DSO 545: Midterm

Case: Building Applichem's Information System Infrastructure

The Unpleasant Meeting

Steve Chu, Vice President of Research and Engineering, came out of the meeting with Richard Ellison, Chairman of the Board, and Joseph Dunn, CEO of Applichem, fuming because he had been made the scapegoat of stagnation in the company performance and lack of information system (IS) infrastructure. A recent study by the board has highlighted various problems in the company, which were discussed in detail in the meeting. They were still resonating in his head:

1. Complacent management at existing plants.
2. Huge time delay in obtaining manufacturing information from the existing plants and databases because all plants are "silos" and the database operator has to download the information through manual queries, summarize the results, and send them to the head office.
3. Production at each plant is done almost independently without taking into account other plants' capacities and exchange rates.
4. Fluctuating exchange rates between countries affecting profitability.

He has been given a one-month time frame to come up with an implementable IS infrastructure plan. Steve Chu immediately reached out to his friend Tim Wright at Trojan Business Intelligence Consulting to study the problems and come up with an implementable IS infrastructure plan. Tim Wright has done outstanding work in the area of business intelligence (BI) and in merging data sources, improving IT capabilities, and re-engineering processes.

Steve Chu wants to use Tim Wright and his plan as a driver of organizational transformation, and to realize the lofty goal of making Applichem a real-time, agile corporation.

Nevertheless, Steve realizes that many challenges remain. The IT staff under his leadership is still learning how to develop technology in cooperation with business users. The "silo" nature of the current database structure has not benefited the company. After multiple discussions with Tim Wright, Steve has been able to understand the need for business intelligence tools and why this is a necessary but not insufficient resource to move Applichem forward.

Steve Chu has given Tim Wright unfettered access to all levels of management and has asked all the four plant managers to provide access to their databases. Chu has also asked Wright to build an executive-level dash board for the CEO so that he can make informed decisions.

Tim Wright's Initial Findings

Tim Wright's discussion with Applichem's plant managers helped him to understand that it is a manufacturer of specialty chemicals and their flagship product is Release Ease, specialty chemical manufactured at each Applichem plant, which it sells to its existing customer base directly.

They have four manufacturing plants in four regions of the world—North America, Europe, Latin America, and the Pacific and the rest of the world.

Exhibit 1: Plants

Region	Name of the Plant
North America	Gary
Europe	Frankfurt
Latin America	Mexico
Pacific & rest of the world	SunChem

The Release Ease specialty chemical can be shipped from the four plants to four major markets (the four regions are the four major markets). Currently, each plant is serving its own region, and the plants are not running at full capacity. The plants have capacity constraints, and the amount to be produced at each plant depends on raw material cost, operating cost, shipping cost, and exchange rate.

From each plant, the following information is gathered daily and is stored in the local database:

Exhibit 2: Variables

Number	Raw Variables
1	Date
2	Plant
3	Number of Workers Direct
4	Number of Workers Indirect
5	Labor Cost of Indirect Labor (in local currency)
6	Labor Cost of Direct Labor (in local currency)
7	Plant Output (in million pounds of Release Ease chemical)
8	Plant Raw Material Used (in million pounds)

Tim Wright's Preliminary Conclusion

For successful operation of Applichem, the scattered information has to be consolidated, and the top management should get the relevant key performance indicators (KPIs) on the fly; the unstructured data is hard to understand, and manual queries are resulting in huge delays in decision making. The current raw data is not integrated and thus is not actionable; it does not provide any business insights nor trends and patterns. For management to improve the operations of the plants and operate them efficiently it has to convert the data into actionable form and structure the data into meaningful form, so that management can obtain meaningful KPI, understand the patterns and trends, maximize the utilization rates of the plants, and maximize profit for the company.

Designing Key Performance Indicators (KPIs) for Applichem

Business intelligence[3] is based on the philosophy that "what gets measured, gets done," and BI capabilities are often described in terms of key performance indicators, or KPIs. KPIs are more than just measurements; they are measurements that embody strategic objectives. They help executives to evaluate performance but also to communicate strategic and tactical goals to their departments. For IT, the challenge was figuring out how the data could be collected, but for the project's business participants an equally important question was what ought to be measured, and when the data need to be available.

Tim Wright wants to show the management what can be done with integration of data and with appropriate KPIs and charts, so that the plant managers and executive management can be empowered to make informed decisions. He has come up with the following KPIs and charts that will help the company to get business insights and make informed decisions.

Of the several KPIs implemented to date, four in particular represent important milestones in the evolution of the business intelligence project, as follows.

KPI 1 = Cost per Thousand Pounds of Release Ease Produced

One of the most important KPIs for manufacturing companies is cost per unit produced (CPP). It is simple division—the total cost per plant divided by the amount of Release Ease produced. The challenge is to get the right time period for calculating it. Different levels of management will need different time period calculations, and executive management will want this number in a common currency (USD) for easy comparison.

KPI 2 = Average Output (in thousand pounds of Release Ease) per Time Period

Applichem has known for a long time that the production capacities at its plants are affected seasonally due to various factors. Quantifying these factors will help them to better plan and meet the demand internationally rather than meeting the demand locally. Again, it is simple division—the output per plant divided by the given time period. The challenge is to get the right time period for calculating it, and because different levels of management will need different time-period calculations, having a time-series plot of the four plants will help them to understand the seasonality effects.

KPI 3 = Average Output (in thousand pounds of Release Ease) per Worker

Applichem's plants at different locations do not have the same efficiency rate. Some are labor intensive and some are not. Also, there are two types of workers in each plant—direct and indirect workers. Quantifying the output per worker will help the plant managers to plan scheduling better and meet demand without delays. Once again, it is simple division—the output per plant divided by the number of workers in a given time period. The challenge is to get the right time period for calculating it, and because different levels of management will need different time-period calculations, having a time-series plot of the four plants will help them to understand the seasonality effects.

KPI 4 = Average Input (in thousand pounds of raw materials) per Time Period

Since Applichem plants at different locations do not have the same production efficiency rate, quantifying these factors will help them to better plan sourcing of raw materials and to meet the demand internationally. It is simple division—the input per plant divided by the given time period. The challenge is to get the right time period for calculating it, and because different levels of management will need different time-period calculations, having a time-series plot of the four plants will help them to understand the seasonality effects.

The following table (see **AdditionalInfo.csv**) contains information that might be useful in your case analysis.

Plant	Exchange Rate in 2010 (for 1USD)	Cost of Raw Material in USD per one thousand pounds of raw materials	Operating Cost (Excluding Labor) in USD per one thousand pounds of Release Ease produced
Mexico	12.645	700	110
Frankfurt	0.755	530	90
Gary	1.000	608	150
Sunchem	87.829	918	400

The actual cost is approximated by summing the cost of raw material, labor cost, and operating costs.

Questions:

1. Import the data.

2. Upload ggplot2 and dplyr packages. Upload any other package you will need for this Case.

3. What is the daily average number of workers in the data set? Hint: **total number of workers = Number of Workers Direct + Number of Workers Indirect**

4. On how many days does the number of indirect workers exceed the number of direct workers?

5. Create three new columns **Labor_Cost _Direct_ USD**, **Labor_Cost _Indirect_USD** and total daily **Labor_Cost _USD** and add them to the table.

   Labor cost in USD = Labor_Costs in local currency / Exchange Rate (for appropriate region), where Exchange rates are in AdditionalInfo.csv

6. Create three column **Labor_Cost_Per_Worker_USD**, **Labor_Cost _Indirect_Per_Worker_USD**, and **Labor_Cost _ Per_Worker_USD** add then to the data table.

7. Create a table that show: **Average_Labor_Cost_ Per_Worker_USD**, **Minimum_Labor_Cost _ Per_Worker_USD** and **Maximum_Labor_Cost_Per_Worker_USD** in each plant.

8. Create side-by-side boxplots that show/compare/contrast daily labor cost in USD in each plant.

9. Create a scatterplot that shows the relationship between **Output** and **Input**. Include categorical variable plant in the scatterplot by coloring points using 4 different colors to represent 4 different plants.

Use the following KPI 1 definition to answer questions 10 – 12

KPI 1 = Cost per Thousand Pounds of Release Ease Produced

One of the most important KPIs for manufacturing companies is cost per unit produced (CPP). It is simple division—the total cost per plant divided by the amount of Release Ease produced. The challenge is to get the right time period for calculating it. Different levels of management will need different time period calculations, and executive management will want this number in a common currency (USD) for easy comparison.

10. Create a column **Raw_Material_Cost_USD**, that shows Cost of Raw materials in USD per 1,000 pounds of raw materials:

    Raw Material cost in USD per one thousand pounds of raw materials = RawMaterial_Used * 1,000 * Cost of Raw Material in USD per one thousand pounds of raw materials (for appropriate plant)

11. Create a column **Operating_Cost_USD** that shows Operating Cost (Excluding Labor) in USD per one thousand pounds of Release Ease produced:

Operating Cost in USD per one thousand pounds of Release Ease produced = Outputs * 1,000 * Operating Cost (for appropriate plant)

12. Create a column called **Total_Cost** that that represents the sum of RawMaterial (Question 10), Labor (Question 5) and Operation costs (Question 11)

Total_Cost = (RawMaterial_Used * 1,000 * Cost of Raw Materials (for appropriate plant))

+ ((Labor_Costs_Direct + Labor_Costs_Indirect) / Exchange Rate (for appropriate region))

+ (Outputs * 1,000 * Operating Cost (for appropriate plant))

13. Create a column called **KPI 1, Cost per Thousand Pounds of Release Ease Produced:**

KPI 1 = Total_Cost / (1000*Output)

14. Create a column that shows month and call it **Month**.

15. Create a table that shows monthly totals of KPI 1 in each month for each plant.

16. On one graph plot 4 trajectories that correspond to 4 plants that show daily average cost in each month. Which plant consistently has the lowest cost? Which one has the highest cost?

17. Consider the total outputs (in thousand pounds of Release Ease product) for each plant during each month of 2010.Create a line graph of monthly totals for a production for each plant separately. **Extra credit part:** On each graph add a layer of points and color them using green color for a point that corresponds to the value below annual monthly average and red color if monthly total is lower than annual monthly average total.

18. What insights can be obtained from the dashboard that you've c reached? Do see any pattern?