**Explaining Each Team Member’s Role:**

1. **Meriem – Objective Function**:  
   Your role is to define the **objective function**, which will represent the goal of our optimization problem. In our case, since we’re only focusing on traffic flow as a constraint, the objective function should aim to **minimize the total travel time** for trucks to complete their delivery route, factoring in variable traffic conditions. Traffic flow will change based on the time of day, which will make the travel times along edges (routes) dynamic. Your job is to mathematically define this objective in a way that it can be used for solving the problem.
2. **Chaima – Scientific Papers and Complexity Classification**:  
   You’re responsible for finding **scientific literature** that will help us classify our decision problem within complexity theory. Specifically, we need to figure out if our problem falls under **P, NP, or NP-Hard**. By researching papers related to the **Traveling Salesman Problem (TSP)** or **Time-Dependent TSP**, you will help us understand where our problem stands in terms of difficulty and which class of problems it belongs to. This will provide theoretical backing for our approach and help justify our decision in the deliverable.
3. **Sitienei – Solution Approaches**:  
   Your task is to explore different **solution approaches** that can be used to solve the problem we’ve modelled. Since we’re focusing on traffic flow, look into algorithms that deal with **time-dependent routing**, such as **heuristic methods (e.g., Genetic Algorithms, Simulated Annealing)** or **dynamic programming approaches**. Your role is to identify which algorithms or methods would be best suited to solve our problem efficiently, given its complexity.
4. **Me (Documentation, Dummy Graph, and Mathematical Modelling)**:  
   I will be responsible for:
   * **Documenting the process**: I'll keep track of all the decisions and progress we make.
   * **Dummy graph model**: I’ll create an **undirected graph** to represent the cities/warehouses and routes. Each edge will have a variable weight (travel time) based on traffic flow. This will be our test case to simulate the traffic dynamics.
   * **Mathematical modelling**: I’ll formalize our problem mathematically, incorporating the traffic flow constraint as the variable weight of the edges. This will serve as the foundation for the problem-solving process.

**Project Summary (First Deliverable):**

For the first deliverable, our focus is on **modelling** the problem. We are tasked with formally defining the problem and proving its theoretical properties. Here's a summary of what we need to do:

1. **Problem Definition**:  
   We are tackling the delivery route optimization problem under the constraint of **variable traffic flow**. Our goal is to find an optimal route that minimizes the total travel time for trucks traveling between cities (warehouses and depots). The roads between cities (edges) will have travel times (weights) that change depending on the time of day, simulating real-world traffic conditions.
2. **Graph Structure**:  
   The problem will be modelled using an **undirected graph** where:
   * Nodes represent **warehouses or depots**.
   * Edges represent the **routes** between them, with the weight of the edges representing **traffic-dependent travel times**.
3. **Mathematical Modelling**:  
   We’ll create a **mathematical model** that incorporates traffic flow as the main constraint. Traffic flow will be represented as a **time-varying function** that changes the weights on the edges. This will be key to the problem’s complexity and our optimization goal.
4. **Theoretical Classification**:  
   Chaima will research the complexity of our problem to classify it in terms of **P, NP, NP-Complete or NP-Hard**, likely drawing parallels with similar problems such as the **Traveling Salesman Problem (TSP) or Vehicle Routing Problem (VRP)** or its time-dependent variant.
5. **Objective Function**:  
   Meriem will define the **objective function**, which will be to **minimize the total travel time** by calculating the shortest route that adapts to varying traffic conditions along each edge.
6. **Solution Approaches**:  
   Sitienei will explore and recommend the best **solution approaches** for this problem, focusing on algorithms that handle **time-dependent routing**, such as **heuristic methods** or **dynamic programming**.

By breaking down the project like this, each member has a clear role, and the entire team is aligned toward delivering the first **modelling-focused** deliverable.

**Problem Statement:**

Given a set of cities/warehouses (nodes) connected by roads (edges) where the travel time between any two cities/warehouses varies with traffic flow (represented as a time-dependent function of the edges), and a set of items with specific collection points, can we find a delivery route for a single truck such that the total travel time is less than or equal to a given threshold T?