

Team Mini Project: Chemical Manufacturing Analysis
DS450-01
Data Science Senior Capstone

Project Goal: To analyze a chemical manufacturing process to determine the most cost-effective method for handling liquid waste from a manufacturing process.

Scenario: Smith-Brown Industrial Chemicals Inc. operates a refinery on the Monongahela River in Pittsburgh PA. The company's primary product is manufactured from a chemical process that requires the use of two raw materials – material X and material Y. The production of one pound of the primary product requires the use of one pound of material X and 2 pounds of material Y. The output of the chemical process is one pound of the primary product, one pound of liquid waste material, and one pound of solid waste by-product. The solid was by-product is given to a local fertilizer plant as payment for picking it up and disposing of it. The liquid waste material has no market value, so the refinery has been dumping it directly into the Monongahela River.

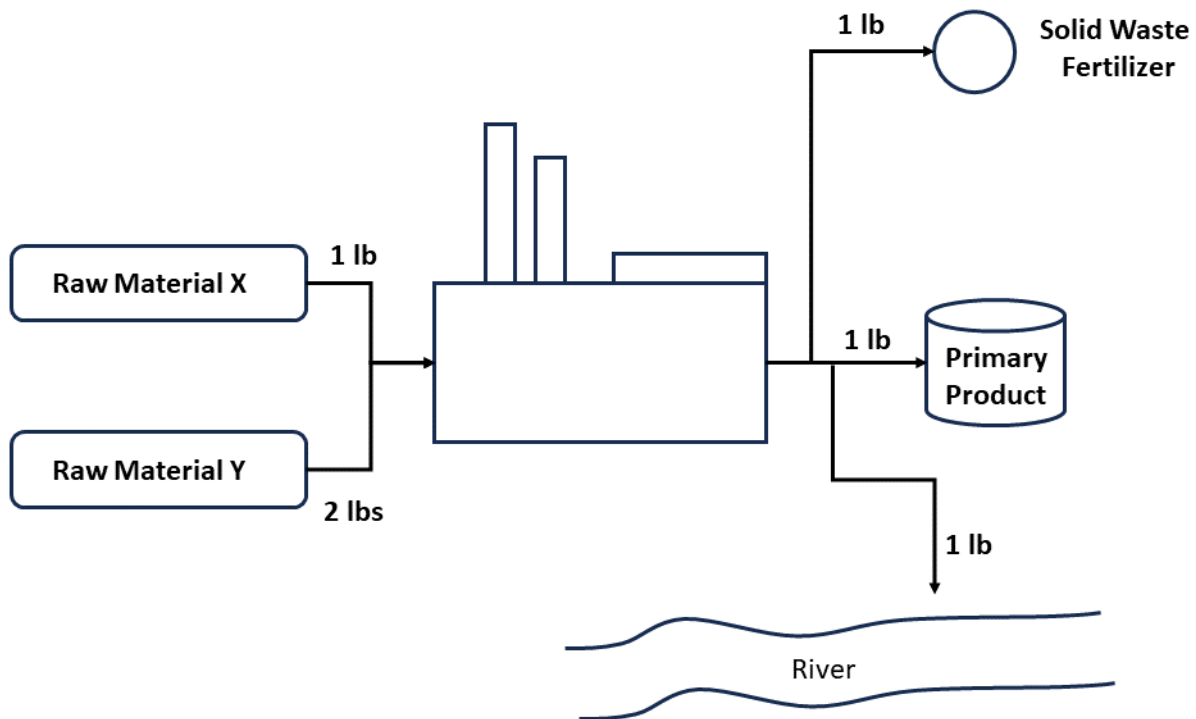


Figure 1: Manufacturing Diagram SBIC Inc.

Government pollution guidelines established by the Environmental Protection Agency (EPA) will no longer permit disposal of liquid waste directly into the river. The refinery's research group developed some alternatives for the liquid waste.

1. Produce a secondary product K by adding one pound of raw material X to every pound of liquid waste.
2. Produce a secondary product M by adding one pound of raw material Y to every pound of liquid waste.

3. Specially treat the liquid waste so that it meets pollution standard before dumping it into the river.

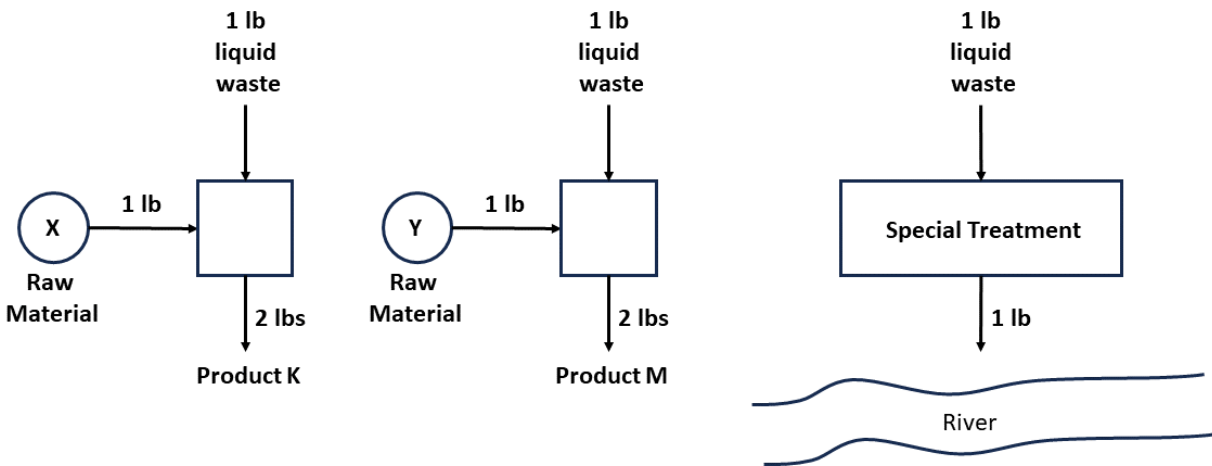


Figure 2: Liquid waste alternatives

The SBIC management knows the secondary products will be low quality and may not be profitable. However, it also recognizes that the special treatment alternative could be expensive. The problem is to determine how to satisfy pollution regulations and maintain the highest profit. Should they produce product K, product M, use special treatment or some combination of the three?

Last month, 12,000.00 pounds of the company's primary product were produced. The accounting department prepared a cost report showing the breakdown of the fixed and variable expenses that were incurred during the month.

Cost Analysis for 12,000 pounds of Primary Product	
Fixed Costs	
Administrative expenses	\$13,000.00
Refinery overhead	\$4,500.00
Variable Costs	
Raw material X	\$16,000.00
Raw material Y	\$17,500.00
Direct Labor	\$5,000.00
Total	\$56,000.00

In this cost analysis, the fixed-cost portion of the expenses is the same every month regardless of production level. Direct labor costs are expected to run \$0.20 per pound for product K and \$0.10 per pound for product M. The company's primary product sells for \$5.70 per pound. Secondary products K and M sell for \$0.80 per pound and \$0.65 per pound respectively. The special treatment of the liquid waste will cost \$0.25 per pound.

A company accountant believes that product K is too expensive to manufacture and cannot be sold at a price that recovers the material and labor cost. The accountant's recommendation is to eliminate product K as an alternative.

For the upcoming production period, 7500 pounds of raw material X and 9000 pounds of raw material Y will be available.

Instructions: Based on the information provided in the Overview, develop an approach to this problem that will allow the company to determine how much primary product to produce, given the limitations on the amount of raw material available. Include recommendations as to how the company should dispose of liquid waste to satisfy the EPA. How many pounds of product K should be produced? How many pounds of product M should be produced? How many pounds of liquid waste should be specially treated and dumped into the Monongahela River? In your analysis, ensure you include the following:

1. A cost analysis showing the profit contribution per pound for the primary product, product K, and product M.
2. The optimal production quantities and waste disposal plan, including the project profit.
3. A discussion of the value of additional pounds of each raw material.
4. A discussion of the sensitivity analysis of the objective function coefficients.
5. Comment on the accountant's recommendation to eliminate product K as an alternative. Does the recommendation appear reasonable? What is your reaction to the recommendation? How would the optimal solution change if the product K were eliminated?

The output for this project should be:

- A report with your analysis/recommendation(s). In your report also reflect on the tools, techniques and skills that were necessary to complete this project. What existing techniques and skills did you already have? What new skills did you need to obtain. What were the challenges for completing this project.
- All analysis files/scripts you used to perform your analysis.
- A five to seven-minute video presentation of your report. All members of your team should be in the video. *Use a narrated PowerPoint to generate the video and upload it on video.bellarmine.edu. Include a link to the video in your README.md file under the heading **Chemical Manufacturing Analysis**.*

Submission: Create a new directory in your git repository of this project and put all your project files in that directory. Upload a link to your GitHub repository in the area provided on Moodle by the deadline specified.