Reliability Assessment of Radial Distribution System by Using Analytical Methods

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ABSTRACT: **This paper presents basic reliability evaluation techniques needed to evaluate the reliability of distribution systems which are applied in distribution system planning and operation. In this paper we consider six different alternatives and examined on distribution system. Basically the reliability study can also help to predict the reliability performance of the system after quantifying the impact of adding new components to the system. The number and locations of new components needed to improve the reliability indices to certain limits can be identified and studied**

Keywords: **Distribution system, Reliability evaluation, Customer interruption costs.**

I.INTRODUCTION

The basic function of an electrical power system is to meet its customers while maintaining acceptable levels of quality and continuity of supply [1]. In this context, the term reliability has a broad, general meaning. It includes load or demand side measures such as quality and continuity of service as understood by the customer. Since the primary purpose of the system is to satisfy customer requirements and since the proper functioning and longevity of the system are essential requisites for continued satisfaction, it is necessary that both demand and supply side considerations are appropriately included. It is important to note that the distribution system is a vital link between the bulk power system and its customers. In many cases, these links are radial in nature that makes them vulnerable to customer interruptions due to a single outage event. A radial distribution circuit generally uses main feeders and lateral distributors to supply customer energy requirements.

In the past, the distribution segment of a power system received considerably less attention in terms of reliability planning compared to generation and transmission segments. The basic reason behind this is the fact that generation and transmission segments are very capital intensive, and outages in these segments can cause widespread catastrophic economic consequences for society. An electric power system comprises generation, transmission and distribution. It is also necessary to ensure a reasonable balance in the reliability of these various constituent parts [2]. Electric power distribution systems constitute the greatest risk to the interruption of power supply. It has been reported in the literature that more than 80% of all customer interruptions occur due to failures in the distribution system. The distribution segment has been the weakest link between the source of supply and the customer load points. Though a single distribution system reinforcement scheme is relatively inexpensive compared to a generation or a transmission improvement scheme, an electric utility normally spends a large sum of capital and maintenance budget collectively on a huge number of distribution improvement projects. Distribution utilities are required only to furnish historical distribution system performance indices to regulatory agencies. Reliability evaluation and maintenance planning techniques have separately been well developed.

A great problem encountered in the area of distribution system is how to reduce the number of interruptions experienced by customers. At first, these reductions can be obtained with the substitution of the equipment with the high failure rates. The reliability study can also help to predict the reliability performance of the system after any expansion and quantify the impact of adding new components to the system. The number and locations of new components needed to improve the reliability indices to certain limits can be identified and studied.

Customer satisfaction regarding reliable electric supply is becoming increasingly important in the new deregulated electric utility environment. Customer outage costs due to electric supply failures are of concern to both utilities and customers. Customer outage cost assessments have been conducted in many countries and the results applied using both analytical and simulation techniques to assess reliability worth.

The magnitude of the interruption cost associated with a specific delivery point will depend on many factors. These include the load curtailed, the type of customers involved and the duration of the outage. The time of day, day of the week and time of year will also have an influence on the magnitude of the interruption cost. In order to make the estimation of delivery point interruption costs a reasonable task, there is obviously a need to develop approximate techniques that use a minimum of load point topology and customer demographic data and still provide acceptable interruption cost estimates. The object of this paper is to present the basic reliability evaluation techniques needed to evaluate the reliability of distribution systems needed to evaluate the reliability of distribution systems.

II. RBTS DISTRIBUTION SYSTEM ANALYSIS

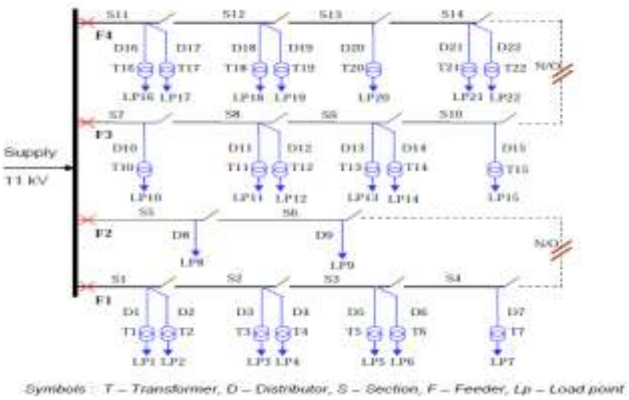

Fig 1.RBTS system

III.RELIABILITY INDICES

A distribution system is the segment of an overall power system which links the bulk system to the individual customers. The basic distribution system reliability indices are the three load point indices of average failure rate, the average outage duration r and the annual outage duration U. These three basic indices are important individual load point parameters. The system indices of SAIFI, SAIDI, CAIDI, ASAI and ASUI can be calculated from the three basic load point indices. The reliability cost worth indices of expected energy not supplied (EENS), expected interruption cost (ECOST) and interrupted energy assessment rate (IEAR) can also be calculated using the three basic load point indices. For the reliability evaluation and improvement of reliability indices for radial distribution system of feeders.

DATA OF THE RBTS

The reliability parameters are as follows:

Average failure rate for each section and distributor =0.065 failures/yr-km

Average repair time for each section and distributor = 5 hours

Average failure rate for a transformer = 0.015 failures/year

Average replacement time for a transformer= 10 hours

Average switching time = 1 hour.

The circuit breakers and fuses are assumed to be 100% reliable. The failure rate of a transformer is considered to be unaffected by the weather conditions. A faulted transformer is replaced by a mobile transformer rather than repairing it.

TABLE 1
FEEDER SECTION AND LATERAL DISTRIBUTOR LENGTHS

Length	Feeder sections	Lateral distributors
0.60 km	S4, S6, S9, S14	D1, D4, D10, D15, D17, D18
0.75 km	S1, S2, S3, S5, S7, S10, S12, S13	D6, D11, D13, D16, D21
0.80 km	S8, S11	D2, D3, D5, D7, D8, D9, D12, D14, D19, D20, D22

TABLE 2

LOAD POINT DATA

Load point	Average load (MW)	Peak load (MW)	Number of customers	Customer type
1, 2, 3, 10, 11	0.535	0.8668	210	Residential
12, 17, 18, 19	0.450	0.7291	200	Residential
8	1.000	1.6279	1	Small user
9	1.150	1.8721	1	Small user
4, 5, 13, 14, 20, 21	0.566	0.9167	1	Institutional
6, 7, 15, 16, 22	0.454	0.7500	10	Commercial

TABLE 3
FEEDER DATA

Feeder	Load points	Average load (MW)	Peak load (MW)	Number of Customers
F1	1–7	3.645	5.934	652
F2	8–9	2.150	3.500	2
F3	10–15	3.106	5.057	632
F4	16–22	3.390	5.509	622
Total	22	12.291	20.00	1908

IV CONVENTIONAL APPROACH

Approximate equation method is used to calculate primary indices**.** The fundamental reliability indices for any load point K of a feeder **[3]** are as follows:

$$\lambda_K = \lambda_T + \lambda_{DK} + \sum \lambda_{Si} \qquad ---(1)$$

$$U_K = \lambda_T r_T + \lambda_{DK} r_{DK} + \sum \lambda_{Si} r_{Si} \qquad ---(2)$$

$$R_K = \frac{U_K}{\lambda_K} \qquad ----(3)$$

where:

λ_T = average failure rate of a transformer

λ_{DK} =average failure rate of distributor k

λ_{Si} =average failure rate of feeder section *i*

r_T = average repair time of a transformer

r_{DK} =average repair time of distributor k

r_{Si} = average repair time of feeder section *i*

The load point indices λ_k and U_k computed using **Equations 1and 2** are used to obtain the feeder or system indices (SAIFI, SAIDI and CAIDI) given by equations below:

$$SAIFI = \sum_{k=1}^{lp} \lambda_K N_K / N \qquad \textbf{- - - (4)}$$

$$SAIDI = \sum_{K=1}^{lp} U_K N_K / N \qquad \textbf{- - - (5)}$$

$$CAIDI = \frac{SAIDI}{SAIFI} \qquad \textbf{- - - (6)}$$

Where, *lp* denotes the number of load points connected to the feeder/system and N_K is the number of customers at load point k, and N is the total number of customers in the system. The indices, SAIFI SAIDI and CAIDI, can be determined for different levels in the system. A single feeder or the combination of feeders can be considered. The cost worth indices of a feeder or a load point can be calculated by using the following equations:

$$ECOST = \sum_{k=1}^{lp} L_{avgk} CDF_{rk} \lambda_k \qquad \textbf{- - - (7)}$$

$$EENS = \sum_{k=1}^{lp} L_{avgk} U_k \qquad \textbf{- - - (8)}$$

$$IEAR = \frac{ECOST}{EENS} \qquad \textbf{- - - (9)}$$

Where L_{avgk} denotes the average load in MW connected at a load point k. λ_k, U_k are the failure rate and unavailability of a load point k.The customer interruption cost (CDF) associated with a particular interruption depends on the composition of the load point. CDF_{rk} in the above equation denotes the customer damage function for an interruption duration r(hrs) of load point k. The sector CDFs used in this paper are shown as demand normalized values (Rs/kW) in the **Table 4.**

The load point indices of average failure rate, average annual outage time (unavailability) and average outage duration obtained without considering weather conditions using **Equations 1-3** are shown in **Table 2.**

We consider six different possible alternatives listed below and the same were applied to a typical RBTS distribution system. The six different alternatives considered are as follow.

1) Base case

2) Effect of lateral distributor protection

3) Effect of disconnects

4) Effect of protection failures

5) Effect of transferring loads without restrictions on transfer

6) Effect of transferring loads with restrictions on transfer

TABLE 4

SECTOR INTERRUPTION COST ESTIMATES (CDF) IN RS/KW

User Sector	interruption Duration (Min.) & Cost (Rs/kW)				
	1 min.	20 min.	60 min.	240 min.	480 min.
Larger user	1 .005	1.508	2.225	3.968	8.24
Industrial	1.625	3.868	9.085	25.16	55.81
Commercial	0.38 1	2.969	8.552	3 1.32	83.01
Agricultural	0.06	0.343	0.649	2.064	4.12
Residential	0.00 1	0.093	0.482	4.9 14	15.69
Govt.&Inst.	0.044	0.369	1.492	6.558	26.04
Office	4.778	9.878	21.06	68.83	119.2

1) **Base Case**:

In this case no fuse gears, disconnects on the feeder

TABLE 5

FEEDER-1 RELIABILITY INDICES FOR BASE CASE

Load point	**λ (f/yr)**	**r (hours)**	***U*(hours/yr)**
1	0.535	5.140187	2.75
2	0.535	5.140187	2.75
3	0.535	5.140187	2.75
4	0.535	5.140187	2.75
5	0.535	5.140187	2.75
6	0.535	5.140187	2.75
7	0.535	5.140187	2.75

2) Effect of lateral distributor protection:

In this arrangement of protection of lateral distributor to install fuse gear at the tee- point in each lateral distributor. In this case a short circuit on a lateral distributor causes its appropriate fuse to blow; this causes disconnection of its load point until the failure is repaired but does not affect or cause the disconnection of any other load point.

TABLE 6

FEEDER-1RELIABILITY INDICES WITH INCLUDING FUSE GEAR

Load point	**λ (f/yr)**	**r (hours)**	***U*(hours/yr)**
1	0.23925	5.31348	1.27125
2	0.25225	5.297324	1.33625
3	0.25225	5.297324	1.33625
4	0.23925	5.31348	1.27125
5	0.25225	5.297324	1.33625
6	0.249	5.301205	1.32
7	0.25225	5.297324	1.33625

3) Effect of disconnects

In this arrangement the provision of disconnects or isolators at appropriate points along the main feeder. These are generally not fault-breaking switches and therefore any short circuit on a feeder still causes the main breaker to operate. After the fault has been detected, however, the relevant disconnect can be opened and the breaker reclosed. This procedure allows restoration of all load points between the supply point and the point of isolation before the repair process has been completed.

TABLE 7

FEEDER 1RELIABILITY INDICES WITH INCLUDING DISCONNECTS

Load point	**λ (f/yr)**	**r (hours)**	***U*(hours/yr)**
1	0.23925	3.031348	0.72525
2	0.25225	3.132805	0.79025
3	0.25225	3.905847	0.98525
4	0.23925	3.846395	0.92025
5	0.25225	4.67889	1.18025
6	0.249	4.674699	1.164
7	0.25225	5.297324	1.33625

4) Effect of protection failures

In this arrangement fuses in the lateral distributor operated whenever a failure occurred on the distributor they were supposed to protecting which assume that the fuse gear operates with a probability of 0.9, i.e. the fuses operate successfully 9 times out of 10 when required. The contribution to the failure rate can be evaluated using the concept of expectation.

Failure rate = (failure rate | fuse operates) x ***p*** (fuse operates) + (failure rate | fuse fails) x *P (*fuse fails)

TABLE 8

FEEDER 1 RELIABILITY INDICES IF THE FUSES OPERATE WITH A PROBABILITY OF 90%

Load point	**λ (f/yr)**	**r (hours)**	***U*(hours/yr)**
1	0.268825	4.838929	1.300825
2	0.280525	4.864183	1.364525
3	0.280525	4.864183	1.364525
4	0.268825	4.838929	1.300825
5	0.280525	4.864183	1.364525
6	0.2776	4.858069	1.3486
7	0.280525	4.864183	1.364525

5) Effect of transferring loads without restrictions on transfer:

In this case, assuming that there is no restriction on the amount of load that can be transferred through the back feed. In which the failure rate of each load point does not change, that the indices of load points do not change because load transfer cannot recover any load lost, and that the greatest effect occurs for the load point furthest from the supply point and nearest to the normally open transfer point.

TABLE 9
FEEDER 1RELIABILITY INDICES WITH UNRESTRICTED LOAD TRANSFER

Load point	**λ (f/yr)**	**r (hours)**	***U*(hours/yr)**
1	0.23925	3.031348	0.72525
2	0.25225	3.132805	0.79025
3	0.25225	3.132805	0.79025
4	0.23925	3.031348	0.72525
5	0.25225	3.132805	0.79025
6	0.249	3.108434	0.774
7	0.25225	2.978196	0.75125

6) Effect of transferring loads with restrictions on transfer

In this case the outage time associated with a failure event is equal to the isolation time if the load can be transferred, or equal to the repair time if the load cannot be transferred. The average of these values can be evaluated using the concept of expectation.

Outage time = (outage time | transfer) x P (of transfer) + (outage time no transfer) x P (of no transfer)

Table 10
FEEDER 1 RELIABILITY INDICES WITH RESTRICTED LOAD TRANSFER

Load point	**λ (f/yr)**	**r (hours)**	***U*(hours/yr)**
1	0.23925	3.031348	0.72525
2	0.25225	3.132805	0.79025
3	0.25225	3.442022	0.86825
4	0.23925	3.357367	0.80325
5	0.25225	3.757367	0.94625
6	0.249	3.73494	0.93
7	0.25225	3.905847	0.98525

A summary of all the indices evaluated in cases 1to 6 is shown in below illustrated Figures.

Table 11
Summary of indices

Load Point Number	**Case-1**	**Case-2**	**Case-3**	**Case-4**	**Case-5**	**Case-6**
Load Point-1	0.535	0.2393	0.2688	0.2393	0.2393	0.2393
	5.1402	5.3135	4.8389	3.0313	3.0313	3.0313
	2.75	1.2713	1.3008	0.7253	0.7253	0.7253
Load Point-2	0.535	0.2523	0.2805	0.2523	0.2523	0.2523
	5.1402	5.2973	4.8642	3.1328	3.1328	3.1328
	2.75	1.3363	1.3645	0.7903	0.7903	0.7903
Load Point-3	0.535	0.2523	0.2805	0.2523	0.2523	0.2523
	5.1402	5.2973	4.8642	3.9058	3.442	3.1328
	2.75	1.3363	1.3645	0.9853	0.8683	0.7903
Load Point-4	0.535	0.2393	0.2688	0.2393	0.2393	0.2393
	5.1402	5.3135	4.8389	3.8464	3.3574	3.0313
	2.75	1.2713	1.3008	0.9203	0.8033	0.7253
Load Point-5	0.535	0.2523	0.2805	0.2523	0.2523	0.2523
	5.1402	5.2973	4.8642	4.6789	3.7512	3.1328
	2.75	1.3363	1.3645	1.1803	0.9463	0.7903
Load Point-6	0.535	0.249	0.2776	0.249	0.249	0.249
	5.1402	5.3012	4.8581	4.6747	3.7349	3.1084
	2.75	1.32	1.3486	1.164	0.93	0.774
Load Point-7	0.535	0.2523	0.2805	0.2523	0.2523	0.2523
	5.1402	5.2973	4.8642	5.2973	3.9058	2.9782
	2.75	1.3363	1.3645	1.3363	0.9853	0.7513

TABLE 12
SUMMARY OF SYSTEM INDICES

.	**Case-1**	**Case-2**	**Case-3**	**Case-4**	**Case-5**	**Case-6**
SAIFI	0.535	0.24799	0.27669	0.24799	0.24799	0.24799
SAIDI	2.75	1.31497	1.34367	0.84703	0.79983	0.76837
CAIDI	5.14019	5.30243	4.85615	3.41552	3.22521	3.09834
ECOST	34.6117	30.767	16.4525	13.3706	9.89758	8.47513
ENS	10.0238	4.79169	4.89633	3.6619	3.13505	2.78381
IEAR	3.45297	6.42092	3.36017	3.65128	3.15708	3.04443

Case 1.Base case shown in Figure.1 (feeder-1)

Case 2.As in Case 1,but with perfect fusing in the lateral distributors

Case 3. As in Case 1, probability of fuse successful lateral distributor fault clearing of 0.9 shown in Figure.1 (feeder-1).

Case 4.As in Case 2.but with disconnects on the main feeder as shown in Figure.1 (feeder-1)

Case 5.As in Case 4, probability of conditional load transfer of 0.9.

Case 6.As in Case 4, but with an alternative as shown in Figure1(feeder-1)

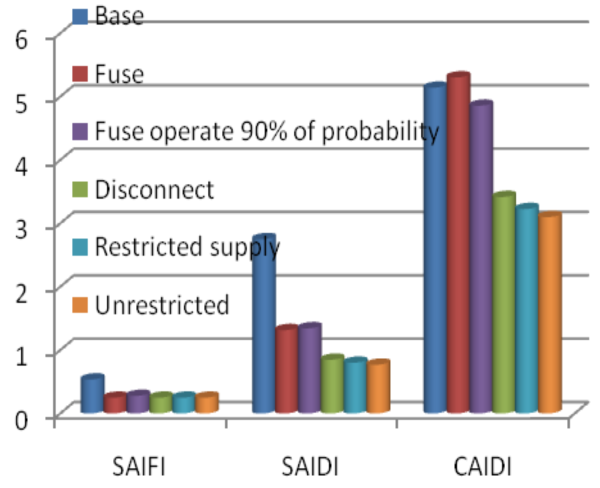

Figure.2.Graphical representation of system indices

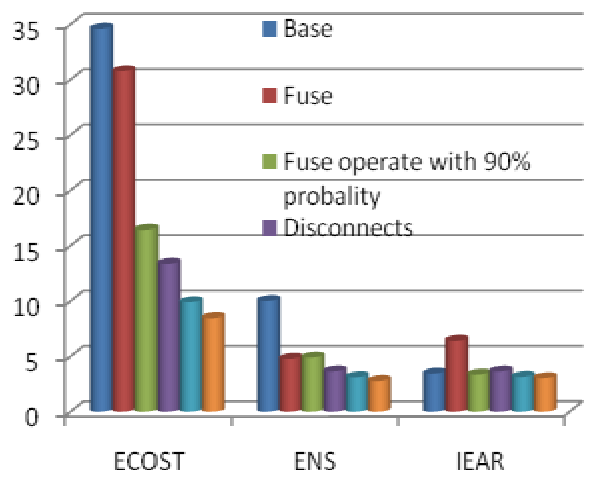

Figure.3.Graphical representation of cost worth system indices

V. APPLICATION TO OVERALL RBTS SYSTEM

A] Analytical Reliability Network Equivalent Technique:

The analytical techniques required for distribution system reliability evaluation are highly developed. Many of the published concepts and techniques are presented and summarized in. Conventional techniques for distribution system reliability evaluation are generally based on failure mode and effect analysis (FMEA)**.** This is an inductive approach that systematically details, on a component-by-component basis, all possible failure modes and identifies their resulting effects on the system. Possible failure events or malfunctions of each component in the distribution system are identified and analyzed to determine the effect on surrounding load points. A final list of failure events is formed to evaluate the basic load point indices. The FMEA technique has been used to evaluate a wide range of radial distribution systems. In systems with complicated configurations and a wide variety of components and element operating modes, the list of basic failure events can become quite lengthy and can include thousands of basic failure events. This requires considerable analysis when the FMEA technique is used. It is therefore difficult to directly use FMEA to evaluate a complex radial distribution system. A reliability network equivalent approach is introduced in this section to simplify the analytical process. The main principle in this approach is using an equivalent element to replace a portion of the distribution network and therefore decompose a large distribution system into a series of simpler distribution systems. This approach provides a repetitive and sequential process to evaluate the individual load point reliability indices.

B] Basic Formulas for a General Feeder

Based on the element data (λi, λk, λs , ri , rk, rs, pk) and the configuration of the general feeder, a set of general formulas for calculating the three basic load point indices of load point failure rate λ_j , average outage duration r_j and average annual outage time U_j for load point j of a general feeder is as follows:

$$\lambda_j = \lambda_{sj} + \sum_{i=1}^{n} \lambda_{ij} + \sum_{k=1}^{n} P_{kj}\lambda_{kj} \qquad \text{....... (10)}$$

$$U_j = \lambda_{sj}r_{sj} + \sum_{i=1}^{n} \lambda_{ij}r_{ij} + \sum_{k=1}^{n} P_{kj}\lambda_{kj}r_{kj} \qquad \text{....... (11)}$$

$$r_j = \frac{U_j}{\lambda_j} \qquad \text{...... (12)}$$

Where is the control parameter of lateral section k that depends on the fuse operating model. It can be 1 or 0 corresponding to no fuse or a 100%reliable fuse respectively and a value between 0 and 1 for a fuse which has a probability of unsuccessful operation of pkj. The parameters λij, λkj, and λsj are the failure rates of the main section i, lateral section k and series element s respectively, and $r$ij , $r$kj , and $r$sj are the outage durations (switching time or repair time) for the three elements respectively.

The $r$ij, $r$kj, and $r$sj data have different values for different load points when different alternate supply operating modes are used and disconnect switches are installed in different locations on the feeder. This is illustrated in the following three cases. The basic Formulas for a General Feeder are deduced to conventional approach approximate equations. These are given as follows:

$$\lambda_K = \lambda_T + \lambda_{DK} + \sum \lambda_{Si} \qquad ---(13)$$

$$U_K = \lambda_T r_T + \lambda_{DK} r_{DK} + \sum \lambda_{Si} r_{Si} \qquad ---(14)$$

$$R_K = \frac{U_K}{\lambda_K} \qquad ----(15)$$

Where:

λ_T = average failure rate of a transformer

λ_{DK} =average failure rate of distributor k

λ_{Si} =average failure rate of feeder section *i*

r_T = average repair time of a transformer

r_{DK} =average repair time of distributor k

r_{Si} = average repair time of feeder section *i*

Case 1: <u>No Alternate Supply:</u>

In this case, r_s is the repair time of the series element s and r_i is the switching time for those load points that can be isolated by disconnection from the failure main section i or the repair time for those load points that cannot be isolated from a failure of the main section i . In this case, r_k is the switching time for those load points that can be isolated by disconnection from a failure on a lateral section k or the repair time for those load points that cannot be isolated from a failure on a lateral section k.

Table 13

Load point indices for conventional approach

Load point	λ (f/yr)	r (hours)	*U*(hours/yr)
1	0.23925	5.31348	1.27125
2	0.25225	5.297324	1.33625
3	0.25225	5.297324	1.33625
4	0.23925	5.31348	1.27125
5	0.25225	5.297324	1.33625
6	0.249	5.301205	1.32
7	0.25225	5.297324	1.33625
8	0.13975	5	0.69875
9	0.13975	5	0.69875
10	0.2425	5.309278	1.2875
11	0.25225	5.297324	1.33625
12	0.2555	5.293542	1.3525
13	0.25225	5.297324	1.33625
14	0.2555	5.293542	1.3525
15	0.2425	5.309278	1.2875
16	0.25225	5.297324	1.33625
17	0.2425	5.309278	1.2875
18	0.2425	5.309278	1.2875
19	0.2555	5.293542	1.3525
20	0.2555	5.293542	1.3525
21	0.25225	5.297324	1.33625
22	0.2555	5.293542	1.3525

Case 2: <u>100%Reliable Alternate Supply:</u>

In this r_i and r_k take the same values as in Case 1. The parameter r_s is the switching time for those load points that are isolated from the failure of a series element by disconnection or the repair time for those load points not isolated from the failure of a series elements.

TABLE 14

LOAD POINT INDICES FOR CONVENTIONAL APPROACH

Load point	λ (f/yr)	r (hours)	*U*(hours/yr)
1	0.23925	3.031348	0.72525
2	0.25225	3.132805	0.79025

3	0.25225	3.132805	0.79025
4	0.23925	3.031348	0.72525
5	0.25225	3.132805	0.79025
6	0.249	3.108434	0.774
7	0.25225	2.978196	0.75125
8	0.13975	3.883721	0.54275
9	0.13975	3.604651	0.50375
10	0.2425	3.004124	0.7285
11	0.25225	3.132805	0.79025
12	0.2555	3.156556	0.8065
13	0.25225	2.92666	0.73825
14	0.2555	2.953033	0.7545
15	0.2425	3.004124	0.7285
16	0.25225	3.132805	0.79025
17	0.2425	3.057732	0.7415
18	0.2425	3.004124	0.7285
19	0.2555	3.105675	0.7935
20	0.2555	3.105675	0.7935
21	0.25225	2.92666	0.73825
22	0.2555	2.953033	0.7545

Case-3: **<u>Alternate Supply with Availability:</u>**

In this case, r_i is the repair time (r1) for those load points not isolated by disconnection from the failure of main section i, the switching time (r_2) for those load points supplied by the main supply and isolated from the failure of the main section i, or r_2p_a+ (1-p_a) r1 for those load points supplied by an alternate supply and isolated from the failure of the main section i. The parameter r_k is the repair time r_1 for those load points not isolated by disconnection from the failure of lateral section k, the switching time r_2 for those load points supplied by the main supply and isolated from the failure of lateral section k or $r_2$pa + (1-p_a) r1 for those load points supplied by an alternate supply and isolated from the failure of a lateral section k. r_s is the same as in Case 2.

TABLE 15
LOAD POINT INDICES FOR CONVENTIONAL APPROACH

Load point	λ (f/yr)	r (hours)	*U*(hours/yr)
1	0.23925	3.487774	0.83445
2	0.25225	3.565709	0.89945
3	0.25225	3.4111	0.86045
4	0.23925	3.324765	0.79545
5	0.25225	3.256492	0.82145
6	0.249	3.233735	0.8052
7	0.25225	2.978196	0.75125
8	0.13975	4.106977	0.57395
9	0.13975	3.604651	0.50375
10	0.2425	3.465155	0.8403
11	0.25225	3.565709	0.89945
12	0.2555	3.583953	0.9157
13	0.25225	3.400793	0.85785
14	0.2555	3.421135	0.8741
15	0.2425	3.465155	0.8403
16	0.25225	3.565709	0.89945
17	0.2425	3.508041	0.8507
18	0.2425	3.465155	0.8403
19	0.2555	3.543249	0.9053
20	0.2555	3.543249	0.9053
21	0.25225	3.400793	0.85785
22	0.2555	3.421135	0.8741

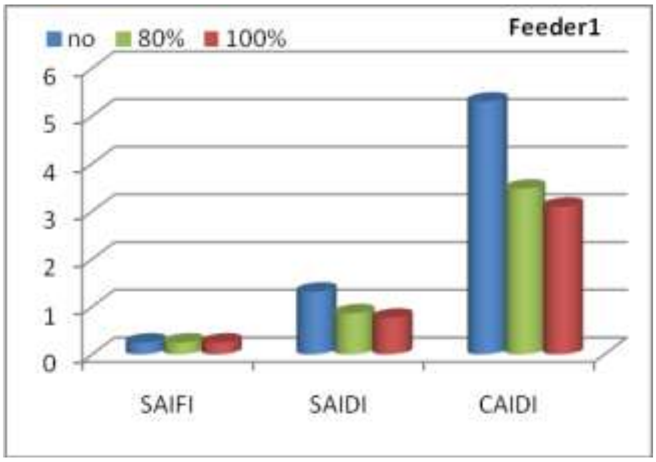

Figure.4.1.Graphical representation of system performance indices for feeder-1

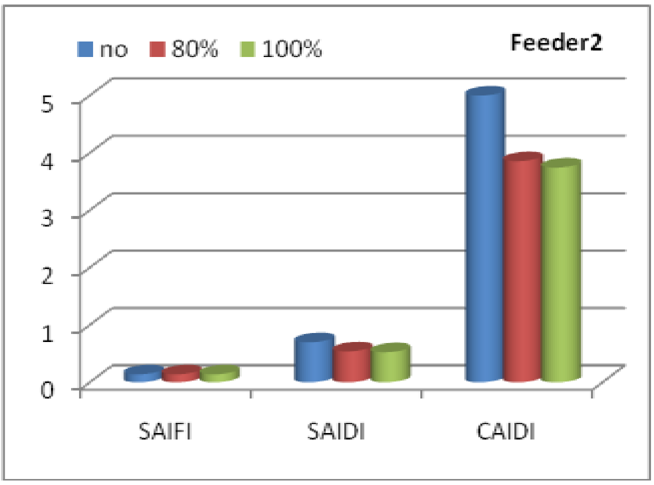

Figure.4.2.Graphical representation of system performance indices for feeder-2

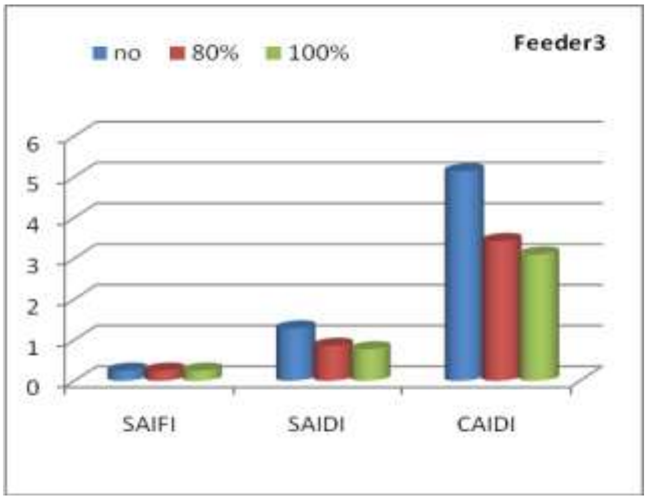

Figure.4.3.Graphical representation of system performance indices for feeder-3

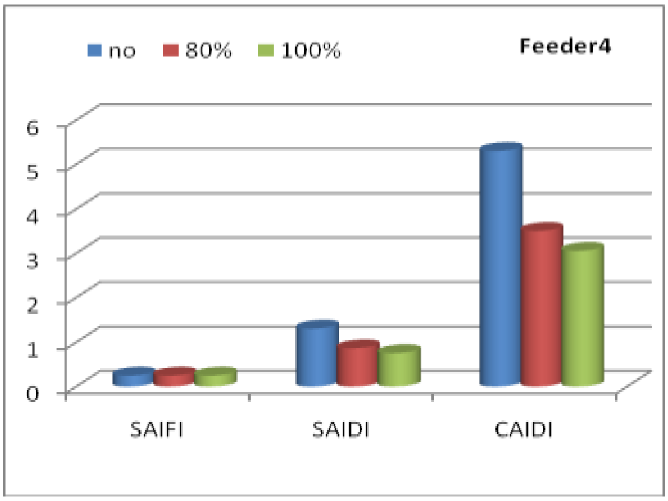

Figure.4.4.Graphical representation of system performance indices for feeder-4

Table.5.16

System indices for conventional approach

	SAIFI (int/Cust-yr)			**SAIDI (hrs/Cust-yr)**			**CAIDI (hrs/Cust-int)**		
Feeder	NO SUPPLY	80% SUPPLY	100% SUPPLY	NO SUPPLY	80% SUPPLY	100% SUPPLY	NO SUPPLY	80% SUPPLY	100% SUPPLY
F1	0.247993	0.247993	0.24799	1.314965	0.861955	0.768367	5.302428	3.475723	3.098342
F2	0.13975	0.13975	0.13975	0.69875	0.53885	0.52325	5	3.855814	3.744186
F3	0.24989	0.24989	0.24989	1.283821	0.856783	0.773758	5.137552	3.428645	3.0964
F4	0.247082	0.247082	0.24708	1.310412	0.866171	0.755111	5.303542	3.505598	3.056111
.SYSTEM	0.248211	0.248211	0.24821	1.302519	0.861278	0.765574	5.247861	3.470267	3.084609

Table.5.17

cost worth indices for conventional approach

	ECOST(kRs/yr)			**EENS(KWh/yr)**			**IEAR(kRs/kWh)**		
FEEDER	NO	80%	100%	NO	80%	100%	NO	80%	100%
F1	16.92011	8.920534	8.475126	4.791689	3.009771	2.783813	3.531137	2.963858	3.044431
F2	24.68013	20.33771	19.99733	1.502313	1.153263	1.122063	16.42809	17.63494	17.82194
F3	11.41731	6.243394	5.415785	4.118689	2.704611	2.351092	2.772073	2.308426	2.303519
F4	16.63163	9.464909	8.328417	4.5099	2.97147	2.586862	3.687804	3.185262	3.219506
SYSTEM	69.64918	44.96655	42.21666	14.92259	9.839115	8.84383	4.667365	4.570182	4.773572

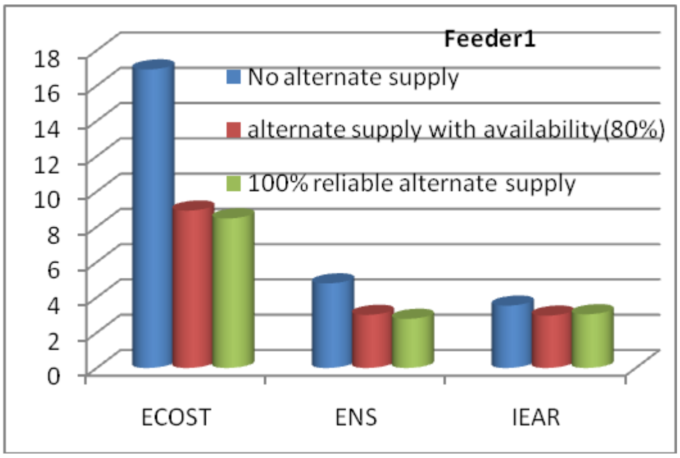

Figure.51..Graphical representation of cost worth indices for feeder-1

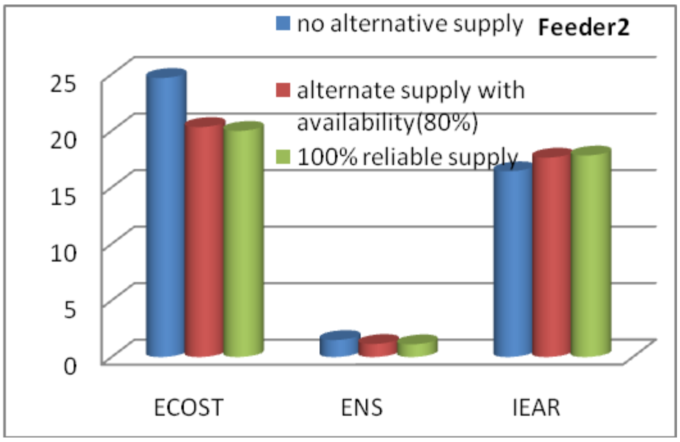

Figure.5.2.Graphical representation of cost worth indices for feeder-2

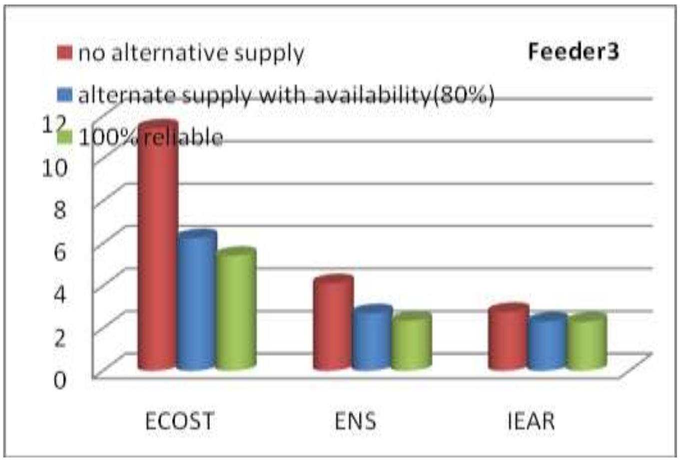

Figure.5.3..Graphical representation of cost worth indices for feeder-3

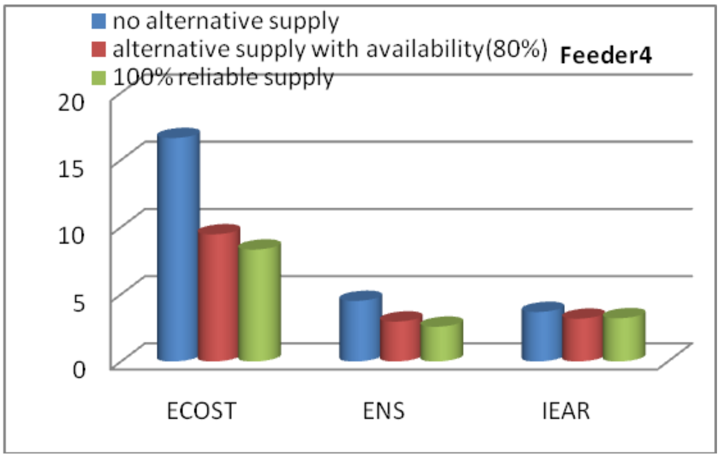

Figure.5.4.Graphical representation of cost worth indices for feeder-4

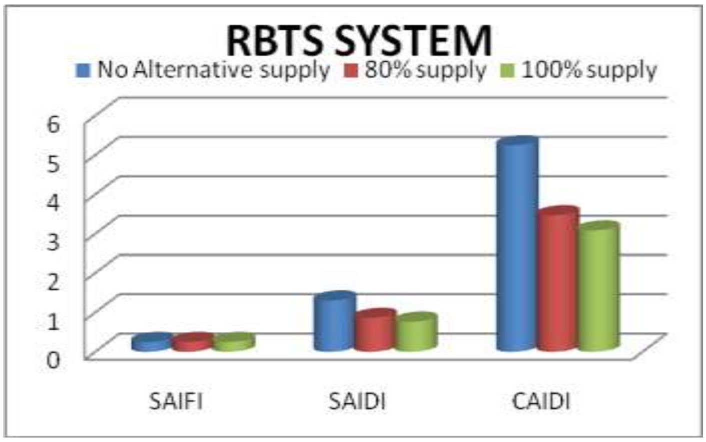

Figure.6.1.The overall RBTS system performance system indices

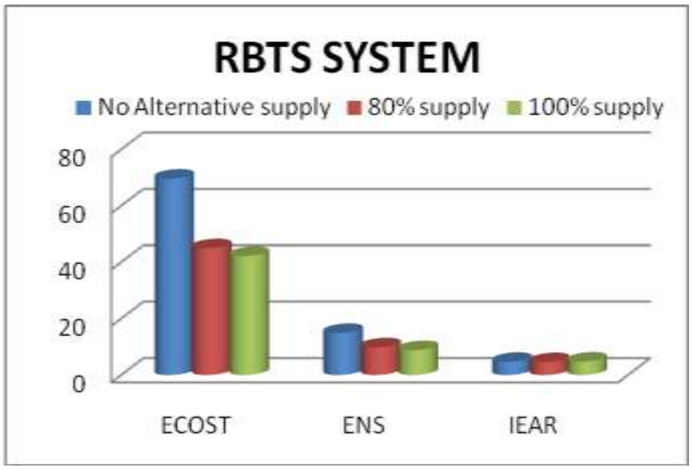

Figure.6.2.The overall RBTS system performance cost/worth indices

VI.CONCLUSION

This paper has shown different techniques for improving the reliability in radial distribution system. In this paper above mentioned all techniques examined on considering system and finally calculated cost/worth indices values. These values decreases with increasing the investment on radial distribution system..In this paper introduced six cases for the assessment of reliability of RBTS distribution system and relationship between characteristics and policy has been shown using case studies.

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