Pt7

Sets

- F : Farms
- P : Facilities
- T : Tankers
- R : Milkruns

Data

- $Supply_f$ - milk supply from each farm $f \in F$ (L)
- $PMin_p$ - minimum daily processing at processing facility $p \in P$ (L)
- $PMax_p$ - maximum daily processing at processing facility $p \in P$ (L)
- $Maintenance_t$ - daily cost of maintenance for tanker $t \in T$
- $MMax$ - maximum number of minutes a tanker can be used for each day (min)
- $RunP_r$ - origin processing facility for milk run $r \in R$
- $RunF_r$ - farms visited by milk run $r \in R$
- $RunT_r$ - time taken to complete milk run $r \in R$ (min)
- $RunC_r$ - cost of travel for milk run $r \in R$ ($)
- $BFarms$ - delay between farms on a milk run (min)
- $BRuns$ - cleaning time between milk runs (min)

Variables

- W_{pt} - binary assignment of tankers $t \in T$ to processing facilities $p \in P$
- X_{prt} - binary assignment of routes $r \in R$ to processing facilities $p \in P$ and tankers $t \in T$
- Y_{prt} - number of extra minutes taken by a tanker $t \in T$ from facility $p \in P$ between farms on a milk run $r \in R$
- Z_{pt} - number of routes each tanker $t \in T$ from processing facility $p \in P$ is assigned to

Objective function

$$\min\Big(\sum_{p\in P}\sum_{r\in R}\sum_{t\in T}\big(X_{prt}\times C_r\big)+\sum_{p\in P}\sum_{t\in T}\big(W_{pt}\times Maintenance_t\big)\Big)$$

Constraints

- Total milk processed at processing facility $p \in P$ cannnot exceed the processing capacity.

$$\sum_{r\in R}\sum_{t\in T}\sum_{\substack{f\in F \text{ st.}\\ f\in RunF_r}} X_{prt}\times Supply_f \le PMax_p, \quad \forall p\in P$$

- Total milk processed at processing facility $p \in P$ must meet the minimal operational requirement.

$$\sum_{r\in R}\sum_{t\in T}\sum_{\substack{f\in F \text{ st.}\\ f\in RunF_r}} X_{prt}\times Supply_f \ge PMin_p, \quad \forall p\in P$$

- Each tanker $t \in T$ from processing facility $p \in P$ cannot be operational for more than 10 hours (600 min) including breaks.

$$\left(\sum_{r\in R} X_{prt}\times RunT_r + Y_{prt}\right)+\Big(Z_{pt}-W_{pt}\Big)\times BRuns \le MMax, \quad \forall p\in P,\ t\in T$$

- The number of routes a tanker is assigned to equals the sum of route assignments to that tanker and processing facility.

$$Z_{pt}=\sum_{r\in R} X_{prt}, \quad \forall p\in P,\ t\in T$$

- If a milkrun does not originate from processing facility $p \in P$, it cannot be assigned to a tanker at that facility.

$$X_{prt} = 0, \quad \forall p \in P,\ t \in T,\ r \in R \text{ if } RunP_r \neq p$$

- If a tanker $t \in T$ is used, the binary tanker variable must be set.

$$X_{prt} = 1 \implies W_{pt} = 1, \quad \forall p \in P,\ t \in T,\ r \in R$$

- Tankers must be used in order, i.e., tanker 1 and then tanker 2 etc.,

$$W_{pt} = 1 \implies W_{p(t-1)} = 1, \quad \forall p \in P,\ t \in T,\ t > 0$$

- If a milk run is assigned to a tanker and processing facility and the run visits multiple farms, the number of minutes required for breaks between the farms is recorded. If there is only one farm on the milk run, no breaks are required.

$$Y_{prt} = \begin{cases} X_{prt} \times \big(|RunF_r| - 1\big) \times BFarms, & \text{if } |RunF_r| > 0 \\ 0, & \text{otherwise} \end{cases}, \quad \forall p \in P,\ t \in T,\ r \in R$$

- Each farm $f \in F$ must be visited on one of the assigned routes.

$$\sum_{p \in P} \sum_{r \in R} \sum_{t \in T} X_{prt} = 1, \quad \forall f \in F \text{ such that } f \in RunF_r$$