1.a) $\Delta c_C = -0{,}1 \times 40 = -4 \in (-\infty, 25]$ (SI from Solver output). Thus, the OS does not change but the profit change is: $\Delta Z = \Delta c_C \times x_C = -4 \times 20 = -80$, that is , decreases by 80 m.u.

1.b) $\Delta b_1 = -30 \in [-140, 60]$ (SI from Solver output). Thus, $\Delta Z = \Delta b_1\, y_1 = -30 \times 15 = -450$. $NewZ = 90 \times 10 + 70 \times 20 + 20 \times 40 - 450 = 2650$ m. u. Decreases by 450 m.u. comparing with the initial.

1.c) As $x_1 = |700 - 240| > 0$ there is a leftover of 180 m^3 of oven capacity that could be make available for other products.

2. The Prim algorithm ensures that an optimal solution is achieved no matter the initial vertex that is selected. So there is no effect on the value.

3.a) x_{ij} = no. boxes that should be send every week from warehouse Ai ($i = 1{,}2$) to the supermarket Sj ($j = 1{,}2{,}3$). The problem is unbalanced, so the total supply > total demand.

$$\min Z = 5x_{11} + 2x_{12} + 9x_{13} + 2x_{21} + 4x_{22} + 5x_{23}$$

$$\text{s.t.:} \begin{cases} x_{11} + x_{12} + x_{13} \leq 1000 \\ x_{21} + x_{22} + x_{23} \leq 800 \\ x_{11} + x_{21} = 900 \\ x_{12} + x_{22} = 300 \\ x_{13} + x_{23} = 400 \\ x_{ij} \geq 0, i = 1{,}2;\ j = 1{,}2{,}3 \end{cases}$$

3.b) No change is needed as all demands and supplies are integer numbers. There is property that ensures integrality of the solution in that conditions.

3.c) Let: $i = 3$ be the index associated to warehouse A3; $y = \begin{cases} 1 & \text{if A1 and A2 are used} \\ 0 & \text{if A3 is used} \end{cases}$; Z and $Z1$ the OF of the original problem and new problem, respectively. Model:

$$\min Z1 = Z + 0{,}5(x_{31} + x_{32} + x_{33}) + 5000(1 - y)$$

$$\text{s.t.:} \begin{cases} x_{11} + x_{12} + x_{13} \leq 1000y \\ x_{21} + x_{22} + x_{23} \leq 800y \\ x_{31} + x_{32} + x_{33} \leq 2000(1 - y) \\ x_{11} + x_{21} + x_{31} = 900 \\ x_{12} + x_{22} + x_{32} = 300 \\ x_{13} + x_{23} + x_{33} = 400 \\ x_{ij} \geq 0,\ \ i, j = 1{,}2{,}3 \\ y \in \{0, 1\} \end{cases}$$