

# A comparison of formulations and solution methods for the Minimum-Envy Location Problem. Additional results

Inmaculada Espejo<sup>1</sup>, Alfredo Marín<sup>2</sup>, Justo Puerto<sup>3</sup>, Antonio Rodríguez-Chía<sup>1</sup>

<sup>1</sup> Departamento de Estadística e Investigación Operativa, Universidad de Cádiz, Spain,

<sup>2</sup> Departamento de Estadística e Investigación Operativa, Universidad de Murcia, Spain,

<sup>3</sup> Departamento de Estadística e Investigación Operativa, Universidad de Sevilla, Spain,

## 1 Formulations

$$\begin{aligned}
 \text{(F1)} \quad & \min \sum_{i=1}^{M-1} \sum_{j=i+1}^M e_{ij} \\
 \text{s.t.} \quad & e_{ij} \geq z_i - z_j, \quad \forall i = 1, \dots, M-1, j = i+1, \dots, M \\
 & e_{ij} \geq z_j - z_i, \quad \forall i = 1, \dots, M-1, j = i+1, \dots, M \\
 & z_i + \sum_{\ell: O_{i\ell} \leq k-1} (k - O_{i\ell}) y_\ell \geq k, \quad \forall i \in A, k = 1, \dots, M-p+1 \\
 & z_i + (M-p+1 - O_{ik}) y_k \leq M-p+1, \quad \forall i, k \in A: O_{ik} \leq M-p \\
 & \sum_{j=1}^M y_j = p \\
 & y_j \in \{0, 1\}, \quad \forall j \in A.
 \end{aligned}$$

$$\begin{aligned}
 \text{(F2)} \quad & \min \sum_{i=1}^M (2i - M - 1) \sum_{k=2}^{M-p+1} x_{ik} \\
 \text{s.t.} \quad & z_{ik} \geq z_{i,k+1}, \quad \forall i \in A, k = 2, \dots, M-p \\
 & z_i O_{ij} - z_{i, O_{ij}+1} \leq y_j, \quad \forall i, j \in A: 2 \leq O_{ij} \leq M-p \\
 & 1 - z_{i2} \leq y_j, \quad \forall i, j \in A: O_{ij} = 1 \\
 & z_{i, M-p+1} \leq y_j, \quad \forall i, j \in A: O_{ij} = M-p+1 \\
 & z_{i, O_{ij}+1} + y_j \leq 1, \quad \forall i, j \in A: O_{ij} \leq M-p \\
 & \sum_{i=1}^M x_{ik} = \sum_{i=1}^M z_{ik}, \quad \forall k = 2, \dots, M-p+1 \\
 & x_{ik} \geq x_{i-1, k}, \quad \forall i = 2, \dots, M, k = 2, \dots, M-p+1 \\
 & \sum_{j=1}^M y_j = p \\
 & y_j \in \{0, 1\}, \quad \forall j \in A \\
 & x_{ik} \in \{0, 1\}, \quad \forall i \in A, k = 2, \dots, M-p+1.
 \end{aligned}$$

---

*E-mails:* inmaculada.espejo@uca.es, amarín@um.es, puerto@us.es, antonio.rodriguezchia@uca.es

$$\begin{aligned}
(\text{F3}) \quad & \min \sum_{i=1}^M \sum_{q=1}^{M-1} 2d_{iq} + \sum_{q=1}^{M-1} 2qt_q - (M-1) \sum_{i=1}^M z_i \\
\text{s.t.} \quad & z_i + \sum_{\ell: O_{i\ell} \leq k-1} (k - O_{i\ell})y_\ell \geq k, \quad \forall i \in A, k = 1, \dots, M-p+1 \\
& z_i + (M-p+1 - O_{ik})y_k \leq M-p+1, \quad \forall i, k \in A: O_{ik} \leq M-p+1 \\
& \sum_{j=1}^M y_j = p \\
& d_{iq} \geq -t_q + z_i, \quad \forall q = 1, \dots, M-1, i \in A \\
& d_{iq} \geq 0 \quad \forall q = 1, \dots, M-1, i \in A \\
& y_j \in \{0, 1\}, \quad \forall j \in A.
\end{aligned}$$

$$\begin{aligned}
(\text{F4}) \quad & \min \sum_{i=1}^M \sum_{q=1}^{M-1} 2d_{iq} + \sum_{q=1}^{M-1} 2qt_q - (M-1) \sum_{i=1}^M \sum_{k=2}^{M-p+1} z_{ik} + M(1-M) \\
\text{s.t.} \quad & z_{ik} \geq z_{i,k+1}, \quad \forall i \in A, k = 2, \dots, M-p \\
& z_{iO_{ij}} - z_{i,O_{ij}+1} \leq y_j, \quad \forall i, j \in A: 2 \leq O_{ij} \leq M-p \\
& 1 - z_{i2} \leq y_j, \quad \forall i, j \in A: O_{ij} = 1 \\
& z_{i,M-p+1} \leq y_j, \quad \forall i, j \in A: O_{ij} = M-p+1 \\
& \sum_{j=1}^M y_j = p \\
& z_{i,O_{ij}+1} + y_j \leq 1, \quad \forall i, j \in A: O_{ij} \leq M-p \\
& d_{iq} \geq -t_q + \sum_{k=2}^{M-p+1} z_{ik} + 1, \quad \forall q = 1, \dots, M-1, i \in A \\
& d_{iq} \geq 0, \quad \forall q = 1, \dots, M-1, i \in A \\
& y_j \in \{0, 1\}, \quad \forall j \in A.
\end{aligned}$$

$$\begin{aligned}
(\text{F5.1}) \quad & \min \sum_{i=1}^M (2i - M - 1)x_i \\
\text{s.t.} \quad & z_i + \sum_{\ell: O_{i\ell} \leq k-1} (k - O_{i\ell})y_\ell \geq k, \quad \forall i \in A, k = 1, \dots, M-p+1 \\
& z_i + (M-p+1 - O_{ik})y_k \leq M-p+1, \quad \forall i, k \in A: O_{ik} \leq M-p+1 \\
& \sum_{j=1}^M y_j = p \\
& x_i \leq x_{i+1}, \quad \forall i = 1, \dots, M-1 \\
& \sum_{i=1}^M x_i = \sum_{i=1}^M z_i \\
& \sum_{i=k}^M x_i \geq \sum_{i \in S} z_i, \quad \forall k = 2, \dots, M, \forall S \subset A: |S| = M - k + 1 \\
& y_j \in \{0, 1\}, \quad \forall j \in A.
\end{aligned}$$

$$\begin{aligned}
(\text{F5.2}) \quad & \min \sum_{i=2}^M 2\theta_i - (M-1) \sum_{i=1}^M z_i \\
\text{s.t.} \quad & z_i + \sum_{\ell: O_{i\ell} \leq k-1} (k - O_{i\ell})y_\ell \geq k, \quad \forall i \in A, k = 1, \dots, M-p+1 \\
& z_i + (M-p+1 - O_{ik})y_k \leq M-p+1, \quad \forall i, k \in A : O_{ik} \leq M-p+1 \\
& \sum_{j=1}^M y_j = p \\
& \theta_k \geq \sum_{i \in S} z_i, \quad \forall k = 2, \dots, M, \forall S \subset A : |S| = M-k+1 \\
& y_j \in \{0, 1\}, \quad \forall j \in A.
\end{aligned}$$

## 2 Computational Results

The previous formulations have been compared by means of a computational study (see Tables 1, 2 and 3).

## 3 Improving formulations

Some of these formulations have been improved and solution method have been again computationally compared on the same testbed.

Table 4 reports a comparative analysis of the results provided when solving formulation (F1) with and without a separation method.

Table 5 shows the running times when solving formulation (F2) with several sets of additional inequalities. A separation procedure have been implemented and the results are given in Table 6. The results of solving the preprocessed formulation (F2) are presented in Table 7.

$$x_{ik} \geq x_{i,k+1}, \quad \forall i \in A, k = 2, \dots, M-p; \quad (1)$$

$$pz_{ik} \leq \sum_{j: O_{ij} \geq k} y_j, \quad \forall i \in A, k = 2, \dots, M-p; \quad (2)$$

$$(p-1)(z_{ik} - z_{i,k+1}) \leq \sum_{j: O_{ij} \geq k+1} y_j, \quad \forall i \in A, k = 2, \dots, M-p; \quad (3)$$

$$\sum_{i=1}^s x_{M+1-i,k} \geq \sum_{i \in S} z_{ik}, \quad \forall s \in A, S \subset A : |S| = s, k = 2, \dots, M-p+1; \quad (4)$$

$$z_{ik} + \sum_{j: O_{ij} < k} y_j \geq 1, \quad \forall i \in A, k = 2, \dots, M-p+1. \quad (5)$$

In Table 8, the results obtained for formulation (F3) with and without the modified objective function have been compared.

A comparison between (F5.1) with and without preprocessing is shown in Table 9.

	$M = 20$					$M = 30$					$M = 40$				
	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$
(F1)	2	0.0	1.2	0.1	144.2	3	0.1	21.1	2.6	641.4	2	0.2	47.0	4.1	532.6
(F2)		0.1	10.8	3.6	420.2		0.6	63.4	25.0	948.2		2.3	2379.9	1127.8	14480.0
(F3)		0.0	1.5	0.1	177.0		0.1	22.7	3.6	718.2		0.5	50.7	4.5	1077.0
(F4)		0.1	3.0	0.1	116.2		0.5	49.4	4.8	548.2		1.9	172.6	21.5	489.8
(F5.1)		0.0	1.1	0.2	163.4		0.0	25.8	4.5	758.6		0.0	51.2	8.4	597.4
(F5.2)		0.0	1.6	0.2	169.8		0.0	31.5	4.1	759.8		0.0	72.5	16.1	698.2
(F1)	3	0.0	2.4	0.2	349.4	6	0.1	83.0	15.6	5006.6	4	0.2	281.5	11.6	3955.4
(F2)		0.1	7.3	2.3	317.8		0.4	4.5	1.7	113.4		1.9	265.8	133.0	2142.6
(F3)		0.0	2.5	0.3	327.8		0.1	81.9	10.8	4357.8		0.2	263.6	29.7	3373.8
(F4)		0.1	4.5	0.6	255.0		0.3	113.1	54.9	2986.5		1.6	813.5	204.8	3623.8
(F5.1)		0.0	2.4	0.4	349.4		0.0	145.8	39.9	5221.0		0.0	496.7	117.9	4619.8
(F5.2)		0.0	3.1	0.3	373.4		0.0	20.3	192.1	5185.4		0.0	534.9	130.7	4085.4
(F1)	5	0.0	3.9	0.9	847.8	10	0.0	177.0	34.1	19892.2	8	0.2	2269.1	735.8	55702.6
(F2)		0.1	2.6	1.1	63.0		0.3	1.3	0.4	35.4		1.3	16.6	5.9	207.8
(F3)		0.0	4.4	1.3	917.0		0.1	174.5	84.1	17987.0		0.2	2443.9	357.9	57277.8
(F4)		0.1	6.0	1.9	599.8		0.2	233.5	63.9	10188.4		1.0	> 1H	–	–
(F5.1)		0.0	4.9	1.1	878.2		0.0	340.6	74.1	14566.0		0.0	> 1H	–	–
(F5.2)		0.0	6.9	1.9	869.4		0.0	610.2	190.7	21099.0		0.0	> 1H	–	–
(F1)	7	0.0	4.0	0.7	1153.0	12	0.0	219.7	150.0	30517.8	10	0.1	> 1H	–	–
(F2)		0.1	1.4	0.7	27.4		0.3	0.7	0.2	7.8		1.2	13.5	14.7	80.6
(F3)		0.0	4.4	0.8	1255.8		0.1	425.6	260.4	51375.0		0.2	> 1H	–	–
(F4)		0.0	4.9	1.2	669.8		0.2	199.5	147.1	11951.0		0.9	> 1H	–	–
(F5.1)		0.0	6.1	2.7	1004.2		0.0	387.7	284.1	22344.2		0.0	> 1H	–	–
(F5.2)		0.0	9.7	2.6	1399.8		0.0	964.4	383.1	37161.4		0.0	> 1H	–	–
(F1)	10	0.0	8.5	1.7	5382.6	15	0.0	680.2	345.5	205131.4	16	0.1	3097.7	836.5	117527.7
(F2)		0.0	0.2	0.1	3.0		0.2	1.9	2.2	13.0		0.8	2.0	0.6	12.2
(F3)		0.0	9.5	2.0	5579.8		0.1	996.8	25.0	249648.0		0.2	> 1H	–	–
(F4)		0.0	10.5	2.6	3671.0		0.1	1043.0	18.0	158639.0		0.6	> 1H	–	–
(F5.1)		0.0	18.0	5.9	5345.0		0.0	1701.9	79.0	208383.0		0.0	> 1H	–	–
(F5.2)		0.0	26.6	2.6	6025.4		0.0	> 1H	–	–		0.0	> 1H	–	–
(F1)	12	0.0	16.5	1.8	16316.2	22	0.0	2453.0	5.0	$2 \cdot 10^6$	20	0.1	> 1H	–	–
(F2)		0.0	0.1	0.0	1.0		0.0	0.2	0.1	1.0		0.6	3.8	6.6	1.8
(F3)		0.0	16.4	1.5	14263.0		0.1	3298.1	150.8	$2 \cdot 10^6$		0.2	> 1H	–	–
(F4)		0.0	21.6	4.0	13839.0		0.1	3107.5	5.4	$2 \cdot 10^6$		0.4	> 1H	–	–
(F5.1)		0.0	33.2	11.9	15626.6		0.0	> 1H	–	–		0.0	> 1H	–	–
(F5.2)		0.0	46.5	6.7	14411.4		0.0	> 1H	–	–		0.0	> 1H	–	–

Table 1: Customers prefer closer sites and self-service is allowed

	$M = 20$					$M = 30$					$M = 40$				
	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$
(F1)	2	0.0	1.1	0.2	120.6	3	0.1	23.9	2.7	799.0	2	0.2	44.9	9.8	437.0
(F2)		0.1	28.2	19.0	2117.8		0.5	814.2	293.8	21899.4		2.0	2717.5	855.7	17868.5
(F3)		0.0	1.4	0.3	167.8		0.1	26.5	2.8	861.9		0.3	53.1	11.2	482.2
(F4)		0.1	3.6	0.9	126.6		0.4	55.1	5.4	644.2		1.8	202.9	59.6	518.2
(F5.1)		0.0	1.0	0.4	127.8		0.0	28.1	4.4	772.2		0.0	48.3	9.5	469.8
(F5.2)		0.0	1.7	0.3	187.0		0.0	39.7	6.9	977.8		0.0	71.0	16.1	575.0
(F1)	3	0.0	0.4	0.2	129.4	6	0.1	52.1	12.2	2672.6	4	0.2	312.0	99.7	4173.4
(F2)		0.1	16.6	7.9	1791.0		0.4	52.0	26.3	2749.8		1.8	> 1H	—	—
(F3)		0.0	2.5	0.4	315.4		0.1	66.9	25.0	3258.6		0.2	326.3	84.6	4029.4
(F4)		0.1	4.5	0.4	213.4		0.3	109.4	46.9	1859.0		1.4	922.7	179.8	3653.8
(F5.1)		0.0	2.4	0.4	329.8		0.0	92.0	51.0	2789.0		0.0	521.6	92.8	4542.2
(F5.2)		0.0	3.1	0.4	324.2		0.0	141.2	50.0	3219.8		0.0	656.4	168.2	4777.8
(F1)	5	0.0	2.9	0.7	584.6	10	0.1	87.7	37.4	7987.8	8	0.2	2000.2	657.0	43647.4
(F2)		0.1	2.5	1.0	364.6		0.4	4.5	2.3	420.4		1.4	846.7	493.9	28928.2
(F3)		0.1	3.2	0.5	597.0		0.1	82.3	6.6	6807.0		0.2	2105.2	302.5	38412.2
(F4)		0.0	5.5	1.2	453.4		0.2	116.3	18.9	4276.0		1.2	3118.8	411.1	21404.5
(F5.1)		0.0	4.3	1.2	690.6		0.0	231.7	16.2	9669.0		0.0	> 1H	—	—
(F5.2)		0.0	6.0	1.6	751.0		0.0	298.3	16.0	9997.8		0.0	> 1H	—	—
(F1)	7	0.0	3.0	0.7	722.2	12	0.0	49.6	23.9	5036.2	10	0.2	2624.0	694.7	62600.0
(F2)		0.1	1.0	0.6	101.4		0.3	1.7	0.4	97.4		1.3	139.6	112.2	4933.4
(F3)		0.0	2.5	1.1	595.4		0.1	48.8	17.7	4261.0		0.2	2763.5	449.3	67043.0
(F4)		0.0	4.0	2.2	489.8		0.2	50.8	13.8	1902.6		0.9	> 1H	—	—
(F5.1)		0.0	4.7	2.3	908.6		0.0	115.0	56.5	5427.4		0.0	> 1H	—	—
(F5.2)		0.0	5.8	3.0	918.6		0.0	215.6	124.4	6569.0		0.0	> 1H	—	—
(F1)	10	0.0	1.0	0.5	315.4	15	0.0	16.1	5.8	2396.6	16	0.1	1555.1	1205.4	41557.0
(F2)		0.1	0.4	0.2	28.6		0.2	2.2	2.0	21.8		0.8	4.2	0.9	136.0
(F3)		0.0	1.3	0.7	411.0		0.1	15.8	0.7	2054.0		0.2	1677.0	1147.9	43331.5
(F4)		0.0	1.5	0.8	207.4		0.2	13.8	4.7	647.0		0.6	1685.2	1138.8	17580.5
(F5.1)		0.0	1.5	1.2	350.6		0.0	27.7	1.3	1697.0		0.0	> 1H	—	—
(F5.2)		0.0	2.0	1.2	374.6		0.0	29.7	1.3	1710.2		0.0	> 1H	—	—
(F1)	12	0.0	0.4	0.2	129.4	22	0.0	0.1	0.0	2.6	20	0.1	315.3	302.2	19865.8
(F2)		0.0	0.4	0.1	10.6		0.1	0.2	0.2	1.8		0.6	2.0	0.4	53.8
(F3)		0.0	0.4	0.2	107.4		0.0	0.2	0.0	3.0		0.2	127.5	26.7	6387.0
(F4)		0.0	0.6	0.3	87.4		0.1	0.3	0.0	3.0		0.4	137.6	61.7	905.10
(F5.1)		0.0	0.4	0.2	114.6		0.0	0.1	0.0	3.4		0.0	353.3	364.8	7442.0
(F5.2)		0.0	0.6	0.3	124.6		0.0	0.1	0.0	3.0		0.0	412.4	371.2	7987.2

Table 2: Customers prefer closer sites but self-service is forbidden

	$M = 20$					$M = 30$					$M = 40$				
	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$
(F1)	2	0.0	1.6	0.1	201.8	3	0.1	28.1	4.1	869.8	2	0.3	90.2	8.6	1082.6
(F2)		0.1	62.7	26.7	4650.6		0.6	$> 1H$	–	–		2.1	$> 1H$	–	–
(F3)		0.0	2.0	0.3	242.6		0.1	34.0	8.0	1033.4		0.0	96.6	13.0	1150.2
(F4)		0.1	3.9	0.6	153.8		0.4	72.5	7.8	756.2		0.0	342.2	12.2	1095.0
(F5.1)		0.0	1.5	0.4	191.8		0.0	42.7	4.1	1155.4		0.0	100.3	14.5	1095.0
(F5.2)		0.0	1.7	0.5	205.0		0.0	47.1	6.8	1000.6		0.0	92.5	6.6	1183.8
(F1)	3	0.0	2.2	0.1	273.0	6	0.1	66.4	17.7	2903.0	4	0.2	459.6	85.5	5656.6
(F2)		0.1	15.5	4.3	1262.6		0.4	113.5	75.0	5463.8		2.0	$> 1H$	–	–
(F3)		0.0	2.5	0.1	293.4		0.1	63.2	10.6	2436.6		0.3	507.0	57.1	5660.2
(F4)		0.1	5.1	0.2	243.8		0.3	125.3	15.9	1989.4		1.5	1236.3	254.0	4778.6
(F5.1)		0.0	74.8	161.1	264.1		0.0	118.2	27.5	3243.8		0.0	917.3	114.8	6964.2
(F5.2)		0.0	2.9	0.4	283.0		0.0	125.6	34.8	2409.4		0.0	859.3	193.8	5883.8
(F1)	5	0.0	2.5	0.2	389.8	10	0.1	32.0	13.5	2085.8	8	0.2	977.1	633.9	15782.6
(F2)		0.1	2.4	0.7	329.4		0.3	2.7	0.4	137.8		1.3	212.8	234.4	4813.8
(F3)		0.0	2.3	0.4	346.2		0.1	27.8	0.1	1443.0		0.2	862.9	402.6	12009.4
(F4)		0.1	4.3	0.9	299.4		0.2	58.5	13.4	1383.0		0.9	1496.8	762.3	7941.4
(F5.1)		0.0	2.8	0.5	394.2		0.0	43.4	29.2	1684.0		0.0	1969.2	879.5	15085.4
(F5.2)		0.0	4.0	1.1	456.2		0.0	45.6	29.1	1710.2		0.0	2169.6	825.9	12589.8
(F1)	7	0.0	1.4	0.4	270.2	12	0.0	18.6	15.6	1384.6	10	0.2	985.2	456.9	19158.2
(F2)		0.1	1.1	0.8	44.6		0.3	1.1	0.2	39.4		1.2	28.4	13.1	645.4
(F3)		0.0	1.7	0.6	329.4		0.1	20.5	16.3	1495.4		0.2	651.4	139.3	11759.0
(F4)		0.0	2.0	0.5	175.8		0.2	23.8	21.1	721.4		0.9	1234.7	145.2	7846.0
(F5.1)		0.0	1.8	0.5	326.2		0.0	36.7	38.1	1661.4		0.0	2390.3	521.4	21169.0
(F5.2)		0.0	2.2	1.2	286.2		0.0	57.5	27.1	1727.4		0.0	2675.9	546.3	22998.2
(F1)	10	0.0	0.5	0.3	145.0	15	0.0	4.7	4.7	50.0	16	0.1	280.2	202.5	9982.2
(F2)		0.0	0.5	0.3	16.2		0.2	0.8	0.1	19.0		0.8	2.7	0.5	31.8
(F3)		0.0	0.6	0.4	166.2		0.1	6.4	7.1	648.0		0.2	336.1	202.0	12150.0
(F4)		0.0	0.7	0.2	70.2		0.1	6.9	6.3	321.0		0.7	315.8	118.8	4096.0
(F5.1)		0.0	0.6	0.3	155.8		0.0	6.2	8.0	451.0		0.0	798.8	256.2	13713.0
(F5.2)		0.0	0.9	0.7	185.4		0.0	7.2	8.1	461.5		0.0	899.4	265.2	13942.0
(F1)	12	0.0	0.2	0.1	33.0	22	0.0	0.0	0.1	2.0	20	0.0	75.3	63.6	3708.2
(F2)		0.0	0.3	0.1	6.2		0.1	0.1	0.0	1.0		0.6	2.1	0.2	39.4
(F3)		0.0	0.2	0.2	51.0		0.0	0.2	0.1	3.0		0.2	71.1	8.3	3689.0
(F4)		0.0	0.4	0.2	27.0		0.1	0.3	0.1	3.0		0.5	96.4	40.9	1975.0
(F5.1)		0.0	0.2	0.1	51.8		0.0	0.1	0.0	3.0		0.0	108.8	36.3	2800.0
(F5.2)		0.0	0.3	0.2	49.0		0.0	0.1	0.0	3.0		0.0	158.3	37.2	2901.2

Table 3: Random preferences

	$M = 20$					$M = 30$					$M = 40$				
	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$
Customers prefer closer sites and self-service is allowed															
(F1)	2	0.0	1.2	0.1	144.2	3	0.1	21.1	2.6	641.4	2	0.2	47.0	4.1	532.6
(F1R)		0.0	1.7	0.1	155.0		0.1	24.8	2.8	557.0		0.2	74.4	10.8	496.6
(F1)	3	0.0	2.4	0.2	349.4	6	0.1	83.0	15.6	5006.6	4	0.2	281.5	11.6	3955.4
(F1R)		0.0	2.8	0.2	285.0		0.1	95.7	23.9	3910.2		0.2	359.1	65.2	3355.8
(F1)	5	0.0	3.9	0.9	847.8	10	0.0	177.0	34.1	19892.2	8	0.2	2269.1	735.8	55702.6
(F1R)		0.0	4.5	1.4	622.6		0.1	180.1	56.3	11339.8		0.1	2655.5	645.9	42317.8
(F1)	7	0.0	4.0	0.7	1153.0	12	0.0	219.7	150.0	30517.8	10	0.1	$> 1H$	–	–
(F1R)		0.0	4.9	1.1	786.2		0.0	188.5	113.1	13592.6		0.1	$> 1H$	–	–
(F1)	10	0.0	8.5	1.7	5382.6	15	0.0	680.2	345.5	205131.4	16	0.1	3097.7	836.5	117527.7
(F1R)		0.0	12.9	2.4	4125.8		0.0	635.6	89.0	116827.0		0.1	$> 1H$	–	–
(F1)	12	0.0	16.5	1.8	16316.2	22	0.0	2453.0	5.0	$2 \cdot 10^6$	20	0.1	$> 1H$	–	–
(F1R)		0.0	25.3	3.3	14071.8		0.0	$> 1H$	–	–		0.1	$> 1H$	–	–
Customers prefer closer sites but self-service is forbidden															
(F1)	2	0.0	1.1	0.2	120.6	3	0.1	23.9	2.7	799.0	2	0.2	44.9	9.8	437.0
(F1R)		0.0	1.6	0.2	120.6		0.1	30.4	4.7	655.8		0.2	64.9	4.2	353.8
(F1)	3	0.0	0.4	0.2	129.4	6	0.1	52.1	12.1	2672.6	4	0.2	312.0	99.7	4173.4
(F1R)		0.0	2.7	0.4	245.8		0.1	75.6	24.6	2389.0		0.2	416.1	88.6	3450.2
(F1)	5	0.0	2.9	0.7	584.6	10	0.1	87.7	37.4	7987.8	8	0.2	2000.2	657.0	43647.4
(F1R)		0.0	4.1	0.9	499.8		0.1	87.5	36.2	4195.0		0.2	2405.5	394.5	29669.0
(F1)	7	0.0	3.0	0.7	722.2	12	0.0	49.6	23.9	5036.2	10	0.2	2624.0	694.7	62600.0
(F1R)		0.0	3.8	1.1	519.0		0.1	61.4	29.8	2890.2		0.1	3020.4	675.4	35502.0
(F1)	10	0.0	1.0	0.5	315.4	15	0.0	16.1	5.8	2396.6	16	0.1	1555.1	1205.4	41557.0
(F1R)		0.0	2.1	1.1	337.8		0.1	23.4	7.7	1117.8		0.2	1261.4	665.5	24426.3
(F1)	12	0.0	0.4	0.2	129.4	22	0.0	0.1	0.0	2.6	20	0.1	315.3	302.2	19865.8
(F1R)		0.0	0.7	0.4	90.6		0.0	0.7	0.4	2.6		0.1	523.3	286.8	11281.8
Random preferences															
(F1)	2	0.0	1.6	0.1	201.8	3	0.1	28.1	4.1	869.8	2	0.3	90.2	8.6	1082.6
(F1R)		0.0	2.1	0.6	183.4		0.1	40.4	1.6	728.6		0.2	147.9	13.0	1052.3
(F1)	3	0.0	2.2	0.1	273.0	6	0.1	66.4	17.7	2903.0	4	0.2	459.6	85.5	5656.6
(F1R)		0.0	2.8	0.4	218.2		0.1	84.4	12.1	2320.6		0.2	767.3	93.0	5431.0
(F1)	5	0.0	2.5	0.2	389.8	10	0.1	32.0	13.5	2085.8	8	0.2	977.1	633.9	15782.6
(F1R)		0.0	3.5	0.9	381.0		0.1	43.2	8.3	1470.2		0.3	1033.7	464.9	9091.4
(F1)	7	0.0	1.4	0.4	270.2	12	0.0	18.6	15.6	1384.6	10	0.2	985.2	456.9	19158.2
(F1R)		0.0	2.2	0.7	248.6		0.1	30.4	21.8	1037.0		0.2	1118.1	1118.7	14588.3
(F1)	10	0.0	0.5	0.3	145.0	15	0.0	4.7	4.7	50.0	16	0.1	280.2	202.5	9982.2
(F1R)		0.0	1.0	0.5	128.2		0.1	8.7	9.4	372.6		0.2	390.0	209.2	4941.0
(F1)	12	0.0	0.2	0.1	33.0	22	0.0	0.0	0.1	2.0	20	0.0	75.3	63.6	3708.2
(F1R)		0.0	0.3	0.2	32.2		0.0	0.2	0.0	3.8		0.2	124.6	47.2	2098.2

Table 4: Comparison of (F1) with and without additional constraints

Ineq.	$\bar{t}$	$n$	$\bar{t}$	$n$	$\bar{t}$	$n$	$\bar{t}$	$n$	$\bar{t}$	$n$	$\bar{t}$	$n$
$M = 20$												
	$p = 2$		$p = 3$		$p = 5$		$p = 7$		$p = 10$		$p = 12$	
None	10.8	420.2	7.3	317.8	2.6	63.0	1.4	27.4	0.2	3.0	0.1	1.0
(1)	4.6	96.2	2.9	71.0	1.2	42.2	0.4	10.0	0.2	5.0	0.1	1.0
(2)	13.8	436.2	8.6	261.8	3.1	57.4	2.2	25.4	0.4	5.0	0.2	5.0
(3)	14.1	415.0	9.5	370.6	3.1	68.6	1.7	15.4	0.1	1.0	0.2	4.2
(5)	11.5	386.7	8.5	284.2	3.2	49.8	1.5	18.2	0.3	5.4	0.1	1.0
(1)(2)	4.7	89.8	2.6	81.8	1.5	31.0	0.7	9.4	0.3	5.0	0.1	1.0
(1)(3)	5.5	71.4	3.1	91.8	1.6	29.4	0.9	8.2	0.6	10.6	0.1	1.0
(1)(5)	5.1	101.0	2.9	69.8	1.1	23.4	1.1	14.2	0.4	8.6	0.1	1.0
(2)(3)	15.4	453.4	7.1	173.8	2.2	32.6	1.8	17.0	0.5	9.0	0.1	1.0
(2)(5)	13.4	294.2	8.3	221.0	2.4	35.0	2.0	12.6	0.3	1.0	0.1	1.0
(3)(5)	14.5	371.8	8.2	199.8	2.8	38.2	1.6	26.6	0.2	3.4	0.1	1.0
(1)(2)(3)	5.0	111.4	3.2	75.8	1.0	23.4	0.9	11.8	0.1	1.0	0.1	1.0
(1)(2)(5)	6.1	99.0	3.6	75.0	0.9	34.2	0.7	6.2	0.3	4.2	0.1	1.0
(1)(3)(5)	7.2	114.6	5.2	98.2	1.0	37.0	1.3	9.4	0.2	4.6	0.2	4.2
(2)(3)(5)	18.2	402.6	13.3	297.0	3.5	52.6	2.5	26.6	0.9	13.0	0.1	1.0
(1)(2)(3)(5)	7.0	97.4	5.1	85.4	1.6	38.6	1.0	9.0	0.5	8.2	0.3	4.2
$M = 30$												
	$p = 3$		$p = 6$		$p = 10$		$p = 12$		$p = 15$		$p = 22$	
None	63.4	948.2	4.5	113.4	1.3	35.4	0.7	7.8	1.9	13.0	0.2	1.0
(1)	10.0	159.0	3.0	8.7	1.1	15.0	0.7	2.3	1.4	11.4	0.2	1.0
(2)	55.8	630.6	8.2	24.1	1.4	25.4	0.9	10.8	0.3	1.0	0.2	1.0
(3)	80.8	1005.0	5.8	17.6	1.8	33.4	0.7	1.8	1.1	7.0	0.2	1.0
(5)	68.9	984.6	5.4	52.2	1.3	25.0	0.7	4.9	1.2	7.0	0.2	1.0
(1)(2)	11.7	117.8	9.3	24.8	1.9	22.2	1.1	3.0	0.6	1.0	0.2	1.0
(1)(3)	14.3	178.6	4.1	26.9	1.6	27.0	2.2	3.7	1.2	6.6	0.2	1.0
(1)(5)	13.5	143.8	5.2	58.6	2.1	16.2	1.1	3.0	1.0	5.8	0.2	1.0
(2)(3)	77.1	671.8	5.7	23.9	1.6	21.4	0.7	4.1	0.4	1.0	0.3	1.0
(2)(5)	75.7	675.0	8.7	48.3	2.3	30.6	1.2	1.7	0.3	1.0	0.3	1.0
(3)(5)	91.7	852.6	7.4	86.8	1.5	17.0	0.8	3.3	1.3	7.0	0.2	1.0
(1)(2)(3)	15.5	141.0	7.2	23.4	1.7	19.4	2.0	2.4	0.5	1.0	0.3	1.0
(1)(2)(5)	21.4	176.6	4.8	22.8	2.5	35.8	1.4	2.4	0.4	1.0	0.3	1.0
(1)(3)(5)	15.6	105.4	4.7	38.1	1.7	15.8	1.2	4.3	0.8	5.0	0.3	1.0
(2)(3)(5)	97.9	777.4	12.0	34.4	2.1	22.6	1.2	1.7	0.4	1.0	0.2	1.0
(1)(2)(3)(5)	23.4	169.8	16.7	28.5	2.7	20.2	1.8	2.4	1.0	5.0	0.3	1.0
$M = 40$												
	$p = 2$		$p = 4$		$p = 8$		$p = 10$		$p = 16$		$p = 20$	
None	2379.9	14480.0	265.8	2142.6	16.6	207.8	13.5	80.6	2.0	12.2	3.8	1.8
(1)	176.9	838.2	51.6	413.8	13.1	143.8	7.2	86.5	2.3	18.5	1.0	1.0
(2)	2106.9	7885.4	283.1	1449.0	32.6	257.8	9.0	93.5	2.0	7.0	0.6	1.0
(3)	$> 1H$	–	359.3	2138.2	31.4	189.8	9.8	92.0	2.0	8.5	4.3	8.0
(5)	$> 1H$	–	338.4	1865.8	18.8	159.4	10.6	108.0	1.7	7.5	0.6	1.0
(1)(2)	185.7	795.8	66.0	348.6	21.0	98.2	9.4	93.5	2.4	16.5	1.0	1.0
(1)(3)	165.4	562.2	58.8	374.2	25.6	110.2	7.0	66.5	2.1	4.0	1.0	1.0
(1)(5)	319.1	642.6	66.4	423.8	26.0	120.2	7.0	73.0	2.2	8.5	0.6	1.0
(2)(3)	2251.6	6124.5	766.1	4007.0	33.8	182.2	30.3	106.5	8.9	7.5	1.0	1.0
(2)(5)	2487.3	7410.5	356.1	1290.2	32.9	232.6	19.1	102.5	10.7	7.0	1.0	1.0
(3)(5)	$> 1H$	–	1022.1	1708.0	48.7	208.2	13.1	99.5	8.9	9.0	1.6	2.0
(1)(2)(3)	219.4	532.6	78.4	333.8	46.6	155.0	18.5	72.5	9.2	13.5	1.5	1.0
(1)(2)(5)	230.2	579.4	115.7	509.8	34.3	87.0	23.2	85.0	6.3	4.5	1.6	1.0
(1)(3)(5)	320.0	790.2	122.5	399.0	47.5	117.4	14.1	107.0	5.5	4.5	2.1	1.0
(2)(3)(5)	2700.5	5293.0	667.8	1988.6	65.5	158.6	23.2	85.0	14.6	8.5	5.2	1.0
(1)(2)(3)(5)	353.3	718.0	155.2	473.4	73.6	119.0	29.7	72.0	8.6	4.0	5.8	1.0

Table 5: Performance of several families of valid inequalities added to (F2)



	$M = 20$			$M = 30$			$M = 40$		
	$p$	$t$	$n$	$p$	$t$	$n$	$p$	$t$	$n$
Customers prefer closer sites and self-service is allowed									
(F2)	2	10.7	420.2	3	63.4	948.2	2	379.9	14480.0
(F2)(1)		4.6	96.2		10.0	159.0		176.9	838.2
(F2)(1)(4)		9.0	67.8		16.7	110.6		101.6	602.2
(F2)	3	7.3	317.8	6	4.5	113.4	4	265.8	2142.6
(F2)(1)		2.9	71.0		3.0	8.7		51.6	413.8
(F2)(1)(4)		4.5	55.8		5.6	53.0		35.8	237.0
(F2)	5	2.6	63.0	10	1.3	35.4	8	16.6	207.8
(F2)(1)		1.2	42.2		1.1	15.0		13.1	143.8
(F2)(1)(4)		1.5	17.4		2.7	13.0		19.2	119.8
(F2)	7	1.4	27.4	12	0.7	7.8	10	13.5	80.6
(F2)(1)		0.4	10.0		0.7	2.3		7.2	86.5
(F2)(1)(4)		0.8	8.6		1.4	4.2		10.5	56.2
(F2)	10	0.2	3.0	15	1.9	13.0	16	2.0	12.2
(F2)(1)		0.2	5.0		1.4	11.4		2.3	18.5
(F2)(1)(4)		0.6	3.8		1.2	6.2		5.0	15.8
(F2)	12	0.1	1.0	22	0.2	1.0	20	3.8	1.8
(F2)(1)		0.1	1.0		0.2	1.0		1.0	1.0
(F2)(1)(4)		0.3	1.0		0.5	1.0		3.1	1.4
Customers prefer closer sites but self-service is forbidden									
(F2)	2	28.2	2117.8	3	814.2	21899.4	2	2717.5	17868.5
(F2)(1)		4.4	193.4		28.2	825.4		125.2	876.6
(F2)(1)(4)		4.0	140.6		29.9	665.4		108.0	719.0
(F2)	3	16.6	1791.0	6	52.0	2749.8	4	> 1H	–
(F2)(1)		3.8	275.4		6.7	304.6		114.6	1815.0
(F2)(1)(4)		3.6	154.2		9.3	187.4		137.8	1382.7
(F2)	5	2.5	364.6	10	4.5	420.4	8	846.7	28928.2
(F2)(1)		3.8	275.4		3.1	171.6		23.1	632.2
(F2)(1)(4)		2.9	103.8		6.6	173.0		88.6	479.2
(F2)	7	1.0	101.4	12	1.7	97.4	10	139.6	4933.4
(F2)(1)		0.7	67.4		1.7	72.2		21.7	740.6
(F2)(1)(4)		1.5	45.4		3.7	65.0		15.7	231.7
(F2)	10	0.4	28.6	15	2.2	21.8	16	4.2	136.0
(F2)(1)		1.3	17.4		1.5	15.0		4.6	75.0
(F2)(1)(4)		0.8	20.2		1.4	13.0		7.4	70.6
(F2)	12	0.4	10.6	22	0.2	1.8	20	2.0	53.8
(F2)(1)		0.6	6.6		0.1	1.0		2.6	19.0
(F2)(1)(4)		0.9	4.6		1.3	1.0		4.1	12.0
Random preferences									
(F2)	2	62.7	4650.6	3	> 1H	–	2	> 1H	–
(F2)(1)		6.2	372.6		93.5	2489.8		> 1H	–
(F2)(1)(4)		6.7	245.5		127.3	3204.6		> 1H	–
(F2)	3	15.5	1262.6	6	113.5	5463.8	4	> 1H	–
(F2)(1)		3.1	287.4		6.6	245.4		1342.9	16320.0
(F2)(1)(4)		5.8	179.4		7.8	180.2		1253.0	16697.7
(F2)	5	2.4	329.4	10	2.7	137.8	8	212.8	4813.8
(F2)(1)		1.2	83.0		2.2	64.6		32.3	182.2
(F2)(1)(4)		2.0	75.4		2.9	28.2		21.5	269.0
(F2)	7	1.1	44.6	12	1.1	39.4	10	28.4	645.4
(F2)(1)		2.1	36.2		1.4	23.4		10.3	166.0
(F2)(1)(4)		1.3	31.0		2.6	20.2		11.2	119.0
(F2)	10	0.5	16.2	15	0.8	19.0	16	2.7	31.8
(F2)(1)		1.0	11.0		1.1	12.0		32.0	4.7
(F2)(1)(4)		0.7	9.0		1.9	18.0		5.9	15.0
(F2)	12	0.3	6.2	22	0.1	1.0	20	2.1	39.4
(F2)(1)		0.3	3.4		0.1	1.0		2.8	16.0
(F2)(1)(4)		0.8	2.6		0.3	1.5		3.6	21.0

Table 6: Comparison between (F2) with and without separation of constraints (4)

	$M = 20$					$M = 30$					$M = 40$				
	$p$	$t_P$	$\%v_0$	$\%v_1$	$t$	$p$	$t_P$	$\%v_0$	$\%v_1$	$t$	$p$	$t_P$	$\%v_0$	$\%v_1$	$t$
Customers prefer closer sites and self-service is allowed															
(F2)	2	–	–	–	10.8	3	–	–	–	63.4	2	–	–	–	2379.9
(F2)(1)	–	–	–	–	4.6	–	–	–	–	10.0	–	–	–	–	176.9
(F2)(1)Pre	0.4	58.6	15.9	1.5	–	0.7	71.5	10.5	5.2	–	0.9	78.1	14.3	59.0	
(F2)	3	–	–	–	7.3	6	–	–	–	4.5	4	–	–	–	265.8
(F2)(1)	–	–	–	–	3.0	–	–	–	–	3.0	–	–	–	–	51.6
(F2)(1)Pre	0.5	59.1	11.2	1.2	–	0.7	72.5	5.5	1.7	–	1.0	78.4	8.2	16.6	
(F2)	5	–	–	–	2.6	10	–	–	–	1.3	8	–	–	–	16.6
(F2)(1)	–	–	–	–	1.2	–	–	–	–	1.1	–	–	–	–	13.1
(F2)(1)Pre	0.4	61.4	6.9	0.6	–	0.8	72.5	3.9	0.9	–	1.2	78.9	4.3	4.6	
(F2)	7	–	–	–	1.4	12	–	–	–	0.7	10	–	–	–	13.5
(F2)(1)	–	–	–	–	0.4	–	–	–	–	0.7	–	–	–	–	7.2
(F2)(1)Pre	0.4	61.7	5.5	0.5	–	0.8	73.8	3.5	0.8	–	1.3	79.1	3.6	2.9	
(F2)	10	–	–	–	0.2	15	–	–	–	1.9	16	–	–	–	2.0
(F2)(1)	–	–	–	–	0.2	–	–	–	–	1.4	–	–	–	–	2.3
(F2)(1)Pre	0.4	62.8	5.0	0.4	–	0.7	73.7	3.3	0.8	–	1.1	79.4	2.6	1.2	
(F2)	12	–	–	–	0.1	22	–	–	–	0.2	20	–	–	–	3.8
(F2)(1)	–	–	–	–	0.1	–	–	–	–	0.2	–	–	–	–	1.0
(F2)(1)Pre	2.2	70.5	5.0	2.5	–	1.6	79.6	3.3	1.7	–	1.7	79.9	3.3	2.0	
Customers prefer closer sites but self-service is forbidden															
(F2)	2	–	–	–	28.1	3	–	–	–	814.1	2	–	–	–	2717.5
(F2)(1)	–	–	–	–	4.4	–	–	–	–	28.1	–	–	–	–	125.2
(F2)(1)Pre	0.5	57.5	14.4	2.7	–	0.8	70.9	9.8	20.5	–	1.0	77.8	13.6	74.6	
(F2)	3	–	–	–	16.6	6	–	–	–	52.0	4	–	–	–	$> 1H$
(F2)(1)	–	–	–	–	3.8	–	–	–	–	6.7	–	–	–	–	114.6
(F2)(1)Pre	0.5	58.2	9.8	2.4	–	1.0	71.3	4.4	4.2	–	1.3	77.8	7.7	90.8	
(F2)	5	–	–	–	2.5	10	–	–	–	4.5	8	–	–	–	846.7
(F2)(1)	–	–	–	–	3.8	–	–	–	–	3.1	–	–	–	–	23.1
(F2)(1)Pre	0.5	59.5	5.4	1.2	–	0.9	71.3	2.6	1.8	–	1.7	78.0	3.5	22.1	
(F2)	7	–	–	–	1.0	12	–	–	–	1.7	10	–	–	–	139.6
(F2)(1)	–	–	–	–	0.7	–	–	–	–	1.7	–	–	–	–	21.7
(F2)(1)Pre	0.5	59.3	3.4	0.7	–	0.9	71.9	1.8	1.2	–	1.9	78.1	2.7	14.3	
(F2)	10	–	–	–	0.4	15	–	–	–	2.2	16	–	–	–	4.2
(F2)(1)	–	–	–	–	1.3	–	–	–	–	1.5	–	–	–	–	4.6
(F2)(1)Pre	0.5	60.9	2.0	0.5	–	0.8	71.6	1.4	1.0	–	1.5	78.0	1.5	2.1	
(F2)	12	–	–	–	0.4	22	–	–	–	0.2	20	–	–	–	2.0
(F2)(1)	–	–	–	–	0.6	–	–	–	–	0.1	–	–	–	–	2.6
(F2)(1)Pre	2.0	67.4	1.1	2.1	–	1.5	76.0	0.0	1.7	–	1.7	78.1	1.1	2.0	
Random preferences															
(F2)	2	–	–	–	62.7	3	–	–	–	$> 1H$	2	–	–	–	$> 1H$
(F2)(1)	–	–	–	–	6.2	–	–	–	–	93.5	–	–	–	–	$> 1H$
(F2)(1)Pre	1.0	65.8	14.6	6.1	–	1.8	72.0	10.6	65.2	–	2.0	78.2	13.7	2005.5	
(F2)	3	–	–	–	15.5	6	–	–	–	113.5	4	–	–	–	$> 1H$
(F2)(1)	–	–	–	–	3.1	–	–	–	–	6.6	–	–	–	–	1342.9
(F2)(1)Pre	1.1	66.6	9.0	4.3	–	3.1	74.5	4.1	6.9	–	4.3	79.6	7.8	397.5	
(F2)	5	–	–	–	2.4	10	–	–	–	2.7	8	–	–	–	212.8
(F2)(1)	–	–	–	–	1.2	–	–	–	–	2.2	–	–	–	–	32.3
(F2)(1)Pre	1.0	68.5	4.3	1.7	–	3.4	77.2	1.5	4.0	–	11.3	80.8	3.1	20.7	
(F2)	7	–	–	–	1.1	12	–	–	–	1.1	10	–	–	–	28.4
(F2)(1)	–	–	–	–	2.1	–	–	–	–	1.4	–	–	–	–	10.3
(F2)(1)Pre	1.0	69.8	2.4	1.3	–	3.2	77.8	1.2	3.6	–	16.8	82.1	2.1	19.3	
(F2)	10	–	–	–	0.5	15	–	–	–	0.8	16	–	–	–	2.7
(F2)(1)	–	–	–	–	1.0	–	–	–	–	1.1	–	–	–	–	32.0
(F2)(1)Pre	0.9	71.8	1.2	0.9	–	2.5	78.7	0.6	2.6	–	17.2	83.4	1.1	17.7	
(F2)	12	–	–	–	0.3	22	–	–	–	0.1	20	–	–	–	2.1
(F2)(1)	–	–	–	–	0.3	–	–	–	–	0.1	–	–	–	–	2.8
(F2)(1)Pre	1.6	73.2	0.5	1.8	–	1.5	81.7	0.0	1.8	–	11.5	84.4	0.9	11.8	

Table 7: Comparison between (F2) with and without preprocessing

	$M = 20$					$M = 30$					$M = 40$				
	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$	$p$	$LP$	$\bar{t}$	$\sigma_t$	$n$
Customers prefer closer sites and self-service is allowed															
(F3)	2	0.0	1.5	0.1	177.0	3	0.1	22.7	3.6	718.2	2	0.5	50.7	4.5	1077.0
(F3R)		0.0	1.4	0.2	153.4		0.1	19.2	3.4	617.0		0.2	42.3	4.3	577.8
(F3)	3	0.0	2.5	0.3	327.8	6	0.1	81.9	10.8	4357.8	4	0.2	263.6	29.7	3373.8
(F3R)		0.0	2.2	0.4	291.4		0.1	65.8	25.5	3955.0		0.2	218.1	32.5	3568.6
(F3)	5	0.0	4.4	1.3	917.0	10	0.1	174.5	84.1	17987.0	8	0.2	2443.9	357.9	57277.8
(F3R)		0.0	3.6	1.1	718.6		0.1	141.5	13.3	10941.0		0.1	1568.4	165.8	37586.2
(F3)	7	0.0	4.4	0.8	1255.8	12	0.1	425.6	260.4	51375.0	10	0.2	> 1H	–	–
(F3R)		0.0	4.0	0.7	874.6		0.0	270.5	161.4	23519.8		0.1	3200.6	626.6	81377.5
(F3)	10	0.0	9.5	2.0	5579.8	15	0.1	996.8	25.0	249648.0	16	0.2	> 1H	–	–
(F3R)		0.0	7.6	0.9	2937.0		0.0	686.0	123.2	107674.0		0.2	> 1H	–	–
(F3)	12	0.0	16.4	1.5	14263.0	22	0.1	3298.1	150.8	1999284.0	20	0.2	> 1H	–	–
(F3R)		0.0	17.8	2.4	10633.4		OOM	–	–	–		0.2	> 1H	–	–
Customers prefer closer sites but self-service is forbidden															
(F3)	2	0.0	1.4	0.3	167.8	3	0.1	26.5	2.8	861.9	2	0.3	53.1	11.2	482.2
(F3R)		0.0	1.4	0.4	137.4		0.1	22.2	4.0	786.2		0.2	39.3	6.1	409.4
(F3)	3	0.0	2.5	0.4	315.4	6	0.1	66.9	25.0	3258.6	4	0.2	326.3	84.6	4029.4
(F3R)		0.0	2.2	0.5	279.4		0.1	57.8	29.9	2917.8		0.2	214.4	67.7	3193.8
(F3)	5	0.0	3.2	0.5	597.0	10	0.1	82.3	6.6	6807.0	8	0.2	2105.2	302.5	38412.2
(F3R)		0.0	2.7	0.1	466.6		0.1	64.4	7.1	4516.0		0.1	1281.3	360.6	28625.8
(F3)	7	0.0	2.5	1.1	595.4	12	0.1	48.8	17.7	4261.0	10	0.2	2763.5	449.3	67043.0
(F3R)		0.0	2.3	0.6	474.2		0.0	31.6	8.5	2208.2		0.1	1829.3	571.6	45384.0
(F3)	10	0.0	1.3	0.7	411.0	15	0.1	15.8	0.6	2054.0	16	0.2	1677.0	1147.9	43331.5
(F3R)		0.0	1.1	0.7	281.4		0.0	8.6	0.6	782.0		0.1	1346.5	948.2	40464.6
(F3)	12	0.0	0.4	0.2	107.4	22	0.0	0.2	0.0	3.0	20	0.2	127.5	26.7	6387.0
(F3R)		0.0	0.4	0.2	96.2		0.0	0.4	0.1	30.0		0.1	96.2	32.0	3906.0
Random preferences															
(F3)	2	0.0	2.0	0.3	242.6	3	0.1	34.0	8.0	1033.4	2	0.0	96.6	13.0	1150.2
(F3R)		0.0	1.7	0.2	175.4		0.1	23.9	2.8	699.4		0.2	70.4	4.5	1028.2
(F3)	3	0.0	2.5	0.1	293.4	6	0.1	63.2	10.6	2436.6	4	0.3	507.0	57.1	5660.2
(F3R)		0.0	2.2	0.3	257.4		0.1	53.5	15.7	2183.8		0.2	319.4	66.4	4102.5
(F3)	5	0.0	2.3	0.4	346.2	10	0.1	27.8	0.1	1443.0	8	0.2	862.9	402.6	12009.4
(F3R)		0.0	2.1	0.4	317.8		0.1	29.8	8.4	1504.0		0.2	447.3	259.3	6487.8
(F3)	7	0.0	1.7	0.6	329.4	12	0.1	20.5	16.3	1495.4	10	0.2	651.4	139.3	11759.0
(F3R)		0.0	1.2	0.5	204.6		0.0	15.3	10.0	919.0		0.2	423.3	48.0	7875.0
(F3)	10	0.0	0.6	0.4	166.2	15	0.1	6.4	7.1	648.0	16	0.2	336.1	202.0	12150.0
(F3R)		0.0	0.7	0.4	160.6		0.1	3.8	3.4	326.0		0.1	388.1	244.2	10534.0
(F3)	12	0.0	0.2	0.2	51.0	22	0.0	0.2	0.1	3.0	20	0.2	71.1	8.3	3689.0
(F3R)		0.0	0.2	0.0	41.4		0.0	0.3	0.1	30.0		0.1	59.6	41.5	2340.0

Table 8: Comparison between (F3) with and without a modification in the objective function

	$M = 20$			$M = 30$			$M = 40$		
	$p$	$\bar{t}_P$	$\bar{t}$	$p$	$\bar{t}_P$	$\bar{t}$	$p$	$\bar{t}_P$	$\bar{t}$
Customers prefer closer sites and self-service is allowed									
(F5.1)	2	–	1.1	3	–	25.8	2	–	51.2
(F5.1)Pre		2.3	3.4		2.4	38.2		2.9	56.3
(F5.1)	3	–	2.4	6	–	145.8	4	–	496.7
(F5.1)Pre		2.0	4.0		2.0	51.5		2.8	881.6
(F5.1)	5	–	4.9	10	–	340.6	8	–	$> 1H$
(F5.1)Pre		1.9	3.2		1.8	2.7		2.3	$> 1H$
(F5.1)	7	–	6.1	12	–	387.7	10	–	$> 1H$
(F5.1)Pre		1.4	1.6		1.8	52.2		2.3	$> 1H$
(F5.1)	10	–	18.0	15	–	1701.9	16	–	$> 1H$
(F5.1)Pre		1.5	1.6		0.8	1058.9		1.9	$> 1H$
(F5.1)	12	–	33.2	22	–	$> 1H$	20	–	$> 1H$
(F5.1)Pre		1.2	1.3		1.3	1.6		2.0	$> 1H$
Customers prefer closer sites but self-service is forbidden									
(F5.1)	2	–	1.0	3	–	28.1	2	–	48.3
(F5.1)Pre		2.1	4.1		1.1	57.7		1.6	81.4
(F5.1)	3	–	2.4	6	–	92.0	4	–	521.6
(F5.1)Pre		1.9	5.5		1.0	176.0		1.8	1779.1
(F5.1)	5	–	4.3	10	–	231.8	8	–	$> 1H$
(F5.1)Pre		1.7	6.0		0.9	310.4		2.4	$> 1H$
(F5.1)	7	–	4.7	12	–	115.0	10	–	$> 1H$
(F5.1)Pre		1.7	5.7		1.0	81.2		2.2	$> 1H$
(F5.1)	10	–	1.5	15	–	27.7	16	–	$> 1H$
(F5.1)Pre		1.6	2.4		0.9	17.5		2.1	2549.5
(F5.1)	12	–	0.4	22	–	0.1	20	–	353.4
(F5.1)Pre		1.2	1.3		0.6	0.7		1.5	9.9
Random preferences									
(F5.1)	2	–	1.5	3	–	42.7	2	–	100.3
(F5.1)Pre		1.7	4.2		1.3	106.3		1.8	150.4
(F5.1)	3	–	74.8	6	–	118.7	4	–	917.3
(F5.1)Pre		1.8	5.9		2.7	163.9		3.1	$> 1H$
(F5.1)	5	–	2.8	10	–	43.4	8	–	1969.2
(F5.1)Pre		1.6	4.6		3.6	56.1		4.7	3066.1
(F5.1)	7	–	1.8	12	–	36.7	10	–	2390.3
(F5.1)Pre		1.5	2.9		3.5	48.6		8.8	1355.5
(F5.1)	10	–	0.6	15	–	6.3	16	–	798.8
(F5.1)Pre		1.5	1.7		4.2	4.8		20.8	642.9
(F5.1)	12	–	0.2	22	–	0.1	20	–	108.8
(F5.1)Pre		1.3	1.5		2.0	2.1		20.2	48.4

Table 9: Comparison between (F5.1) with and without preprocessing