**Background Description**

We are tasked with optimizing the setup of pick-up points to efficiently serve various demand areas. Our primary objectives are to minimize the costs associated with establishing and operating these pick-up points, and to minimize the transportation time for delivering goods to these areas. This dual focus aims to enhance operational efficiency while ensuring customer satisfaction by reliably meeting their demands in a timely manner.

Critical considerations in this endeavor include the costs of transporting goods from pick-up points to demand areas, the fixed costs of establishing these points, the capacity constraints of each location, and an overarching investment budget that must not be exceeded. Furthermore, we aim to balance these economic objectives with the operational goal of reducing delivery times, thereby maintaining a high level of customer satisfaction and reflecting the efficiency in fulfilling the demand.

The **challenge** lies in formulating an optimization model that effectively balances these dual objectives, possibly through multi-objective optimization techniques such as weighted objectives or hierarchical optimization. This model will inform the strategic decision-making process for determining the optimal number and locations of pick-up points, taking into account both cost-effectiveness and timeliness within the given constraints.

**Model 1 - Cost Minimization Model (MILP)**

**Objective:** Minimize the total cost, including fixed and transportation costs.

**Decision Variables:**

: The flow of goods from pick-up point i to demand area j (continuous variable).

: Binary variable indicating whether a pick-up point is established at location i.

**Objective Function:**

where is the transportation cost from pick-up point to demand area, and Fi is the fixed cost of establishing a pick-up point at location.

**Constraints:**

**Capacity Constraint:**

**Demand Satisfaction Constraint:**

**Pickup Point Number Limit:**

**Investment Constraint:**

# Model 2 - Transportation Time Minimization Model (MIP) [Based on the optimized solution of Model 1]

**Objective:**

Minimize the total transportation time using different types of vehicles for goods delivery.

**Decision Variables:**

: The number of trucks purchased at the th delivery station.

: The number of motorcycles purchased at theth delivery station.

: The number of bicycles purchased at theth delivery station.

**Objective Function:**

**Constraints:**

**Cargo Flow Constraint:**

**Daily Max Departures for Each Vehicle Type:**

Trucks:

Motorcycles:

Bicycles:

**Vehicle Purchase Constraints:**

Trucks:

Motorcycles:

Bicycles: