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DS-450

March 7, 2024

TMP4: Chemical Manufacturing Analysis

Two separate analyses were done in this project, with some similar and some different assumptions for each. In both analyses, it is assumed that the materials made available have been purchased and cannot be refunded. Based on this assumption, the costs of materials X and Y are not factored into the profit. Analysis one assumed that these products cannot be rolled over into the next production period. In other words, if 2000 units of product X are not used in this production period, they “expire” or lose their value completely at the end of this period. Analysis two includes the possibility of products being rolled over and maintaining their value through the next production period. These produced the same result. Although the main procedure only created one pound of primary product, the secondary procedures each created two pounds of secondary product. To simplify the setup, we treated the secondary processes as if they were creating only one pound of product and doubled the sale price and labor costs. Because we adjusted the final results to reflect the actual number of pounds involved, this should not have posed any issues.

This problem was set up in Excel and utilized the “Data Solver” feature. Overall profit was the objective value, and the goal was to maximize. The positive values in the equation for profit included the sum of the following: the number of pounds of primary product produced times the revenue for each pound of this product produced ($5.7), the number of pounds of product K produced times the revenue from each pound of this product produced ($1.6), and the number of pounds of product M produced times the revenue from each pound of this product produced ($1.3). The negative values in the profit equation included the sum of the following: the number of pounds of primary product produced times the labor cost for each pound of this product produced ($0.42), the number of pounds of product K produced times the labor cost for each pound of this product produced ($0.4), the number of pounds of product M produced times the labor cost from each pound of this product produced ($0.2), and the number pounds of liquid waste which received special treatment times the cost of special treatment per pound ($0.25). The fixed cost of $17,500 was also subtracted in this equation. In analysis two, we also added the number of remaining pounds of materials X and Y, multiplied by their respective values (~$1.33 and ~$0.73). Analysis one contained everything mentioned above except for the leftover materials. A screenshot of the profit formula from the secondary analysis can be seen below:

A screenshot of a computer

Description automatically generated

The constraints made sure that the number of pounds of product X used did not exceed 7500 and that the number of pounds of product Y used did not exceed 9000. The number of pounds used of material X were measured by adding the produced number of pounds of the primary product and the produced number of pounds of secondary product K. The number of pounds used of material Y were measured by adding two times the produced number of pounds of the primary product to the produced number of pounds of secondary product K. This sum for the used pounds of material X was set as a constraint to be less than 7500, while the sum of used pounds of product Y was set as a constraint to be less than 9000.

The variable values used were the number of pounds of primary product produced, the number of pounds of product K produced, the number of pounds of product M produced, and the number of pounds of liquid waste which received special treatment. With all of the required steps taken, we were able to use the data solver function to find the optimal resource allocation.

The optimal solution given in both the first and second analyses was to produce 4500 pounds of the primary product, produce 6000 pounds of secondary product K (or 3000 procedures, with each producing 2 pounds of product K), produce 0 pounds of secondary product M, and perform special treatment on 1500 pounds of liquid waste. This returns a profit of $9,485. If we adjust to account for the cost of materials X and Y with which we begin this production period, however, we find a profit of -$7,077.50. This negative profit may seem to imply that the business is not profitable, but this overlooks one key fact: If no production occurred, the total profit would be -$17,500 due to the present fixed cost. This shows that the profit we obtain is positive, but it is outweighed by the fixed cost. There are two potential ways that this business could obtain a positive return: by increasing production while keeping fixed costs the same (or relatively low), or by purchasing materials X and Y in quantities that produce better profits. For example, because product M is more profitable than product K, purchasing materials X and Y so that there is an excess of material Y rather than X would be ideal.

The accountant who recommended the elimination of product K had a good reason for concern, although his recommendation is not best in this case or some others. Because of the cheaper cost of material Y and the lower labor cost associated with product M, producing product M is preferable over producing product K for liquid waste management. Without an excess of material Y, however, the production of product K is best for liquid waste management. The profit of producing product K is approximately -$0.13, the profit of producing product K is approximately $0.37. It may seem that with a negative profit, product K would never be useful, but this cost is preferable to the cost of liquid waste treatment, which is -$0.25. So, while there is basis for his claim, this accountant is mistaken with this blanket statement.

We did run into some issues with this problem, all of which involved setting up the given information to fit the “Data Solver.” The skills needed for this project were learned in an Operations Research class, but some of the details had been forgotten and needed to be remembered. Setting up the constraints posed some challenges, but it was easily resolved. Making sure there was no leftover liquid waste was difficult, but after some time and various attempts, we managed to make it work. While the optimal resource allocation in these circumstances causes a net loss, there is likely opportunity for profit in this business.