Multiple Heterogeneous Vehicle Routing Problem allowing Simultaneous Delivery and Pick-up from Single Depot while minimizing the Distance travelled by all vehicles to complete the entire operation

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Proof of the 3rd constraint

1. The transformation of the third formualtion as illustrated by Mustafa Avci and Seyda Topaloglu is shown below:-

   This has been done to remove a third variable being used by them

   Ensures that each customer is visited and left by the same vehicle [As per Mustafa Avci et. al.]

   $$\sum_{i \in N_0} x_{ipk} - \sum_{j \in N_0} x_{pjk} = 0 \qquad \forall k \in VN \quad \& \quad \forall p \in N_0$$

   $$\sum_{j \in N_0} x_{jpk} - \sum_{j \in N_0} x_{pjk} = 0 \qquad \forall k \in VN \quad \& \quad \forall p \in N_0$$

   $$\sum_{j \in N_0} (x_{jpk} - x_{pjk}) = 0 \qquad \forall k \in VN \quad \& \quad \forall p \in N_0$$

   $$\sum_{j \in N_0} (x_{jik} - x_{ijk}) = 0 \qquad \forall k \in VN \quad \& \quad \forall i \in N_0$$

   Ensuring the same number of each type of vehicles entering any node also leaves it [As per present formulation being considered which is identical apart from the fact that the set of Vehicles is replaced by the set of Vehicle types]

   $$\sum_{j \in N_0} (x_{ijk} - x_{jik}) = 0 \qquad \forall k \in VT \quad \& \quad \forall i \in N_0$$