$$\text{Minimize} \sum_{S \in Ns} O_S Z_S + \sum_{h1 \in H} \sum_{i \in Nds,\, j \in Ns} Ch1 X_{ij}^{h1} + \sum_{h2 \in H} \sum_{i \in Nsc,\, j \in Nc} Ch2 X_{ij}^{h2} \tag{4}$$

$$+ \sum_{(i,j) \in E} \sum_{h \in H} \sum_{m=1}^{3} \lambda k^h N^h v^h (T_{ij}^m Y_{ij}^m) \tag{5}$$

$$+ \sum_{(i,j) \in E} \sum_{h \in H} \sum_{m=1}^{3} \lambda \gamma \beta^h (V_m)^3 (T_{ij}^m Y_{ij}^m) \tag{6}$$

$$+ \sum_{(i,j) \in E} \sum_{h \in H} \lambda \gamma d_{ij} (\mu^h + f^h{}_{ij}) x_{ij}^h \tag{7}$$

Subject to:

$$\sum_{h1 \in H} \sum_{i \in ND} f_{is}^{h1} = \sum_{C \in Nc} Dem_C U_{sc} \qquad \forall S \in N_S \tag{8}$$

$$\sum_{S \in Ns} f_{is}^{h1} < Q_{h1} \qquad \forall h1 \in H,\ i \in N_D \tag{9}$$

$$f_{is}^{h1} \le Caps \qquad \forall h1 \in H,\ i \in N_D, S \in N_S \tag{10}$$

$$\sum_{i \in Nds} \sum_{h1 \in H} X_{is}^{h1} = Z_S \qquad \forall S \in N_S \tag{11}$$

$$\sum_{j \in Nds} X_{ji}^{h1} = \sum_{j \in Nds} X_{ij}^{h1} \qquad \forall h1 \in H,\ i \in N_{ds} \tag{12}$$

$$\sum_{i \in \bar{S}} \sum_{J \in \bar{S}} X_{ij}^{h1} \le |\bar{s}| - 1 \qquad \forall h1 \in H, \bar{S} \in NS, |\bar{s}| \succ 2 \tag{13}$$

$$\sum_{h2 \in H} \sum_{i \in Nsc} X_{ic}^{h2} = 1 \qquad VC \in N_C \tag{14}$$

$$\sum_{j \in Nsc} X_{ji}^{h2} = \sum_{j \in Nsc} X_{ij}^{h2} \qquad \forall i \in Nsc, h2 \in H \tag{15}$$

$$\sum_{i \in Ns} \sum_{J \in Ns} X_{ij}^{h2} = 0 \qquad \forall h2 \in H \tag{16}$$

$$\sum_{i \in \bar{Nc}} \sum_{j \in \bar{Nc}} X_{ij}^{h2} \le |\bar{c}| - 1 \qquad \forall h2 \in H, \bar{C} \in Nc, |\bar{c}| \succ 2 \tag{17}$$

$$\sum_{i \in Nsc} \sum_{j \in Nc} Dem_C X_{ij}^{h2} \le Q_{h2} \qquad \forall h2 \in H \tag{18}$$

$$\sum_{k \in Nc} Dem_K X_{jk}^{h2} \le f_{ij}^{h1} \qquad \forall i \in N_D, j \in N_S, (h1, h2) \in H \tag{19}$$

$$\sum_{s \in Ns} U_{sc} = 1 \qquad VC \in N_C \tag{20}$$

$$\sum_{C \in Nc} Dem_C\ U_{SC} \le Caps\ Z_S \qquad \forall S \in N_S \tag{21}$$

$$\sum_{m=1}^{3} Y_{ij}^m = X_{ij}^h \qquad \forall (i,j) \in E,\ h \in H \tag{22}$$

$$L_C \le T_{d,c,m} = T_{d,s}^m + T_{s,c}^m \le U_C \qquad \forall C \in N_C,\ S \in N_S,\ m \in M \tag{23}$$

$$f_{ij}^h \ge 0 \qquad \forall (i,j) \in E,\ h \in H \tag{24}$$

$$X_{ij}^h \in \{0,1\} \qquad (i,j) \in E,\ h \in H \tag{25}$$

$$Z_S \in \{0,1\} \qquad S \in N_S \tag{26}$$

$$U_{SC} \in \{0,1\} \qquad S \in N_S,\ C \in N_C \tag{27}$$