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Maintenance - Maintenance within physical asset management - Framework for improving the value of the physical assets through their whole life cycle

Maintenance - Maintenance dans le cadre de la gestion d'actifs physiques - Cadre pour l'amélioration de la valeur des actifs physiques tout au long de leur cycle de vie

Instandhaltung - Instandhaltung im Rahmen des Anlagenmanagements - Methodik zur Verbesserung des physischen Assetwerts während des gesamten Lebenszyklusses

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (EN 17485:2021) has been prepared by Technical Committee CEN/TC 319 “Maintenance”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2021, and conflicting national standards shall be withdrawn at the latest by December 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

EN 17485 introduces methods and procedures about maintenance within physical asset management for all the levels and functions of the organizations' management, including corporate planning management, plant management, technical management, production management, financial management, asset management, maintenance management, and quality management.

EN 16646 'Maintenance - Maintenance within physical asset management' was published in December 2014. Since it gives a general framework to allow and determine the role and tasks of maintenance within the larger frame of physical asset management, but does not introduce detail methods and procedures to implement or establish it. The aim of EN 17485 is to close this gap.

This document addresses the principles of physical asset management, which are relevant from the maintenance point of view. This document offers a framework for a systematic management approach. The aims of this document are to:

— create and systematize the link between business, physical asset management and maintenance activities of organizations;

— indicate external and internal influencing factors and their effect on physical asset and maintenance management;

— promote cross-functional cooperation;

— address transparency in organizational decision making;

— address simulation and visualization as effective tools to support decision making;

— address uncertainty management to improve the quality of decision making;

— improve information management as an activity to achieve the above-mentioned objectives;

— address the sustainability of operations.

These targets improve the chances of success in meeting the physical asset management challenges mentioned in EN 16646. It mentions several reasons why physical asset management is nowadays more important than ever before. The same reasons are valid when we evaluate the importance of methods and procedures.

This document introduces methods and approaches to build a bridge between maintenance and the other functions.

Many benefits can be achieved when applying the methodology presented in this document:

— economically more efficient, effective and profitable use of capital: 'turnover of and return on assets';

— more accurate long-term life cycle decisions;

— integrated investment and maintenance planning;

— integrated approach for the production function (assets, operation and maintenance);

— direction given to maintenance strategies and activities;

— improved position for maintenance among the other company functions;

— improved assessment of performance and control;

— enhanced capability to operate within extended enterprise ecosystems (including customers/suppliers);

— enhanced reputation;

— more sustainable use of capital.

Further and maybe even greater benefits are now being found through improved credibility in the eyes of customers, regulators and other stakeholders. Physical asset management also results in much greater engagement and motivation of the workforce, and in more sustainable, continual improvement business processes. Physical asset management builds up the required link between maintenance management and the organizational strategic plan and gives direction to maintenance activities.

The standards EN 16646 and EN 17485 build the bridge between ISO 5500x (Asset management system standards) and the EN maintenance standards. ISO 55001 states that organizations should determine e.g. the organizational context, requirements for the assets, decision criteria, strategic asset management plan and asset management plan (including maintenance). However, it does not describe how to do it. Respectively, maintenance standards often introduce e.g. the concept of the required function or the concept of maintenance strategy, but do not explain how they have been determined. EN 17485 introduces a methodological framework which advises organizations to implement the requirements presented in ISO 55001. By doing this it creates the bridge between the several maintenance standards and ISO 5500x in order to give an applicable starting point to the more detailed documents for the specific sub-functions of maintenance (See Figure 1).

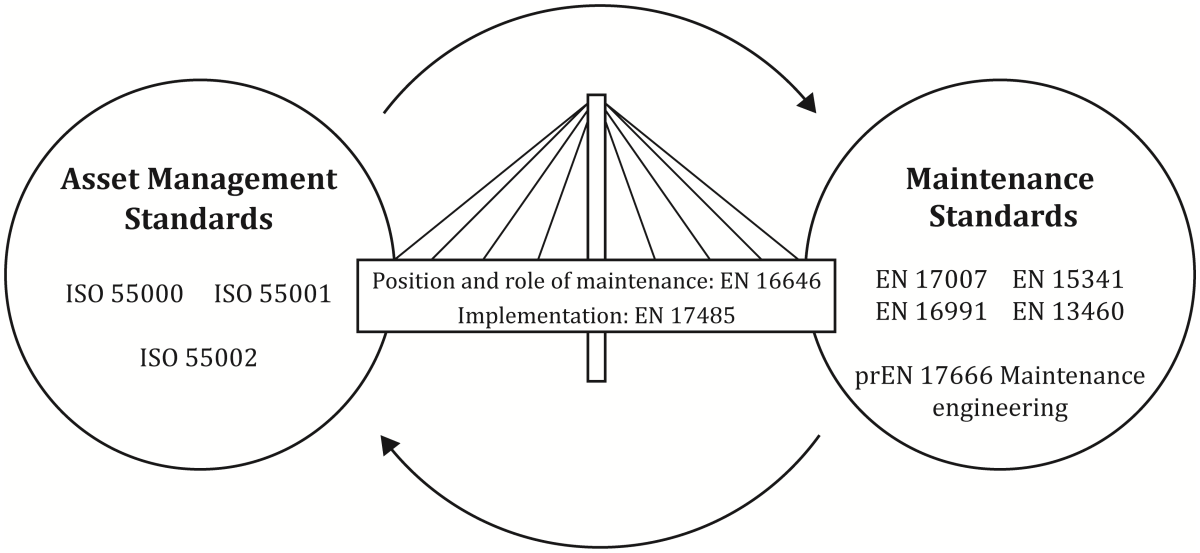

Figure 1 — Links between EN 17485 and other standards

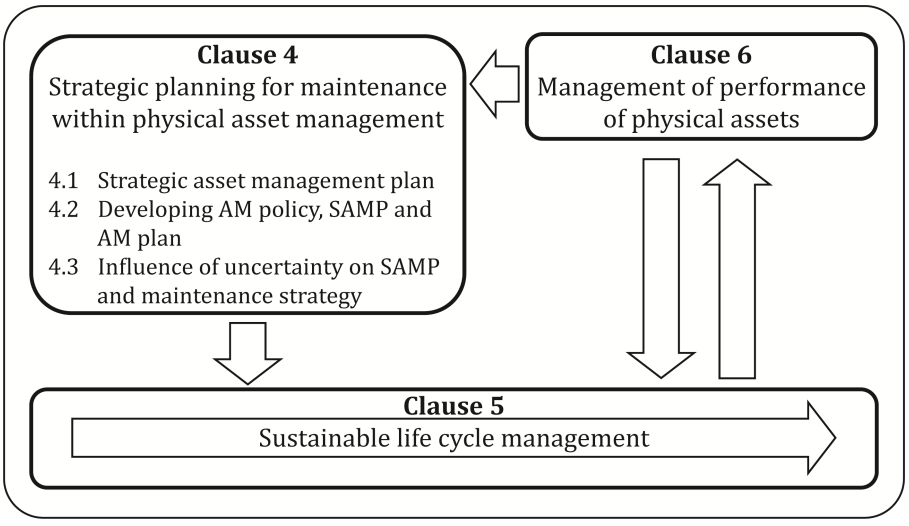

Figure 2 — The structure of the core clauses

In Figure 2, life cycle management covers 3 main life cycles stages (see in detail 5.2):

1. Acquisition stages (6 sub-stages) where the impact of maintenance on asset solutions have been indicated and the first contributions on maintenance strategies and programmes have been created;

2. Utilization stages (3 sub-stages) which are:

   — Utilization of physical assets;

   — Maintenance of physical assets;

   — Replacements including reconditioning, improvements, modifications, modernizations;

3. Disposal stage.

1 Scope

This document specifies methods and procedures when applying physical asset management as a framework to take maintenance into account as an influencing factor within an organizations' strategic and tactical decisions on its physical assets, and when applying physical asset management as a framework to maintenance activities. It also specifies the relationship between organizational strategic plan and the maintenance management system at a methodological level and describes the interrelations between maintenance process and all the other physical asset management processes at a procedural level.

This document is applicable to managing the physical assets of organizations of all sizes especially organizations producing goods and services with physical assets. It introduces methods and procedures for all the levels and functions of the organizations' management such as corporate planning management, plant management, technical management, production management, financial management, asset management, maintenance management, quality management, etc. The focus of the document is at the asset portfolio and system levels and consists of guidance and recommendations. It does not apply to certification, regulatory, or contractual use.

However, if specific documents exist for a particular domain, it is important to also consider those documents.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13306:2017, *Maintenance — Maintenance terminology*

EN 16646:2014, *Maintenance — Maintenance within physical asset management*

ISO 55000:2014, *Asset management — Overview, principles and terminology*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13306, ISO 55000, EN 16646 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
asset
item, thing or entity that has potential or actual value to an organization

Note 1 to entry: In this document the term 'asset' means *physical asset* (3.1.2).

Note 2 to entry: A machine or device (e.g. a pump, a gear, a valve) can be called a single asset.

[SOURCE: ISO 55000:2014, 3.2.1, modified – Note 2 to entry has been redrafted and renumbered as Note 1 to entry; Notes 1 and 3 to entry have been deleted]

3.1.2
physical asset
item that has potential or actual value to an organization

[SOURCE: EN 13306:2017, 3.2, modified]

3.1.3
asset portfolio
assets that are within the scope of the asset management system

Note 1 to entry: An asset portfolio consists of several asset systems.

Note 2 to entry: See Annex A.

[SOURCE: ISO 55000:2014, 3.2.4, modified – Notes 1 and 2 to entry have been deleted and new Notes 1 and 2 to entry have been drafted]

3.1.4
asset replacement value
ARV
estimated amount of capital that would be required to replace the old plant or asset to the similar new asset

Note 1 to entry: Replacement value is often equivalent to the fire insurance value.

Note 2 to entry: In the literature also plant replacement value (PRV) is widely used.

3.1.5
asset solution
asset that fulfils the requirements set in the concept definition

Note 1 to entry: A non-asset solution fulfils the requirements without asset ownership.

3.1.6
asset system
set of assets that interact or are interrelated

Note 1 to entry: A production line, sewage water treatment plant, transport vehicle and power plant units are typical examples of asset systems.

[SOURCE: ISO 55000:2014, 3.2.5, modified – Note 1 to entry has been added]

3.1.7
asset specificity
aspect or feature of an asset (such as a specialized machine) that makes it useful for one or few specific purposes, and therefore no other owner can get the same value from it

Note1 to entry: 'Asset specific' indicates high value of asset specificity.

3.1.8
business environment
all the external factors within the market, technology and community influencing on the decision making of the organization

[SOURCE: EN 16646:2014]

3.1.9
commercially constrained
property of the assets or asset systems, that limits profitable transaction because of asset specificity, competition reasons, obsolescence or price level

3.1.10
competence
proven ability to use knowledge, skills (3.10), and personal, social and/or methodological abilities, in work or study situations and in professional and personal development

Note 1 to entry: Competence is described in the terms of responsibility and autonomy.

[SOURCE: EN 15628:2014, 3.1]

3.1.11
concept definition
stage of the asset life cycle after feasibility study, where the basic technological solution is determined

3.1.12
creation of physical asset
acquisition process, which can include concept definition, design, manufacturing, installation, commissioning

[SOURCE: EN 16646:2014, 3.1.3]

3.1.13
improvement
dependability improvement
combination of all technical, administrative and managerial actions, intended to ameliorate the intrinsic reliability and/or maintainability and/or safety of an asset, without changing the original function

Note 1 to entry: An improvement may also be introduced to prevent misuse in operation and to avoid failures.

[SOURCE: EN 13306:2017, 7.6]

3.1.14
integrity
asset integrity
ability of a system to sustain its form, stability and robustness, and maintain its consistency of performance and use

3.1.15
item
part, component, device, subsystem, functional unit, equipment or system that can be individually described and considered

Note 1 to entry: A number of items e.g. a population of items, or a sample, may itself be considered as an item.

Note 2 to entry: An item may consist of hardware, software or both.

Note 3 to entry: Software consists of programs, procedures, rules, documentation and data of an information processing system.

[SOURCE: EN 13306:2017, 3.1]

3.1.16
critical success factor
attribute required for an organization to ensure the success of an organization

[SOURCE: EN 16646:2014, 3.1.4, modified – 'critical success factor' instead of 'key success factor']

3.1.17
lagging indicator
measure of an output

[SOURCE: ISO 41014:2020, 3.8.1]

3.1.18
leading indicator
measure of an input

[SOURCE: ISO 41014:2020, 3.8.2]

3.1.19
life cycle of a physical asset
series of stages through which a physical asset goes, from its conception to disposal

[SOURCE: EN 13306:2017, 4.18, modified – 'of a physical asset' added, 'an item' replaced by 'a physical asset', example and Note 1 to entry have been deleted]

3.1.20
maintenance
function which includes all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function

Note 1 to entry: Maintenance is not limited to a maintenance department.

Note 2 to entry: The maintenance is contributed by all the functions of the organization.

[SOURCE: EN 13306:2017, 2.1, modified – 'combination of' replaced by 'function which includes', Notes 1, 2 and 3 to entry have been deleted and new Notes 1 and 2 to entry have been drafted]

3.1.21
minimum effective expansion investment
smallest investment that is possible to increase capacity

Note 1 to entry: Minimum effective expansion investment is closely associated with the level of step costs

Note 2 to entry: For example, if a paper mill having one paper machine wants to increase its capacity it should invest in another paper machine having a very high step cost. If 5 % additional capacity is needed only, then other measures e.g. improved maintenance, could be more effective. Whereas a dressmaker's shop having 100 sewing machines can easily increase its capacity with 5 machines at a low step cost.

3.1.22
modernization
modification or improvement in the case of nonconformity of the asset, regarding technological advances, to meet new or changed requirements

[SOURCE: EN 13306:2017, 7.8, modified]

3.1.23
modification
combination of all technical, administrative and managerial actions intended to change one or more functions of a physical asset

Note 1 to entry: Modification is not a maintenance action but has to do with changing the required function of an item to a new required function. The changes may have an influence on the dependability characteristics.

Note 2 to entry: Modification may involve the maintenance organization.

Note 3 to entry: The change of an item where a different version is replacing the original item without changing the function or ameliorating the dependability of the item is called a replacement and is not a modification.

[SOURCE: EN 13306:2017, 7.7, modified – 'of an item' replaced by 'of a physical asset']

3.1.24
operating conditions
physical loads and environmental conditions as experienced by the asset during the entire life cycle

Note 1 to entry: Operating conditions can vary during the asset's life cycle.

[SOURCE: EN 13306:2017, 4.22, modified – 'experienced by the item during a given period' replaced by 'as experienced by the asset during the entire life cycle', 'item' replaced by 'asset' in Note 1 to entry]

3.1.25
operating constraints
characteristics of the asset, which set limits for the use of the asset and may determine requirements for maintenance activities

Note 1 to entry: These characteristics are the results of design and construction of the assets and are influenced by the operational mode and operation conditions.

[SOURCE: EN 13306:2017, 4.21, 'item' replaced by 'asset' in definition and Note 1 to entry, Note 1 to entry has been redrafted]

3.1.26
operational mode
operating profile
configuration in which an item is operated and utilized during a given period characterized by units of use (hours, loads, number of starts/stops, number of transients, etc.)

Note 1 to entry: Operational mode determines the frequency, load, continuity and performance rate of utilization.

[SOURCE: EN 13306:2017, 4.20]

3.1.27
physical asset management
coordinated activities of an organization to realize value from physical assets

Note 1 to entry: Realization of value will normally involve a balancing of costs, risks, opportunities and benefits.

Note 2 to entry: In the life cycle context, physical asset management is the optimal life cycle management of physical assets to sustainably achieve the stated business objectives.

[SOURCE: ISO 55000:2014, 3.3.1, modified, added 'physical']

3.1.28
technical depreciation
difference between the asset replacement value and actual value

Note 1 to entry: Technical depreciation should be based on the asset replacement value but not on asset book value.

Note 2 to entry: Technical depreciation are calculated as a ratio of asset replacement value and expected life.

Note 3 to entry: Technical depreciation measures and depicts technical aging of the assets in money terms.

[SOURCE: EN 16646:2014, 3.1.14]

3.1.29
strategic asset management plan
SAMP
documented information that specifies how organizational objectives are to be converted into asset management objectives, the approach for developing asset management plans, and the role of the asset management system in supporting achievement of the asset management objectives

Note 1 to entry: A strategic asset management plan is derived from the organizational plan.

Note 2 to entry: A strategic asset management plan may be contained in, or may be a subsidiary plan of the organizational plan.

[SOURCE: ISO 55000:2014, 3.3.2]

3.1.30
sustainability
state of the global system, including environmental, social and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their own needs

Note 1 to entry: The environmental, social and economic aspects interact, are interdependent and are often referred to as the three dimensions of sustainability.

Note 2 to entry: Sustainability is the goal of sustainable development (3.2).

[SOURCE: ISO Guide 82:2019, 3.1 'Guidelines for addressing sustainability in standards']

3.1.31
conversion cost
transformation cost
total cost required to convert materials into product or service, excluding cost of raw materials, packaging and auxiliary materials

Note 1 to entry: Conversion costs are a manufacturer's production costs other than the costs of raw materials.

3.1.32
useful life
time interval from first use until the instant when a limiting state is reached

Note 1 to entry: The limiting state may be a function of failure rate, maintenance support requirement, physical condition, economics, age, obsolescence, changes in the user's requirements or other relevant factors.

Note 2 to entry: The limiting state may be redefined by changes in conditions of use.

Note 3 to entry: In this context, 'first use' excludes testing activities prior to hand-over of the item to the end-user.

[SOURCE: EN 13306:2017, 4.16]

3.1.33
key performance indicator
KPI
indicator considered significant

[SOURCE: EN 15341:2019, 3.5]

3.2 Abbreviations

The list of abbreviations used in this document is given in Table 1.

Table 1 — List of abbreviations

Abbreviation	Meaning
AHP	Analytic hierarchy process
ARV	Asset replacement value
FMEA	Failure mode and effects analysis
FMECA	Failure mode, effects, and criticality analysis
FTA	Fault tree analysis
JIT	Just in time
KPI	Key performance indicator
LCC	Life-cycle cost
LCP	Life cycle profit
MTTM	Mean time to failure
MTTF	Mean time to maintain
MTTR	Mean time to restoration
OEE	Overall equipment effectiveness
PAM	Physical asset management
POA	Potential opportunity analysis
PPA	Potential problem analysis
RA	Risk assessment
RBI	Risk based inspection
RCM	Reliability centred maintenance
SAMP	Strategic asset management plan
RBD	Reliability Block Diagram
QFD	Quality Function Deployment

4 Strategic planning for maintenance within physical asset management

4.1 Strategic asset management plan (SAMP)

4.1.1 Introduction

The purpose of physical asset management is to manage an organization's physical assets effectively in order to deliver the objectives of the organization's strategic plan. Therefore, the organization should prepare a strategic asset management plan (SAMP) for the physical assets.

Various combinations of organizational, market and technological influencing factors (see Annex C and Annex D) affect SAMP including required *asset solutions* (see 3.1.5), operative policies, maintenance strategies, and replacement / modernizations needs and finally asset disposals. The number of combinations of influencing factors is theoretically huge, but in practice there is a limited number of combinations of influencing factors which really matter and make a difference. These differences result in basic requirements on technical asset solutions establishing the production system of the organization. However, the real sustainable competitive advantage can be achieved with innovative modes of operation and technological advancement.

4.1.2 Purpose

Consistent with the definition in ISO 55000:2014 and the requirements in ISO 55001:2014, the SAMP should fulfil a number of purposes (modified from the complete text of ISO 55002:2018, C.2):

— to detail in documented information the role of the assets, asset management and asset management system in supporting the achievement of the organizational objectives and to provide clarity and direction for everyone in the organization from top management to delivery teams;

— to translate organizational objectives into strategic asset management objectives which can have an impact on the assets and asset management;

— to guide an approach for developing the asset management plans and the asset management system, while applying the asset management policy to ensure alignment;

— to document the decision-making criteria that enable the definition of value realization for the organization and its stakeholders and the coordinated approach for performance evaluation;

— to present a consolidated plan at the asset portfolio level for achieving the strategic asset management objectives and linking these to the organization's financial plans;

— to present a plan for creating or improving the asset management system in order to ensure that the required capabilities and resources are available to achieve the asset management objectives.

4.1.3 The content

The organization should determine the areas to be addressed and the level of detail for the SAMP to meet its specific needs. A list of key areas that should be addressed in a SAMP to meet the purposes is given in ISO 55002:2018, C.4.

The scope introduces a supporting methodological framework for maintenance within physical asset management. This document is also a useful guide for many of the issues mentioned in the contents for SAMP.

Although, the list of contents for SAMP contains elements such as a summary of the organizational plan, influencing factors, critical success factors and requirements for the assets, they are presented in Figure 3 in separate boxes, as separate issues, because they are important elements of the organizational strategic plan. Especially, a summary of the organizational plan, influencing factors and critical success factors are significant inputs for strategy formulation within physical asset management and therefore, they also should be presented in SAMP. The presentation of the elements will follow the order of Figure 3.

4.1.4 The significance of assets

The significance of assets in delivery of the objectives can vary greatly depending on the products and services provided. Also, the organizations' strategic decisions determine the importance of the physical assets and therefore that of the maintenance activities. As far as manufacturing is concerned, the asset portfolio and assets within it are crucial in achieving the organizational objectives. The same applies in many cases also for services. Physical assets contribute to the quality of the organizations' services or products. Similarly, they have an influence on costs, performance and risks of the organization. There are several factors that can define the strategic importance of physical assets e.g.:

Associated with profitability and productivity:

— typical return on physical assets within the sector;

— physical assets turnover, productivity of fixed capital: sales / physical assets (book value);

— required operating rate (at which percentage rate production is profitable);

Associated with-performance and efficiency:

— technical turnover of physical assets: sales / physical assets replacement value;

— productivity of physical assets as a competitive factor in the market;

— significance of physical assets in meeting critical success factors of the organization;

— availability of non-asset solutions;

Associated with cost structure:

— relationship between personnel costs and capital costs;

— fixed capital as a barrier to entry (e.g. minimum effective investment in relation to sales);

— costs of physical asset solutions (very high investment costs may set a barrier to entry and encourage an organization towards non-asset solutions or avoid an investment).

The organization's specific significance depends on the critical success factors of the organization and the production technology in use. The asset portfolio supports the organization in delivering identified critical success factors and requirements. Maintenance has a strong role in realization of the effects of the physical assets on the delivery of organizations objectives. Maintenance activities should improve the performance and cost efficiency of the organization. Effective maintenance activities can increase the potential for higher sales by increasing OEE (overall equipment effectiveness), and therefore the capacity to produce higher volumes. The same chain of influence decreases a need for new investments, and therefore results in lower depreciation. Finally, effective maintenance decreases a need for capital in terms of fixed assets and inventories and therefore results in a higher return on the asset portfolio. In addition to the above influences, maintenance can realize the capability of the asset portfolio to create improved reliability of the product deliveries and meet other success factors.