BAB 6

KESIMPULAN DAN SARAN

6.1. Kesimpulan

Algoritma *Tabu Search* yang digunakan pada penelitian ini dapat berjalan dengan baik sehingga pengolahan data dapat dijalankan dengan akurat oleh program. Dari hasil komputasi, didapat bahwa *makespan* terkecil = 961,76 detik dengan urutan komponen : 7-2-5-12-9-4-11-10-3-8-13-6-1, yaitu :

1. Sandaran atas
2. Dua buah kaki belakang
3. Dua buah tanganan
4. Dua buah bing duduk samping
5. Sebelas buah slat sandaran
6. Palang kaki depan
7. Bing duduk belakang
8. Bing duduk depan
9. Palang kaki belakang
10. Sandaran bawah
11. Sebelas buah slat dudukan
12. Dua buah sandaran tanganan
13. Dua buah kaki depan

Pada kasus penelitian ini, semakin besar *stopping rule*, *makespan* cenderung semakin mendekati minimal. Namun untuk *tabu size*, ukuran ini cenderung tidak berpengaruh terhadap keminimalan *makespan*.

6.2. Saran

Saran yang dapat diberikan untuk mengembangkan penelitian ini adalah sebagai berikut :

a. Menggunakan prosedur *Tabu Search* yang berbeda dari apa yang telah dilakukan, misalnya dengan tabu list bukan berupa pasangan (*partial*), namun urutan secara keseluruhan. Dengan hal ini, mungkin dapat ditemukan solusi yang lebih baik.

b. Mencoba prosedur *Tabu Search* ini pada jumlah mesin dan *job* yang lebih besar untuk mengetahui pengaruhnya terhadap keoptimalan solusi akhir.

c. Memperbesar *tabu size* untuk dapat melihat lebih jauh pengaruhnya terhadap solusi akhir.

d. Memperbandingkan hasil *Tabu Search* pada kasus ini dengan pengolahan data menggunakan jenis algoritma yang lain (Algoritma Genetik, Simulasi *Annealing*, *Ant Colony Optimization*, dan lain sebagainya).

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LAMPIRAN

Lampiran 1. Listing Program Quick Basic 4.5.

```
CLS

PRINT "                              TABU SEARCH"
PRINT "                 Program Optimasi Waktu Produksi Komponen"
PRINT "                       Prestige Garden Furniture"
PRINT "                          untuk produk kursi"

PRINT
PRINT
PRINT "Ratih Marsiana"
PRINT "3908 / TI"
PRINT
PRINT
PRINT


DIM k(13) AS STRING, d(13, 9) AS SINGLE, w(13, 9) AS SINGLE
DIM ws(13, 9) AS DOUBLE, wm(13, 9) AS DOUBLE, r(14, 200) AS
INTEGER
DIM rt1 AS INTEGER, rt2 AS INTEGER
DIM wt(200) AS DOUBLE, wo AS DOUBLE

RANDOMIZE TIMER


k(1) = "2 buah kaki depan"
k(2) = "2 buah kaki belakang"
k(3) = "palang kaki belakang"
k(4) = "palang kaki depan"
k(5) = "2 buah tanganan"
k(6) = "2 buah sandaran tanganan"
k(7) = "sandaran atas"
k(8) = "sandaran bawah"
k(9) = "11 buah slat sandaran"
k(10) = "bing duduk depan"
k(11) = "bing duduk belakang"
k(12) = "2 buah duduk samping"
k(13) = "11 buah slat dudukan"

'waktu proses
'1. Planner
d(1, 1) = 7.63
d(2, 1) = 7.63
d(3, 1) = 5
d(4, 1) = 5.02
```

```
d(5, 1) = 6.25
d(6, 1) = 0
d(7, 1) = 6.35
d(8, 1) = 6.23
d(9, 1) = 0
d(10, 1) = 6.19
d(11, 1) = 6.11
d(12, 1) = 6.63
d(13, 1) = 0

'2. Technicer
d(1, 2) = 15
d(2, 2) = 18.1
d(3, 2) = 6.09
d(4, 2) = 9.09
d(5, 2) = 13.13
d(6, 2) = 14.03
d(7, 2) = 9.06
d(8, 2) = 9.16
d(9, 2) = 66.06
d(10, 2) = 7.09
d(11, 2) = 7.23
d(12, 2) = 14.13
d(13, 2) = 66.34

'3. Circle potong
d(1, 3) = 6.2
d(2, 3) = 8.21
d(3, 3) = 6.07
d(4, 3) = 6.19
d(5, 3) = 8.1
d(6, 3) = 11.11
d(7, 3) = 9.05
d(8, 3) = 9.17
d(9, 3) = 66.09
d(10, 3) = 9.2
d(11, 3) = 8.87
d(12, 3) = 9.18
d(13, 3) = 66.16

'4. Spindel
d(1, 4) = 40.99
d(2, 4) = 63.02
d(3, 4) = 0
d(4, 4) = 0
d(5, 4) = 63.07
d(6, 4) = 41.28
d(7, 4) = 13.18
d(8, 4) = 0
d(9, 4) = 221.07
d(10, 4) = 0
d(11, 4) = 0
d(12, 4) = 21.15
d(13, 4) = 221.06
```

```
'5. Tenon
d(1, 5) = 0
d(2, 5) = 0
d(3, 5) = 9.07
d(4, 5) = 8.07
d(5, 5) = 0
d(6, 5) = 0
d(7, 5) = 9.05
d(8, 5) = 9.07
d(9, 5) = 66.12
d(10, 5) = 9.08
d(11, 5) = 9.05
d(12, 5) = 0
d(13, 5) = 66.12

'6. Mourtise
d(1, 6) = 7.63
d(2, 6) = 7.62
d(3, 6) = 0
d(4, 6) = 0
d(5, 6) = 0
d(6, 6) = 0
d(7, 6) = 9.05
d(8, 6) = 9.07
d(9, 6) = 66.14
d(10, 6) = 8.99
d(11, 6) = 9
d(12, 6) = 0
d(13, 6) = 66.13

'7. Bor
d(1, 7) = 6.19
d(2, 7) = 7.13
d(3, 7) = 0
d(4, 7) = 0
d(5, 7) = 0
d(6, 7) = 0
d(7, 7) = 46.24
d(8, 7) = 46.19
d(9, 7) = 0
d(10, 7) = 41.21
d(11, 7) = 41.19
d(12, 7) = 0
d(13, 7) = 0

'8. Sending
d(1, 8) = 12.4
d(2, 8) = 22.33
d(3, 8) = 7.58
d(4, 8) = 6.21
d(5, 8) = 16.28
d(6, 8) = 16.2
d(7, 8) = 10.33
d(8, 8) = 10.36
d(9, 8) = 8.25
d(10, 8) = 10.25
```

```
d(11, 8) = 9.31
d(12, 8) = 10.32
d(13, 8) = 8.51

'9. Router
d(1, 9) = 26.35
d(2, 9) = 34.31
d(3, 9) = 15.32
d(4, 9) = 14.32
d(5, 9) = 26.17
d(6, 9) = 27.28
d(7, 9) = 13.35
d(8, 9) = 14.35
d(9, 9) = 133.32
d(10, 9) = 12.35
d(11, 9) = 15.27
d(12, 9) = 14.21
d(13, 9) = 132.32


'input
INPUT "masukkan nilai tabu size (1 (2 pasang) atau 2 (4
pasang))=", uts

IF uts = 1 OR uts = 2 THEN
INPUT "masukkan nilai stopping rule = ", sr

io = 1

DO UNTIL s = sr
      iter = iter + 1

      IF iter = 1 THEN


            'membangkitkan 13 bilangan random yang berbeda sebagai
iterasi awal
            PRINT "iterasi 1= ";
            FOR i = 1 TO 13
                  r(i, 1) = RND * 12 + 1
                  IF i = 2 THEN
                        DO UNTIL r(2, 1) <> r(1, 1)
                              r(2, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 3 THEN
                        DO UNTIL r(3, 1) <> r(1, 1) AND r(3, 1) <>
r(2, 1)
                              r(3, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 4 THEN
                        DO UNTIL r(4, 1) <> r(1, 1) AND r(4, 1) <>
r(2, 1) AND r(4, 1) <> r(3, 1)
                              r(4, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 5 THEN
```

```
                        DO UNTIL r(5, 1) <> r(1, 1) AND r(5, 1) <>
r(2, 1) AND r(5, 1) <> r(3, 1) AND r(5, 1) <> r(4, 1)
                              r(5, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 6 THEN
                        DO UNTIL r(6, 1) <> r(1, 1) AND r(6, 1) <>
r(2, 1) AND r(6, 1) <> r(3, 1) AND r(6, 1) <> r(4, 1) AND r(6, 1)
<> r(5, 1)
                              r(6, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 7 THEN
                        DO UNTIL r(7, 1) <> r(1, 1) AND r(7, 1) <>
r(2, 1) AND r(7, 1) <> r(3, 1) AND r(7, 1) <> r(4, 1) AND r(7, 1)
<> r(5, 1) AND r(7, 1) <> r(6, 1)
                              r(7, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 8 THEN
                        DO UNTIL r(8, 1) <> r(1, 1) AND r(8, 1) <>
r(2, 1) AND r(8, 1) <> r(3, 1) AND r(8, 1) <> r(4, 1) AND r(8, 1)
<> r(5, 1) AND r(8, 1) <> r(6, 1) AND r(8, 1) <> r(7, 1)
                              r(8, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 9 THEN
                        DO UNTIL r(9, 1) <> r(1, 1) AND r(9, 1) <>
r(2, 1) AND r(9, 1) <> r(3, 1) AND r(9, 1) <> r(4, 1) AND r(9, 1)
<> r(5, 1) AND r(9, 1) <> r(6, 1) AND r(9, 1) <> r(7, 1) AND r(9,
1) <> r(8, 1)
                              r(9, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 10 THEN
                        DO UNTIL r(10, 1) <> r(1, 1) AND r(10, 1)
<> r(2, 1) AND r(10, 1) <> r(3, 1) AND r(10, 1) <> r(4, 1) AND
r(10, 1) <> r(5, 1) AND r(10, 1) <> r(6, 1) AND r(10, 1) <> r(7,
1) AND r(10, 1) <> r(8, 1) AND r(10, 1) <> r(9 _
, 1)
                              r(10, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 11 THEN
                        DO UNTIL r(11, 1) <> r(1, 1) AND r(11, 1)
<> r(2, 1) AND r(11, 1) <> r(3, 1) AND r(11, 1) <> r(4, 1) AND
r(11, 1) <> r(5, 1) AND r(11, 1) <> r(6, 1) AND r(11, 1) <> r(7,
1) AND r(11, 1) <> r(8, 1) AND r(11, 1) <> r(9 _
, 1) AND r(11, 1) <> r(10, 1)
                              r(11, 1) = RND * 12 + 1
                        LOOP
                  ELSEIF i = 12 THEN
                        DO UNTIL r(12, 1) <> r(1, 1) AND r(12, 1)
<> r(2, 1) AND r(12, 1) <> r(3, 1) AND r(12, 1) <> r(4, 1) AND
r(12, 1) <> r(5, 1) AND r(12, 1) <> r(6, 1) AND r(12, 1) <> r(7,
1) AND r(12, 1) <> r(8, 1) AND r(12, 1) <> r(9 _
, 1) AND r(12, 1) <> r(10, 1) AND r(12, 1) <> r(11, 1)
                              r(12, 1) = RND * 12 + 1
                        LOOP
                  ELSE
                        DO UNTIL r(13, 1) <> r(1, 1) AND r(13, 1)
<> r(2, 1) AND r(13, 1) <> r(3, 1) AND r(13, 1) <> r(4, 1) AND
```

```
                    'membangkitkan 2 bilangan random yang
berurutan
                    rt1 = RND * 11 + 1
                    FOR i = 1 TO 12
                          IF r(i, iter) = rt1 THEN
                                rt2 = r(i + 1, iter)
                          END IF
                    NEXT i


                    'menukar 2 bilangan random sebagai iterasi
berikutnya
                    FOR i = 1 TO 12
                          IF r(i, iter) = rt1 THEN
                                r(i, iter) = rt2
                                r(i + 1, iter) = rt1
                                EXIT FOR
                          END IF
                    NEXT i


                          k = 1

                    ELSE
                          k = k + 1
                    END IF


              LOOP
        END IF

        PRINT "iterasi "; iter; " = ";
        FOR i = 1 TO 13
              PRINT r(i, iter);
        NEXT i
        PRINT
        INPUT "", jeda
  END IF


  'merubah urutan waktu job sesuai iterasi
  FOR j = 1 TO 9
        FOR i = 1 TO 13
              w(i, j) = d(r(i, iter), j)
              'PRINT w(i, j);
        NEXT i
        'PRINT
  NEXT j
  'PRINT


  'menghitung makespan
  FOR j = 1 TO 9
        FOR i = 1 TO 13
              IF i = 1 THEN
                    IF j = 1 THEN
```

```
                        END IF
                        IF i = 2 THEN
                                tl1 = 0
                        ELSE
                                tl1 = r(i - 2, iter)
                        END IF
                        EXIT FOR
                END IF
        NEXT i

        IF z > 1 AND uts = 2 THEN
        t12 = t11
        t22 = t21
        t32 = t31
        t42 = t41
        END IF

        t11 = tl1
        t21 = tl2
        t31 = tl3
        t41 = tl4


        'penulisan tabu list
        IF uts = 1 THEN
        PRINT "tabu list iterasi"; iter; "="; tl1; "-";
tl2; ","; tl3; "-"; tl4
        ELSE
                IF z = 1 THEN
                PRINT "tabu list iterasi"; iter; "="; tl1;
"-"; tl2; ","; tl3; "-"; tl4
                ELSE
                PRINT "tabu list iterasi"; iter; "="; tl1;
"-"; tl2; ","; tl3; "-"; tl4; ","; t12; "-"; t22; ","; t32; "-";
t42
                END IF
        END IF

        io = iter

    ELSE
        IF a = 0 THEN
                wo = wt(1)
        ELSE


                'penulisan tabu list
                IF uts = 1 THEN
                PRINT "tabu list iterasi"; iter; "="; tl1;
"-"; tl2; ","; tl3; "-"; tl4
                ELSE
                        IF z = 1 THEN
                        PRINT "tabu list iterasi"; iter;
"="; tl1; "-"; tl2; ","; tl3; "-"; tl4
                        ELSE
```

```
                              PRINT "tabu list iterasi"; iter;
"="; t11; "-"; t12; ","; t13; "-"; t14; ","; t12; "-"; t22; ",";
t32; "-"; t42
                              END IF
                        END IF

                  END IF


                  'stopping rule
                  s = s + 1


            END IF
      END IF


      INPUT "", jeda
      PRINT

LOOP


'mencetak hasil akhir
PRINT
PRINT "urutan yang menghasilkan solusi mendekati optimum = "
FOR i = 1 TO 13
      PRINT r(i, io);
NEXT i
PRINT
FOR i = 1 TO 13
      PRINT i; ". "; k(r(i, io));
      PRINT
NEXT i
PRINT
PRINT
PRINT USING "makespan = ###,###.##"; wo

ELSE
PRINT "nilai tabu size yang anda masukkan dibatasi antara nilai 1
dan 2"

END IF

END
```

Lampiran 2. Contoh Output Program

```
                         TABU SEARCH
          Program Optimasi Waktu Produksi Komponen
                  Prestige Garden Furniture
                     untuk produk kursi


Ratih Marsiana
3908 / TI

masukkan nilai tabu size (1 (2 pasang) atau 2 (4
pasang)) =2
masukkan nilai stopping rule = 5

iterasi 1= 3 10 11 9 1 6 13 4 8 5 7 12 2
waktu total iterasi 1 = 1071.850008964539

iterasi 2 = 3 10 11 9 6 1 13 4 8 5 7 12 2
waktu total iterasi 2 = 1071.850008964539

iterasi 3 = 3 10 11 9 6 1 13 4 8 5 7 12 2
waktu total iterasi 3 = 1071.850008964539

iterasi 4 = 3 10 11 9 1 13 6 4 8 5 7 12 2
waktu total iterasi 4 = 1057.850010871887
tabu list iterasi 4 = 1 - 6 , 13 - 4

iterasi 5 = 11 3 10 9 13 1 4 6 8 5 12 7 2
waktu total iterasi 5 = 1044.220009803772
tabu list iterasi 5 = 1 - 6 , 4 - 8 , 1 - 6 , 13 - 4

iterasi 6 = 9 10 3 11 13 1 4 12 8 6 2 5 7
waktu total iterasi 6 = 1017.700009346008
tabu list iterasi 6 = 4 - 8 , 12 - 6 , 1 - 6 , 4 - 8

iterasi 7 = 9 10 3 11 13 4 1 12 8 6 2 5 7
waktu total iterasi 7 = 1017.700009346008
tabu list iterasi 7 = 4 - 8 , 12 - 6 , 1 - 6 , 4 - 8

iterasi 8 = 9 10 3 11 13 1 12 4 6 8 2 5 7
waktu total iterasi 8 = 1017.700009346008
tabu list iterasi 8 = 4 - 8 , 12 - 6 , 1 - 6 , 4 - 8

iterasi 9 = 9 10 3 11 13 1 4 12 8 6 5 2 7
waktu total iterasi 9 = 1017.700009346008
tabu list iterasi 9 = 4 - 8 , 12 - 6 , 1 - 6 , 4 - 8
```

```
iterasi  10  =  9  10  3  13  11  1  4  12  8  6  2 5 7
waktu total iterasi  10 = 1032.970009803772
tabu list iterasi 10 = 4 - 8 , 12 - 6 , 1 - 6 , 4 - 8

iterasi  11  =  9  10  3  11  13  1  4  12  8  6  2 5 7
waktu total iterasi  11 = 1017.700009346008
tabu list iterasi 11 = 4 - 8 , 12 - 6 , 1 - 6 , 4 - 8

urutan yang menghasilkan solusi mendekati optimum =
 9  10  3  11  13  1  4  12  8  6  2  5  7
 1 . 11 buah slat sandaran
 2 . bing duduk depan
 3 . palang kaki belakang
 4 . bing duduk belakang
 5 . 11 buah slat dudukan
 6 . 2 buah kaki depan
 7 . palang kaki depan
 8 . 2 buah duduk samping
 9 . sandaran bawah
 10 . 2 buah sandaran tanganan
 11 . 2 buah kaki belakang
 12 . 2 buah tanganan
 13 . sandaran atas

makespan =   1,017.70
```