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TMP3 Chemical Manufacturing Report

If the costs of 7,500 lbs of raw material X and 9,000 lbs of raw material Y has already been accounted for in a previous production period, then the optimal production plan would be to produce 4,500 lbs of primary product, 3,000 lbs of secondary product, and treating 1,500 lbs of liquid waste for a maximum profit of \$11,435. However, this would not be a sustainable method of manufacturing, as in future production periods, this cost will have to be accounted for. Thus, the objective function and the following results include the cost of raw materials.

Cost Analysis and Profit Contribution per Pound

The primary product (P) and secondary product K are the only profitable options, yielding a maximum profit of \$-5,710 at an optimal production level of 4,500 pounds and 3,000 pounds respectively. In contrast, secondary products M is not viable due to its high raw material and labor costs, which results in a net loss rather than a profit. Given these cost structures, producing M would reduce overall profitability, confirming that excluding it from production is the best financial decision. The profit contribution per pound \$2.49, \$0.07, \$-0.18, \$-0.25 for primary product, product K, product M, and treatment respectively affirms this conclusion.

Optimal Production Quantities and Waste Disposal Plan

The optimal production plan focuses mostly on the primary product, with an output of 4,500 pounds. The production then favors product K formation as that has the next greatest profit contribution. No production of secondary products M is recommended due to its lack of profitability. Regarding waste management, the remaining 1,500 pounds of liquid waste generated from production must be treated at a cost of \$0.25 per pound to ensure compliance with EPA regulations. This disposal method is the most cost-effective solution. Under this production and waste disposal strategy, the company achieves a projected maximum profit of \$-5,710.

Value of Additional Raw Material

Raw material Y serves as a limiting factor in production, as the entire available 9,000 pounds are fully utilized. If more raw material Y could be acquired, it might allow for increased production and potentially higher profits. This indicates that acquiring additional raw material X is unnecessary unless the production scale increases with the purchase of more raw material Y.

Sensitivity Analysis of Objective Function Coefficients

The sensitivity analysis indicates that small fluctuations in the profit per pound ($\pm \$0.10$) or treatment costs do not impact the optimal production plan. Even if the selling prices of secondary product M increases slightly, they remain unprofitable under current cost conditions. Additionally, the cost of liquid waste treatment would need to rise significantly before producing K or M becomes a more attractive alternative. These findings reinforce that the current production strategy is stable under minor cost variations.

Accountant's Recommendation to Eliminate Product K

The accountant's recommendation to eliminate product K is unsupported by the analysis. Product K production is the only other profitable product to manufacture. Eliminating product K does not alter the optimal production plan, further confirming that it is necessary under current conditions. Given the present cost structure, producing product K is the most financially sound decision and aligns with the company's goal of maximizing profit while complying with EPA regulations.

Tools, Techniques, and Skills Used

In this coding project, we utilized Python with the `scipy.optimize.linprog` library to perform optimization for determining the most cost-effective method of handling liquid waste and creating primary product. We had to learn how the function worked as well as how to set up matrices in python. The project required applying linear algebra knowledge to construct matrices representing the limiting factors and constraints of the equation. Additionally, effective communication skills were essential as we collaborated to navigate and solve a complex mathematical problem, ensuring accuracy and shared understanding throughout the process.

Challenges Faced

One of the primary challenges faced in this project was creating a formula that incorporated all the different price factors involved in the liquid waste handling process. This required careful consideration of multiple variables, such as the price of waste disposal methods, production limits, and the value of the primary product, making sure each factor was correctly represented in the optimization equation. Another difficulty was understanding how the price of the primary product was calculated, as it involved multiple steps and external data that were not immediately clear. This meant we had to spend time researching and clarifying how the pricing structure worked before including it in our model. Lastly, due to the complexity of the problem, we needed to conduct extensive testing by plugging in different sets of values to check if the final price made sense compared to the other numbers in the problem. This testing process helped us catch errors, refine our formula, and ensure that our solution was both accurate and realistic.