Assessment of distribution system in reliability

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Abstract

Distribution reliability is the availability and quality of power supply for the customer service entrance. The reliability problem
is measured by the power interruption problems and it is a big concern in our day to day life. So, many researchers developed different method of power reliability with related to the quality, stability and loss reduction for
distribution system. This review
is to provide the clear illustration of detailed comparisons and literature surveys with different improvement methods, assessment methods and reliability indices for distribution substation reliability. It reviews also different authors work on optimization techniques and protection devices such as recloser, sectionalizer, disconnector, combinations of them and other
devices. Generally, this paper includes benefits and challenges, key points and observations, conclusions andRecommendations for future work with in the consideration of all references, and indicating the gap on this field.

Key words

Assessment method, Improvement method, Optimization techniques, Protection devices, Reliability indices

Introduction

Reliable power supply is of great importance in the electrical power system network for residential, commercial, industrial for
purpose of economic growth for a given nation or place. Many researchers have been developed different reliability measures
and improvement techniques, for the last many years. . Geol, L. et al. [1] paper is talking about determination of reliability for
distribution system planning. The reliability in a distribution system can be improved by network reconfiguration, which is
accomplished by closing normally-open switches and opening normally closed switches. Proposed network reconfiguration to increase reliability worth by an improved genetic algorithm.Simron paper was introducing simulated annealing based network configuration for distribution system reliability worth enhancement. Its discussed different aspects of reliability, describe details regarding modeling, provide examples of

reliability assessment techniques, and it was also discuss the concept of reliability worth. It

presented about power system reliability by the qualitative assessment and its application to cost benefit assessment in power system planning with increasing interest, it was also introduces using the concept of optimal placement of switches for feeder automation of the system.It discussed about demand response consideration for distribution reliability evaluation; modified

RBTS is used for system studies and lead to Time-of-use pricing changes of the demand profile, which results in a better

reliability performance and smoother load curve. A very simple analytical method has been implemented for the system analysis is presented .

A hybrid methodology for finding optimal DG connection

specifications is proposed to operate the power system with minimal power loss and with high reliable power transmission and distribution based on the

combination of neural network and genetic algorithm approach is discussed .It shows the reliability of power system can be calculated by different reliability indices, the performance can be improved by system planning and analysis studies to provide switches, sectionalizers and other protective devices at appropriate places presented the way of modeling a subsystem of the power system from the power supply interruption consumer's point, results of reliability assessment indicate significant differences of results depending on the modeling and understanding of the input data.

DG(distribution generation) based reliability analysis of distribution system and uses a new

method based on Bayesian Networks, the method permits not only calculating the reliability indices of a distribution system and

also the effect of each component or some components on the system reliability was discussed. It alsoidentifies the causes for power interruptions and customer dissatisfaction and discusses the design, reliability and operation and

maintenance of Addis Ababa distribution system (Addis center), based on load forecast for 25 years. T. It waspresented reliability evaluation techniques which are applied in distribution system planning studies and operation. Reliability of distribution systems is an important issue in power engineering for both utilities and customers by using distribution

generations. Researchers studied about analytical methods to determine the reliability indices and effect of distribution

substation configuration and network to the reliability indices performance. Solomon D. et al. [16] shows the use of smart

reclosers for improving reliability of a distribution system of one of the major cities of Ethiopia had been presented. It presented about distributed generation based reliability assessment of a power grid, the distributed generation units considered the Combined Heat and Power (CHP) units operated by individual customers at their site.

It talks about a simple method for placing an optimal number of re closer and the algorithm is solved using genetic algorithm as the optimization method has been presented the reliability improvement with effect

of customer scattering on distribution system with Distributed Generation (DG). It shows the network reconfiguration has been conducted to improve the power quality and reliability of distribution systems in presence of distributed generation. In this paper the Nigde Region's electricity system performance indices estimation and its reliability indices obtained by analytically and Monte Carlo (MC) simulation method approach.This paper is about reliability assessment of one of the substation in Ethiopia and it assess the reliability indices which

is SAIDI, SAIFI, CAIDI, EENS, AENS, ASAI, ASUI, and expected interruption costs are being assessed and considered. It has been presented, the improvement of power reliability using DG as a backup for one of the higher

substation in Ethiopia. Due to the quick operation of reclosers, some power quality issues may happen in the system. In this

paper, a Monte Carlo based method has been proposed for setting reclosers . This paper introduces about reliability performance of existing distribution network with and without protection devices has been

evaluated, power distribution system with protection device along the feeder evaluated using ETAP software. This paper

addressed the automation of distribution systems to reconfigure the network in the case of system disturbances and changes in

loads; it was presented in two times which was in Saudi Arabia 2012 and in USA by 2018

Motivation of the Review

The reliable electricity supply has become an important part of the electric power system concerning with the mutual benefits of power companies and the customers. Interruption of power supply is the greater risk for electric power distribution systems.

The motivation behind this paper is to establish compressive overview of the field of analytical power system reliability

assessment techniques, numerical technique's, optimization techniques and different improvement methods and to serve as an

input for further research and development in the area of applicability.

Overview of Reliability Assessment

This method is used to analyzing the existing system (or) calculating how many interruptions are happen in the system. The

expectation values of reliability indices are calculated by solving an equation system . Monte Carlo simulation method is mostt common numerical method. In this method, the random behavior of the system is analyzed through simulation of physical

relationships. The outcome of a Monte Carlo simulation is not only the average values as in analytical methods, i.e. expectation

value probability distributions of reliability indices. The analytical method offers the probability to apply more sophisticated

component models, e.g. including effects of component aging. However, this leads to increased computation time, why Markov

models are often used. To assess the reliability of a power system, aspects of multiple discipline .

Classification of reliability assessment methods

Basically, power system reliability assessment can be categorized into two aspects such as deterministic and probabilistic.

Deterministic method uses the reserve margin and the largest set in the system as the reliability indices in which the stochastic

component, which can be handled well with system behavior is not included. The probabilistic method considers the dynamic system behavior such as faults, component

failures, and so on for the reliability assessment of the power system . It can be subdivided into two methods such as

analytical method and numerical method.

 Benefits and challenges on reliability assessments

Generally as many authors indicating that reliability assessment is very essential for every electrical power. In Monte Carlo

simulation method is used for non-homogenous Poisson process characterization of life time of aging components .The

Markov model gives a simple description of a mathematical methods . The Monte Carlo techniques are normally a very time consuming due to large number of drawing necessary in order to obtain accurate

results. The analytical approach is based upon assumptions concerning statistical distribution of failure rate and repair times [15].

Overview of Reliability Indices

This is a necessary condition for having indices that expresses system failure event on probability and frequency basis. There

are three basic indices: failure rate (λ), outage duration (r) and average annual outage time (U), which permits the measurement

of reliability at each load point to be quantified and allow subsidiary indices such as the customer interruption indices to be

determined .

Distribution system reliability indices

The system indices commonly used by electricity supply utilities are divided in to two categories.

    A.   Customer Based Indices

    B.   Probabilistic

Overview

There are different improvement methods listed in different papers, such as network reconfiguration, using distribution

generators, component aging and by using different protection devices and combination of protection devices. For faults on the

line-sectionalizing device (recloser or sectionalizer) and the main feeder line can be used to divide the feeder into smaller line

segments. All taps should have a protective device (fuses for small taps, a recloser or sectionalizer for larger taps) where they

connect to the main feeder. Even a fuse should be used for on very small taps. The shorter line segment minimizes the number

of customers affected and minimizes the time required to patrol the line and locate the fault. A combination of a recloser and

fuses is typically used to provide protection against both transient and permanent faults.

Some authors are doing reliability improvement by distribution generators, DG (Distribution Generation) improves the system

adequacy index while in the peak shaving way, DG enhances the system reliability by serving some of loads and decreasing

energy costs in high demand periods . Many authors are done reconfiguration of the system with

different techniques and protection devices. Network reconfiguration is conducted with differential evolution algorithm to

increase power quality subjects such as harmonics and voltage sags.

Classification of reliability improvement methods

Reliability is improved by different methods with related to protections and optimization method.

Benefits and challenges of reliability improvement methods with protection devices Profile and reliable production. And the challenges are it require high installation cost, does not consider fault, not looking in

protection: depends on whether condition and less reliable estment cost, proper clearing permanent or temporary ser, Sectionalizer and limit fuse [10][52]: used for fault before the source side device interrupt, Outage restricted, improve voltage profile and decrease loading existing

electric equipment, less operation cost. And it require replacement cost for fuse,

high installation cost temporary [24][74]. It Can prevent long term outage by detecting reconfiguration [12][25][40][120][67]: The advantages of this system are growth, balancing the load, is extremely fulfill to minimize the losses and improves voltage profile. The challenges may

the requirement of additional investment and it takes time.

Benefits and challenges of reliability improvement with optimization methods

Fuzzy set optimization technique is used to examine the influence of various sub-systems that comprise in distribution network

in term of reliability. Enable the possibility of adding new fuzzy system to existing model. The flexibility of fuzzy model allows

for its application simplify complex concept to easy concept . And artificial neural network is used as radial basic function

neural network classifier to distinguish the high reliability and Low reliability of load point. This method not applicable to ring

distribution network and network classification error may occur due to complexity need further improvements . The dynamic

Bayesian is also used to construct the topological relationship of distribution system on influence of each component on the

system. This method not considers the impact of time factor to variables but reflect the probabilistic dependence between

variable and time varying of variables. It is almost the same as Monte Carlo method. And Able to describe the dynamic

evolution process of distribution system due to disconnect switch and protection device .

Key Points and Observations of the Review

Key points and discussion nil to fulfilled reliability assessment methods and its distribution system electricity requirements in reliable manner.

Optimization methods used for reliability improvement efficiency

sectionalizers, fuses, Disconnector, co-ordinations of those devices etc.

Table 1: A summary of few papers with their objective and work explanation

Key References

Main objective

Approach

Work explanation

⌉ To evaluate reliability indices by using fuzzy membership functions and simulation on the IEEE RBTS Bus 2 network with MATLAB.

⌉ Fuzzy logic

⌉ The lines and transformers were considered the most critical components for reliability analysis of distribution system. And the most influential operational and environmental variables on the failure rate of these components such as the age of component, weather conditions, and the exposure to the risk.

⌉ To estimate the reliability performance indices for the systems.

⌉ Monte Carlo

load points, reliability indices such as the SAIFI and SAIDI are determined, using two methods analytically and simulation based.

⌉ To improve the reliability of radial distribution feeders, reduce the time consumption.

⌉ Genetic Algorithm

⌉ This paper was presented an effective application of the genetic algorithm optimization to practical distribution system automation with reclosers response.

⌉ To evaluate distribution syste

⌉ Reliability index of the reliability benefit brought by IEEE Stdl 366™-2012 are give a quantitative assessment of the reliability benefit brought by the two DR programs, which are time-of-use pricing and interruptible load.

⌉ To analyze the reliability indices and to ascertain the Load Point Indices, System and Cost worth Indices of the distribution network.

⌉ Analytical

⌉ Reliability assessment and the reliability indices shown was done by Analytical approach with ETAP software, improvement onetown Networks

⌉ This paper was presented the instructive concrete information for Real engineering decision making which is improving system reliability,

identifying weak components and making check and repair plan, etc

Observations

profit. Many researches work distribution generator improving only voltage looking for other causes like short circuit, line to ground fault, line to line fault, improper arrangement component aging etc.

service availability index(ASAI), average system reliability indices such average service unavailability index(ASUI), energy not supply index(ENS), average customer curtailment index(ACCI) for the are not considering the impact of classification method may applicable to Png distribution network and network complexity need further

Probabilistic dependence between variable and time varying of variables.

improvements such as artificial intelligent method.

Conclusion and Recommendation

Conclusion

In this paper, we have observed that reliability with different assessment and improvement methods growing researches in various aspects. Many developed countries have already applied better reliable systems in their electricity network, but there are many other countries used less reliable electricity networks and high interruption times. Large numbers of research papers have been reviewed to include reliability assessment techniques, reliability improvement methods with various protection methods and optimization techniques. Each reliability improvement methods of the distribution system has been explored in detail and details

of their optimization and protection methods, benefits with their implementation and challenges in their advancement have been

explained in detail. It is also found that various reliability indices like System Average Interruption Frequency Index (SAIFI),

System average interruption duration index (SAIDI), Customer average interruption duration index (CAIDI) and so on are listed.

Recommendation

This review recommends with the consideration of all references listed in below.

References

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Power Delivery, (July 1994), Vol. 9, No. 3, pp. 1577-1583, (1994).

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