**Operations Research**

**NMIMS Centre for Distance and Online Education (NCDOE)**

**Internal Assignment Applicable for April 2025 Examination**

**1. An automobile manufacturing company is evaluating the expected demand for a new electric vehicle (EV) model to optimize its production plan. Due to uncertainty in market demand, the company has decided to use Monte Carlo simulation to estimate the likely range of monthly sales. Historical data suggests that demand follows a normal distribution with a mean of 1,000 units and a standard deviation of 200 units. Using random numbers, simulate the monthly sales for 10 months and compute the average sales over this period. Discuss the importance of Monte Carlo simulation in handling uncertainty in demand forecasting. Apply the simulation for the given scenario and analyze the results to suggest an optimal production plan for the EV model.**

**Answer:**

**Introduction:**

In the dynamic automotive industry, accurate demand forecasting is crucial for optimizing production and inventory management. This is especially true for electric vehicles (EVs), where market demand is influenced by factors such as government policies, consumer preferences, and technological advancements. However, uncertainty in demand poses challenges for manufacturers in determining the optimal production volume. Monte Carlo simulation, a statistical technique that models uncertainty using random sampling, helps address this issue by providing a range of possible outcomes based on historical data. In this case, demand for a new EV model follows a normal distribution with a mean of 1,000 units and a standard deviation of 200 units. By simulating monthly sales for 10 months, the company can make informed production decisions.

**This is partially solved sample answer**

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**2. You are a procurement manager for an electronics manufacturing company tasked with optimizing the transportation of raw materials from multiple warehouses to various production facilities using transportation problem-solving techniques. There are four warehouses (W1, W2, W3, W4) and five production facilities (P1, P2, P3, P4, P5). The supply and demand at each location are as follows:**

|  |  |
| --- | --- |
| **Warehouse** | **Supply (in tons)** |
| **W1** | **40** |
| **W2** | **30** |
| **W3** | **25** |
| **W4** | **35** |
| **Production Facility** | **Demand (in tons)** |
| **P1** | **30** |
| **P2** | **25** |
| **P3** | **35** |
| **P4** | **20** |
| **P5** | **20** |

**The transportation costs (in $ per ton) from each warehouse to each production facility are:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **P1** | **P2** | **P3** | **P4** | **P5** |
| **W1** | **7** | **6** | **9** | **8** | **5** |
| **W2** | **6** | **5** | **7** | **4** | **6** |
| **W3** | **8** | **7** | **5** | **6** | **4** |
| **W4** | **5** | **4** | **6** | **7** | **8** |

**Firstly, derive an initial basic feasible solution using Vogel's Approximation Method (VAM) to find the initial feasible solution for transporting raw materials from warehouses to production facilities while minimizing transportation costs. Then, use the stepping stone method to identify potential improvements in the initial solution and determine the optimal solution, providing a step-by-step analysis of the stepping stone method, including detailed calculations, improvement possibilities, and the updated allocation in the transportation table.**

**Answer:**

**Introduction:**

Efficient transportation of raw materials is critical for cost optimization in electronics manufacturing. Given multiple warehouses and production facilities, the transportation problem aims to minimize shipping costs while meeting supply and demand constraints. To achieve this, Vogel’s Approximation Method (VAM) provides an initial basic feasible solution by prioritizing allocations based on the highest cost savings. However, this solution may not be optimal. The stepping stone method is then applied to evaluate potential cost improvements by analyzing unused routes and redistributing allocations accordingly. In this scenario, four warehouses (W1, W2, W3, W4) supply materials to five production facilities (P1, P2, P3, P4, P5), with defined costs per ton. A step-by-step analysis helps determine the most cost-effective transportation plan.

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**3. You are managing a large-scale renewable energy power plant construction project. The project consists of multiple interdependent activities that must be carefully planned and executed to ensure timely commissioning of the facility. Consider the following activities and their dependencies:**

**1. Land Clearance (A)**

**2. Foundation Construction (B)**

**3. Turbine Installation (C)**

**4. Power Transmission Setup (D)**

**5. Control Room Configuration (E)**

**6. External Landscaping (F)**

**7. Final Testing and Handover (G)**

**The estimated durations and dependencies are as follows:**

|  |  |  |
| --- | --- | --- |
| **Activity** | **Duration (weeks)** | **Dependencies** |
| **A** | **2** | **-** |
| **B** | **5** | **A** |
| **C** | **6** | **A** |
| **D** | **4** | **B, C** |
| **E** | **3** | **D** |
| **F** | **2** | **D, E** |
| **G** | **1** | **F** |

**Part a: Using this data, create a project schedule to identify the earliest start and finish times for each activity. Determine the critical path for the project and calculate the total project duration.**

**Now assume activity durations follow a normal distribution with the following means and standard deviations:**

|  |  |  |
| --- | --- | --- |
| **Activity** | **Mean Duration (weeks)** | **Standard Deviation (weeks)** |
| **A** | **2** | **0.3** |
| **B** | **5** | **0.8** |
| **C** | **6** | **0.9** |
| **D** | **4** | **0.4** |
| **E** | **3** | **0.5** |
| **F** | **2** | **0.3** |
| **G** | **1** | **0.2** |

**Answer:**

**Introduction:**

Managing a large-scale renewable energy power plant construction requires precise scheduling to ensure timely completion. The project involves multiple interdependent activities, each with specific durations and dependencies. Using Critical Path Method (CPM), we determine the earliest start and finish times, identify the critical path, and calculate the total project duration. Additionally, incorporating uncertainty in activity durations through a normal distribution helps assess project risk. This analysis enables better planning, minimizing delays and ensuring efficient resource allocation for successful project execution.

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**Part b: Using the provided data, calculate the probability of completing the project in 14 weeks or less and the probability of completing the project between 13 and 15 weeks.**

**Answer:**

**Introduction:**

In large-scale renewable energy projects, managing uncertainty in activity durations is crucial for effective scheduling. Given activity durations follow a normal distribution, probabilistic analysis helps estimate project completion likelihood within specific timeframes. Using the Program Evaluation and Review Technique (PERT), we calculate the expected project duration and standard deviation. Applying the normal distribution, we determine the probability of completing the project in 14 weeks or less and between 13 and 15 weeks, aiding risk assessment and contingency planning.

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