Q1.A.

**Parameters:**

N : Number of Cities

p : Maximum Number of FCs to be opened

: Travelling Cost from fulfilment centre in city ‘f’ to demand centre in city ‘c’

: Demand in city ‘c’

**Variables:**

: Binary, = 1 if an FC is opened in city ‘f’, 0 otherwise

: Binary, = 1 if FC in city ‘f’ is catering to demand in city ‘c’

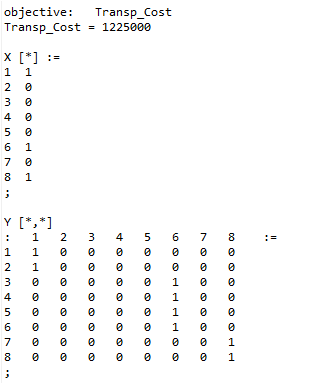
**Model:**

Minimize{ }

Subject to Constraints:

1. FC Requirement: = p
2. Coverage Requirement: ≥ 1
3. Aggregate Constraint: ≤ N\*

**Results:**



Q1.B.

**Parameters:**

N : Number of Cities

p : Maximum Number of FCs to be opened

: Travelling Cost from fulfilment centre in city ‘f’ to demand centre in city ‘c’

: Demand in city ‘c’

**Variables:**

: Binary, = 1 if an FC is opened in city ‘f’, 0 otherwise

: Binary, = 1 if FC in city ‘f’ is catering to demand in city ‘c’

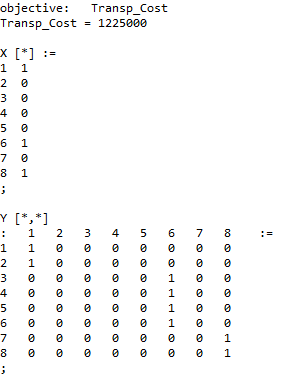
**Model:**

Minimize{ }

Subject to Constraints:

1. FC Requirement: = p
2. Coverage Requirement: ≥ 1
3. Disaggregate Constraint: ≤

**Results:**



Q1.C.i

**Parameters**

N : Number of Cities

p : Maximum Number of FCs to be opened

: Travelling Cost from fulfilment centre in city ‘f’ to demand centre in city ‘c’

: Demand in city ‘c’

**Variables**

: ~~Binary, = 1 if an FC is opened in city ‘f’, 0 otherwise~~ (Relaxed)

: ~~Binary, = 1 if FC in city ‘c’ is catering to demand in city ‘f’~~(Relaxed)

**Model**

Minimize{ }

Subject to Constraints:

1. FC Requirement: = p
2. Coverage Requirement: ≥ 1
3. Aggregate Constraint: ≤ N\*
4. ≥ 0
5. ≤ 1
6. ≥ 0
7. ≤ 1

Q1.C.ii

**Parameters**

N : Number of Cities

p : Maximum Number of FCs to be opened

: Travelling Cost from fulfilment centre in city ‘f’ to demand centre in city ‘c’

: Demand in city ‘c’

**Variables**

: ~~Binary, = 1 if an FC is opened in city ‘f’, 0 otherwise~~ (Relaxed)

: ~~Binary, = 1 if FC in city ‘f’ is catering to demand in city ‘c’~~ (Relaxed)

**Model**

Minimize{ }

Subject to Constraints:

1. FC Requirement: = p
2. Coverage Requirement: ≥ 1
3. Disaggregate Constraint: ≤
4. ≥ 0
5. ≤ 1
6. ≥ 0
7. ≤ 1

**Results:**

|  |  |  |
| --- | --- | --- |
|  | Aggregate Formulation | Disaggregate Formulation |
| IP Optimal Objective Function Value | 1225000 | 1225000 |
| IP Optimal Decision Variables | [1,0,0,0,0,1,0,1] | [1,0,0,0,0,1,0,1] |
| LP Relaxation Objective Function Value | 0 | 1225000 |
| LP Relaxation Decision Variables | [1,1,0.375,0.125,0.125,0.125,0.125,0.125] | [1,0,0,0,0,1,0,1] |

Q2A)

**Parameters:**

N : Number of Cities

p : Number of FCs to be opened

: Travelling Cost from fulfilment centre in city ‘f’ to demand centre in city ‘c’

**Variables:**

: Binary, = 1 if an FC is opened in city ‘f’, 0 otherwise

: Binary, = 1 if FC in city ‘c’ is catering to demand in city ‘f’

: The maximum distance between any demand node and facility node

**Model:**

Minimize

Subject to Constraints:

1. FC Requirement: = p
2. Coverage Requirement: = 1
3. Aggregate Constraint: ≤ N\*
4. Each FC to service at least 1 city:
5. Max distance constraint:

**Results:**

(Objective function value)

X (Optimal decision variable) = [1, 0, 0, 0, 1, 0, 0, 1]

Q2B)

**Parameters:**

N : Number of Cities

p : Number of FCs to be opened

: Distance from fulfilment centre in city ‘f’ to demand centre in city ‘c’

M: Maximum distance between any 2 cities.

**Variables:**

: Binary, = 1 if an FC is opened in city ‘f’, 0 otherwise

: Binary, = 1 if FC in city ‘c’ is catering to demand in city ‘f’

: The minimum distance between any 2 FCs.

**Model:**

Maximize

Subject to Constraints:

1. FC Requirement: = p
2. Coverage Requirement: = 1
3. Y, X relation constraint: ≤
4. Each FC to service at least 1 city:
5. Min distance constraint:

**Results:**

(Objective function value)

X (Optimal decision variable) = [1, 0, 0, 1, 0, 0, 1, 0]

Q2C)

**Parameters:**

N : Number of Cities

p : Number of FCs to be opened

: Distance from fulfilment centre in city ‘f’ to demand centre in city ‘c’

M: Maximum distance between any 2 cities.

**Variables:**

: Binary, = 1 if an FC is opened in city ‘f’, 0 otherwise

: Minimum distance of any facility from city f.

**Model:**

Maximize

Subject to Constraints:

1. FC Requirement: = p
2. Min distance constraint:

**Results:**

Objective function value: 53

X (Optimal decision variable) = [0, 0, 0, 0, 1, 0, 1, 1]