**MATH MODEL**

1. **Indices and Sets**
2. ***Indices***

* N: Number of node
* F: Number of feeders
* :

Indices representing the components (nodes), where 0 typically denotes the origin or depot.

* : indices representing the feeders.

1. ***Sets***

Represents the pairing of each component i with its corresponding feeder f.

1. **Parametters**

* : Distance from node 𝑖 to feeder 𝑓.
* Distance from node 𝑖 to the origin.

1. **Decision Variables**

* :

Binary variable equal to 1 if the SMT moves directly from node 𝑖 to node ; 0 otherwise.

* Represents the distance traveled when moving from node i to node j.
* Auxiliary continuous variable used for subtour elimination.

1. **Objectives**

*Minimize the total distance traveled by the SMT:*

1. **Constraints**
2. ***Route Initiation and Termination***

*Ensure that the SMT starts at the origin and ends at the origin*

*Origin Outgoing Constraint:*

The SMT departs from the origin to exactly one node.

*Origin Incoming Constraint:*

The SMT returns to the origin from exactly one node.

1. ***Flow Conservation***

*Ensure that each node (excluding the origin) has exactly one incoming and one outgoing route:*

*Outgoing from Each Node:*

From each node i, the SMT departs to exactly one other node j.

*Incoming to Each Node:*

To each node j, the SMT arrives from exactly one other node i.

*Self-loops elimination:*

The SMT does not move from any node i back to itself, preventing self-loops.

1. ***Distance Calculation***

*Movement Between Feeder-Associated Nodes from origin to last node before coming back to the origin:*

If the SMT moves from node i to node , it must come to the feeder associated with the node j then move to node j.

*Movement from the last node to the Origin:*

If the SMT moves from node i to the origin, it move directly to the origin.

1. ***Subtour Elimination***

These constraints ensure that no subtours are formed, maintaining a single, comprehensive tour covering all nodes.

1. ***Variable definition:***

*Binary Variables:*

*Auxiliary Variables:*

*Non-negative Variables:*