Untitled

2023-04-07

# Results

In this section, we give an example of the solution of the optimization model we derived in the previous section. In this example, we consider an instant where and so that we have 2508 decision variables.

## Parameters values

The following tables show the matrix of raw-material flexibility of all items.

Next, we present the instant of the total raw material demands during a planning horizon.

the flexibility matrix of items 1-11

item

week 1

week 2

week 3

week 4

1

2,555.1

2,555.1

0.0

10,220.4

2

0.0

4,300.0

8,600.0

0.0

3

0.0

0.0

0.0

1,800.0

4

0.0

495.0

0.0

0.0

5

0.0

0.0

0.0

0.0

6

3,150.0

0.0

6,300.0

0.0

7

0.0

1,050.0

0.0

350.0

8

1,650.0

0.0

0.0

2,200.0

9

2,080.0

1,560.0

1,040.0

0.0

10

0.0

1,280.0

0.0

0.0

11

0.0

0.0

4,200.0

0.0

12

0.0

2,700.0

0.0

0.0

13

350.0

350.0

0.0

0.0

14

0.0

300.0

500.0

200.0

15

85.0

0.0

0.0

0.0

the flexibility matrix of items 12-51

item

week 1

week 2

week 3

week 4

16

110.0

165.0

0.0

0.0

17

0.0

0.0

17,400.0

17,400.0

18

74,050.0

222,150.0

14,800.0

0.0

19

0.0

11,605.0

0.0

0.0

20

12,750.0

0.0

0.0

0.0

21

3,500.0

0.0

14,000.0

14,000.0

22

42,100.0

0.0

10,550.0

0.0

23

0.0

0.0

5,600.0

11,200.0

24

5,400.0

5,400.0

0.0

5,400.0

25

1,350.0

2,250.0

0.0

0.0

26

0.0

32,400.0

43,200.0

0.0

27

10,350.0

31,050.0

0.0

0.0

28

118,200.0

0.0

0.0

0.0

29

3,330.0

4,995.0

0.0

0.0

30

0.0

1,950.0

0.0

5,850.0

31

0.0

6,300.0

6,300.0

0.0

32

2,310.0

3,465.0

0.0

0.0

33

0.0

2,500.0

0.0

0.0

34

0.0

0.0

20,850.0

0.0

35

12,150.0

0.0

0.0

0.0

36

0.0

0.0

0.0

0.0

37

12,750.0

12,750.0

8,500.0

8,500.0

38

1,550.0

3,100.0

0.0

0.0

39

0.0

10,600.0

5,300.0

21,200.0

40

0.0

0.0

10,450.0

20,900.0

41

9,625.0

0.0

1,375.0

1,375.0

42

0.0

0.0

3,080.0

0.0

43

0.0

2,250.0

450.0

2,250.0

44

0.0

0.0

14,100.0

0.0

45

6,700.0

13,400.0

10,050.0

6,700.0

46

6,500.0

13,000.0

0.0

0.0

47

26,200.0

13,100.0

0.0

0.0

48

12,000.0

8,000.0

0.0

12,000.0

49

0.0

126.0

0.0

0.0

50

1,323.0

0.0

3,969.0

0.0

51

1,170.0

1,170.0

0.0

780.0

We can see that items 5 and 36 do not have to be produced during this planning horizon. We also can see that most items have to be produced only in to or three weeks of this planning horizon, with varying demand.

The others parameters values are given in the following table.

From Table 2 we know that raw material 4 must be purchased since item 49 and 50 can be produced just by using raw material 4. The price of raw material 4 is the lowest one. But the minimal one-year order quantity is the second smallest. So that we may guess that on the optimal solution, will have a big value but is not the biggest one among others.

## Optimal solution

We solve the optimization problem by creating computer codes using R language (version 4) where the optimization problem formulation and the solution technique used are referred to dplyr (Wickham et al. 2023) and ompr (Schumacher 2022) libraries. This program runs on a computer with the Linux Ubuntu 20 LTS operating system with an Intel i7 8 Cores processor and 16 GB RAM.

The values of are given in the second column of Table 6 in the following. The weekly deliveries are given on columns 4 up to 6. We see that the total one-month order quantity exceeds the minimum one-month order quantity so that set of Constraints I is satisfied.

Besides the values above, we also get and values in the optimal solution. We have checked that set of **Constraints II – V** are satisfied by this optimal solution. Most values of are which mean most of items are produced by using a composition of two raw materials. The values of may vary from one week to another week.

The fulfillment of the safety stock constraint and the maximum capacity constraint (set of **Constraints VII and VIII**) can be seen in the following table.

Schumacher, Dirk. 2022. *Ompr: Model and Solve Mixed Integer Linear Programs*. <https://github.com/dirkschumacher/ompr>.

Wickham, Hadley, Romain François, Lionel Henry, Kirill Müller, and Davis Vaughan. 2023. *Dplyr: A Grammar of Data Manipulation*.