

BAB III

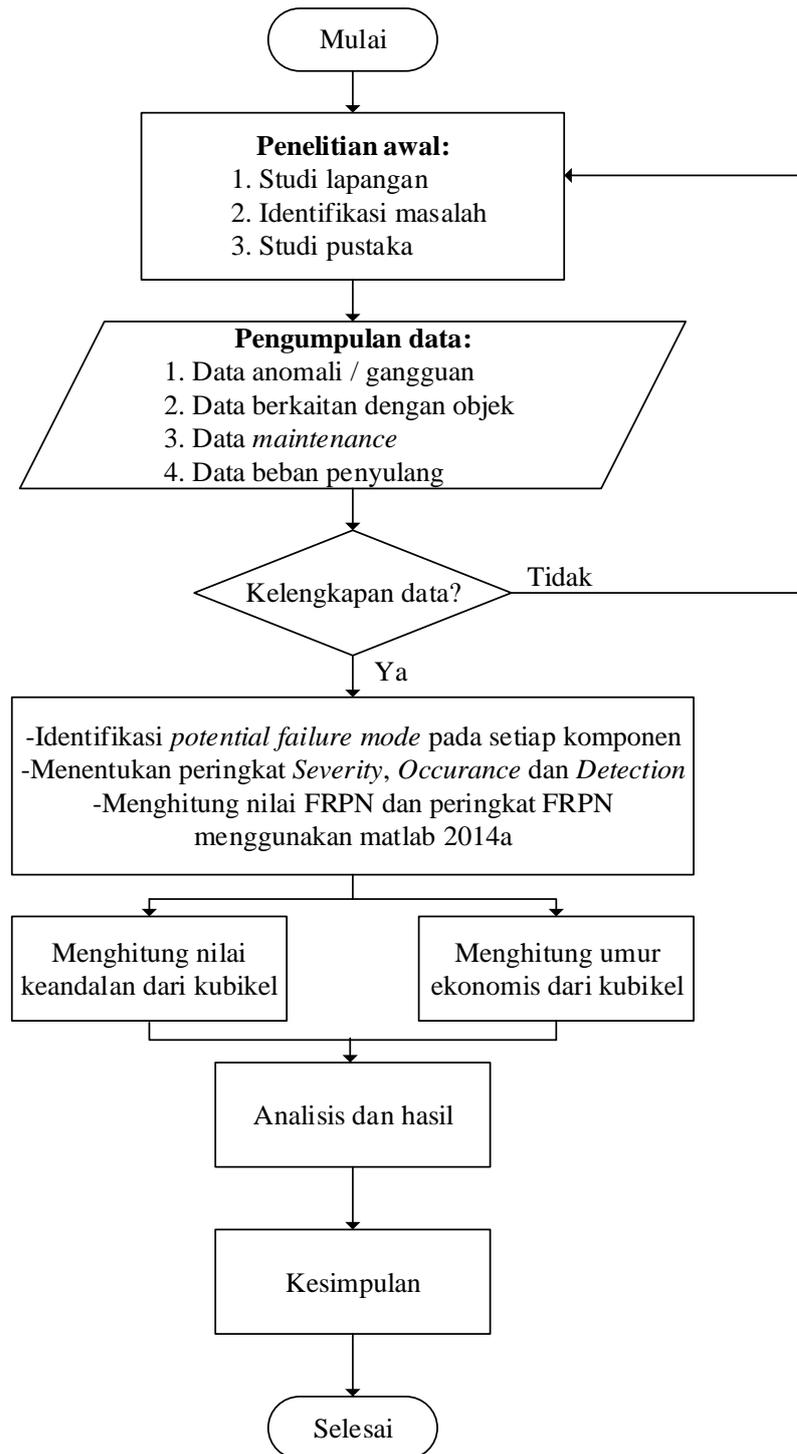
METODE PENELITIAN

Langkah-langkah penelitian ini dibuat dalam diagram alir seperti Gambar 3.1. Gambar 3.1 menunjukkan langkah-langkah penelitian yang jelas dan terperinci.

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Gambar 3.1 Diagram Alir penelitian

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3.1 Lokasi Penelitian

Objek yang akan diteliti pada penelitian ini ialah pada kubikel *out going* 20 kV pada gardu induk di wilayah kerja Area Pembagi Distribusi Jawa Barat (APD Jabar) dan HAR Bandung Raya. Pengambilan data dilakukan di PT. PLN (Persero) Area Pembagi Distribusi Jawa Barat (APD Jabar), yang terletak di jalan Ir.Dr. Soekarno Nomor 3 Bandung 40111 dan HAR Bandung Raya, yang terletak di kompleks PLN Cigereleng.

3.2 Metode Penelitian

Penelitian ini merupakan penelitian kualitatif dan kuantitatif, yakni untuk menentukan berapa besar nilai *Severity*, *Occurrence* dan *Detection* lalu digunakan untuk menghitung *Fuzzy Risk Priority Number* (FRPN) dari kubikel menggunakan logika *fuzzy* yang teradpat pada *software* Matlab 2014a. Berdasarkan frekuensi dan waktu gangguan pun dilakukan analisis keandalan dan umur ekonomis dari kubikel. Analisis keandalan dilakukan menggunakan *mean time between failure* (MTBF) dan *mean time to repair* (MTTR) berdasarkan data *breakdown* instrument kubikel *outgoing* 20 kV dibantu dengan *software* Minitab atau SPSS. Analisis umur ekonomis dilakukan dengan menggunakan *ekuivalent annual cost* (EAC).

3.3 Metode Pengumpulan Data

Dalam penelitian mengenai analisis FRPN, keandalan serta umur ekonomis dari kubikel ini ada beberapa kegiatan yang telah dilakukan penulis berkaitan dengan pengumpulan data, adapun kegiatan tersebut adalah:

a. Observasi (Pengamatan Langsung)

Pengambilan data dengan metode observasi (pengamatan langsung dilakukan dengan cara mencari data-data teknis secara langsung ke lapangan. Penulis melakukan observasi langsung ke lapangan, agar lebih mengetahui keadaan *real* pada sistem dan juga supaya mendapatkan data yang paling baru.

b. Wawancara

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Pengambilan data dengan metode wawancara dilakukan dengan cara konsultasi langsung dengan karyawan PT. PLN (Persero) APD Jawa Barat dan HAR Bandung Raya. Penulis melakukan wawancara kepada narasumber dengan maksud agar mendapat informasi yang lebih akurat terkait kubikel.

c. Diskusi

Melakukan konsultasi dan bimbingan dengan dosen pembimbing di Departemen Pendidikan Teknik Elektro Universitas Pendidikan Indonesia dan pihak-pihak lain yang membantu terlaksananya penelitian ini.

d. Dokumentasi/literature

Pengambilan data dengan metode dokumentasi/literature dilakukan dengan mengumpulkan materi-materi yang berhubungan dengan penelitian ini, baik berasal dari buku ajar, internet, jurnal atau artikel ilmiah ataupun buku panduan dari PT. PLN (Persero). Selain itu, pengambilan data teknis terkait penelitian ini berasal dari PT. PLN (Persero) APD Jawa Barat.

3.4 Metode Pengolahan Data

Dalam penelitian ini *instrument* yang digunakan adalah *Matlab 2014a* bertujuan untuk menganalisis *Fuzzy Risk Priority Number* (FRPN) dimana diketahui nilai *Severity*, *Occurrence* dan *Detection* untuk mengetahui instrument mana yang memiliki tingkat kegagalan tertinggi. Berdasarkan data gangguan pun dihitung nilai keandalan dari kubikel 20kV berdasarkan MTBF dan MTTR serta umur ekonomis dari kubikel tersebut.

Setelah data berhasil dikumpulkan, maka penulis membuat rancangan dan kerangka penelitian ini direncanakan melalui beberapa tahapan sebagai berikut:

1. Membuat form FMEA serta tingkat S, O dan D.
2. Membuat membership function untuk nilai S, O dan D.
3. Menentukan nilai dan peringkat FRPN.
4. Membuat diagram Pareto.
5. Menghitung nilai MTBF dan MTTR.

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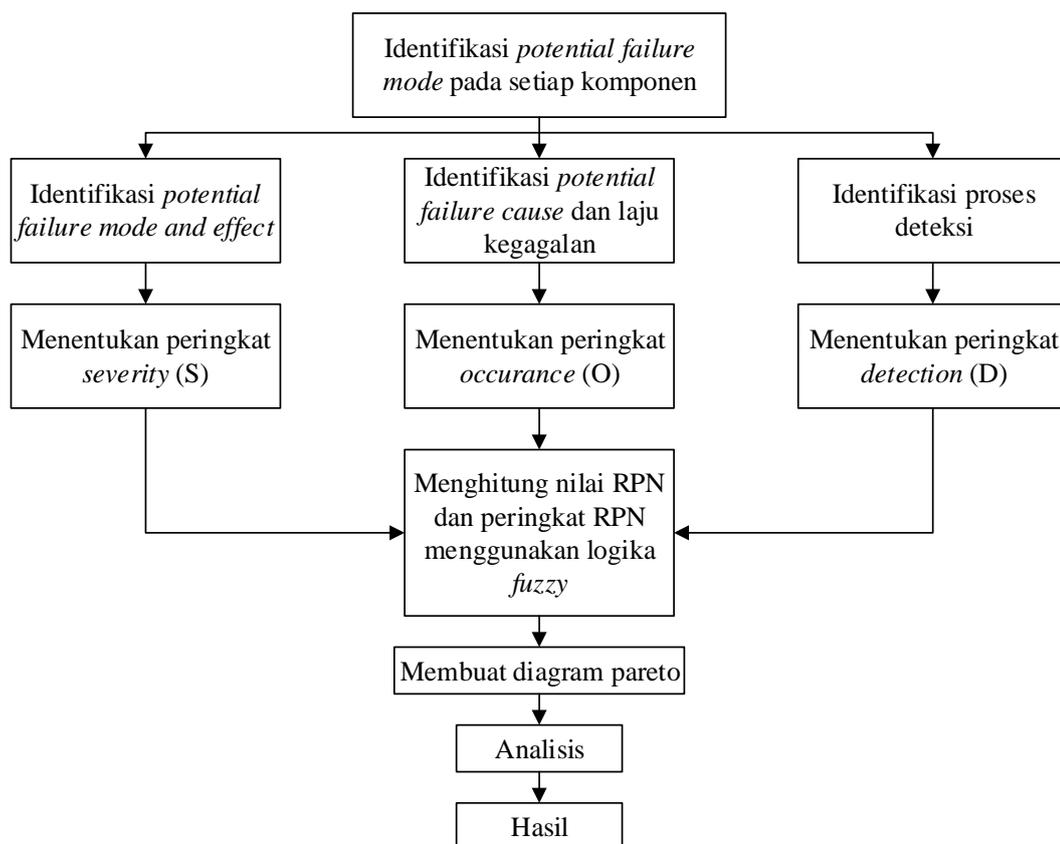
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6. Menghitung nilai keandalan kubikel.
7. Menghitung umur ekonomis kubikel.

3.5 Penetapan Nilai *Severity*, *Occurrence* dan *Detection*

Untuk mendapat peringkat atau kriteria kejadian/*anomaly* dalam metode FMEA, maka perlu dilakukan penetapan nilai *severity*, *occurrence* dan *detection* sesuai dengan kejadian yang terjadi dilapangan. Pada Gambar 3.2 diperlihatkan proses FMEA.



Gambar 3.2 Diagram Alir Tahapan FMEA

Kriteria *severity*, *occurrence*, dan *detection* ini di diambil dari referensi manual *potential failure mode and effects analysis* (FMEA) dari *automotive industry action group* (AIAG) yang menggambarkan industri otomotif. Untuk itu diperlukan penyesuaian serta modifikasi yang menggambarkan objek penelitian

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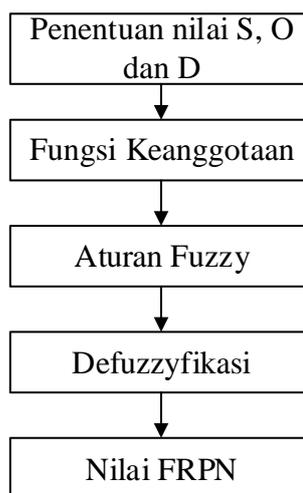
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tentang PMT Kubikel *outgoing* 20 kV dan kejadian berdasarkan pengalaman dilapangan. Maka berdasarkan dengan gangguan yang terjadi kriteria dari severity, occurrence dan detection ditetapkan sesuai dengan Tabel 2.2, Tabel 2.3 dan Tabel 2.4.

3.6 Logika Fuzzy

Logika *fuzzy* digunakan menyelesaikan Simulink logika *fuzzy* pada *software* Matlab R2014a. Alir penelitian tersebut diperlihatkan pada Gambar 3.3.



Gambar 3.3 Diagram Alir Tahapan Logika *Fuzzy*

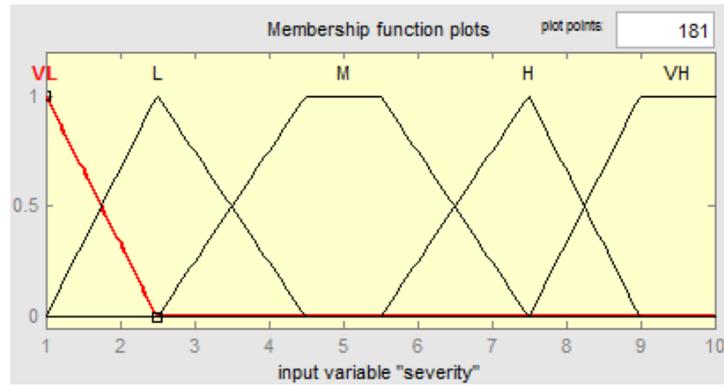
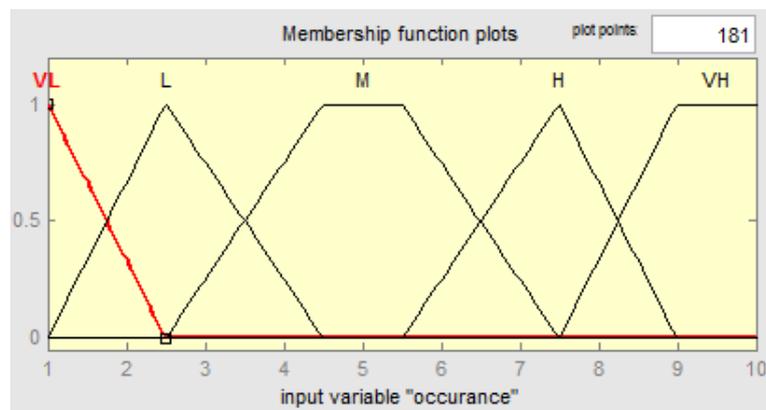
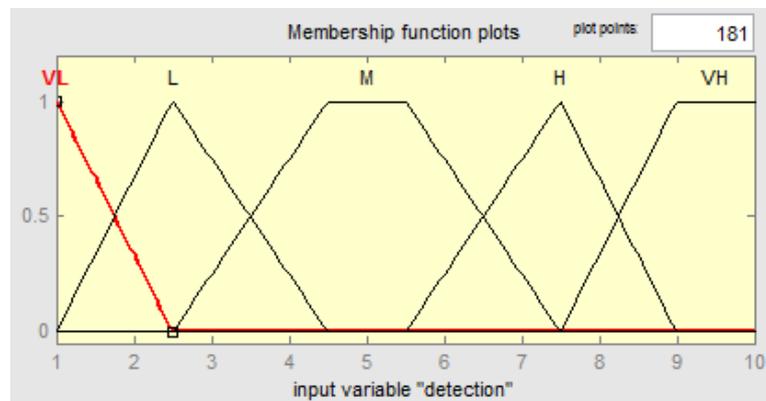
3.6.1 Fungsi Keanggotaan

Penentuan nilai FRPN dilakukan menggunakan logika *fuzzy*. Metode yang digunakan adalah metode mamdani dengan menggunakan toolbox pada Matlab R2014a. Logika *fuzzy* disini mempunyai input S, O dan D, sedangkan *outputnya* adalah nilai FRPN (*Fuzzy Risk Peiority Number*). S, O dan D mempunyai range antara 1 sampai 10 sedangkan *outputnya* (FRPN) mempunyai range antara 1 sampai 1000. Fungsi keanggotaan dari S,O dan D dibagi menjadi lima yaitu: VL (*very low*), L (*low*), M (*medium*), H (*high*), VH (*very high*). Pada Gambar 3.4, Gambar 3.5, Gambar 3.6 dan Gambar 3.7 diperlihatkan fungsi keanggotaan *fuzzy*.

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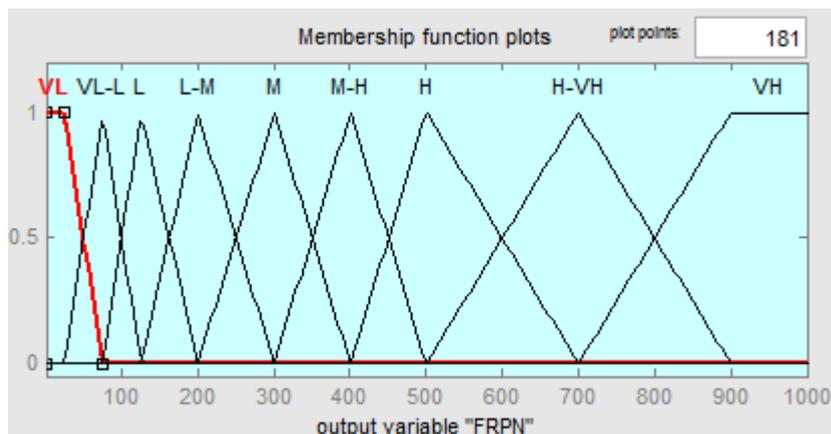
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Gambar 3.4 Fungsi Keanggotaan *severity*Gambar 3.5 Fungsi Keanggotaan *occurrence*Gambar 3.6 Fungsi Keanggotaan *detection*

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Gambar 3.7 Fungsi Keanggotaan FRPN

Fungsi keanggotaan dari *output* (FRPN) dibagi menjadi Sembilan yaitu: VL (*very low*), VL-L (*very low-low*), L (*low*), L-M (*low-medium*), M (*medium*), M-H (*medium-high*), H (*high*), H-VH (*high-very high*) dan VH (*very high*).

3.6.2 Aturan Dasar

Aturan dasar diperlukan untuk menentukan hasil dari input menjadi *output* yang tepat. Penentuan nilai FRPN berdasarkan dari input S, O dan D dinyatakan dalam bentuk aturan dasar dalam bentuk berikut:

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1. If (severity is VL) and (occurance is VL) and (detection is VL) then (FRPN is VL) (1)
2. If (severity is VL) and (occurance is VL) and (detection is L) then (FRPN is VL) (1)
3. If (severity is VL) and (occurance is VL) and (detection is M) then (FRPN is VL) (1)
4. If (severity is VL) and (occurance is VL) and (detection is H) then (FRPN is VL) (1)
5. If (severity is VL) and (occurance is VL) and (detection is VH) then (FRPN is VL) (1)
6. If (severity is VL) and (occurance is L) and (detection is VL) then (FRPN is VL) (1)
7. If (severity is VL) and (occurance is L) and (detection is L) then (FRPN is VL) (1)
8. If (severity is VL) and (occurance is L) and (detection is M) then (FRPN is VL) (1)
9. If (severity is VL) and (occurance is L) and (detection is H) then (FRPN is VL) (1)
10. If (severity is VL) and (occurance is L) and (detection is VH) then (FRPN is VL) (1)
11. If (severity is VL) and (occurance is M) and (detection is VL) then (FRPN is VL) (1)
12. If (severity is VL) and (occurance is M) and (detection is L) then (FRPN is VL) (1)
13. If (severity is VL) and (occurance is M) and (detection is M) then (FRPN is VL) (1)
14. If (severity is VL) and (occurance is M) and (detection is H) then (FRPN is VL) (1)
15. If (severity is VL) and (occurance is M) and (detection is VH) then (FRPN is VL) (1)
16. If (severity is VL) and (occurance is H) and (detection is VL) then (FRPN is VL) (1)
17. If (severity is VL) and (occurance is H) and (detection is L) then (FRPN is VL) (1)
18. If (severity is VL) and (occurance is H) and (detection is M) then (FRPN is VL) (1)
19. If (severity is VL) and (occurance is H) and (detection is H) then (FRPN is VL-L) (1)
20. If (severity is VL) and (occurance is H) and (detection is VH) then (FRPN is VL-L) (1)
21. If (severity is VL) and (occurance is VH) and (detection is VL) then (FRPN is VL) (1)
22. If (severity is VL) and (occurance is VH) and (detection is L) then (FRPN is VL) (1)
23. If (severity is VL) and (occurance is VH) and (detection is M) then (FRPN is VL) (1)
24. If (severity is VL) and (occurance is VH) and (detection is H) then (FRPN is VL-L) (1)
25. If (severity is VL) and (occurance is VH) and (detection is VH) then (FRPN is VL-L) (1)
26. If (severity is L) and (occurance is VL) and (detection is VL) then (FRPN is VL) (1)
27. If (severity is L) and (occurance is VL) and (detection is L) then (FRPN is VL) (1)
28. If (severity is L) and (occurance is VL) and (detection is M) then (FRPN is VL) (1)
29. If (severity is L) and (occurance is VL) and (detection is H) then (FRPN is VL) (1)
30. If (severity is L) and (occurance is VL) and (detection is VH) then (FRPN is VL) (1)
31. If (severity is L) and (occurance is L) and (detection is VL) then (FRPN is VL) (1)
32. If (severity is L) and (occurance is L) and (detection is L) then (FRPN is VL) (1)
33. If (severity is L) and (occurance is L) and (detection is M) then (FRPN is VL) (1)
34. If (severity is L) and (occurance is L) and (detection is H) then (FRPN is VL) (1)
35. If (severity is L) and (occurance is L) and (detection is VH) then (FRPN is VL-L) (1)
36. If (severity is L) and (occurance is M) and (detection is VL) then (FRPN is VL) (1)
37. If (severity is L) and (occurance is M) and (detection is L) then (FRPN is VL) (1)
38. If (severity is L) and (occurance is M) and (detection is M) then (FRPN is VL-L) (1)
39. If (severity is L) and (occurance is M) and (detection is H) then (FRPN is VL-L) (1)
40. If (severity is L) and (occurance is M) and (detection is VH) then (FRPN is L) (1)
41. If (severity is L) and (occurance is H) and (detection is VL) then (FRPN is VL) (1)
42. If (severity is L) and (occurance is H) and (detection is L) then (FRPN is VL) (1)
43. If (severity is L) and (occurance is H) and (detection is M) then (FRPN is VL-L) (1)
44. If (severity is L) and (occurance is H) and (detection is H) then (FRPN is L) (1)
45. If (severity is L) and (occurance is H) and (detection is VH) then (FRPN is L-M) (1)
46. If (severity is L) and (occurance is VH) and (detection is VL) then (FRPN is VL) (1)
47. If (severity is L) and (occurance is VH) and (detection is L) then (FRPN is VL-L) (1)
48. If (severity is L) and (occurance is VH) and (detection is M) then (FRPN is L) (1)
49. If (severity is L) and (occurance is VH) and (detection is H) then (FRPN is L-M) (1)
50. If (severity is L) and (occurance is VH) and (detection is VH) then (FRPN is L-M) (1)

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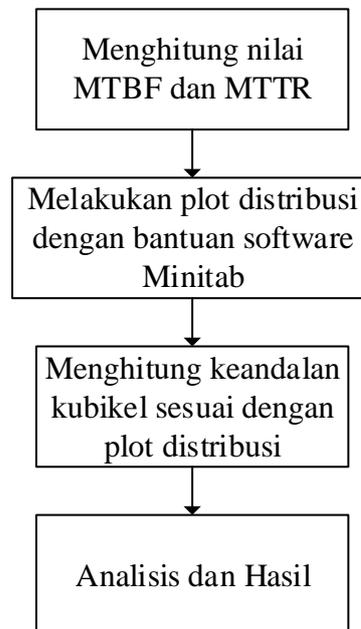
51. If (severity is M) and (occurrence is VL) and (detection is VL) then (FRPN is VL) (1)
52. If (severity is M) and (occurrence is VL) and (detection is L) then (FRPN is VL) (1)
53. If (severity is M) and (occurrence is VL) and (detection is M) then (FRPN is VL) (1)
54. If (severity is M) and (occurrence is VL) and (detection is H) then (FRPN is VL-L) (1)
55. If (severity is M) and (occurrence is VL) and (detection is VH) then (FRPN is VL-L) (1)
56. If (severity is M) and (occurrence is L) and (detection is VL) then (FRPN is VL) (1)
57. If (severity is M) and (occurrence is L) and (detection is L) then (FRPN is VL) (1)
58. If (severity is M) and (occurrence is L) and (detection is M) then (FRPN is VL-L) (1)
59. If (severity is M) and (occurrence is L) and (detection is H) then (FRPN is L) (1)
60. If (severity is M) and (occurrence is L) and (detection is VH) then (FRPN is L-M) (1)
61. If (severity is M) and (occurrence is M) and (detection is VL) then (FRPN is VL) (1)
62. If (severity is M) and (occurrence is M) and (detection is L) then (FRPN is VL-L) (1)
63. If (severity is M) and (occurrence is M) and (detection is M) then (FRPN is L) (1)
64. If (severity is M) and (occurrence is M) and (detection is H) then (FRPN is L-M) (1)
65. If (severity is M) and (occurrence is M) and (detection is VH) then (FRPN is L-M) (1)
66. If (severity is M) and (occurrence is H) and (detection is VL) then (FRPN is VL) (1)
67. If (severity is M) and (occurrence is H) and (detection is L) then (FRPN is VL-L) (1)
68. If (severity is M) and (occurrence is H) and (detection is M) then (FRPN is L-M) (1)
69. If (severity is M) and (occurrence is H) and (detection is H) then (FRPN is M) (1)
70. If (severity is M) and (occurrence is H) and (detection is H) then (FRPN is M-H) (1)
71. If (severity is M) and (occurrence is VH) and (detection is VL) then (FRPN is VL) (1)
72. If (severity is M) and (occurrence is VH) and (detection is L) then (FRPN is L) (1)
73. If (severity is M) and (occurrence is VH) and (detection is M) then (FRPN is L-M) (1)
74. If (severity is M) and (occurrence is VH) and (detection is H) then (FRPN is M-H) (1)
75. If (severity is M) and (occurrence is VH) and (detection is VH) then (FRPN is H) (1)
76. If (severity is H) and (occurrence is VL) and (detection is VL) then (FRPN is VL) (1)
77. If (severity is H) and (occurrence is VL) and (detection is L) then (FRPN is VL) (1)
78. If (severity is H) and (occurrence is VL) and (detection is M) then (FRPN is VL) (1)
79. If (severity is H) and (occurrence is VL) and (detection is H) then (FRPN is VL-L) (1)
80. If (severity is H) and (occurrence is VL) and (detection is VH) then (FRPN is VL-L) (1)
81. If (severity is H) and (occurrence is L) and (detection is VL) then (FRPN is VL) (1)
82. If (severity is H) and (occurrence is L) and (detection is L) then (FRPN is VL) (1)
83. If (severity is H) and (occurrence is L) and (detection is M) then (FRPN is VL-L) (1)
84. If (severity is H) and (occurrence is L) and (detection is H) then (FRPN is L) (1)
85. If (severity is H) and (occurrence is L) and (detection is VH) then (FRPN is L-M) (1)
86. If (severity is H) and (occurrence is M) and (detection is VL) then (FRPN is VL) (1)
87. If (severity is H) and (occurrence is M) and (detection is L) then (FRPN is VL-L) (1)
88. If (severity is H) and (occurrence is M) and (detection is M) then (FRPN is L-M) (1)
89. If (severity is H) and (occurrence is M) and (detection is H) then (FRPN is M) (1)
90. If (severity is H) and (occurrence is M) and (detection is VH) then (FRPN is M-H) (1)
91. If (severity is H) and (occurrence is H) and (detection is VL) then (FRPN is VL-L) (1)
92. If (severity is H) and (occurrence is H) and (detection is L) then (FRPN is L) (1)
93. If (severity is H) and (occurrence is H) and (detection is M) then (FRPN is M) (1)
94. If (severity is H) and (occurrence is H) and (detection is H) then (FRPN is M-H) (1)
95. If (severity is H) and (occurrence is H) and (detection is VH) then (FRPN is H) (1)
96. If (severity is H) and (occurrence is VH) and (detection is VL) then (FRPN is VL-L) (1)
97. If (severity is H) and (occurrence is VH) and (detection is L) then (FRPN is L-M) (1)
98. If (severity is H) and (occurrence is VH) and (detection is M) then (FRPN is M-H) (1)
99. If (severity is H) and (occurrence is VH) and (detection is H) then (FRPN is H) (1)
100. If (severity is H) and (occurrence is VH) and (detection is VH) then (FRPN is H-VH) (1)
101. If (severity is VH) and (occurrence is VL) and (detection is VL) then (FRPN is VL) (1)
102. If (severity is VH) and (occurrence is VL) and (detection is L) then (FRPN is VL) (1)
103. If (severity is VH) and (occurrence is VL) and (detection is M) then (FRPN is VL) (1)
104. If (severity is VH) and (occurrence is VL) and (detection is H) then (FRPN is VL-L) (1)
105. If (severity is VH) and (occurrence is VL) and (detection is VH) then (FRPN is VL-L) (1)
106. If (severity is VH) and (occurrence is L) and (detection is VL) then (FRPN is VL) (1)
107. If (severity is VH) and (occurrence is L) and (detection is L) then (FRPN is VL-L) (1)
108. If (severity is VH) and (occurrence is L) and (detection is M) then (FRPN is L) (1)
109. If (severity is VH) and (occurrence is L) and (detection is H) then (FRPN is L-M) (1)
110. If (severity is VH) and (occurrence is L) and (detection is VH) then (FRPN is L-M) (1)

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111. If (severity is VH) and (occurance is M) and (detection is VL) then (FRPN is VL) (1)
 112. If (severity is VH) and (occurance is M) and (detection is L) then (FRPN is L) (1)
 113. If (severity is VH) and (occurance is M) and (detection is M) then (FRPN is L-M) (1)
 114. If (severity is VH) and (occurance is M) and (detection is H) then (FRPN is M-H) (1)
 115. If (severity is VH) and (occurance is M) and (detection is VH) then (FRPN is H) (1)
 116. If (severity is VH) and (occurance is H) and (detection is VL) then (FRPN is VL-L) (1)
 117. If (severity is VH) and (occurance is H) and (detection is L) then (FRPN is L-M) (1)
 118. If (severity is VH) and (occurance is H) and (detection is M) then (FRPN is M-H) (1)
 119. If (severity is VH) and (occurance is H) and (detection is H) then (FRPN is H) (1)
 120. If (severity is VH) and (occurance is H) and (detection is VH) then (FRPN is H-VH) (1)
 121. If (severity is VH) and (occurance is VH) and (detection is VL) then (FRPN is VL-L) (1)
 122. If (severity is VH) and (occurance is VH) and (detection is L) then (FRPN is L-M) (1)
 123. If (severity is VH) and (occurance is VH) and (detection is M) then (FRPN is H) (1)
 124. If (severity is VH) and (occurance is VH) and (detection is H) then (FRPN is H-VH) (1)
 125. If (severity is VH) and (occurance is VH) and (detection is VH) then (FRPN is VH) (1)

3.7 Keandalan Kubikel

Nilai keandalan kubikel didapatkan dari pengolahan data-data yang ada. Proses pengolahan data dilakukan sesuai dengan diagram alir pada Gambar 3.8.



Gambar 3.8 Diagram Alir Analisis Keandalan Kubikel

Perhitungan dari nilai keandalan dilakukan dengan data-data gangguan yang terjadi pada kubikel selama rentang waktu 2016-2017 dikarenakan kubikel ini mulai beroperasi pada akhir 2015. Perhitungan dilakukan dengan cara menghitung MTBF dan MTTR dari data gangguan tersebut. Setelah itu dilakukan plot

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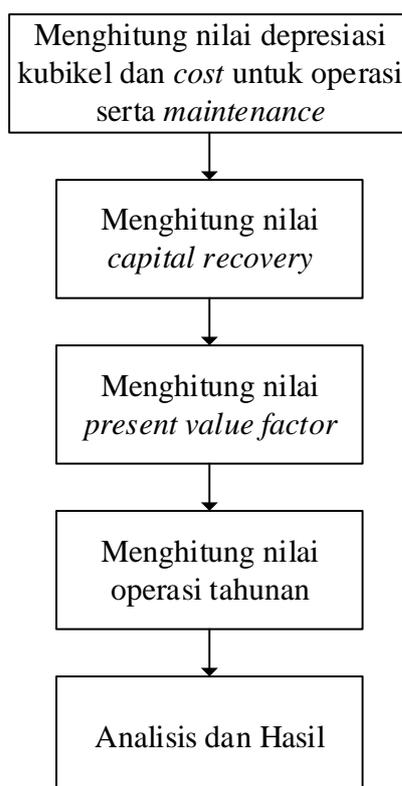
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distribusi yang dibantu oleh perangkat lunak Minitab17 agar mencapai hasil yang lebih maksimal. Hasil dari perangkat lunak tersebut dijadikan acuan untuk memilih rumus distribusi mana yang harus digunakan untuk menghitung keandalan dari kubikel tersebut.

3.8 Umur Ekonomis

Umur ekonomis dari kubikel didapatkan dari pengolahan data-data yang ada. Proses pengolahan data dilakukan sesuai dengan diagram alir pada Gambar 3.9.



Gambar 3.9 Diagram Alir Analisis Umur Ekonomis Kubikel

Perhitungan nilai ekonomis dari kubikel menggunakan data *maintenance* serta gangguan dari kubikel tersebut. Secara teknis umur dari kubikel adalah 20 tahun mengacu pada asset PLN. Perhitungan umur ekonomis dilakukan dengan cara menghitung nilai depresiasi dari harga kubikel tersebut dan dihitung pula

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biaya untuk operasi serta *maintenance* yang dilakukan. Setelah itu dilakukan perhitungan nilai *capital recovery* sehingga akan didapat total biaya operasi tahunan. Berdasarkan hasil depresiasi dan total biaya tahunan dapat dilihat umur ekonomis dari kubikel tersebut.

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