans;
 - Investment plans; and
 - Other related plans.
- Maintenance Policy - the Maintenance Policy describes and reviews the concept, process and framework of modern maintenance management of assets by:
 - Concentrating specifically on modern modelling tools (deterministic and probabilistic) for maintenance planning and scheduling;
 - Presenting new perspectives of maintenance management;
 - Focusing on the course of maintenance actions;
 - Presenting a structure that ensures proper support for the maintenance management;
 - Clarifying the functionality that is required from information technology when applied to maintenance;
 - Describing the functions of modern maintenance engineering; and
 - Creating a set of practical models for maintenance management planning and scheduling.

4.1.4 Related Subjects

- Asset management leadership
- Organizational structure
- Organizational culture
- Competence management
- Risk assessment and management
- Contingency planning & resilience analysis
- Management of change
- Asset management planning
- Operations & maintenance decision-making
- Configuration Management
- Maintenance Delivery
- Shutdown & outage management
- Fault & incident response

4.1.5 Example of Related Standards

- ISO5500X Asset Management Suite

- ISO/IEC15288 Systems Engineering
- ISO 31000 Risk Management
- ISO 17021-5 Requirements for bodies providing audit and certification
- ISO 14000 Environmental Management
- ISO 14224 Petroleum, petrochemical and natural gas industries -- Collection and exchange of reliability and maintenance data for equipment
- International Financial Reporting Standards (IFRS)
- International Accounting Standards (IAS)
- EN 16646 - Maintenance within physical asset management

4.2 Subject Group 2: Maintenance Strategy Management

4.2.1 Definition

Strategic management is the continuous process of creating, implementing, evaluating and adjusting decisions that organizations use to systematically manage and align resources and actions with vision, mission and strategy throughout the organization.

Strategy development is also the basis for establishing a well-defined maintenance management process in any industry which will lead the way to a reliable operation in order to meet the business goals and requirements.

To achieve the required asset availability and reliability, an effective maintenance strategy needs to be identified. The strategy selection process requires an understanding of the needed asset function, the likely ways in which the asset might fail and the risks associated with those failure mechanisms.

4.2.2 Context

Maintenance strategy development is an important building block in the process to assuring a reliable asset. This will in turn avoid undesired risks from asset failures.

4.2.3 Artefacts

Typical artefacts within this subject include:

- Asset management strategy
- Asset maintenance policy

4.2.4 Related Subjects

- The Asset Register is the system used to account for all assets that are installed in a facility. Modern asset registration is usually handled by a computerized system and critical asset data is often shared by the enterprise-wide system. Asset registration requires all relevant engineering data to be entered and well maintained for all assets. This enables all operation and maintenance history to be captured and assists in making the best decisions impacting the maintenance strategy of an asset.
- Asset Criticality Analysis is the process of developing an understanding of the role of each asset to deliver the required function, and the risk associated with operating a particular asset.
- Failure Mode Effect Analysis (FMEA, FMECA) are tools designed to help determine the potential failures of systems, subsystems, equipment, component and their consequences. This process is part of mitigating or reducing the risks associated with the identified failures

to safely and reliably operate those assets. Failure mode analysis will also assist to identify the best strategies to maintain these assets throughout their lifecycle.

- Maintenance Plan (execution of the strategy) of an asset is developed based on the failure mode effect analysis associated with that particular asset or system. It is meant to carry out actions to prevent the expected impact of asset failure.

4.2.5 Example of Relevant Standards

- CSN EN 15341
- ISO/IEC 15288 Systems Engineering
- International Financial Reporting Standards (IFRS)
- International Accounting Standards (IAS)
- ISO 5500X Asset Management Suite
- IEC Dependability Suite of standards
- ISO 31000 Risk Management
- United States Department of Defense (24 November 1980) Military Standard 1629A - Procedures for performing a failure mode effect and criticality analysis.
- Norsok z-008 Criticality analysis for maintenance purposes
- EN 16646 - Maintenance within physical asset management

4.3 Subject Group 3: Maintenance Management

4.3.1 Definition

Maintenance management is the collective term for describing the management process of leadership and organization, planning and scheduling, preventive maintenance, condition monitoring, execution of maintenance repairs, recording, root cause failure analysis, spare parts management and management of technical data that demonstrably delivers business needs and outcomes.

4.3.2 Context

Maintenance management is a process to assure that assets continue to do what the business requires both in the present and future operating contexts.

Maintenance management can be used to achieve improvements in safety and reliability, improvements to operating procedures and strategies and the establishment of capital and operating regimes. Successful implementation of a maintenance management system can lead to improvements in cost effectiveness, asset reliability and availability complemented by a comprehensive understanding and management of risk.

4.3.3 Artefacts

Typical artefacts within this Subject include:

- Asset management policy
- Asset Maintenance strategy / policy
- Maintenance management business processes

4.3.4 Related Subjects

- Maintenance engineering is the discipline and profession of applying engineering concepts to the optimization of equipment, procedures, and departmental budgets to achieve the required maintainability, reliability, and availability of assets and asset systems.

- Preventive Maintenance (PM) is the process maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the function of an item (ISO14224 section 3.42).
- Predictive Maintenance (PdM) and condition monitoring (CM) techniques are designed to help determine the condition of critical in-service equipment in order to identify defects and determine when maintenance should be performed to prevent the consequences of failure. Condition monitoring is the process of monitoring a parameter of condition in machinery (vibration, temperature etc.) in order to identify a significant change which may indicate a developing fault. It is a major component of predictive maintenance.
- Inspections are most generally, an organized examination or formal evaluation task. In maintenance activities inspection involves the measurements, tests, and gauges applied to certain characteristics in regard to an object or activity. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets, often with a Standard Inspection Procedure in place to ensure consistent checking. Inspections are usually non-destructive.
- Performance management in the fields of maintenance and asset lifecycle management is the monitoring and management of performance and availability of assets. Performance management strives to detect and diagnose application performance problems to maintain an expected level of service. Performance management is "the translation of maintenance metrics into business meaning, i.e. value".
- Corrective maintenance is a maintenance task performed to identify, isolate, and rectify a fault so that the failed asset can be restored to an operational condition within the tolerances or limits established for in-service operations. It includes conditional and functional failures.

4.3.5 Relevant Standards

- ISO/IEC 15288 Systems Engineering
- International Financial Reporting Standards (IFRS)
- International Accounting Standards (IAS)
- ISO 5500X Asset Management Suite
- IEC Dependability Suite of standards
- ISO 31000 Risk Management
- EN 16646 - Maintenance within physical asset management

4.4 Subject Group 4: Maintenance Execution

4.4.1 Definition

Efficient work order execution ensures that all work that needs to be done will be executed on time with little or no waste of human and material resources. Key aspects of successful work order execution management are:

- Objectives
- Priorities
- Responsibilities
- Process performance
- Quality

4.4.2 Context

All work with regard to work order management, e.g. planning, priority and capacity scheduling, supply of parts, tools and instruments are focused on efficient work order execution. To ensure that the tasks that need to be done will be done on time with little or no waste of human and material resources.

This requires developed processes and governance to ensure effective and efficient work order execution. Of all the tasks required to provide a sound base for work order execution, planning & scheduling are the most critical. Without enforced schedule compliance, there can be no true measure of improved work execution. In addition, without effective methods for data capture future analysis will be based on incorrect, incomplete or insufficient data.

Key aspects of successful work execution management are:

- Objectives
- Priorities
- Responsibilities
- Processes
- Measuring and reviewing performance
- Audits

The framework for managerial action follows a formal management system for the control of work order execution, and is an essential component in managing maintenance.

The execution of work orders is an integral part of Maintenance management and relies on a series of processes, knowledge and skills:

- Work package preparation
- Job preparation; material logistics, labor requirements, tools & equipment's, work instructions & procedures and safety instructions
- Co-ordination; operation, purchasing, suppliers, engineering, etc.
- Scheduling; daily programs / weekly programs
- Job execution
- Quality assurance
- Data capture / Reviews / follow up work in progress
- Training, education and qualification
- Repair knowledge
- Quality control & assurance
- Out-sourcing and in-sourcing
- Information and Communication Technology
- Remote maintenance
- Relations Operational / Maintenance staff
- Shutdown & turnaround management
- Competency matrix
- Competency requirements

4.4.3 Artefacts

Typical artefacts within this Subject include:

- Asset management policy
- Instructions, guidelines, standards and procedures
- Skills matrix
- Training and education plan(s)

4.4.4 Related Subjects

- Request for maintenance; identify, validate, prioritize and approve work requests,
- Work planning; develop work packages including scope, procedures, references, material, tools, services, testing, etc.
- Work scheduling; produce work schedules, balance resources, monitor work backlog, manage break-in work, coordinate equipment access, etc.
- Work coordination; manage resources, control inventory, manage spare parts and equipment, manage contractors
- Work execution; manage labor, material, and services; control productivity, ensure SHE compliance, etc.
- Job completion; close work orders (time & material consumption), create post-work documentation process, record failures, collect data (?), analyze and follow-up work orders, measure work management performance

4.4.5 Relevant Standards

- IEC 60300-3-14-2004 Maintenance and maintenance support
- IEC 60300-3-3-2004 Dependability management - Application guide - Life Cycle Costing
- NF X60-000-2002 Maintenance function (French Standard)
- EN 15341-2007 Maintenance — Maintenance Key Performance Indicators
- ISO 13381-1 Condition monitoring and diagnostics of machines - Prognostics - General guidelines
- ISO 13379 Condition monitoring and diagnostics of machines – General guidelines on data interpretation and diagnostics techniques
- EN 13269 Maintenance - Guideline on preparation of maintenance contracts
- IEC 60300-3-16 Application guide – Guidelines for specification of maintenance support services
- EN 13306 Maintenance Terminology
- IEC 50(191) International Electro-technical Vocabulary - Dependability and quality of service
- IEC 61703 Mathematical expressions for reliability, maintainability and maintenance support items
- IEC 60300-3-11 Application guide – Reliability Centered Maintenance
- SAE JA1011 Evaluation Criteria for Reliability-Centered Maintenance (RCM) Processes
- SAE JA1012 A guide to RCM standard
- CEN/TS 15331 Criteria for design, management and control of maintenance services for buildings

4.5 Subject Group 5: Deliverables

4.5.1 Definition

The deliverable from maintenance management is the assurance that assets are available when required and can fulfil their function reliably and safely in compliance with all specified requirements. This addresses the value delivery during the operations phase of the asset life cycle in balance with the incurred costs of maintenance.

The Deliverables of maintenance is also the preservation of asset value ensuring that assets are in good working condition to fulfil their function throughout the designed or desired lifetime of the asset. Maintenance is an important element in ensuring minimum lifecycle costs of the asset.

4.5.2 Context

Maintenance delivers value to the organization as maintenance counteracts assets natural deterioration processes that otherwise would reduce or eliminate the value creation of the assets or be the cause of other losses.

Key elements in the delivery of value from maintenance include:

- Availability of an asset is the probability that the asset is in a condition where it can perform its required function when this function is needed. Availability is the key driver of value creation of the asset. Maintenance can improve availability through the avoidance of unplanned breakdowns and through efficient maintenance procedures with minimum downtime.
- Reliability of an asset is the probability that the asset can perform its required function for a specified length of time. Any asset has a given reliability by design and maintenance can counteract the reduction of reliability over time. Reduced reliability cause losses through reduced availability and may cause losses through required changes to procedures or design.
- Safety and risk of an asset and the operation of an asset requires that critical equipment is well maintained and in a good condition. Hidden failures in safety systems have been the historic cause of major incidents and only maintenance can remove such hidden failures.
- Compliance is the assurance that assets are maintained in accordance with the requirements set forth by external regulators. Maintenance can deliver compliance through good procedures and timely activities. Compliance is normally considered a value in itself and may be a prerequisite for license to operate in highly regulated environments.
- Quality and service level of the outcome of the assets functions is strongly influences by maintenance. Quality requires adequate maintenance procedures and timely maintenance actions for the asset consistently to perform its function within tight tolerances. Service level is often dictated by the asset reliability.
- Cost control is the continuous verification that the required maintenance and operation activities are performed at minimum cost. Maintenance activities must be performed effectively to minimize costs and the level of maintenance must be right-sized in respect of the potential values maintenance can deliver. Declining availability or reliability can increase the cost of operating the asset in many ways. Maintenance can also control some operational costs that are not caused by downtime such as increased consumption of energy or raw materials over time.
- Life cycle costs of an asset is the sum of all costs occurred over the lifetime of the asset including acquisition, operation, maintenance and decommissioning. Maintenance and operation is often a major component of life cycle costs why maintenance cost control can have a significant influence on total life cycle costs.
- Capital investments in new or existing assets can be reduced by maintenance in several ways. Good maintenance can increase the technical lifetime of the asset and delay the need for refurbishing and reinvestment. High availability utilizes the full capacity of the asset and may delay the need for capacity expansion. High reliability may reduce the need for investments in redundancy.
- Financial performance of the organization is affected by maintenance through all of the above elements of value delivery. Revenue may be increased, operational costs may be reduced, capital investments may be reduced, financial costs and depreciations may be

reduced. For asset intensive companies the impact of maintenance on the financial performance can be significant.

4.5.3 Artefacts

Typical artefacts within this Subject include:

- Key Performance Indicators (KPI's)

4.5.4 Related Subjects

- Maintenance Execution
- Continual Improvement
- Value management
- Whole-life cost
- Balanced scorecard
- Financial reporting

4.5.5 Relevant Standards

- EN 15341: Maintenance Key Performance Indicators
- EN 1325:2014: Value Management. Vocabulary. Terms and definitions
- EN 16646 - Maintenance within physical asset management
- IEC 60300-3-3 : Dependability management - Application guide - Life cycle costing
- ISO 55000: Asset management — Overview, principles and terminology, Clause 2.2

4.6 Subject Group 6: Continual Improvement

4.6.1 Definition

Continual Improvement is defined as a recurring activity to enhance performance' (ISO 55000). Continuous Improvement can also be defined as 'the ongoing improvement of processes that lead to achievement of higher levels of performance through incremental change' (EFQM). Continuous Improvement can therefore be viewed as an organization-wide initiative of on-going improvements in processes as well as equipment and people performance. Continuous Improvement includes the proactive pursuit of best practices; increased effectiveness and efficiency of management systems; and increased productivity of personnel.

4.6.2 Context

Continual Improvement is a cross-functional discipline applied to all facets of asset management, including Maintenance management. Several focused Continuous Improvement methodologies like Lean Manufacturing, Six-Sigma, Total Quality Management and Theory of Constraints have been implemented in manufacturing as well as in maintenance. Specific improvement methodologies for maintenance include Total Productive Maintenance, Reliability-centered Maintenance, Business-centered maintenance and Total Quality Maintenance. These maintenance strategies are often implemented to achieve a major improvement in system reliability, safety and reduction in maintenance cost.

Continual Improvement is often achieved as a result of small, incremental improvements in processes, people, assets, strategy and relationships. Sometimes a large improvement or breakthrough in some aspect of maintenance could also occur. The basis for most improvement methodologies is the Plan-Do-Check-Act (PDCA) or Plan-Do-Study-Act (PDSA) cycle promoted by Deming. It can be used to improve equipment design, equipment reliability, maintainability,

maintenance systems, work practices, employee effectiveness as well as safety, health and environmental aspects of Maintenance execution.

The following general steps are usually performed to implement Continual Improvement in the maintenance environment:

- Establish current maintenance performance
- Define objectives for future maintenance performance
- Determine reasons for current performance
- Identify alternative solutions to achieve objectives
- Identify impact of possible changes
- Implement most promising solutions
- Define and implement effective controls to maintain new performance levels

4.6.3 Artefacts

Typical artefacts within this subject include:

- Key performance indicators
- Critical success factors
- Key objectives for maintenance
- Maintenance audit reports
- Root Cause Analysis process

4.6.4 Related Subjects

- Quality Management
- Performance Management
- Total Productive Maintenance
- Reliability-centered Maintenance
- Total Quality Management
- Root Cause Failure Analysis
- Optimization
- Organizational maturity
- Theory of Constraints
- Equipment Reliability
- Process Reliability

4.6.5 Relevant Standards

- BS EN 15341:2007 Maintenance. Maintenance Key Performance Indicators
- ISO 9000:2005 Quality management systems – Fundamentals and vocabulary
- ISO 9001:2008 Quality management systems – Requirements
- ISO 55000:2013 Asset management – Overview, principles and vocabulary
- ISO 55001:2013 Asset Management – Requirements
- ISO 55002:2013 Asset management – Management systems - Guidelines on the application of ISO 55001
- EFQM Excellence Model 2010

4.7 Subject Group 7: Allocation of Resources

4.7.1 Definition

Allocation of resources is the assignment of available resources to various uses, to “achieve the most appropriate balance of cost, risk and performance”. In the context of an entire company, resources can be allocated by upper management, middle management, by central planning, or by some combination of the above mentioned. In maintenance management, resource allocation or resource management is the scheduling of activities and the resources required by those activities while taking into consideration both the resource availability and the execution time.

4.7.2 Context

Allocation of Resources is where at one level an organization tries to “achieve the desired balance of cost, risk and performance.” As a consequence, systems and procedures need to be in place to achieve the desired balance.

Asset support requirements are the wherewithal that enable a design solution to achieve its intended purpose both in the short and long term - in fact for the duration of the life cycle. As a result, the development of support requirements is the application of risk based decisions making, where the support requirements are the tasks that, when implemented, mitigate the risks.

Support analysis involves analyzing the support needs, over the intended life of the asset. Often the greatest challenge in the support analysis process is the allocation of resources. The real challenge in asset and maintenance management is therefore to understand the relationship between the cost, the risk that can be achieved with that level of financial resource and the resultant asset performance.

The required support should be in place on the first day of commissioning and in fact its verification should ideally be part of that commissioning activity. It matters little that the asset is brand new, it can and will fail and if the right spare is not available or the staff are not trained etc., the design intent of the asset will not be achieved and the business case for its acquisition will be compromised.

Integrated support comprises all the support needed for the asset to deliver the designed output, namely:

- Operations activities and plans
- Maintenance activities and plans
- Spare parts management; spares and spares location
- Data and information technology
- Finance (CAPEX and OPEX)
- Packaging, handling and support
- Operator and maintainer training

Integrated support has inherent characteristics that affect two major performance aspects of the ownership of equipment. One, how long it performs its function (called reliability and/or availability) and the how long it is not available because of corrective maintenance (called maintainability) of the asset.

These two inherent design characteristics (reliability and maintainability) determine the availability of the assets and asset systems. Each and every aspect of the integrated support elements above affect both reliability and maintainability.

For example, if an organization has not acquired sufficient spares or they are not stored close to the item, then down time will be long. If the spares are of poor quality, or stored incorrectly, asset and asset system reliability will be shortened.

This integrated approach is intended to assure that the necessary support is available on the first day of service. That is, the organization has the necessary support to achieve the inherent design capabilities of the asset and asset systems.

4.7.3 Artefacts

- Key performance indicators
- Critical success factors
- Key objectives for maintenance
- Maintenance audit reports
- Asset Management policy
- Maintenance strategy / policy

4.7.4 Related Subjects

- Budget allocation
- Allocation of Services
- Allocation of Materials
- Allocation of Labor

4.7.5 Relevant Standards?

- EN 15628 Maintenance – Qualification of maintenance personnel
- IEC 60300-3-16:2008 - Dependability management - Part 3-16: Application guide - Guidelines for specification of maintenance support services

5 Review Process for the Maintenance Framework

The review process in the production of this document consisted of the following stages:

- Development of descriptions of each subject by mapping the Framework Subjects to IEC 60300-3-14:2004, Dependability management - Part 3 -14: Application guide - Maintenance and maintenance support;
- Analysis of these descriptions to identify the Definition, Object, Artefacts, Qualifiers and standards for each Subject;
- Review of these descriptions to remove or reallocate statements that did not align with the Subject heading;
- Independent review of the output from the above stages by a Lead Reviewer;
- Definition of criteria to assess the validity of a Subject; and
- Review of the Subjects against these criteria and propose changes to the Subjects.

5.1.1 Criteria

The criteria that were defined to decide what constitutes a valid Subject were as follows:

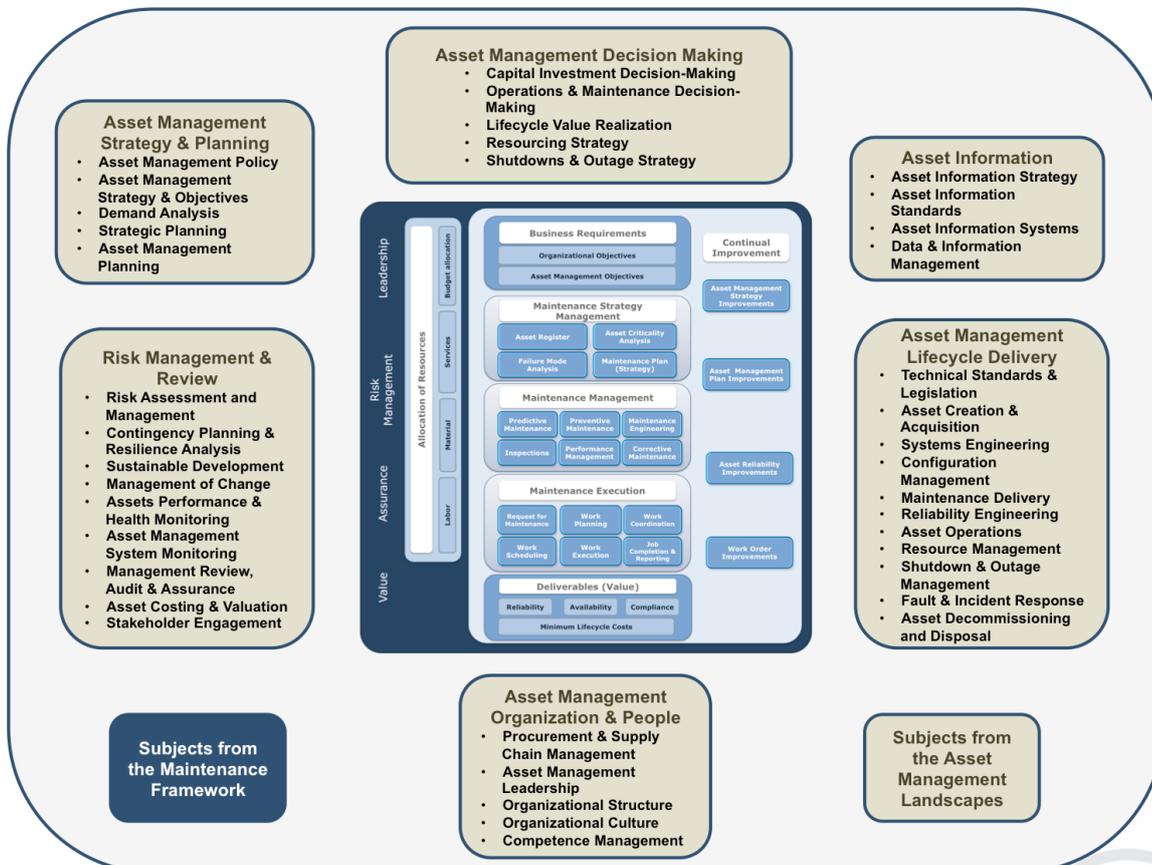
- The Subject should be of interest to the maintenance and Maintenance management domain;
- The Subject should contain at least one clear concept;
- The Subject should contain concept(s) that are mutually exclusive to other Subjects;
- The Subject should describe where possible a system or series of processes. Artefacts are not in themselves sufficient to be a Subject;
- Subjects can cover what/why in one Subject and how in another; therefore Subjects are not required to have all decision making levels in that Subject;
- The Subject should not contain more than one main concept / process / capability; and
- The Subject should be consistent with a relevant standard (see the attached list of relevant standards).

6 Appendices – Conceptual Models

The following diagrams, included as appendices are early conceptual models which show maintenance and maintenance management in the overall business context.

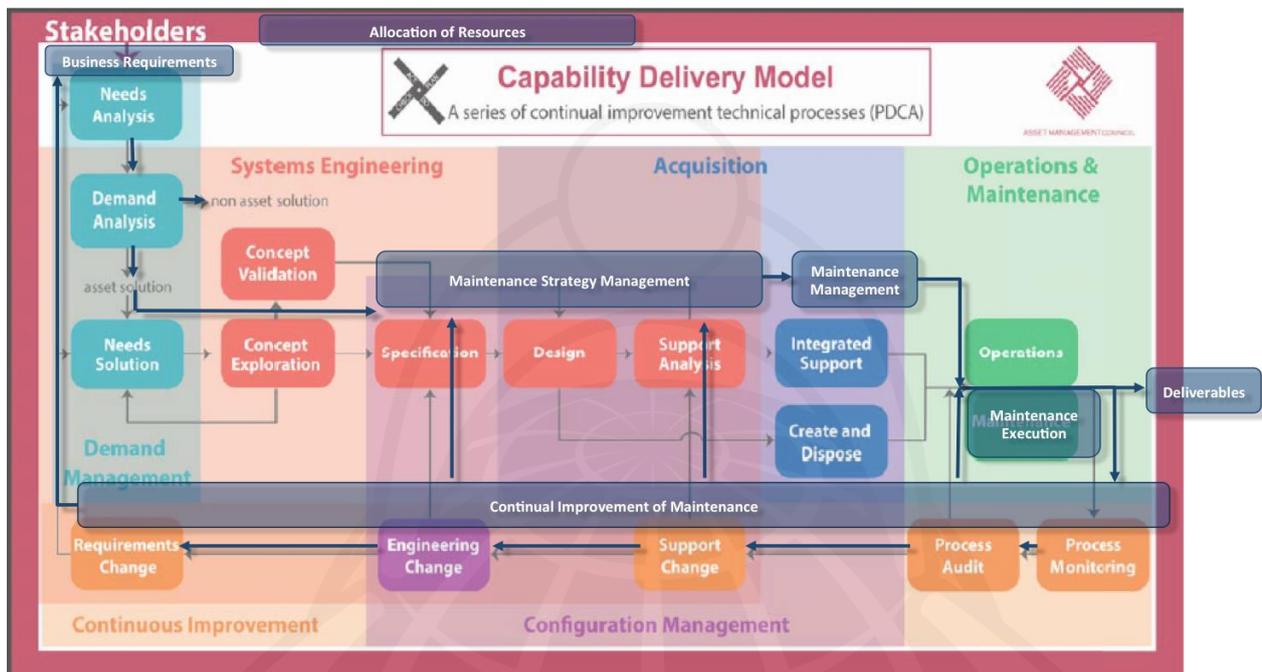
6.1 Appendix 1

Seven (7) subjects of the Maintenance Framework set within the thirty nine (39) subjects of the Asset Management Landscape.



6.2 Appendix 2

Seven (7) subjects of the Maintenance Framework in the context of the “Asset Capability Delivery Model” from the Asset Management Council of Australia (AMC).



6.3 Appendix 3

Maintenance within Physical Asset Management concept model according to EN 16646
'Maintenance within Physical Asset Management.

