

# Assignment

## Assumption

- All demand must be met
- Inhouse production cost is not given, so assuming that the inhouse cost will be lesser than outsourced cost. Therefore, if demand is not met by the inhouse production due to capacity constraint, then only items are outsourced

## Question 1

### Variables and Parameters

$x_t$  : quantity to be produced inhouse in month  $t$

$y_t^1$  : quantity to be outsourced from OMP1 in month  $t$

$y_t^2$  : quantity to be outsourced from OMP2 in month  $t$

$y_t^3$  : quantity to be outsourced from OMP3 in month  $t$

$z_t^1$  : binary variable to indicate if quantities are outsourced from OMP1 in month  $t$

$z_t^2$  : binary variable to indicate if quantities are outsourced from OMP2 in month  $t$

$z_t^3$  : binary variable to indicate if quantities are outsourced from OMP3 in month  $t$

$CO_t^1$  : production cost from OMP1 in month  $t$

$CO_t^2$  : production cost from OMP2 in month  $t$

$CO_t^3$  : production cost from OMP3 in month  $t$

$OC_t^1$  : capacity of OMP1 in month  $t$

$OC_t^2$  : capacity of OMP2 in month  $t$

$OC_t^3$  : capacity of OMP3 in month  $t$

$PC_t$  : inhouse capacity in month  $t$

$D_t$  : quantity demand in month  $t$

### Model

$$\min \sum_{t=1}^{12} CO_t^1 * y_t^1 + CO_t^2 * y_t^2 + CO_t^3 * y_t^3 \quad (1)$$

$$s. t. \quad x_t + y_t^1 + y_t^2 + y_t^3 \geq D_t \quad \forall t \in \{1, 2, \dots, 12\} \quad (2)$$

$$x_t \leq PC_t \quad \forall t \in \{1, 2, \dots, 12\} \quad (3)$$

$$y^1_t \leq z^1_t * OC^1_t \quad \forall t \in \{1,2, \dots, 12\} \quad (4)$$

$$y^2_t \leq z^2_t * OC^2_t \quad \forall t \in \{1,2, \dots, 12\} \quad (5)$$

$$y^3_t \leq z^3_t * OC^3_t \quad \forall t \in \{1,2, \dots, 12\} \quad (6)$$

$$\sum_{t=1}^{12} z^1_t \leq 5 \quad (7)$$

$$\sum_{t=1}^{12} z^2_t \leq 5 \quad (8)$$

$$\sum_{t=1}^{12} z^3_t \leq 5 \quad (9)$$

$$z^1_t + z^2_t + z^3_t \leq 2 \quad \forall t \in \{1,2, \dots, 12\} \quad (10)$$

$$y^1_t + y^2_t + y^3_t \leq 0.3 * (x_t + y^1_t + y^2_t + y^3_t) \quad \forall t \in \{1,2, \dots, 12\} \quad (11)$$

$$x_t, \quad y^1_t, \quad y^2_t, \quad y^3_t \geq 0 \quad (12)$$

$$z^1_t, \quad z^2_t, \quad z^3_t \in \{0, 1\} \quad (13)$$

## Question 2

### Variables and Parameters

All the variables and parameters in Question 1 with additional variable  $s_t$

$s_t$  : stock left at the end of the month  $t$

$s_0$  : initial stock (assumed:  $s_0 = 0$ )

### Model

$$\min \sum_{t=1}^{12} CO^1_t * y^1_t + CO^2_t * y^2_t + CO^3_t * y^3_t \quad (1)$$

$$s.t. \quad s_{t-1} + x_t + y^1_t + y^2_t + y^3_t - s_t \geq D_t \quad \forall t \in \{1,2, \dots, 12\} \quad (2)$$

$$x_t \leq PC_t \quad \forall t \in \{1,2, \dots, 12\} \quad (3)$$

$$y^1_t \leq z^1_t * OC^1_t \quad \forall t \in \{1,2, \dots, 12\} \quad (4)$$

$$y^2_t \leq z^2_t * OC^2_t \quad \forall t \in \{1,2, \dots, 12\} \quad (5)$$

$$y^3_t \leq z^3_t * OC^3_t \quad \forall t \in \{1,2, \dots, 12\} \quad (6)$$

$$\sum_{t=1}^{12} z^1_t \leq 5 \quad (7)$$

$$\sum_{t=1}^{12} z_t^2 \leq 5 \quad (8)$$

$$\sum_{t=1}^{12} z_t^3 \leq 5 \quad (9)$$

$$z_t^1 + z_t^2 + z_t^3 \leq 2 \quad \forall t \in \{1,2,\dots,12\} \quad (10)$$

$$y_t^1 + y_t^2 + y_t^3 \leq 0.3 * (x_t + y_t^1 + y_t^2 + y_t^3) \quad \forall t \in \{1,2,\dots,12\} \quad (11)$$

$$s_0 = 0 \quad (12)$$

$$x_t, \quad y_t^1, \quad y_t^2, \quad y_t^3, \quad s_t \geq 0 \quad (13)$$

$$z_t^1, \quad z_t^2, \quad z_t^3 \in \{0,1\} \quad (14)$$

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