

BAB 6

KESIMPULAN DAN SARAN

6.1. Kesimpulan

Pada penelitian ini menghasilkan kesimpulan bahwa nilai parameter ρ yang paling baik untuk kasus I (5 mesin - 20 job), kasus II (10 mesin - 50 job), dan kasus III (10 mesin - 100 job) yaitu 0,75.

6.2. Saran Pengembangan

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

- a. Algoritma *Ant Colony* perlu dicoba untuk jumlah mesin dan job yang lebih besar, untuk mengetahui apakah algoritma ini memiliki performansi yang mendekati optimum pada ukuran mesin dan job yang besar.
- b. Memodifikasi prosedur penentuan *sequence* yang lain pada algoritma *Ant Colony*, mungkin dapat memperbaiki *makespan* yang didapat.

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Lampiran 1. Listing Program Quick Basic 4.5.

```
DECLARE SUB tb ()
DECLARE SUB best ()
DECLARE SUB makesp ()
DECLARE SUB dat ()
DECLARE SUB ba ()

DIM u(100) AS SINGLE
DIM SHARED i AS SINGLE
DIM SHARED mesin AS INTEGER
DIM hasil(100) AS SINGLE
DIM SHARED x AS INTEGER
DIM SHARED d AS INTEGER
DIM SHARED job AS INTEGER
DIM SHARED zbest AS SINGLE
DIM SHARED t(50, 50) AS SINGLE
RANDOMIZE TIMER
DIM SHARED a(50, 50) AS SINGLE
DIM SHARED s(50, 50) AS SINGLE
DIM SHARED makespan(100) AS SINGLE
DIM taojum(100, 100) AS SINGLE
DIM SHARED j AS INTEGER
DIM SHARED l AS INTEGER
DIM SHARED k AS INTEGER
DIM SHARED tsem(100, 100) AS SINGLE
DIM SHARED tbest(100, 100) AS SINGLE
DIM tao(100, 100) AS SINGLE
DIM SHARED j(100) AS INTEGER
DIM SHARED jbest(100) AS INTEGER
DIM SHARED jsem(100) AS INTEGER
DIM tjum(50, 50) AS SINGLE
DIM p(50, 50) AS SINGLE
DIM pa AS SINGLE
DIM dev(20) AS SINGLE

CLS
'PRINT " PROGRAM ANT COLONY UNTUK SISTEM PRODUKSI FLOWSHOP"
awal = TIMER
pa = .75
mesin = 5
job = 20

FOR i = 1 TO mesin
    FOR j = 1 TO job
        READ t(i, j)
    NEXT j
NEXT i

DATA 61,86,16,42,14,92,67,77,46,41,78,3,72,95,53,59,34,66,42,63
DATA 27,92,8,65,34,6,42,39,2,7,85,32,14,74,59,95,48,37,59,4
DATA 42,93,32,30,16,95,58,12,95,21,74,38,4,31,62,39,97,57,9,54
```

DATA 13,47,6,70,19,97,41,1,57,60,62,14,90,76,12,89,37,35,91,69
DATA 55,48,56,84,22,51,43,50,62,61,10,87,99,40,91,64,62,53,33,16

```
FOR i = 1 TO mesin
  FOR j = 1 TO job
    PRINT t(i, j);
  NEXT j
  PRINT
NEXT i
```

```
FOR i = 1 TO job
  j(i) = i
NEXT i
```

```
FOR j = 1 TO job
  FOR k = 1 TO job
    IF t(1, j) < t(1, k) THEN
      SWAP t(1, j), t(1, k)
      SWAP j(j), j(k)
      FOR x = 2 TO mesin
        SWAP t(x, j), t(x, k)
      NEXT x
    END IF
  NEXT k
NEXT j
PRINT
```

a(1, 1) = 0

```
FOR i = 2 TO job
  a(1, i) = a(1, i - 1) + t(1, i - 1)

  s(1, i - 1) = a(1, i)
NEXT i
```

```
FOR i = 2 TO mesin
  a(i, 1) = s(i - 1, 1)
  FOR j = 2 TO job
    a(i, j) = a(i, j - 1) + t(i, j - 1)
    s(i, j - 1) = a(i, j)
    waktu = a(i - 1, j) + t(i - 1, j)
    IF waktu > s(i, j - 1) THEN
      a(i, j) = waktu
    ELSE
      a(i, j) = s(i, j - 1)
    END IF
  NEXT j
NEXT i
```

makespa = a(mesin, job) + t(mesin, job)

```

zbest = makespa

taomax = 1 / ((1 - pa) * zbest)
taomin = taomax / 5

FOR i = 1 TO job
  FOR k = 1 TO job
    c = ABS(k - i + 1)
    IF c <= job / 4 THEN
      tao(j(k), i) = 1 / zbest
    ELSEIF c > job / 4 AND c <= job / 2 THEN
      tao(j(k), i) = 1 / (2 * zbest)
    ELSE
      tao(j(k), i) = 1 / (4 * zbest)
    END IF
  NEXT k
NEXT i

DO
  i = 1
  DO
    u(i) = RND

    IF u(i) <= (job - 4) / job THEN
      FOR s = 1 TO job
        FOR x = 1 TO job
          taojum(s, x) = 0
        NEXT x
      NEXT s

      FOR l = i TO i + 3
        FOR m = l + 1 TO i + 4
          IF taojum(j(l), i) < taojum(j(m), i) THEN
            SWAP j(l), j(m)
            FOR v = 1 TO mesin
              SWAP t(v, l), t(v, m)
            NEXT v
          END IF
        NEXT m
      NEXT l

    ELSE
      FOR l = i TO i + 4
        FOR k = 1 TO i
          taojum(j(l), k) = taojum(j(l), k - 1) +
tao(j(l), k)
        NEXT k
      NEXT l

      tjum = 0
      FOR k = i TO i + 4

```

```

        tjum = tjum + taojum(j(k), i)
    NEXT k

    FOR k = i TO i + 4
        p(j(k), i) = taojum(j(k), i) / tjum
    NEXT k

    rn = RND
    FOR k = i TO i + 4
        dev(k) = ABS(rn - p(j(k), i))
    NEXT k

    min = dev(i)
    ni = i

    FOR k = i + 1 TO i + 4
        IF dev(k) - min < 0 THEN
            min = dev(k)
            ni = k
        END IF
    NEXT k

    sel = ni - i

    END IF

    i = i + 1
    LOOP WHILE job - i >= 4

FOR i = 1 TO job
    jsem(i) = j(i)
NEXT i

FOR i = 1 TO mesin
    FOR j = 1 TO job
        tsem(i, j) = t(i, j)
    NEXT j
NEXT i

FOR i = 1 TO job

    FOR k = 1 TO job

        IF k <> i THEN
            IF k - i = 1 OR i - k = 1 THEN
                SWAP j(k), j(i)
                FOR l = 1 TO mesin
                    SWAP t(l, k), t(l, i)
                NEXT l
            ELSEIF i > k THEN

```

```

j(k) = j(i)
FOR l = 1 TO mesin
    t(l, k) = t(l, i)
NEXT l

FOR g = k + 1 TO i
    j(g) = jsem(g - 1)

    FOR l = 1 TO mesin
        t(l, g) = tsem(l, g - 1)
    NEXT l
NEXT g

ELSEIF i < k THEN
    j(k) = j(i)

    FOR l = 1 TO mesin
        t(l, k) = t(l, i)
    NEXT l

END IF

END IF

NEXT k

NEXT i

FOR l = 1 TO job
    FOR x = 1 TO job
        IF l = x THEN
            tao(j(l), x) = pa * tao(j(l), x) + (1 / zbest)
        ELSE
            tao(j(l), x) = pa * tao(j(l), x)
        END IF
    NEXT x
NEXT l

taomax = 1 / ((1 - pa) * zbest)
taomin = taomax / 5

FOR i = 1 TO job
    FOR j = 1 TO job
        IF tao(i, j) > taomax THEN
            tao(i, j) = taomax
        ELSEIF tao(i, j) < taomin THEN
            tao(i, j) = taomin
        END IF
    NEXT j
NEXT i

```

```
hasil(y) = zbest

    IF hasil(y) = hasil(y - 1) THEN
        f = f + 1
    ELSE
        f = 0
    END IF
akhir = TIMER

LOOP UNTIL f = 2 OR y = job

PRINT
FOR v = 1 TO y
PRINT "hasil"; v; " :"; hasil(v)
NEXT v
FOR i = 1 TO job
    PRINT j(i);
NEXT i
PRINT
PRINT "nilai y :"; y
PRINT " nilai f:"; f
PRINT " waktu komputasi :"; akhir - awal
PRINT "makespan terbaik: "; zbest
```

Lampiran 2. Contoh Output Program untuk Kasus I

PROGRAM ANT COLONY UNTUK SISTEM PRODUKSI FLOWSHOP

```

61 86 16 42 14 92 67 77 46 41 78 3 72 95
53 59 34 66 42 63
27 92 8 65 34 6 42 39 2 7 85 32 14 74 59
95 48 37 59 4
42 93 32 30 16 95 58 12 95 21 74 38 4 31
62 39 97 57 9 54
13 47 6 70 19 97 41 1 57 60 62 14 90 76 12
89 37 35 91 69
55 48 56 84 22 51 43 50 62 61 10 87 99 40
91 64 62 53 33 16

```

dengan metode SPT

```

3 14 16 34 41 42 42 46 53 59 61 63 66 67
72 77 78 86 92 95
32 34 8 48 7 65 59 2 59 95 27 4 37 42 14
39 85 92 6 74
38 16 32 97 21 30 9 95 62 39 42 54 57 58 4
12 74 93 95 31
14 19 6 37 60 70 91 57 12 89 13 69 35 41
90 1 62 47 97 76
87 22 56 62 61 84 33 62 91 64 55 16 53 43
99 50 10 48 51 40

```

makespan pertama : 1413

makespan pertama : 1413

1413

```

tao ( 12 , 1 ) = 7.077141E-04
tao ( 5 , 1 ) = 7.077141E-04
tao ( 3 , 1 ) = 7.077141E-04
tao ( 17 , 1 ) = 7.077141E-04
tao ( 10 , 1 ) = 7.077141E-04
tao ( 4 , 1 ) = 3.53857E-04
tao ( 19 , 1 ) = 3.53857E-04
tao ( 9 , 1 ) = 3.53857E-04
tao ( 15 , 1 ) = 3.53857E-04
tao ( 16 , 1 ) = 3.53857E-04
tao ( 1 , 1 ) = 1.769285E-04
tao ( 20 , 1 ) = 1.769285E-04
tao ( 18 , 1 ) = 1.769285E-04

```

tao (7 , 1) = 1.769285E-04
 tao (13 , 1) = 1.769285E-04
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 tao (11 , 1) = 1.769285E-04
 tao (2 , 1) = 1.769285E-04
 tao (6 , 1) = 1.769285E-04
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 tao (3 , 16) = 7.077141E-04
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 tao (18 , 16) = 7.077141E-04
 tao (7 , 16) = 7.077141E-04

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 tao (8 , 16) = 7.077141E-04
 tao (11 , 16) = 7.077141E-04
 tao (2 , 16) = 7.077141E-04
 tao (6 , 16) = 7.077141E-04
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 tao (18 , 18) = 7.077141E-04
 tao (7 , 18) = 7.077141E-04
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 tao (11 , 18) = 7.077141E-04

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 tao (6 , 18) = 7.077141E-04
 tao (14 , 18) = 7.077141E-04
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 tao (9 , 19) = 7.077141E-04
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 tao (6 , 19) = 7.077141E-04
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 tao (19 , 20) = 7.077141E-04
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 tao (16 , 20) = 7.077141E-04
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 tao (18 , 20) = 7.077141E-04
 tao (7 , 20) = 7.077141E-04
 tao (13 , 20) = 7.077141E-04
 tao (8 , 20) = 7.077141E-04
 tao (11 , 20) = 7.077141E-04
 tao (2 , 20) = 7.077141E-04
 tao (6 , 20) = 7.077141E-04
 tao (14 , 20) = 7.077141E-04

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3 14 16 34 41 42 42 46 53 59 61 63 66 67 72
77 78 86 92 95
 32 34 8 48 7 65 59 2 59 95 27 4 37 42 14
39 85 92 6 74
 38 16 32 97 21 30 9 95 62 39 42 54 57 58 4
12 74 93 95 31
 14 19 6 37 60 70 91 57 12 89 13 69 35 41
90 1 62 47 97 76
 87 22 56 62 61 84 33 62 91 64 55 16 53 43
99 50 10 48 51 40
u( 1 ) = .153454
taojum( 12 , 1 ) : 7.077141E-04
taojum( 5 , 1 ) : 7.077141E-04
taojum( 3 , 1 ) : 7.077141E-04
taojum( 17 , 1 ) : 7.077141E-04
taojum( 10 , 1 ) : 7.077141E-04
urutan job
12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

u( 2 ) = .3459545
taojum( 5 , 2 ) : 1.415428E-03
taojum( 3 , 2 ) : 1.415428E-03
taojum( 17 , 2 ) : 1.415428E-03
taojum( 10 , 2 ) : 1.415428E-03
taojum( 4 , 2 ) : 1.061571E-03
urutan job
12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

u( 3 ) = .6731771
taojum( 3 , 3 ) : 2.123142E-03
taojum( 17 , 3 ) : 2.123142E-03
taojum( 10 , 3 ) : 2.123142E-03
taojum( 4 , 3 ) : 1.769285E-03
taojum( 19 , 3 ) : 1.415428E-03
urutan job
12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

u( 4 ) = .4148371
taojum( 17 , 4 ) : 2.830856E-03

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taojum( 10 , 4 ) : 2.830856E-03
taojum( 4 , 4 ) : 2.476999E-03
taojum( 19 , 4 ) : 2.123142E-03
taojum( 9 , 4 ) : 1.769285E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

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u( 5 ) = .707374
taojum( 10 , 5 ) : 3.53857E-03
taojum( 4 , 5 ) : 3.184713E-03
taojum( 19 , 5 ) : 2.830856E-03
taojum( 9 , 5 ) : 2.476999E-03
taojum( 15 , 5 ) : 2.123142E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

```

```

u( 6 ) = .214712
taojum( 4 , 6 ) : 3.892428E-03
taojum( 19 , 6 ) : 3.53857E-03
taojum( 9 , 6 ) : 3.184713E-03
taojum( 15 , 6 ) : 2.830856E-03
taojum( 16 , 6 ) : 2.476999E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

```

```

u( 7 ) = .7253519
taojum( 19 , 7 ) : 4.246284E-03
taojum( 9 , 7 ) : 3.892428E-03
taojum( 15 , 7 ) : 3.53857E-03
taojum( 16 , 7 ) : 3.184713E-03
taojum( 1 , 7 ) : 2.653928E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

```

```

u( 8 ) = .5329709
taojum( 9 , 8 ) : 4.600142E-03
taojum( 15 , 8 ) : 4.246284E-03
taojum( 16 , 8 ) : 3.892428E-03
taojum( 1 , 8 ) : 3.361642E-03

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```
taojum( 20 , 8 ) : 2.830856E-03
  urutan job
  12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14
```

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u( 9 ) = .7789981
taojum( 15 , 9 ) : 4.953998E-03
taojum( 16 , 9 ) : 4.600142E-03
taojum( 1 , 9 ) : 4.069356E-03
taojum( 20 , 9 ) : 3.53857E-03
taojum( 18 , 9 ) : 3.007785E-03
  urutan job
  12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14
```

```
u( 10 ) = .9717637
taojum( 16 , 10 ) : 5.307856E-03
taojum( 1 , 10 ) : 4.77707E-03
taojum( 20 , 10 ) : 4.246284E-03
taojum( 18 , 10 ) : 3.715499E-03
taojum( 7 , 10 ) : 3.184713E-03
  tjum = 2.123142E-02
p( 16 , 10 ) : .25
p( 1 , 10 ) : .225
p( 20 , 10 ) : .2
p( 18 , 10 ) : .175
p( 7 , 10 ) : .15
rn( 10 ) = .7884253
dev 10 : .5384253
dev 11 : .5634253
dev 12 : .5884253
dev 13 : .6134253
dev 14 : .6384253
nilai i: 10
ni: 10
  urutan job
  12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14
```

```
u( 11 ) = .5910652
taojum( 1 , 11 ) : 5.484784E-03
taojum( 20 , 11 ) : 4.953998E-03
taojum( 18 , 11 ) : 4.423213E-03
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taojum( 7 , 11 ) : 3.892427E-03
taojum( 13 , 11 ) : 3.361642E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

```

```

u( 12 ) = .1127719
taojum( 20 , 12 ) : 5.661712E-03
taojum( 18 , 12 ) : 5.130927E-03
taojum( 7 , 12 ) : 4.600141E-03
taojum( 13 , 12 ) : 4.069356E-03
taojum( 8 , 12 ) : 3.53857E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

```

```

u( 13 ) = .6962723
taojum( 18 , 13 ) : 5.838641E-03
taojum( 7 , 13 ) : 5.307855E-03
taojum( 13 , 13 ) : 4.77707E-03
taojum( 8 , 13 ) : 4.246284E-03
taojum( 11 , 13 ) : 3.715499E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

```

```

u( 14 ) = .6874095
taojum( 7 , 14 ) : 6.015569E-03
taojum( 13 , 14 ) : 5.484784E-03
taojum( 8 , 14 ) : 4.953998E-03
taojum( 11 , 14 ) : 4.423213E-03
taojum( 2 , 14 ) : 3.892427E-03
  urutan job
    12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
  11 2 6 14

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u( 15 ) = .9265833
taojum( 13 , 15 ) : 6.192497E-03
taojum( 8 , 15 ) : 5.661712E-03
taojum( 11 , 15 ) : 5.130927E-03
taojum( 2 , 15 ) : 4.600141E-03
taojum( 6 , 15 ) : 4.069355E-03
  tjum = 2.565463E-02

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p( 13 , 15 ) : .2413793
p( 8 , 15 ) : .2206897
p( 11 , 15 ) : .2
p( 2 , 15 ) : .1793104
p( 6 , 15 ) : .1586207
rn( 15 )= .2588055
dev 15 : 1.742615E-02
dev 16 : .0381158
dev 17 : 5.880545E-02
dev 18 : .0794951
dev 19 : .1001848
nilai i: 15
ni: 15
urutan job
12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

u( 16 ) = 5.040801E-02
taojum( 8 , 16 ) : 6.369426E-03
taojum( 11 , 16 ) : 5.83864E-03
taojum( 2 , 16 ) : 5.307855E-03
taojum( 6 , 16 ) : 4.777069E-03
taojum( 14 , 16 ) : 4.246284E-03
urutan job
12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

MMAS
12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
urut
5 12 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 2 : 1413
urut
5 3 12 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 3 : 1413
urut
5 3 17 12 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 4 : 1413
urut

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5 3 17 10 12 4 19 9 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 5 : 1413
 urut
 5 3 17 10 4 12 19 9 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 6 : 1413
 urut
 5 3 17 10 4 19 12 9 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 7 : 1413
 urut
 5 3 17 10 4 19 9 12 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 8 : 1413
 urut
 5 3 17 10 4 19 9 15 12 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 9 : 1413
 urut
 5 3 17 10 4 19 9 15 16 12 1 20 18 7 13 8
 11 2 6 14
 makespan ke 10 : 1413
 urut
 5 3 17 10 4 19 9 15 16 1 12 20 18 7 13 8
 11 2 6 14
 makespan ke 11 : 1413
 urut
 5 3 17 10 4 19 9 15 16 1 20 12 18 7 13 8
 11 2 6 14
 makespan ke 12 : 1413
 urut
 5 3 17 10 4 19 9 15 16 1 20 18 12 7 13 8
 11 2 6 14
 makespan ke 13 : 1413
 urut
 5 3 17 10 4 19 9 15 16 1 20 18 7 12 13 8
 11 2 6 14
 makespan ke 14 : 1413
 urut
 5 3 17 10 4 19 9 15 16 1 20 18 7 13 12 8
 11 2 6 14
 makespan ke 15 : 1413

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urut
  5 3 17 10 4 19 9 15 16 1 20 18 7 13 8 12
11 2 6 14
  makespan ke 16 : 1413
urut
  5 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
12 2 6 14
  makespan ke 17 : 1441
urut
  5 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 12 6 14
  makespan ke 18 : 1448
urut
  5 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 6 12 14
  makespan ke 19 : 1472
urut
  5 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 6 14 12
  makespan ke 20 : 1497

zbest : 1413
urut sementara
  12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
nilai i: 1
urut
  5 12 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
  makespan ke 1 : 1413
urut
  12 3 5 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
  makespan ke 3 : 1413
urut
  12 3 17 5 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
  makespan ke 4 : 1413
urut
  12 3 17 10 5 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
  makespan ke 5 : 1413
urut

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12 3 17 10 4 5 19 9 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 6 : 1413
 urut
 12 3 17 10 4 19 5 9 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 7 : 1413
 urut
 12 3 17 10 4 19 9 5 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 8 : 1413
 urut
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 11 2 6 14
 makespan ke 9 : 1413
 urut
 12 3 17 10 4 19 9 15 16 5 1 20 18 7 13 8
 11 2 6 14
 makespan ke 10 : 1413
 urut
 12 3 17 10 4 19 9 15 16 1 5 20 18 7 13 8
 11 2 6 14
 makespan ke 11 : 1413
 urut
 12 3 17 10 4 19 9 15 16 1 20 5 18 7 13 8
 11 2 6 14
 makespan ke 12 : 1413
 urut
 12 3 17 10 4 19 9 15 16 1 20 18 5 7 13 8
 11 2 6 14
 makespan ke 13 : 1413
 urut
 12 3 17 10 4 19 9 15 16 1 20 18 7 5 13 8
 11 2 6 14
 makespan ke 14 : 1413
 urut
 12 3 17 10 4 19 9 15 16 1 20 18 7 13 5 8
 11 2 6 14
 makespan ke 15 : 1413
 urut
 12 3 17 10 4 19 9 15 16 1 20 18 7 13 8 5
 11 2 6 14
 makespan ke 16 : 1413

urut
12 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
5 2 6 14
makespan ke 17 : 1432

urut
12 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 5 6 14
makespan ke 18 : 1415

urut
12 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 6 5 14
makespan ke 19 : 1418

urut
12 3 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 6 14 5
makespan ke 20 : 1421

zbest : 1413
urut sementara
12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
nilai i: 2

urut
3 12 5 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 1 : 1413

urut
12 3 5 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 2 : 1413

urut
12 5 17 3 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 4 : 1413

urut
12 5 17 10 3 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 5 : 1413

urut
12 5 17 10 4 3 19 9 15 16 1 20 18 7 13 8
11 2 6 14
makespan ke 6 : 1413

urut

12 5 17 10 4 19 3 9 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 7 : 1413
 urut
 12 5 17 10 4 19 9 3 15 16 1 20 18 7 13 8
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 makespan ke 8 : 1413
 urut
 12 5 17 10 4 19 9 15 3 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 9 : 1413
 urut
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 makespan ke 10 : 1413
 urut
 12 5 17 10 4 19 9 15 16 1 3 20 18 7 13 8
 11 2 6 14
 makespan ke 11 : 1413
 urut
 12 5 17 10 4 19 9 15 16 1 20 3 18 7 13 8
 11 2 6 14
 makespan ke 12 : 1413
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 makespan ke 13 : 1413
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 makespan ke 14 : 1413
 urut
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 11 2 6 14
 makespan ke 15 : 1413
 urut
 12 5 17 10 4 19 9 15 16 1 20 18 7 13 8 3
 11 2 6 14
 makespan ke 16 : 1413
 urut
 12 5 17 10 4 19 9 15 16 1 20 18 7 13 8 11
 3 2 6 14
 makespan ke 17 : 1413

urut

12 5 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 3 6 14

makespan ke 18 : 1429

urut

12 5 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 6 3 14

makespan ke 19 : 1428

urut

12 5 17 10 4 19 9 15 16 1 20 18 7 13 8 11
2 6 14 3

makespan ke 20 : 1453

zbest : 1413

urut sementara

12 5 3 17 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

nilai i: 3

urut

17 12 5 3 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

makespan ke 1 : 1413

urut

12 17 5 3 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

makespan ke 2 : 1413

urut

12 5 17 3 10 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

makespan ke 3 : 1413

urut

12 5 3 10 17 4 19 9 15 16 1 20 18 7 13 8
11 2 6 14

makespan ke 5 : 1413

urut

12 5 3 10 4 17 19 9 15 16 1 20 18 7 13 8
11 2 6 14

makespan ke 6 : 1413

urut

12 5 3 10 4 19 17 9 15 16 1 20 18 7 13 8
11 2 6 14

makespan ke 7 : 1413

urut

12 5 3 10 4 19 9 17 15 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 8 : 1413
 urut
 12 5 3 10 4 19 9 15 17 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 9 : 1413
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 11 2 6 14
 makespan ke 10 : 1413
 urut
 12 5 3 10 4 19 9 15 16 1 17 20 18 7 13 8
 11 2 6 14
 makespan ke 11 : 1413
 urut
 12 5 3 10 4 19 9 15 16 1 20 17 18 7 13 8
 11 2 6 14
 makespan ke 12 : 1413
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 11 2 6 14
 makespan ke 13 : 1413
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 makespan ke 15 : 1413
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 11 2 6 14
 makespan ke 16 : 1413
 urut
 12 5 3 10 4 19 9 15 16 1 20 18 7 13 8 11
 17 2 6 14
 makespan ke 17 : 1457
 urut
 12 5 3 10 4 19 9 15 16 1 20 18 7 13 8 11
 2 17 6 14
 makespan ke 18 : 1476

urut
 12 5 3 10 4 19 9 15 16 1 20 18 7 13 8 11
 2 6 17 14
 makespan ke 19 : 1416

urut
 12 5 3 10 4 19 9 15 16 1 20 18 7 13 8 11
 2 6 14 17
 makespan ke 20 : 1441

zbest : 1413
 urut sementara
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 11 2 6 14
 nilai i: 4

urut
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 11 2 6 14
 makespan ke 1 : 1413

urut
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 11 2 6 14
 makespan ke 2 : 1413

urut
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 11 2 6 14
 makespan ke 3 : 1413

urut
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 11 2 6 14
 makespan ke 4 : 1413

urut
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 11 2 6 14
 makespan ke 6 : 1413

urut
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 11 2 6 14
 makespan ke 7 : 1413

urut
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 11 2 6 14
 makespan ke 8 : 1413

urut

12 5 3 17 4 19 9 15 10 16 1 20 18 7 13 8
 11 2 6 14
 makespan ke 9 : 1413
 urut
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 11 2 6 14
 makespan ke 10 : 1413
 urut
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 11 2 6 14
 makespan ke 11 : 1413
 urut
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 11 2 6 14
 makespan ke 12 : 1413
 urut
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 11 2 6 14
 makespan ke 13 : 1413
 urut
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 11 2 6 14
 makespan ke 14 : 1413
 urut
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 11 2 6 14
 makespan ke 15 : 1413
 urut
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 11 2 6 14
 makespan ke 16 : 1413
 urut
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 10 2 6 14
 makespan ke 17 : 1413
 urut
 12 5 3 17 4 19 9 15 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 18 : 1393
 nilai d: 1
 urut
 12 5 3 17 4 19 9 15 16 1 20 18 7 13 8 11
 2 6 10 14

makespan ke 19 : 1432
 urut
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 2 6 14 10
 makespan ke 20 : 1453

 zbest : 1393
 urut sementara
 12 5 3 17 4 19 9 15 16 1 20 18 7 13 8 11
 2 10 6 14
 nilai i: 5
 urut
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 2 10 6 14
 makespan ke 1 : 1393
 urut
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 2 10 6 14
 makespan ke 2 : 1393
 urut
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 2 10 6 14
 makespan ke 3 : 1393
 urut
 12 5 3 19 17 4 9 15 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 4 : 1393
 urut
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 2 10 6 14
 makespan ke 5 : 1393
 urut
 12 5 3 17 4 9 19 15 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 7 : 1393
 urut
 12 5 3 17 4 9 15 19 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 8 : 1393
 urut
 12 5 3 17 4 9 15 16 19 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 9 : 1393

urut
12 5 3 17 4 9 15 16 1 19 20 18 7 13 8 11
2 10 6 14
makespan ke 10 : 1393

urut
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2 10 6 14
makespan ke 11 : 1393

urut
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2 10 6 14
makespan ke 12 : 1393

urut
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2 10 6 14
makespan ke 13 : 1393

urut
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2 10 6 14
makespan ke 14 : 1393

urut
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2 10 6 14
makespan ke 15 : 1393

urut
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2 10 6 14
makespan ke 16 : 1409

urut
12 5 3 17 4 9 15 16 1 20 18 7 13 8 11 2
19 10 6 14
makespan ke 17 : 1433

urut
12 5 3 17 4 9 15 16 1 20 18 7 13 8 11 2
10 19 6 14
makespan ke 18 : 1433

urut
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10 6 19 14
makespan ke 19 : 1442

urut
12 5 3 17 4 9 15 16 1 20 18 7 13 8 11 2
10 6 14 19

makespan ke 20 : 1435

zbest : 1393

urut sementara

12 5 3 17 4 19 9 15 16 1 20 18 7 13 8 11
2 10 6 14

nilai i: 6

urut

9 12 5 3 17 4 19 15 16 1 20 18 7 13 8 11
2 10 6 14

makespan ke 1 : 1393

urut

12 9 5 3 17 4 19 15 16 1 20 18 7 13 8 11
2 10 6 14

makespan ke 2 : 1393

urut

12 5 9 3 17 4 19 15 16 1 20 18 7 13 8 11
2 10 6 14

makespan ke 3 : 1393

urut

12 5 3 9 17 4 19 15 16 1 20 18 7 13 8 11
2 10 6 14

makespan ke 4 : 1393

urut

12 5 3 17 9 4 19 15 16 1 20 18 7 13 8 11
2 10 6 14

makespan ke 5 : 1393

urut

12 5 3 17 4 9 19 15 16 1 20 18 7 13 8 11
2 10 6 14

makespan ke 6 : 1393

urut

12 5 3 17 4 19 15 9 16 1 20 18 7 13 8 11
2 10 6 14

makespan ke 8 : 1393

urut

12 5 3 17 4 19 15 16 9 1 20 18 7 13 8 11
2 10 6 14

makespan ke 9 : 1393

urut

12 5 3 17 4 19 15 16 1 9 20 18 7 13 8 11
2 10 6 14

makespan ke 10 : 1393

urut
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 2 10 6 14
 makespan ke 11 : 1393
 urut
 12 5 3 17 4 19 15 16 1 20 18 9 7 13 8 11
 2 10 6 14
 makespan ke 12 : 1393
 urut
 12 5 3 17 4 19 15 16 1 20 18 7 9 13 8 11
 2 10 6 14
 makespan ke 13 : 1393
 urut
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 2 10 6 14
 makespan ke 14 : 1393
 urut
 12 5 3 17 4 19 15 16 1 20 18 7 13 8 9 11
 2 10 6 14
 makespan ke 15 : 1393
 urut
 12 5 3 17 4 19 15 16 1 20 18 7 13 8 11 9
 2 10 6 14
 makespan ke 16 : 1423
 urut
 12 5 3 17 4 19 15 16 1 20 18 7 13 8 11 2
 9 10 6 14
 makespan ke 17 : 1443
 urut
 12 5 3 17 4 19 15 16 1 20 18 7 13 8 11 2
 10 9 6 14
 makespan ke 18 : 1442
 urut
 12 5 3 17 4 19 15 16 1 20 18 7 13 8 11 2
 10 6 9 14
 makespan ke 19 : 1404
 urut
 12 5 3 17 4 19 15 16 1 20 18 7 13 8 11 2
 10 6 14 9
 makespan ke 20 : 1426

 zbest : 1393
 urut sementara

12 5 3 17 4 19 9 15 16 1 20 18 7 13 8 11
 2 10 6 14
 nilai i: 7
 urut
 15 12 5 3 17 4 19 9 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 1 : 1393
 urut
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 2 10 6 14
 makespan ke 2 : 1393
 urut
 12 5 15 3 17 4 19 9 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 3 : 1393
 urut
 12 5 3 15 17 4 19 9 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 4 : 1393
 urut
 12 5 3 17 15 4 19 9 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 5 : 1393
 urut
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 2 10 6 14
 makespan ke 6 : 1393
 urut
 12 5 3 17 4 19 15 9 16 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 7 : 1393
 urut
 12 5 3 17 4 19 9 16 15 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 9 : 1393
 urut
 12 5 3 17 4 19 9 16 1 15 20 18 7 13 8 11
 2 10 6 14
 makespan ke 10 : 1393
 urut
 12 5 3 17 4 19 9 16 1 20 15 18 7 13 8 11
 2 10 6 14
 makespan ke 11 : 1393

urut
 12 5 3 17 4 19 9 16 1 20 18 15 7 13 8 11
 2 10 6 14
 makespan ke 12 : 1393
 urut
 12 5 3 17 4 19 9 16 1 20 18 7 15 13 8 11
 2 10 6 14
 makespan ke 13 : 1393
 urut
 12 5 3 17 4 19 9 16 1 20 18 7 13 15 8 11
 2 10 6 14
 makespan ke 14 : 1393
 urut
 12 5 3 17 4 19 9 16 1 20 18 7 13 8 15 11
 2 10 6 14
 makespan ke 15 : 1393
 urut
 12 5 3 17 4 19 9 16 1 20 18 7 13 8 11 15
 2 10 6 14
 makespan ke 16 : 1398
 urut
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 15 10 6 14
 makespan ke 17 : 1402
 urut
 12 5 3 17 4 19 9 16 1 20 18 7 13 8 11 2
 10 15 6 14
 makespan ke 18 : 1402
 urut
 12 5 3 17 4 19 9 16 1 20 18 7 13 8 11 2
 10 6 15 14
 makespan ke 19 : 1406
 urut
 12 5 3 17 4 19 9 16 1 20 18 7 13 8 11 2
 10 6 14 15
 makespan ke 20 : 1431

 zbest : 1393
 urut sementara
 12 5 3 17 4 19 9 15 16 1 20 18 7 13 8 11
 2 10 6 14
 nilai i: 8
 urut

16 12 5 3 17 4 19 9 15 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 1 : 1393
 urut
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 2 10 6 14
 makespan ke 2 : 1393
 urut
 12 5 16 3 17 4 19 9 15 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 3 : 1393
 urut
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 2 10 6 14
 makespan ke 4 : 1393
 urut
 12 5 3 17 16 4 19 9 15 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 5 : 1393
 urut
 12 5 3 17 4 16 19 9 15 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 6 : 1393
 urut
 12 5 3 17 4 19 16 9 15 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 7 : 1393
 urut
 12 5 3 17 4 19 9 16 15 1 20 18 7 13 8 11
 2 10 6 14
 makespan ke 8 : 1393
 urut
 12 5 3 17 4 19 9 15 1 16 20 18 7 13 8 11
 2 10 6 14
 makespan ke 10 : 1393
 urut
 12 5 3 17 4 19 9 15 1 20 16 18 7 13 8 11
 2 10 6 14
 makespan ke 11 : 1393
 urut
 12 5 3 17 4 19 9 15 1 20 18 16 7 13 8 11
 2 10 6 14
 makespan ke 12 : 1393

urut
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2 10 6 14

makespan ke 13 : 1393

urut
12 5 3 17 4 19 9 15 1 20 18 7 13 16 8 11
2 10 6 14

makespan ke 14 : 1393

urut
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2 10 6 14

makespan ke 15 : 1409

urut
12 5 3 17 4 19 9 15 1 20 18 7 13 8 11 16
2 10 6 14

makespan ke 16 : 1428

urut
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16 10 6 14

makespan ke 17 : 1414

urut
12 5 3 17 4 19 9 15 1 20 18 7 13 8 11 2
10 16 6 14

makespan ke 18 : 1414

urut
12 5 3 17 4 19 9 15 1 20 18 7 13 8 11 2
10 6 16 14

makespan ke 19 : 1423

urut
12 5 3 17 4 19 9 15 1 20 18 7 13 8 11 2
10 6 14 16

makespan ke 20 : 1447

zbest : 1393

urut sementara

12 5 3 17 4 19 9 15 16 1 20 18 7 13 8 11
2 10 6 14

nilai i: 9

urut

1 12 5 3 17 4 19 9 15 16 20 18 7 13 8 11
2 10 6 14

makespan ke 1 : 1393

urut

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 2 10 6 14
 makespan ke 2 : 1393
 urut
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 2 10 6 14
 makespan ke 3 : 1393
 urut
 12 5 3 1 17 4 19 9 15 16 20 18 7 13 8 11
 2 10 6 14
 makespan ke 4 : 1393
 urut
 12 5 3 17 1 4 19 9 15 16 20 18 7 13 8 11
 2 10 6 14
 makespan ke 5 : 1393
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 2 10 6 14
 makespan ke 6 : 1393
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 12 5 3 17 4 19 1 9 15 16 20 18 7 13 8 11
 2 10 6 14
 makespan ke 7 : 1393
 urut
 12 5 3 17 4 19 9 1 15 16 20 18 7 13 8 11
 2 10 6 14
 makespan ke 8 : 1393
 urut
 12 5 3 17 4 19 9 15 1 16 20 18 7 13 8 11
 2 10 6 14
 makespan ke 9 : 1393
 urut
 12 5 3 17 4 19 9 15 16 20 1 18 7 13 8 11
 2 10 6 14
 makespan ke 11 : 1393
 urut
 12 5 3 17 4 19 9 15 16 20 18 1 7 13 8 11
 2 10 6 14
 makespan ke 12 : 1393
 urut
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 2 10 6 14
 makespan ke 13 : 1393

urut
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2 10 6 14

makespan ke 14 : 1393

urut
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2 10 6 14

makespan ke 15 : 1393

urut
12 5 3 17 4 19 9 15 16 20 18 7 13 8 11 1
2 10 6 14

makespan ke 16 : 1393

urut
12 5 3 17 4 19 9 15 16 20 18 7 13 8 11 2
1 10 6 14

makespan ke 17 : 1374

nilai d: 1

urut
12 5 3 17 4 19 9 15 16 20 18 7 13 8 11 2
10 1 6 14

makespan ke 18 : 1374

urut
12 5 3 17 4 19 9 15 16 20 18 7 13 8 11 2
10 6 1 14

makespan ke 19 : 1362

nilai d: 1

urut
12 5 3 17 4 19 9 15 16 20 18 7 13 8 11 2
10 6 14 1

makespan ke 20 : 1387

zbest : 1362

urut sementara

12 5 3 17 4 19 9 15 16 20 18 7 13 8 11 2
10 6 1 14

nilai i: 10

urut
18 12 5 3 17 4 19 9 15 16 20 7 13 8 11 2
10 6 1 14

makespan ke 1 : 1362

urut

12 18 5 3 17 4 19 9 15 16 20 7 13 8 11 2
 10 6 1 14
 makespan ke 2 : 1362
 urut
 12 5 18 3 17 4 19 9 15 16 20 7 13 8 11 2
 10 6 1 14
 makespan ke 3 : 1362
 urut
 12 5 3 18 17 4 19 9 15 16 20 7 13 8 11 2
 10 6 1 14
 makespan ke 4 : 1362
 urut
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 10 6 1 14
 makespan ke 5 : 1362
 urut
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 10 6 1 14
 makespan ke 6 : 1362
 urut
 12 5 3 17 4 19 18 9 15 16 20 7 13 8 11 2
 10 6 1 14
 makespan ke 7 : 1362
 urut
 12 5 3 17 4 19 9 18 15 16 20 7 13 8 11 2
 10 6 1 14
 makespan ke 8 : 1362
 urut
 12 5 3 17 4 19 9 15 18 16 20 7 13 8 11 2
 10 6 1 14
 makespan ke 8 : 1362
 urut
 12 5 3 17 4 19 9 15 16 18 20 7 13 8 11 2
 10 6 1 14
 makespan ke 10 : 1362
 urut
 12 5 3 17 4 19 9 15 16 20 7 18 13 8 11 2
 10 6 1 14
 makespan ke 12 : 1362
 urut
 12 5 3 17 4 19 9 15 16 20 7 13 18 8 11 2
 10 6 1 14
 makespan ke 13 : 1362

urut
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 10 6 1 14
 makespan ke 14 : 1362

urut
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 10 6 1 14
 makespan ke 15 : 1362

urut
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 10 6 1 14
 makespan ke 16 : 1353

nilai d: 1

urut
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 18 6 1 14
 makespan ke 17 : 1353

urut
 12 5 3 17 4 19 9 15 16 20 7 13 8 11 2 10
 6 18 1 14
 makespan ke 18 : 1349

nilai d: 1

urut
 12 5 3 17 4 19 9 15 16 20 7 13 8 11 2 10
 6 1 18 14
 makespan ke 19 : 1349

urut
 12 5 3 17 4 19 9 15 16 20 7 13 8 11 2 10
 6 1 14 18
 makespan ke 20 : 1349

zbest : 1349

urut sementara
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 6 18 1 14

nilai i: 11

urut
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 6 18 1 14
 makespan ke 1 : 1349

urut
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 6 18 1 14

makespan ke 2 : 1349
 urutan
 12 5 13 3 17 4 19 9 15 16 20 7 8 11 2 10
 6 18 1 14
 makespan ke 3 : 1349
 urutan
 12 5 3 13 17 4 19 9 15 16 20 7 8 11 2 10
 6 18 1 14
 makespan ke 4 : 1349
 urutan
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 6 18 1 14
 makespan ke 5 : 1349
 urutan
 12 5 3 17 4 13 19 9 15 16 20 7 8 11 2 10
 6 18 1 14
 makespan ke 6 : 1349
 urutan
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 6 18 1 14
 makespan ke 7 : 1349
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 6 18 1 14
 makespan ke 8 : 1349
 urutan
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 6 18 1 14
 makespan ke 9 : 1349
 urutan
 12 5 3 17 4 19 9 15 16 13 20 7 8 11 2 10
 6 18 1 14
 makespan ke 10 : 1349
 urutan
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 6 18 1 14
 makespan ke 11 : 1349
 urutan
 12 5 3 17 4 19 9 15 16 20 7 8 13 11 2 10
 6 18 1 14
 makespan ke 13 : 1349
 urutan

12 5 3 17 4 19 9 15 16 20 7 8 11 13 2 10
 6 18 1 14
 makespan ke 14 : 1349
 urut
 12 5 3 17 4 19 9 15 16 20 7 8 11 2 13 10
 6 18 1 14
 makespan ke 15 : 1361
 urut
 12 5 3 17 4 19 9 15 16 20 7 8 11 2 10 13
 6 18 1 14
 makespan ke 16 : 1360
 urut
 12 5 3 17 4 19 9 15 16 20 7 8 11 2 10 6
 13 18 1 14
 makespan ke 17 : 1415
 urut
 12 5 3 17 4 19 9 15 16 20 7 8 11 2 10 6
 18 13 1 14
 makespan ke 18 : 1397
 urut
 12 5 3 17 4 19 9 15 16 20 7 8 11 2 10 6
 18 1 13 14
 makespan ke 19 : 1376
 urut
 12 5 3 17 4 19 9 15 16 20 7 8 11 2 10 6
 18 1 14 13
 makespan ke 20 : 1405
 zbest : 1349
 urut sementara
 12 5 3 17 4 19 9 15 16 20 7 13 8 11 2 10
 6 18 1 14
 nilai i: 12
 urut
 8 12 5 3 17 4 19 9 15 16 20 7 13 11 2 10
 6 18 1 14
 makespan ke 1 : 1356
 urut
 12 8 5 3 17 4 19 9 15 16 20 7 13 11 2 10
 6 18 1 14
 makespan ke 2 : 1349
 urut
 12 5 8 3 17 4 19 9 15 16 20 7 13 11 2 10
 6 18 1 14

makespan ke 3 : 1349

urut

12 5 3 8 17 4 19 9 15 16 20 7 13 11 2 10
6 18 1 14

makespan ke 4 : 1349

urut

12 5 3 17 8 4 19 9 15 16 20 7 13 11 2 10
6 18 1 14

makespan ke 5 : 1349

urut

12 5 3 17 4 8 19 9 15 16 20 7 13 11 2 10
6 18 1 14

makespan ke 6 : 1349

urut

12 5 3 17 4 19 8 9 15 16 20 7 13 11 2 10
6 18 1 14

makespan ke 7 : 1349

urut

12 5 3 17 4 19 9 8 15 16 20 7 13 11 2 10
6 18 1 14

makespan ke 8 : 1349

urut

12 5 3 17 4 19 9 15 8 16 20 7 13 11 2 10
6 18 1 14

makespan ke 9 : 1349

urut

12 5 3 17 4 19 9 15 16 8 20 7 13 11 2 10
6 18 1 14

makespan ke 10 : 1349

urut

12 5 3 17 4 19 9 15 16 20 8 7 13 11 2 10
6 18 1 14

makespan ke 11 : 1349

urut

12 5 3 17 4 19 9 15 16 20 7 8 13 11 2 10
6 18 1 14

makespan ke 12 : 1349

urut

12 5 3 17 4 19 9 15 16 20 7 13 11 8 2 10
6 18 1 14

makespan ke 14 : 1349

urut

12 5 3 17 4 19 9 15 16 20 7 13 11 2 8 10
6 18 1 14

makespan ke 15 : 1328

nilai d: 1

urut

12 5 3 17 4 19 9 15 16 20 7 13 11 2 10 8
6 18 1 14

makespan ke 16 : 1328

urut

12 5 3 17 4 19 9 15 16 20 7 13 11 2 10 6
8 18 1 14

makespan ke 17 : 1328

urut

12 5 3 17 4 19 9 15 16 20 7 13 11 2 10 6
18 8 1 14

makespan ke 18 : 1328

urut

12 5 3 17 4 19 9 15 16 20 7 13 11 2 10 6
18 1 8 14

makespan ke 19 : 1328

urut

12 5 3 17 4 19 9 15 16 20 7 13 11 2 10 6
18 1 14 8

makespan ke 20 : 1322

nilai d: 1

zbest : 1322

urut sementara

12 5 3 17 4 19 9 15 16 20 7 13 11 2 10 6
18 1 14 8

nilai i: 13

urut

2 12 5 3 17 4 19 9 15 16 20 7 13 11 10 6
18 1 14 8

makespan ke 1 : 1478

urut

12 2 5 3 17 4 19 9 15 16 20 7 13 11 10 6
18 1 14 8

makespan ke 2 : 1443

urut

12 5 2 3 17 4 19 9 15 16 20 7 13 11 10 6
18 1 14 8

makespan ke 3 : 1441
 urut
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 18 1 14 8
 makespan ke 4 : 1425
 urut
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 18 1 14 8
 makespan ke 5 : 1372
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 18 1 14 8
 makespan ke 6 : 1344
 urut
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 18 1 14 8
 makespan ke 7 : 1387
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 18 1 14 8
 makespan ke 8 : 1326
 urut
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 18 1 14 8
 makespan ke 9 : 1325
 urut
 12 5 3 17 4 19 9 15 16 2 20 7 13 11 10 6
 18 1 14 8
 makespan ke 10 : 1312
 nilai d: 1
 urut
 12 5 3 17 4 19 9 15 16 20 2 7 13 11 10 6
 18 1 14 8
 makespan ke 11 : 1302
 nilai d: 1
 urut
 12 5 3 17 4 19 9 15 16 20 7 2 13 11 10 6
 18 1 14 8
 makespan ke 12 : 1315
 urut
 12 5 3 17 4 19 9 15 16 20 7 13 2 11 10 6
 18 1 14 8
 makespan ke 13 : 1324

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urut
12 5 3 17 4 19 9 15 16 20 7 13 11 10 2 6
18 1 14 8
makespan ke 15 : 1342
urut
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18 1 14 8
makespan ke 16 : 1301
nilai d: 1
urut
12 5 3 17 4 19 9 15 16 20 7 13 11 10 6 18
2 1 14 8
makespan ke 17 : 1301
urut
12 5 3 17 4 19 9 15 16 20 7 13 11 10 6 18
1 2 14 8
makespan ke 18 : 1333
urut
12 5 3 17 4 19 9 15 16 20 7 13 11 10 6 18
1 14 2 8
makespan ke 19 : 1360
urut
12 5 3 17 4 19 9 15 16 20 7 13 11 10 6 18
1 14 8 2
makespan ke 20 : 1387

zbest : 1301
urut sementara
12 5 3 17 4 19 9 15 16 20 7 13 11 10 6 2
18 1 14 8
nilai i: 14
urut
6 12 5 3 17 4 19 9 15 16 20 7 13 11 10 2
18 1 14 8
makespan ke 1 : 1377
urut
12 6 5 3 17 4 19 9 15 16 20 7 13 11 10 2
18 1 14 8
makespan ke 2 : 1326
urut
12 5 6 3 17 4 19 9 15 16 20 7 13 11 10 2
18 1 14 8
makespan ke 3 : 1324

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urut
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18 1 14 8
makespan ke 4 : 1308

urut
12 5 3 17 6 4 19 9 15 16 20 7 13 11 10 2
18 1 14 8
makespan ke 5 : 1362

urut
12 5 3 17 4 6 19 9 15 16 20 7 13 11 10 2
18 1 14 8
makespan ke 6 : 1322

urut
12 5 3 17 4 19 6 9 15 16 20 7 13 11 10 2
18 1 14 8
makespan ke 7 : 1304

urut
12 5 3 17 4 19 9 6 15 16 20 7 13 11 10 2
18 1 14 8
makespan ke 8 : 1304

urut
12 5 3 17 4 19 9 15 6 16 20 7 13 11 10 2
18 1 14 8
makespan ke 9 : 1328

urut
12 5 3 17 4 19 9 15 16 6 20 7 13 11 10 2
18 1 14 8
makespan ke 10 : 1304

urut
12 5 3 17 4 19 9 15 16 20 6 7 13 11 10 2
18 1 14 8
makespan ke 11 : 1304

urut
12 5 3 17 4 19 9 15 16 20 7 6 13 11 10 2
18 1 14 8
makespan ke 12 : 1304

urut
12 5 3 17 4 19 9 15 16 20 7 13 6 11 10 2
18 1 14 8
makespan ke 13 : 1304

urut
12 5 3 17 4 19 9 15 16 20 7 13 11 6 10 2
18 1 14 8

makespan ke 14 : 1307
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urut

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tao(14 , 15) : 2.653928E-04
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tao(14 , 17) : 5.307855E-04

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tao(18 , 6) : 2.653928E-04
tao(18 , 7) : 2.653928E-04
tao(18 , 8) : 2.653928E-04
tao(18 , 9) : 5.307855E-04
tao(18 , 10) : 5.307855E-04
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tao(8 , 5) : 1.326964E-04
tao(8 , 6) : 1.326964E-04
tao(8 , 7) : 2.653928E-04
tao(8 , 8) : 2.653928E-04
tao(8 , 9) : 2.653928E-04
tao(8 , 10) : 2.653928E-04
tao(8 , 11) : 2.653928E-04
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tao(8 , 16) : 5.307855E-04
tao(8 , 17) : 5.307855E-04
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taomin : 6.18238E-04

nilai f: 0

hasil 1 : 1294

3	14	16	34	42	42	46	53	59	63	67	72	78	41
92	86	61	95	66	77								
32	34	8	48	65	59	2	59	95	4	42	14	85	7 6
92	27	74	37	39									
38	16	32	97	30	9	95	62	39	54	58	4	74	21 95
93	42	31	57	12									
14	19	6	37	70	91	57	12	89	69	41	90	62	60
97	47	13	76	35	1								
87	22	56	62	84	33	62	91	64	16	43	99	10	61
51	48	55	40	53	50								

Lampiran 3. Hasil Makespan dan Waktu Komputasi pada Ketiga Kasus

Hasil Mean dan Waktu Komputasi pada Kasus I

Iterasi	$\rho = 0,1$		$\rho = 0,25$		$\rho = 0,5$		$\rho = 0,75$		$\rho = 0,9$	
	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi
1	1250	0,328125	1250	0,375	1250	0,3828125	1250	0,4921875	1250	0,28125
2	1240	0,5546875	1258	0,328125	1277	0,3359375	1277	0,21875	1258	0,4921875
3	1244	0,3828125	1250	0,265625	1250	0,328125	1250	0,2734375	1277	0,328125
4	1250	0,2734375	1250	0,265625	1258	0,2734375	1252	0,3828125	1250	0,21875
5	1252	0,390625	1277	0,2734375	1250	0,28125	1252	0,390625	1250	0,328125
6	1250	0,375	1251	0,2734375	1250	0,265625	1262	0,3828125	1240	0,5
7	1250	0,328125	1252	0,3203125	1250	0,328125	1244	0,3828125	1252	0,3828125
8	1277	0,2734375	1244	0,546875	1271	0,4375	1277	0,2734375	1251	0,2265625
9	1262	0,390625	1262	0,3828125	1251	0,21875	1240	0,4921875	1258	0,328125
10	1289	0,21875	1266	0,390625	1252	0,390625	1252	0,4453125	1305	0,2265625

Hasil Mean dan Waktu Komputasi pada Kasus II

Iterasi	$\rho = 0,1$		$\rho = 0,25$		$\rho = 0,5$		$\rho = 0,75$		$\rho = 0,9$	
	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi
1	3170	14,44531	3170	14,89063	3170	14,45313	3112	15,42969	3158	12,20313
2	3186	9,71875	3204	12,03125	3180	10,60156	3132	18,39844	3144	17,41406
3	3152	18,50781	3102	23,13281	3245	9,5	3174	13,89063	3158	14,125
4	3119	14,10938	3156	11,92188	3145	11,59375	3170	14,17188	3141	18,17969
5	3126	14,66406	3128	20,92969	3105	16,70313	3159	11,53906	3170	14,34375
6	3214	9,617188	3102	23,5625	3174	11,86719	3127	14,10938	3047	34,82031
7	3107	11,59375	3110	20,92969	3135	14,29688	3134	14,60938	3126	16,80469
8	3114	14,23438	3146	23,17969	3184	11,58594	3135	14,55469	3178	16,32031
9	3097	16,53125	3201	9,671875	3169	13,94531	3060	25,42969	3181	11,58594
10	3105	16,46875	3145	11,63281	3086	18,51563	3087	32,35156	3082	21,53125

Hasil Mean dan Waktu Komputasi pada Kasus III

Iterasi	$\rho = 0,1$		$\rho = 0,25$		$\rho = 0,5$		$\rho = 0,75$		$\rho = 0,9$	
	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi	Makespan	Waktu Komputasi
1	5819	112,6484	5766	131,1099	5844	77,10938	5796	95,01563	5796	93,49219
2	5796	94,96094	5796	93,54004	5796	94,35938	5800	94,14063	5761	130,8281
3	5863	75,19531	5783	111,6602	5763	112,1016	5801	96,44531	5828	111,4922
4	5781	93,14844	5801	87,77002	5867	74,75	5744	148,9609	5803	93,8125
5	5756	111,8828	5804	94,42017	5763	115,8438	5853	93,15625	5827	74,25781
6	5894	75,20313	5790	93,86987	5756	131,6484	5847	75,03125	5796	93,27344
7	5771	131,6563	5841	94,91016	5777	112,0547	5756	131,5	5781	105,3516
8	5768	93,375	5747	128,04	5847	98,38281	5768	148,3594	5787	137,0938
9	5769	74,76563	5858	71,22998	5794	75,40625	5751	132,0938	5769	119,9141
10	5757	112,8047	5756	147,4204	5796	94,08594	5760	113,6406	5955	51,29688

Lampiran 4. Nilai τ_{ik} pada Kasus Verifikasi Program Iterasi Kedua

τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai
$\tau_{8,1}$	0,0335	$\tau_{8,2}$	0,01389	$\tau_{8,3}$	0,01389	$\tau_{8,4}$	0,01389	$\tau_{8,5}$	0,01389		
$\tau_{2,1}$	0,01389	$\tau_{2,2}$	0,0335	$\tau_{2,3}$	0,01389	$\tau_{2,4}$	0,01389	$\tau_{2,5}$	0,01389		
$\tau_{6,1}$	0,00694	$\tau_{6,2}$	0,01389	$\tau_{6,3}$	0,0335	$\tau_{6,4}$	0,01389	$\tau_{6,5}$	0,01389		
$\tau_{3,1}$	0,00694	$\tau_{3,2}$	0,00694	$\tau_{3,3}$	0,01389	$\tau_{3,4}$	0,0335	$\tau_{3,5}$	0,01389		
$\tau_{1,1}$	0,00347	$\tau_{1,2}$	0,00694	$\tau_{1,3}$	0,00694	$\tau_{1,4}$	0,01389	$\tau_{1,5}$	0,0335		
$\tau_{9,1}$	0,00347	$\tau_{9,2}$	0,00347	$\tau_{9,3}$	0,00694	$\tau_{9,4}$	0,00694	$\tau_{9,5}$	0,01389		
$\tau_{4,1}$	0,00347	$\tau_{4,2}$	0,00347	$\tau_{4,3}$	0,00347	$\tau_{4,4}$	0,00347	$\tau_{4,5}$	0,00694		
$\tau_{7,1}$	0,00347	$\tau_{7,2}$	0,00347	$\tau_{7,3}$	0,00347	$\tau_{7,4}$	0,00694	$\tau_{7,5}$	0,00694		
$\tau_{5,1}$	0,00347	$\tau_{5,2}$	0,00347	$\tau_{5,3}$	0,00347	$\tau_{5,4}$	0,00347	$\tau_{5,5}$	0,00347		
τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai		
$\tau_{8,6}$	0,01389	$\tau_{8,7}$	0,01389	$\tau_{8,8}$	0,01389	$\tau_{8,9}$	0,01389				
$\tau_{2,6}$	0,01389	$\tau_{2,7}$	0,01389	$\tau_{2,8}$	0,01389	$\tau_{2,9}$	0,01389				
$\tau_{6,6}$	0,01389	$\tau_{6,7}$	0,01389	$\tau_{6,8}$	0,01389	$\tau_{6,9}$	0,01389				
$\tau_{3,6}$	0,01389	$\tau_{3,7}$	0,01389	$\tau_{3,8}$	0,01389	$\tau_{3,9}$	0,01389				
$\tau_{1,6}$	0,01389	$\tau_{1,7}$	0,01389	$\tau_{1,8}$	0,01389	$\tau_{1,9}$	0,01389				
$\tau_{9,6}$	0,0335	$\tau_{9,7}$	0,01389	$\tau_{9,8}$	0,01389	$\tau_{9,9}$	0,01389				
$\tau_{4,6}$	0,00694	$\tau_{4,7}$	0,0335	$\tau_{4,8}$	0,01389	$\tau_{4,9}$	0,01389				
$\tau_{7,6}$	0,01389	$\tau_{7,7}$	0,01389	$\tau_{7,8}$	0,0335	$\tau_{7,9}$	0,01389				
$\tau_{5,6}$	0,00694	$\tau_{5,7}$	0,00694	$\tau_{5,8}$	0,01389	$\tau_{5,9}$	0,0335				

Lampiran 5. Output nilai τ_{ik} dari Program untuk Iterasi Kedua

τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai
$\tau 8,1$	3.349673E-02	$\tau 8,2$	1.388889E-02	$\tau 8,3$	1.388889E-02	$\tau 8,4$	1.388889E-02	$\tau 8,5$	1.388889E-02
$\tau 2,1$	1.388889E-02	$\tau 2,2$	3.349673E-02	$\tau 2,3$	1.388889E-02	$\tau 2,4$	1.388889E-02	$\tau 2,5$	1.388889E-02
$\tau 6,1$	6.944444E-03	$\tau 6,2$	1.388889E-02	$\tau 6,3$	3.349673E-02	$\tau 6,4$	1.388889E-02	$\tau 6,5$	1.388889E-02
$\tau 3,1$	6.944444E-03	$\tau 3,2$	6.944444E-03	$\tau 3,3$	1.388889E-02	$\tau 3,4$	3.349673E-02	$\tau 3,5$	1.388889E-02
$\tau 1,1$	3.472222E-03	$\tau 1,2$	6.944444E-03	$\tau 1,3$	6.944444E-03	$\tau 1,4$	1.388889E-02	$\tau 1,5$	3.349673E-02
$\tau 9,1$	3.472222E-03	$\tau 9,2$	3.472222E-03	$\tau 9,3$	6.944444E-03	$\tau 9,4$	6.944444E-03	$\tau 9,5$	1.388889E-02
$\tau 4,1$	3.472222E-03	$\tau 4,2$	3.472222E-03	$\tau 4,3$	3.472222E-03	$\tau 4,4$	3.472222E-03	$\tau 4,5$	6.944444E-03
$\tau 7,1$	3.472222E-03	$\tau 7,2$	3.472222E-03	$\tau 7,3$	3.472222E-03	$\tau 7,4$	6.944444E-03	$\tau 7,5$	6.944444E-03
$\tau 5,1$	3.472222E-03	$\tau 5,2$	3.472222E-03	$\tau 5,3$	3.472222E-03	$\tau 5,4$	3.472222E-03	$\tau 5,5$	3.472222E-03
τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai	τ	Nilai
$\tau 8,6$	1.388889E-02	$\tau 8,7$	1.388889E-02	$\tau 8,8$	1.388889E-02	$\tau 8,9$	1.388889E-02		
$\tau 2,6$	1.388889E-02	$\tau 2,7$	1.388889E-02	$\tau 2,8$	1.388889E-02	$\tau 2,9$	1.388889E-02		
$\tau 6,6$	1.388889E-02	$\tau 6,7$	1.388889E-02	$\tau 6,8$	1.388889E-02	$\tau 6,9$	1.388889E-02		
$\tau 3,6$	1.388889E-02	$\tau 3,7$	1.388889E-02	$\tau 3,8$	1.388889E-02	$\tau 3,9$	1.388889E-02		
$\tau 1,6$	1.388889E-02	$\tau 1,7$	1.388889E-02	$\tau 1,8$	1.388889E-02	$\tau 1,9$	1.388889E-02		
$\tau 9,6$	3.349673E-02	$\tau 9,7$	1.388889E-02	$\tau 9,8$	1.388889E-02	$\tau 9,9$	1.388889E-02		
$\tau 4,6$	6.944444E-03	$\tau 4,7$	3.349673E-02	$\tau 4,8$	1.388889E-02	$\tau 4,9$	1.388889E-02		
$\tau 7,6$	1.388889E-02	$\tau 7,7$	1.388889E-02	$\tau 7,8$	3.349673E-02	$\tau 7,9$	1.388889E-02		
$\tau 5,6$	6.944444E-03	$\tau 5,7$	6.944444E-03	$\tau 5,8$	1.388889E-02	$\tau 5,9$	3.349673E-02		