CONCEPTUAL DESIGN FOR ASSET MANAGEMENT SYSTEM UNDER THE FRAMEWORK OF ISO 55000

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ABSTRACT

Electrical utilities are requested to operate the power network at acceptable risk levels, increase the quality of service and control investments. In consideration of this challenging environment, utilities are looking for technically and financially balanced solutions in order to increase the system performance and optimize the operating cost. A newly released international standard such as ISO 55000 series suggests the framework of a structured Asset Management (AM) System. Such a framework can provide a general platform for an AM system policy and methodology, however utilities are struggling to translate this into proper technical asset management plans for implementation. A logical selection of methodologies is based on the gap analysis between utilities' current and desired level at each stage of the asset life span, from specification of manufacturing for procurement to commissioning, operating, maintaining and retiring. This paper proposes a decision support diagram in order to facilitate utilities to develop an appropriate and suitable AM system and its scope to enhance system reliability in a cost effective way by selecting proper options according to associated financial and technical objectives. In order to achieve this goal, technical methodologies and practical techniques, that are available in the industry, will also be investigated.

INTRODUCTION

Driven by the need for efficiency, effectiveness, risk control and transparency, having a financially and technically balanced asset management system is one of the challenges many utilities are facing nowadays. With the introduction of PAS 55 (2004, 2008) and ISO 55000 (2014), there now is an internationally recognised terminology and framework for asset management that the utilities can adopt to enhance the asset performance while minimizing the risk and controlling costs.
The ISO 55000 series (55000, 55001 and 55002 [1]) are proposing an integral framework of multi-disciplinary collaboration, involving the organization, operation planning, and performance evaluation for continual improvement. The new framework is expected to bring fundamental changes to:

1. Asset-related decision making process across the organization
2. Data collection, sharing, and analysis methodology
3. Asset-related organizational structure

The present work focuses on how to apply the ISO 55000 series in power utilities, and how to incorporate it in the AM system processes.

ASSET MANAGEMENT SYSTEM UNDER THE FRAMEWORK OF ISO 55000

ISO 55000 series defines general terms related to the assets and AM system, presenting key elements and the relationship as shown in Figure 1.

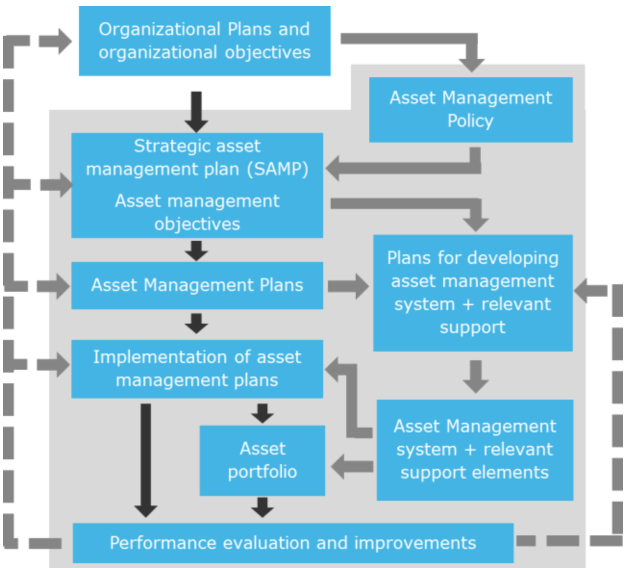

Figure 1 Relationship between key elements of an asset management system [1]

The figure provides an overview of the overall AM system, and facilitates a systematic approach to building an AM system that fulfils the needs of the utilities and their stakeholders. The AM system begins with utilities' policy and objectives which can be transformed into a Strategic Asset Management Plan (SAMP).
This SAMP is the result of an appropriate decision making process for asset-related issues which make it possible to prioritize, plan, resource and implement AM activities. Eventually, the AM process should be evaluated with measurable markers after performance evaluation in order to be improved continuously. Where

ISO 55001 and 55002 set the requirements and provide guidance for an AM system, the detailed design is largely context dependent. In order to apply the approach to power utilities, logical steps are proposed with technical scopes available in this paper.

PROPOSED FOUR PHASE FRAMEWORK FOR ASSET MANAGEMENT SYSTEM IMPLEMENTATION UNDER ISO 55000

Figure 2 shows a proposed step-wise implementation of an AM system.

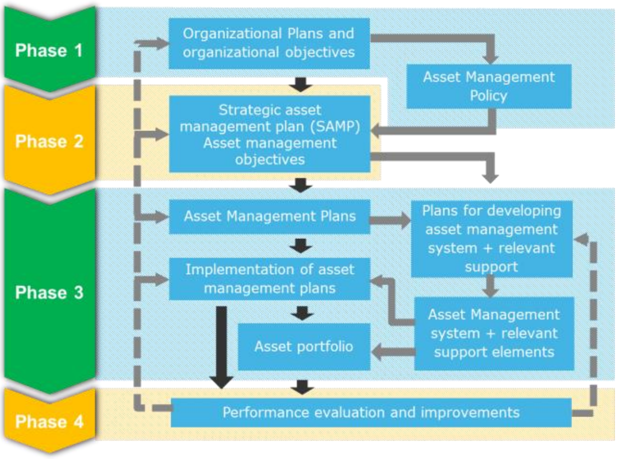

Figure 2 Proposed four phase approach for Asset Management implementation

Phase 1: Understanding the organization

The incorporation of organizational objectives and goals requires an in-depth understanding of internal and external requirements. This involves demand growth and failure behaviour, and other major trends and drivers impacting on the organization with regard to reliability, financial, safety, social, political, legal, and regulatory perspective. Key considerations also include an internal perspective related to the organization's capabilities, resources and information system, authorization structure and process.

Phase 2: Scoping Asset Management system

In this phase, utilities develop asset management objectives and a SAMP which are in alignment with organizational objectives. The SAMP is developed in consideration of expectations and needs from all stakeholders, and includes:

1. Business values and Key Performance Indicators (KPI's)
2. Decision making processes and criteria.
3. Boundaries of the AM system with scope.
4. Plans and programs to achieve the AM system objectives.

Phase 3: Resource planning and implementation of Asset Management system

Phase 3 is dedicated to the actual implementation of the AM system including the required resources. This involves the development of processes and procedures, development of the right technical and IT tools and systems, and competence building, and awareness & communication on a regular basis. The technical scope of AM needs to be aligned with the asset life cycle. In particular, different AM practices should address four different stages of the life span of the asset; specification and design, commissioning, maintenance and operation, and retiring.

1. **Specification and design**: When utilities decide to procure new assets for extension or replacement, the assets need to be specified taking into account the latest requirements imposed by standards, as well as the particular circumstances of the utility itself, which can be controlled by Factory Acceptance Test (FAT). In addition, network topology, redundancy and protective relay schemes should be carefully coordinated in order to avoid any cascading failure in the system.
2. **Commissioning**: Although well manufactured assets can pass quality control in the factory FAT, bad workmanship during installation may cause serious technical defects, which can highly increase the risk of the failure, escalating into larger scale of losses. Thus, it is critical to have properly arranged Site Acceptance Test (SAT), or commissioning test on asset and system level. All site remarks also can provide vital information for the AM system. For this reason, collecting, sharing and approving such data are important.
3. **Maintenance and Operation**: While the asset is being operated, extracting proper condition related diagnostic and operational markers are instrumental for proper maintenance and operation plans and practices. Those data can be furthermore analysed through for instance a Health Index (HI) system, which provides a single indicator that represents the condition of an asset in relation to its specified performance and lifetime [2, 3]. It is also important to have a root cause analysis in case a failure happens during operation of the asset to prevent the same case resulting in high maintenance cost and penalties. It can be prevented if the proper failure analysis carried out with remedy actions taken on the asset in which the same installation methods and material were used.
4. **Retiring**: In case the estimated life time of the asset is reaching the end of the life with significant failure probability, the retirement of the assets can be framed. Assets should not be replaced too soon (cost issues) or too late (reliability issues). Proper replacement management requires a predictive

horizon of typically 10 to 15 years, and identification of critical short term replacement needs [2].

Technical methodologies in each stage of the life span of the asset are shown in the Figure 3. The methodologies have to be selected to manage the asset in each stage properly in order to reduce the risk, achieving the real advantages and benefits of the AM system.

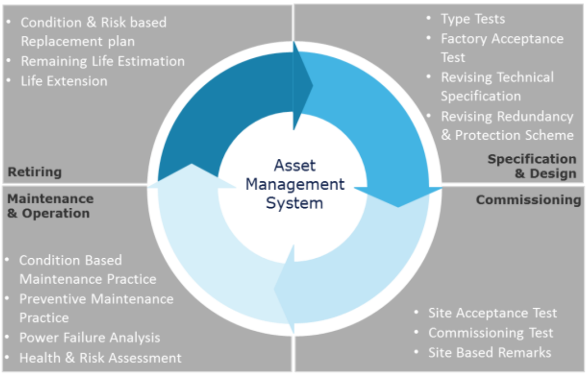

Figure 3 Technical Asset Management methodologies in different life stage of asset

Phase 4 : Evaluation and improvement

The AM system should be continuously evaluated for possible improvements and corrections to be in alignment with inherent objectives. In this respect, systematic measurement of performance with quantitative and qualitative indices can contribute to the AM system improvement with SMART targets for a specific process or the system.

BUILDING THE ASSET MANAGEMENT SYSTEM: TECHNICAL GAP ANALYSIS AND SUPPORTING TOOLS

The ISO 55000 series present a starting point of the asset management system, with a focus on organization and process. A technically enhanced AM system, however, can be achieved by adding a technical gap analysis for the proper decisions processes, resources and supporting tools.

Technical and financial constraints of the utilities usually hinder AM system realization as planned. In order to overcome such constraints and to plan the AM system in a tailor-made manner for short/long term goals, a technical gap analysis can be carried out for understanding the gap between current practices with technical competence and required scenario's, prioritizing required technologies, tools or competences in an appropriate order.

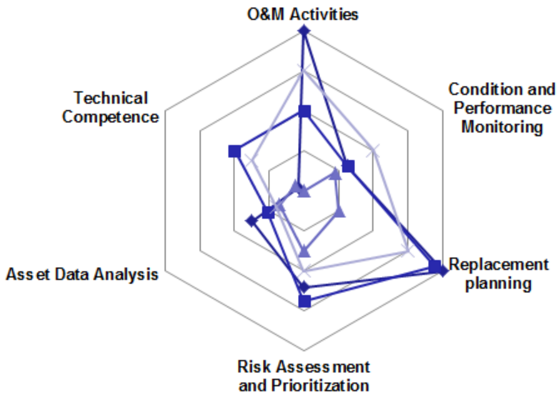

Figure 4 Example of a technical gap analysis.

This technical gap analysis not only enables to assess the current practice, but can also be used to list and prioritize the technologies and methodologies to which the utility has to pay attention first within utilities' objectives and resource boundary, planning for the resourcing of required tools on a short or long-term basis.

Asset Management supporting tools

Information Technology (IT) tools play an important role to support the technical performance of the AM system in order to maintain, control, and analyse the information and its trend over the time, understanding of assets and their risks throughout their life cycle. Since sound decisions can be highly dependent on having a high quality of information, support by efficient IT tools for data acquisition and analysis is critical. In this sense, some considerations of IT tools are

1. Scalability: IT tools should accommodate all assets the utility likes to include for monitoring and maintenance. In case of grid extension, new set of assets should be maintained using the same IT tools.
2. Life cycle coverage: IT tools should cover all available information and its trend over the life cycle of the asset.
3. Compatibility: When utilities decide to adapt new condition assessment or monitoring software solution, IT tools should communicate core condition information on assets to one another. As valuable information regarding the operation of the assets is mostly available from the Supervisory Control And Data Acquisition / Energy Management System (SCADA/EMS), IT tools should house key operational information when required.
4. Flexibility: IT tools should support any specific methods and information as a template in which the utilities like to add or remove at any time.

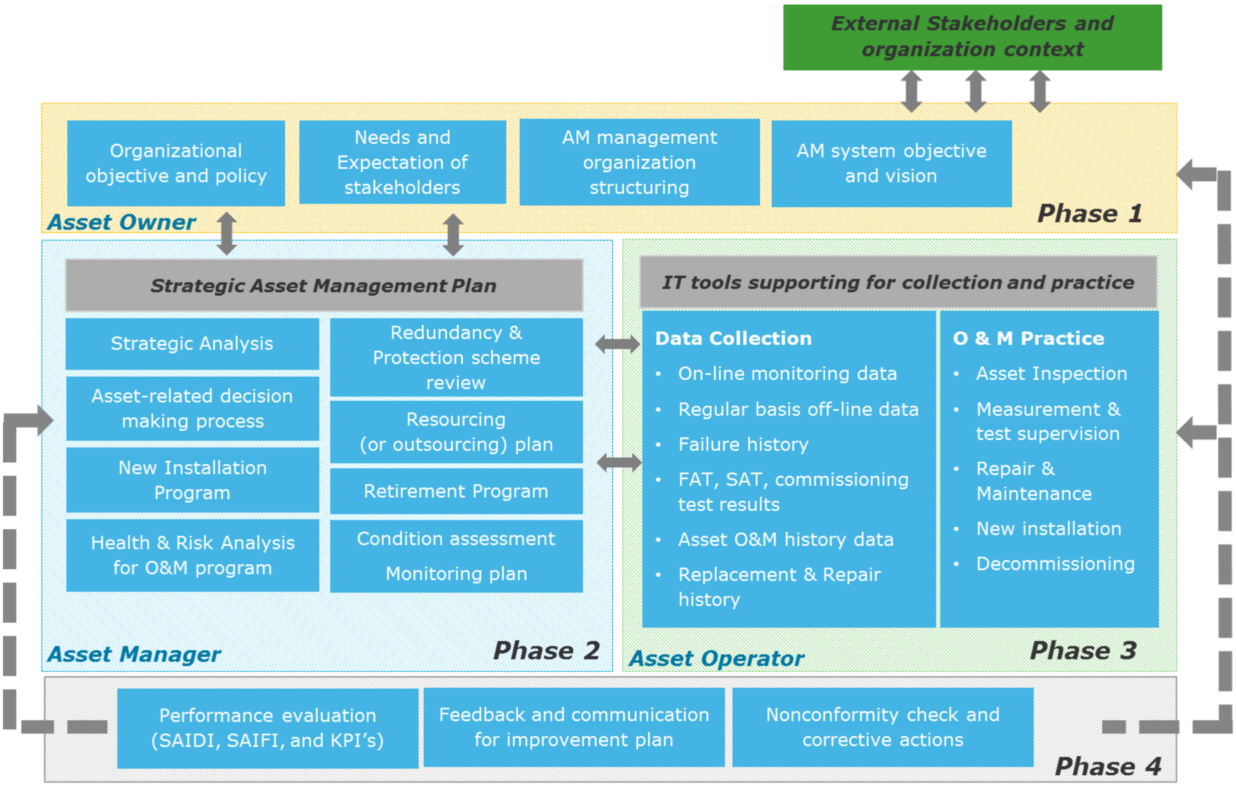

Figure 5 Conceptual Diagram of Asset Management system under ISO 55000 series within electric utilities context

Nowadays many utilities are considering to utilize on-line monitoring devices to extract meaningful dynamic condition parameters such as Partial Discharge [4], Tangent Delta, or Dissolved Gas Analysis. The data can bolster maintenance timing and planning, resulting in financial benefits. Moreover, the utilities can add values by analysing them on a system level creating Health Index (HI) of the asset in order to calculate remaining life time and expected time to additional required maintenance (TAM) in much detail [2]. HI can also help to prioritize the assets relatively for further investigation to perform preventive maintenance practices.

CONCEPTUAL DESIGN OF AN ASSET MANAGEMENT SYSTEM FROM ELECTRIC UTILITY PERSPECTIVE

In Figure 5, a conceptual diagram for electrical utilities under the ISO 55000 series is proposed. Even though the main leaders (asset owner, manager and operator) have different levels of involvement in each stage, all stakeholders should participate to build the AM system regarding the detailed scope, technologies, tools and programs in each phase. The main roles of those internal stakeholders are:

1. Asset Owner: leading organization's objectives and goals, external stakeholders such as insurance companies and regulator's needs can be taken into account to build the AM system objectives and vision for the roadmap.
2. Asset Manager: planning and leading the AM system implementation and performing the AM analysis and planning. The detailed programme to scope the AM system with a rational asset-related decision making process can be developed
3. Asset Operator: executing and performing the site duties depending upon the operational plans for construction, maintenance, operations and data collection. In this respect, the functionality of the IT tools should be convenient for asset operators to collect, share and process the data and information, and for the asset manager to analyse and act on the data and information. Technical competence in addition is critical to carry out right data collection and O&M practice.

Depending upon the organization's status and the criticality of the assets, the AM strategy for condition assessment and maintenance practice can be selected such as run-to-failure, time-based, condition based, and risk based monitoring and maintenance. Each method has pros and cons, and a decision depends on the applications and the unit under the program, on the impact of failure, on the options for monitoring or diagnosis, and so on.

All processes and programmes included in the AM system should be evaluated by the performance indices of the electric utilities such as System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) and other KPI's to identify improvement options. Furthermore, through regular communication among stakeholders, qualitative feedbacks for improvement items can be obtained. Lastly internal and external auditing can track nonconformities with ISO 55000 series with corrective actions for the electric utilities.

CONCLUSION: KEY FACTORS TO BUILD RELIABLE ASSET MANAGEMENT SYSTEM

ISO 55000 series provides a fundamental and overall structure of an AM system for utilities, aligned with the utilities' objectives and policy. Key ingredients of such a system include:

- An overall policy, strategy and objectives aligned with stakeholder requirements;
- A clear set of business values and KPI's;
- A risk based methodology for assessing, prioritizing and mitigating risks and producing asset management plans;
- Availability of high quality data (complete, correct, unique and accessible);
- An IT system that supports, and not governs, the AM system;
- A solid system for quality assurance and continuous improvement.

It can be noted however that the standards do not provide specific guidance for specific utilities to develop favoured technologies for specific assets to constitute the system. Appropriate technologies and methods could be used in different stage of asset life cycle to enhance the reliability of the AM system, which can use actual condition information of the asset for further maintenance practices or replacement plan.

Based on our experience in implementing AM systems, key success factors to build a reliable AM system are:

1. **Data quality**: the data extracted as a condition of the asset should be carefully selected and measured as relevant, complete, and accurate as possible to formulate meaningful analysis.
2. **Competence and awareness**: the utility is highly encouraged to have required training for understanding the technologies, processes, and the whole system as well as the meaning of the parameters as a result of the test. Therefore, full control of the AM system can come into existence.
3. **Commitments on all levels**: the chain is as strong as the weakest link. High quality asset management requires commitment from field to board. Commitment may be strongly enhanced by pilot projects and short term performance improvements.
4. **Evaluation**: the AM system should be improved by clear indicators based on the performance evaluation and every level of the organization should be continuously aware and focused on how to improve the performance.

As a conclusion we state that the ISO 55000 provides a solid basis for the AM system in terms of process and organization, and that implementation in a specific type of utility requires an additional dedicated technical framework I order to be successful. Further research and works could be focused on the development of this technical framework under different customer's circumstances on both the asset and the system level.

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