

OPERATIONAL EXCELLENCE IN OPTIMAL PLANNING AND UTILIZATION OF POWER DISTRIBUTION NETWORK

Bahman JAMSHIDIEINI Kamran REZAIE Nasser ESKANDARI Ali DADASHI
AEPDC/Tehran University – Iran Tehran University – Iran AEPDC-Iran AEPDC-Iran
bahmanjamshidi@gmail.com krezaie@tuvnordiran.com Nasser_eskandari@yahoo.com a.dadashi@ymail.com

ABSTRACT

Power distribution companies like other organizations should create value for their customers. There are many disciplines which can be used to guide companies to maximize the values considering limited resources. Product leadership, Customer intimacy and Operational excellence (OPEX) are the main disciplines used by companies that have taken leadership positions in the market. Operational excellence is an approach that focuses on customers' convenience and eliminating excessive overhead cost and waste of resources in the supply chain. In current essay, the OPEX framework which has been developed exclusively for power distribution companies will be introduced.

INTRODUCTION

Power distribution companies allocate an enormous amount of resources for constructing and utilizing of the power distribution network. However, a great portion of these resources cannot be converted to tangible value for energy consumers. Operational excellence (OPEX) is a discipline that can be applied for overcoming this issue. In this approach, integrated asset management, resilient and reliable value stream, stable processes, balanced metrics, continuous improvements, and stakeholders' involvement techniques are used in an integrated manner in order to reduce waste of resources as well as enhance service resilience.

The OPEX framework which has been used in Alborz Electric Power Distribution Company (AEPDC) for optimal planning and utilization of power grid consists of five fundamental elements: First element is stable and standard processes; the processes of network planning and utilization have been standardized. For instance, predefined procedures for network planning, network restoration and reconfiguration have been developed. In addition, the stability of main processes is controlled by statistical tools. Second element is using best practices, stakeholders' involvement and industrial engineering techniques. A flexible and versatile suggestion system have been implemented in AEPDC that motivates stakeholders, including employees, contractors, suppliers and customers, to involve in the continuous improvement of AEPDC processes. It is important to note that OPEX framework comprises technical approaches such as optimization, simulation and engineering calculations as well. In other words, OPEX framework is used to coordinate engineering techniques and stakeholders' knowledge. Third element is integrated asset management. It helps the company to acquire, utilize, maintain and dispose network physical assets such as cables, overhead

lines, transformers and communication device in an optimal, sustainable, holistic and risk-based way. Fourth element is reliable, resilient and waste-free supply chain; all processes should support reliable and resilient services to customers and finally fifth element is continuous improvement. The improvement is measured by balanced metrics. For each key process, proper metrics have been defined and are monitored continuously.

Although many articles related to various parts of AEPDC operational excellence framework have been accepted in CIRED conferences, the whole framework has not been introduced to other power distribution companies. Current essay will illustrate how power distribution companies can use an integrated framework to increase the long-term reliability and resiliency of their services while reduce their expenditure.

OPEX DEFINITION

Customers of electric power distribution companies judge the value of services on the basis of cost, quality, convenience and dependability. Therefore, operational excellence is a suitable discipline for these companies. The objectives of a company that has chosen OPEX as its guideline are reducing overhead costs and optimizing key processes. The main differences between OPEX and other disciplines have been explained by Treacy and Wiersema [1].

Although many definitions of OPEX have been introduced, in current project we adopt Friedli definition as follows:

“Operational Excellence constitutes the continuous pursuit of improvement of a production plant in all dimensions. Improvement is measured by balanced performance metrics comprising efficiency and effectiveness, thus providing a mutual basis for an improvement evaluation” [2].

ELEMENTS OF OPEX IN PLANNING AND UTILIZATION OF POWER DISTRIBUTION NETWORK

The original OPEX framework which has been developed in AEPDC includes five elements:

- 1- Stabilized and standard processes
- 2- Using best-practices, stakeholders' involvement and industrial engineering techniques to create value for customers considering incompatible factors.
- 3- Integrated asset management
- 4- Reliable, resilient and waste-free supply chain
- 5- Pursuing continuous improvement in the value stream where improvement is measured by balanced performance metrics comprising efficiency and effectiveness.



Figure 1: Operational excellence framework of electrical power distribution

These five elements are interconnected to each other. The OPEX framework of electrical power distribution is shown in figure 1 graphically.

STABILIZED AND STANDARD PROCESSES

This aspect of excellence has three sub-elements:

1- Standard processes:

The key processes of power distribution companies should be well defined and the staff of these companies should follow standard procedures. These processes are buying electricity (energy wholesale market), selling electricity to consumers, network reconfiguration (changing the position of the switches based on load flow, voltage profile and other technical factors), conducting planned activities on power grid (preventive maintenance, network extension and upgrade installed components), outage management, connecting new consumers to grid, designing distribution grid, network construction and long-term load forecasting.

2- Stabilized and in-control processes:

It is evident that a process usually cannot produce identical results over long period of time. In other words, variation is inevitable. There are two kinds of source that can cause variation: Common causes that consistently acts on the process and assignable cause that make the process instable. Control charts can be used to differentiate assignable causes from common ones. A process can be considered stable if it does not trigger detection rules of its control chart. In reference [3] a method that can be used to evaluate the stability of short-time load forecasting was introduced. Similar approach can be applied for assessing the stability of other processes such as outage management.

3- Capable processes:

Processes should be not only stable but also capable. Process capability analysis (PCA) determines how well a process meets a predefined limits. If the capability indices of a process are high enough we can be sure that the output of the process is usually within the acceptable band. In

reference [3] the capability of a load forecasting model was evaluated by PCA. Similarly, the capability of a distribution network to maintain voltage in predefined level in the presence of the distributed generators was estimated in references [4] and [5]

USING BEST PRACTICES, STAKEHOLDERS' INVOLVEMENT AND INDUSTRIAL ENGINEERING TECHNIQUES

There are many approaches that can be used to improve processes. In the operational excellence framework which was developed in AEPDC these three facilitators have been integrated in order to create value-driven improvements:

1- Best practices:

Generally, a best practice is a technique that has been accepted as the best method of achieving an objective. In other words, the result of best practices is better than any alternatives. Best practices can be obtained by benchmarking, surveying documented success of peer companies and conducting training courses. The suppliers and contractors who work for other power distribution companies play an important role in acquisition of the related knowledge.

2- Stakeholders' involvement:

Stakeholders are every organization and individual who has an influence on electric power distribution in the power distribution company region or has interest in this activity. The effective participation of stakeholders such as customers, employees, suppliers and contractors in planning, implementing, modifying and monitoring of key processes plays a pivotal role in creating value for customers. Software-based suggestion system is the approach which is used by AEPDC to promote stakeholders participation. Nowadays, the majority of employees, a lot of contractors and suppliers as well as many customers use Alborz Electric Power Distribution Company's suggestion system to contribute to enhancing its value stream. The experience of AEPDC in using

suggestion system for enhancing energy distribution processes has been explained in reference [6].

3- Industrial Engineering techniques

Although there are many useful electrical engineering techniques like load flow which can be applied to power distribution problems, the importance of using industrial engineering techniques is not negligible. Operational research, statistical analysis, multi-criteria decision making, project management and data mining are main tools that can help power distribution companies to optimize their activities. In reference [7] different multi-objective approaches which have been used in power distribution network planning was compared. In reference [8] the effect of financial and technical uncertainty on distribution network reconstruction was studied and in reference [9] the faults in communication substructure of outage management contact center were analyzed by data mining.

INTEGRATED ASSET MANAGEMENT

Integrated asset management is a systematic, holistic and integrated approach that is used by an organization in order to optimally and sustainably manages its assets as well as related risks, expenditures and performance over their life cycle [10]. There are five types of assets that need consideration: Physical assets, financial assets, information assets, human assets and intangible assets. Physical assets which comprise cables, overhead lines, transformers and other installed components of the power grid are the most important assets of a power distribution company. Integrated physical assets management covers all activities related to creating, acquiring, utilizing, maintaining and disposing physical properties. Best practices, stakeholders' involvement and industrial engineering techniques can be used to improve this aspect of operational excellence.

FOCUSING ON RELIABLE, RESILIENT AND WASTE-FREE SUPPLY CHAIN

A company that adopt operational excellence discipline should provide services with minimum overhead costs and inconvenience for its customers as well as maintain sustainable energy supply chain. Sustainability of electricity supply chain can be achieved by pursuing three objectives. Firstly, reducing the rate of failure (improving reliability). Secondly, minimizing the number of customers or activities affected by a disruption (reducing vulnerability) and finally increasing the ability of the supply chain to cope with disturbing changes (enhancing resiliency) [11]. To achieve operational excellence, the supply chain of energy distribution should has three properties:

1- Reliable

The importance of the reliability in the power distribution network is evident. Power distribution companies should maintain a reliable supply chain for energy consumers.

2- Resilient

Power grids are vulnerable against natural disasters such as earthquake, storm and flood. The ability of a power

distribution company to restore its services after any major disruption is called resiliency. In order to increase the resiliency of energy delivery the following steps should be followed: 1- Defining strategic priorities 2- Identifying vulnerabilities of electricity supply chain 3- Proactive action in design and utilization of supply chain components to reduce the length of time and the extent of post-disaster recovery 4-Monitoring resiliency of supply by comparable metrics 5- Being aware of warning signals and carrying out proactive actions to reduce extent of disasters. In reference [11] a practical method which can be used to estimate the resiliency of electricity distribution network was introduced.

3- Waste-free

Waste is any kind of expenditure or effort that cannot generates value for the customers. The companies who decide to adopt operational excellence should provide value for their customers with minimum waste. In other words, they maximize the customers' value while minimize the waste. The ultimate objective of this approach is implementation of perfect value-creating process for customers with zero waste. Overproduction, waiting, transporting, over processing, unnecessary inventory, excess motion, defects and underutilization of employees are eight types of waste which can be found in any business. Although the mentioned waste names have been derived from manufacturing processes, each type of waste has equivalent in electric power distribution. For instance, defect waste happens when remote devices or data gathering system do not work properly because of software bugs, failure of communication components or data mismatch [12].

PURSuing CONTINUOUS IMPROVEMENT IN THE VALUE STREAM

Continuous improvement is the fifth element of operational excellence. Sustainable success of a power distribution company is entirely dependent upon continuous improvement of the key processes. Furthermore, the issues related to other aspects of operational excellence such as integrated asset management or supply chain reliability should be improved gradually over the time. This improvement should be measured by balance metrics.

IMPLEMENTATION OF OPERATIONAL EXCELLENCE

Although the concept of operational excellence is an interesting idea, the full potential of it cannot be exploited without proper implementation.

The first stage of implementation is identifying, understanding and documenting the key processes. In this stage the interrelation between the processes is considered. Then, balanced metrics for each key process are defined. Stability, reliability and resilience of the processes are monitored by suitable metrics if it is possible. The next stage is finding waste sources in these processes. Finally, best practices, stakeholders' involvement and industrial engineering techniques are used to reduce waste as well as

improve the effectiveness and efficiency of the process. The processes are improved continually in order to reach perfect value creating processes. Implementing operational excellence in a power distribution company is not a project with a certain end. In contrast, it should be the culture of the company.

CASE STUDY: DISTRIBUTION NETWORK RECONFIGURATION

Network reconfiguration is a process that carries out by power distribution companies to reduce the power loss, increase the reliability and improve the voltage profile. Operational excellence can be used to enhance this process in the following ways:

1- Any loss in a distribution network is a waste. So, the minimization of loss is main objective of this process. In addition, the network should be able to maintain voltage level in an acceptable band. Therefore, instead of just calculating voltage drop in full load we should evaluate the capability of the network to maintain voltage in suitable level, especially in the presence of distributed generators. In reference [5], a practical approach was introduced in order to estimate the capability of distribution network to maintain voltage level.

2- Before any major change in power distribution network configuration, the resiliency of the energy supply chain should be evaluated and if the change has negative impacts on this factor, suitable corrective action should take place before conducting the reconfiguration.

3- Optimization techniques are used in network reconfiguration. The start point of the optimization is usually random or current situation. The convergence speed and the quality of optimization result can be enhanced, if the knowledge and experiences of the employees is used in choosing start point.

CONCLUSION

Operational excellence is a practical and systematic approach that can be used to increase the value created for electricity customers while improve the reliability and resiliency of the services. Although we have worked on operational excellence for more than three years, the whole potential of it is yet to be undiscovered.

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