

Towards a Best Practice Asset Management Framework for Electrical Power Distribution Organisations

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Abstract— *Asset management in electrical power distribution organizations is becoming progressively explicit. However, organizations are encountering much difficulties in outlining and institutionalizing their asset management because of the complexity of the discipline. This paper has developed a useful capability maturity model for benchmarking and improving asset management for electrical power distribution organizations. In addition, a process-based framework is introduced for asset management, where thirteen key process areas and seven attributes are identified in this research for electrical power distribution organizations. Implementation of such model should enable these organizations to manage their assets more effectively for optimal service delivery as well as ensure reliability of their assets.*

Index Terms— *Ageing assets, Asset life cycle, ISO 55000, Maturity model, Power industries.*

I. INTRODUCTION

THE streamlining and development of electric power industries worldwide have expanded their motivations for a cost effective and efficient use of the existing assets. According to the British Standard 2014 an asset is defined as “An item, thing or entity that has potential or actual value to an organization” and asset management is defined as “coordinated activity of an organization to realize value from assets” [1].

Asset management is a process of attaining, utilization and removal of assets to make the best out of it in terms of cost and output without compromising on risks involved during their whole life cycle [2]. Over the decades, electric power industries are growing rapidly and the management of its assets has become a challenging issue for the industry. Electric power industry consists of mainly three sectors; these are namely, (i) power generation, (ii) power transmission, and (iii) power distribution. The main focus of this paper would mainly be on the distribution side for consumers, such as households and manufacturing industries.

The main task of an electricity distribution system is to provide and fulfil the customers’ energy demands after receiving the bulk energy from the generation side. However, due to increasing demands everyday it has become difficult for the organization to keep the customers satisfy by providing

good quality services. Moreover, in most cases the electrical equipment are becoming obsolete and major investment is needed to update the system time to time. It is therefore necessary for every organization to assess their asset management practice areas and compare them against the best practiced asset management for providing and maintaining better service delivery [3].

The increasing population and their growing demands are becoming a challenge for the electric power industry. Moreover, managing assets have been more complex due to ageing assets, decreasing budget, changing climate, and changing business environment. The organizations expect more from their assets and to achieve that proper asset management plan is mandatory [4].

The idea of the asset management has been used in both public and private sectors with various level of understanding. In electricity distribution context, asset management is described as an organized procedure of operating, maintaining and improving of electrical assets by using combined engineering practices and economic analysis along with thorough business practices [5].

Large amount of harmonics are produced in recent years by the use of electronic equipment, arcing devices and other non-linear loads in power systems. Hence, serious problems are faced by the utility and customer equipment once the harmonics flow into distribution system from the non-linear loads. Harmonic distortion and voltage distortion can cause bursting capacitors, blown fuses, overheating of power equipment and insulation failure [6].

The objectives of this paper is to explore the current asset management processes and practice areas, develop a maturity model and finally set a suitable benchmark of asset management practices for electrical power distribution organizations.

This paper is organized as follows: Introduction is in section I, Section II discussed the current trends in asset management, methodology and maturity model are presented in section III and the structure towards best practiced asset management is presented and some preliminary findings are described in section IV. Finally, the conclusion is presented in section V.

II. CURRENT TRENDS IN ASSET MANAGEMENT

Asset management is often confused with portfolio management and the trading of stocks and bonds [7]. Therefore, it is very important to point out specifically, asset management of physical infrastructure when it comes to the asset management in engineering environment. By physical infrastructure it means semi-permanent physical installations which contribute to the stability and development of economy and finally supports the society in general [8].

In distribution asset management systems many techniques from financial asset management are applicable to it, out of which the controlling of reliability and the risk of not meeting reliability targets are the most important ones. However, due to various reasons, distribution assets are more complex to manage as compared to the financial assets. The reasons are the presence of non-financial characteristics of performance and risk, the involvement of maintenance and replacement of assets, and the formation of a highly complex interconnected system [9].

The asset management strategies in electrical power industry can be categorized on short-term, mid-term or long-term time scales. Operational issues of the network are related to short term asset management, while the maintenance of systems assets are associated with mid-term asset management and the strategic planning of distribution system is a part of long-term asset management [2]. These management strategies are linked with the asset management capabilities of an organization and service delivery performance of their assets.

It is necessary for an organization to have a tool which they can use to assess their capabilities and service delivery. Capability maturity models (CMMs) tools are used to evaluate the ability of an organization to achieve the key processes required to deliver a product or a service [10]. It demonstrates and refines industry practices into a logical, and procedure-based structure. These models can be constructed ranges from adhoc to optimised maturity level. The maturity model was first developed by the Software Engineering Institute where they explored the design capability of software development organizations [11]. Since then this method has been widely adopted by other industries and academia.

The CMMs allow organizations to identify their current level of process maturity and find the steps accordingly to move to a higher level, by improving their strengths and overcoming the weaknesses. There are five levels in a maturity model, namely initial, repeatable, defined, managed and optimized [11]. To develop a strategy for evaluating an organization on a maturity model, it requires to define attributes.

Attributes

Attributes can assist evaluating a maturity model for an organisation. In this paper seven main key attributes are adopted using British Standard Asset Management Systems [1]. Following are the seven attributes;

1) *Scope*: The scope of implementation is proposed to be associated with the maturity. For example, a well-defined process does not constitute high organizational maturity if it's only restricted to engineering.

2) *Leadership*: The development of asset management policy and asset management objectives is the responsibility of top management and leaders.

3) *Planning*: To establish the asset management objectives and to define the role of the asset management system in achieving these objectives, the organization's strategic asset management plan should be used.

4) *Support*: Different parts of the organization should collaborate and share the resources in this way the whole organization gets aware of the asset management objectives.

5) *Operation*: The organization's asset management system can assist the directing, implementation and control of its asset management activities.

6) *Performance evaluation*: The performance of assets, asset management, and asset management system should be evaluated by the organization. These performance measure could be financial or non-financial, direct or indirect.

7) *Improvement*: To match the complex and continually evolving organization's asset management system, improvements can be made by monitoring the performance of the asset management system and asset performance itself.

Key process areas

Key process area is a group of activities when performed together help to achieve the requirement of enhancing process capability [11]. The key process areas are the building blocks that identify the areas requiring attention for an organization to improve to reach the next level. Hence, they assist in identifying the issues when addressed properly can accomplish a maturity level.

Following is a list of key process areas evaluated from the Western Power asset management system review final report [12], Energex distribution annual planning report [13] and Ergon Energy distribution annual planning report [14]. Organization's maturity level will be assessed according to these key process areas. If an organization excels in all the following areas, then it would be termed as an optimized organization.

- *Asset Policy*: Based on corporate policy and corporate objectives and align with the government policy framework.

- *Asset Planning*: Focusing on meeting customer needs in most effective and efficient manner (i.e. delivering the right service at the right price).

- *Asset Creation and Acquisition*: Provision or improvement of an asset where the expenditure can be expected to deliver benefits beyond the year of expenditure.

- *Asset Disposal*: Effective asset disposal frameworks include concern of alternatives for the disposal of under-performing, obsolete, surplus or unserviceable assets. Evaluation of alternatives are in cos-benefit terms.

- *Environmental Analysis*: Examining the asset system environment and assessment of all external factors affecting the asset system.

- *Asset Operations*: Operations functions relate to everyday running of assets and directly affects costs and service levels.

- *Asset Maintenance*: It relates to the maintenance of assets and directly affects costs and service levels.

- *Asset Management Information System*: The combination of software, data and processes which support the asset management functions.
- *Risk Management*: The identification and management of risk within an acceptable level.
- *Contingency Planning*: Documenting the steps to deal with an unexpected failure of an asset.
- *Financial Planning*: Evaluating the financial elements of the service delivery to ensure its practicality over the long term.
- *Capital Expenditure Planning*: Scheduling of new projects, rehabilitation and replacement works and estimating annual expenditure on each over the next five or more years.
- *Review of Asset Management System*: Reviewing the asset management system regularly and updating as necessary.

III. METHODOLOGY AND MATURITY MODEL

A systematic literature review method is adopted for this research where various literature are used to explore the current practices and gaps in key process areas of asset management for electrical power distribution organizations. Conducting a systematic literature review needs an explicit research method that uses literature as an input, instead of observations, interviews and questionnaire [15]. The purpose of literature review is to explore best practiced asset management for the electrical power distribution organizations. The organizations will utilize the best practice process areas as a benchmark to compare with their current practices.

Benchmarking means a standard or point of reference against which capabilities may be compared. British Standard Asset Management [1], Project Management Body of Knowledge (PMBOK) [16], annual reports of real world electrical power distribution organizations and the available other relevant literature are used for benchmarking key process areas of asset management [17-23]. The methodology is broken up into two parts as follows;

Part 1: Explorative and unstructured literature review:

An explorative and unstructured literature search on the current asset management systems initiated this study. A comprehensive literature review of various asset management systems, plans, and processes particularly in electrical power distribution sector has undertaken, which provided a basis for further studies [15].

Part 2: Framework for systematic literature review:

This part follows a more systematic approach. A clear and unambiguous research method is required when conducting a systematic literature review, where we use literature as an input, instead of interviews, observations or questionnaire data [17].

According to [18], the systematic literature review is, “a replicable, scientific and transparent process ... that aims to minimize bias ... by providing an audit trail of the reviewers decisions, procedures and conclusions” [18]. The systematic literature review outline is adopted from [19] which are as follows: (i) design the review, (ii) explain the scope and

analyze the topic, (iii) find, read and select literature, (iv) investigate the selected literature and finally, and (v) develop a maturity model. This approach is illustrated in Figure 1 as given below:

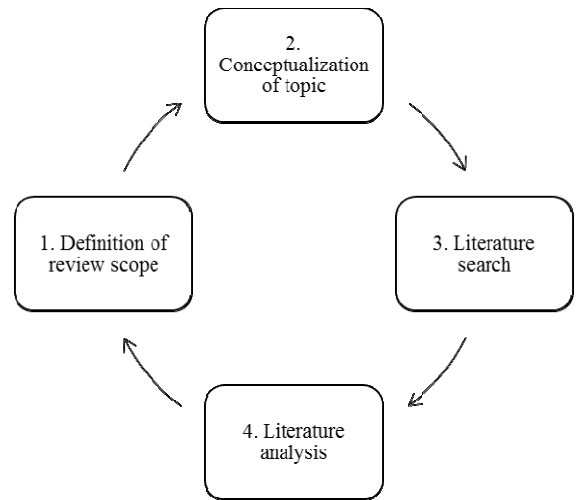


Figure 1. Framework for a systematic literature review.

This part 2 can be further broken down into five phases. The brief overview of phases are as follows;

Phase (a): In this phase, the planning for literature review is carried out. The systematic literature review’s coverage is fairly broad with the aim of including most of the literature within the defined scope.

Phase (b): The scope of this phase is to narrow down the keywords. For this reason, this phase begins with the identification of keywords and themes of relevant literature from IEEE publications, PMBOK [16] and ISO 55000 [1] which will help in further investigation processes.

Phase (c): This phase includes searching, evaluating and selecting of relevant literature. The aim is to explore the specific literature for this particular research project.

Phase (d): The analysis of the selected literature is the main task of this phase, where literature review is divided into two coding processes. First one includes inductive analysis [24], where the primary goal is to find the relevant topics and second one includes sorting selected reports from industry and academic publications into associated categories.

Phase (e): The development of maturity model is carried out in this phase, where we evaluated key process areas and attributes.

Maturity Model

A maturity model for benchmarking asset management in electrical power distribution organizations is to be developed. It will be designed to measure and improve the existing asset management practices. Hence, it will be process-based rather than just emphasizing on one particular area. Continuous process based improvements involves series of small, evolutionary stages on the contrary to revolutionary stages [11].

Maturity Levels

Process improvement involves setting of practical goals and to achieve that differences between mature and immature organizations should be known [11, 25]. In this paper, five maturity levels are to be developed to characterize organizational behaviors and process areas. To assess the maturity of an organization it is vital to know what is the actual meaning of these levels and what do they represent in practice. Below is the hierarchy of maturity levels.

The brief overview of each level can be described as follows;

Level 1: Also known as initial or ad hoc phase where limited formal asset management schemes are used.

Level 2: The repeatable organization or Level 2 organizations have the knowledge of asset management and they understand the need of it.

Level 3: These are defined organizations which define and implement asset management strategies in their business areas.

Level 4: Also called the controlled organizations. They not only support asset management plans but also make sure they their effective execution.

Level 5: These are optimized organizations which are adjustable, flexible and consider human and organizational behavior.

The maturity level of the organization would be determined by the key process areas. The level 1 organization would perform least and the level 5 organization would be score the best in key process areas.

IV. TOWARDS A BEST PRACTICED ASSET MANAGEMENT

A framework is developed which includes a series of guideline statements to assist how each process is carried out at each maturity level with reference to the key attributes. The illustration in figure 2 describes the internal structure of the framework.

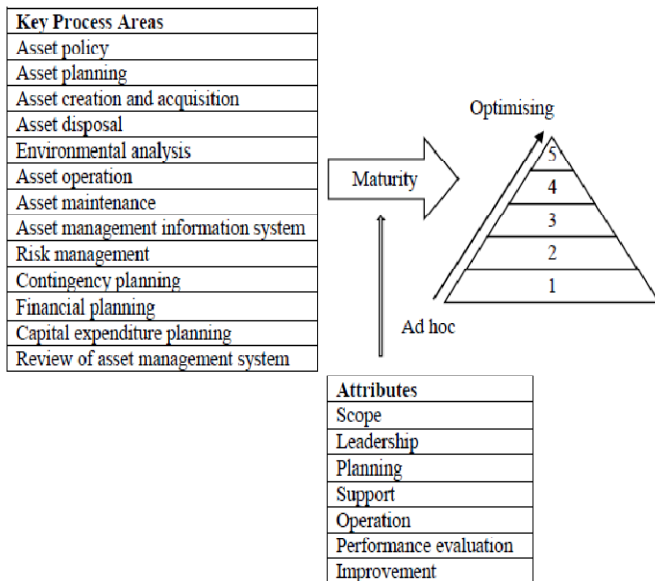


Figure 2. Generalized structural overview of the CMM.

Some of the preliminary findings based on the case organisations are described as below;

Case 1: Ergon Energy asset management framework

Ergon energy’s asset management approach is based on the principles outlined in the Publically Available Specification 55 (PAS55:2008) asset management standard. The asset management framework guides the asset manager to develop an asset management plan for the organization.

Network planning

Long-term strategic network development plans are involved in the Ergon Energy’s planning process which can assess the electricity supply infrastructure requirements for defined areas based on the 20-year load growth projections forecast. Alternative development plans are also used for a range of possible outcomes (e.g., high growth, more intense weather patterns).

A number of objectives are pursued in planning and development of asset management, which are as follows [14];

- forecasting distribution network load
- identifying constraints
- providing a capable and safe distribution network that will supply existing and future customer loads
- eliminating existing and future system constraints
- minimizing power losses
- improving network reliability with minimization of unsupplied load and reduced customer loss minutes
- maintaining appropriate quality of supply and levels of reliability on the distribution network
- minimizing investment and operation and maintenance costs
- developing an effective capital investment program based on project priorities and risk assessments
- integrating distribution augmentation plans with other capital works, etc.
- facilitating customer level outcomes such as distributed generation.

Risk management

Assets have the tendency to fail at some point in time. Ergon Energy has adopted a risk management approach which is consistent with Queensland legislation and contemporary asset management practice in order to manage any asset failures.

- Asset failures with high cost on service outcomes are managed through a program of inspection, testing, corrective maintenance and eventual replacement at the end of their life cycle. Whereas, asset failures with low cost and consequences on service outcomes are allowed to run to failure.
- Safety risks are replaced as risk mitigation programs to protect Ergon staff, customers and the general public from dangerous electrical events.

Case 2: Energex asset management framework

Energex’s asset management framework is based on international standard ISO 55000. The main purpose of the

asset management plan is to optimize capital and operating investments and to deliver improved management of the electricity distribution network assets [13].

Asset management policy

Energex asset management policies are outlined and documented to support alignment with ISO 55000. The processes required for effective management of assets throughout their asset life cycle are as follows;

- Procurement
- Planning
- Design
- Construction
- Network Operation
- Refurbishment
- Run to failure
- Asset replacement, retirement and disposal.

Risk management

Risk management is an integral part of Energex's asset management framework. It was developed in accordance with AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines. According to this risk management plan there are five risk categories to assess network risks;

- Safety
- Environment
- Legislated Requirements
- Customer Impacts
- Business Impacts.

V. CONCLUSION

The paper begins with identifying the associated problems in relation to current asset management practice areas of the electrical power distribution organizations. To address these problems organizations have to adopt an asset management maturity model. An asset management maturity model can be utilized as a basis for benchmarking and improving asset management particularly in electrical power distribution organizations. The model's theoretical foundations (framework) has been addressed and its practical definition is described explicitly. It is expected that electrical power distribution organizations can improve their asset management effectively by the implementation of this proposed model and hence deliver a better quality of service to its customers.

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