Case Assignment #1: Building Applichem's Information System Infrastructure

(This case is adapted from the "Applichem (A) (Abridged)" HBS Case 9-694-030)

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.

Teaching the plant managers the elements of the business intelligence tools

Tim Wright's next task was to educate plant managers and upper management in the elements of business intelligence tools and make them realize the importance of BI tools in Applichem. As part of the training, he collected the following information and presented it to management.

Data Warehouse

"A subject-oriented, integrated, time-variant, and non-volatile collection of data in support of management's decision-making process" (Inmom, 1993).

- Subject Oriented: A data warehouse is organized around high-level business groupings called subjects.
- Integrated: The data in the warehouse must be integrated and consistent. That is, if two different source systems store conflicting data about entities, or attributes of an entity, the differences need to be resolved during the process of transforming the source data and loading it into the data warehouse.
- Time Variant: One of the key characteristics distinguishing warehouses from operational environments is the currency of the data. Operational systems require real-time views of the data. Data warehouse applications generally deal with longer-term, historical data. They can also provide access to a greater volume of more detailed information, as required, over the longer time period.
- Non-Volatile: The contents of online transaction processing (OLTP) systems are, by their nature, continuously changing. Inserts, deletes, and updates form the basis of a large volume of business transactions that result in a very volatile set of data. By contrast, data warehouses are static. The data in the warehouse are read-only; update or refresh of the data occurs on a periodic incremental or full-refresh basis.

Star Schema

A star schema consists of fact tables and dimension tables. *Fact tables* contain the quantitative or factual data about a business—the information being queried. This information is often numerical, additive measurements and can consist of many columns and millions or billions of rows. *Dimension tables* are usually smaller and hold descriptive data that reflect the dimensions, or attributes, of a business. Structured Query Language (SQL) queries then use joins between fact and dimension tables and constraints on the data to return selected information.

Fact and dimension tables differ from each other only in their use within a schema. Their physical structure and the SQL syntax used to create the tables are the same. In a complex schema, a given table can act as a fact table under some conditions and as a dimension table under others. The way in which a table is referred to in a query determines whether a table behaves as a fact table or a dimension table.

Even though they are physically the same type of table, it is important to understand the difference between fact and dimension tables from a logical point of view. To demonstrate the difference between fact and dimension tables, consider how an analyst looks at business performance:

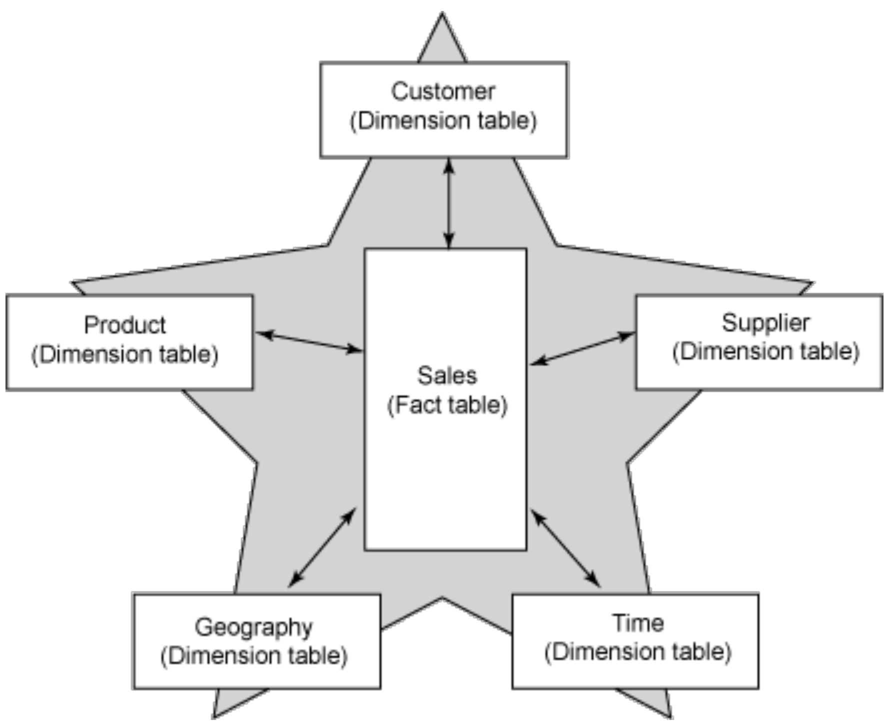
- A salesperson analyzes revenue by customer, product, market, and time period.
- A financial analyst tracks actuals and budgets by line item, product, and time period.
- A marketing person reviews shipments by product, market, and time period.

The facts—what is being analyzed in each case—are revenue, actual, budgets, and shipments. These items belong in fact tables. The business dimensions—the *by* items–are product, market, time period, and line item. These items belong in dimension tables.

For example, a fact table in a sales database, implemented with a star schema, might contain the sales revenue for the products of the company from each customer in each geographic market over a period of time. The dimension tables in this database define the customers, products, markets, and time periods used in the fact table.

A well-designed schema provides dimension tables that allow a user to browse a database to become familiar with the information in it and then to write queries with constraints so that only the information that satisfies those constraints is returned from the database.

Exhibit 3: Sample Star Schema



Extract, transform, load (ETL) tools

Data from diverse sources are "cleaned," rendered consistent, and loaded into the data warehouse by means of an ETL tool.

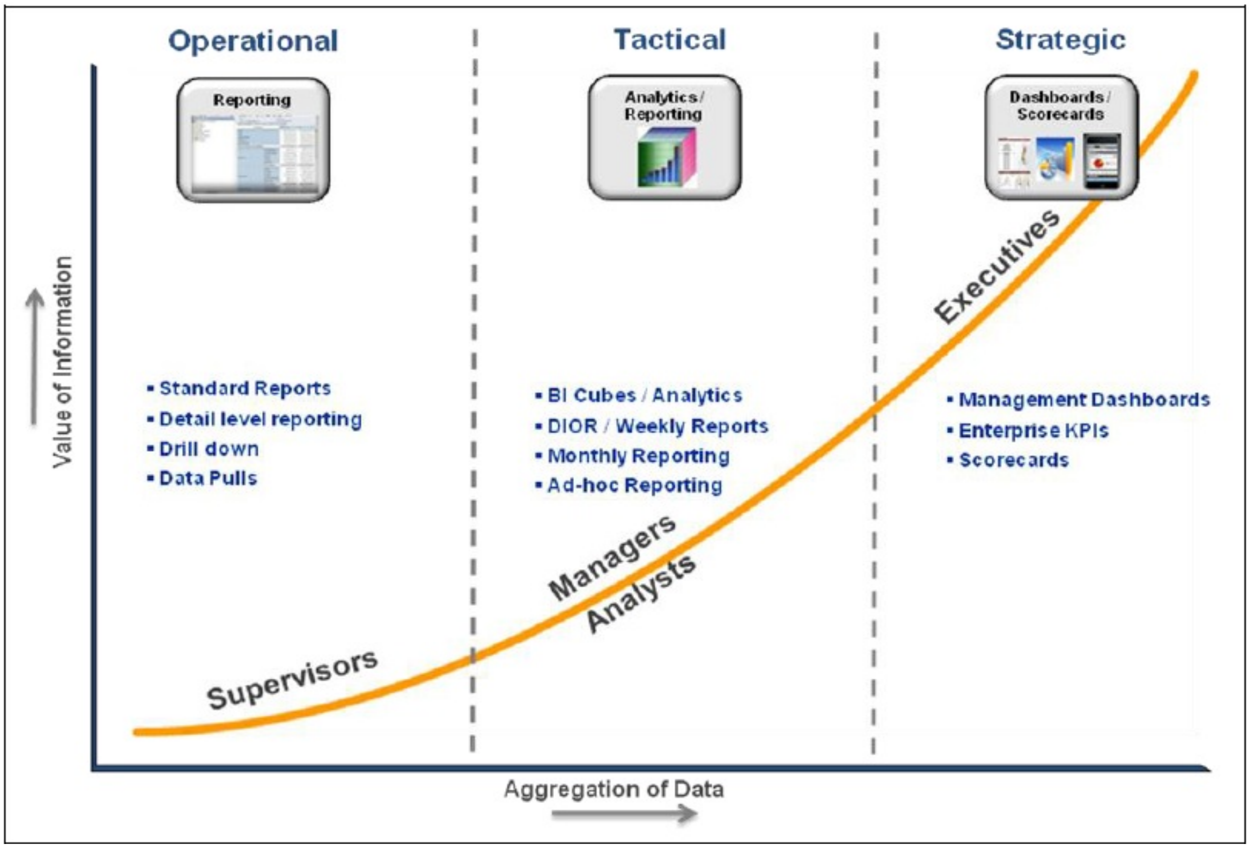
Reports, Dashboards, Scorecards, and Alerts[1]

From the point of view of most business users, business intelligence is about asking business questions and getting timely answers. There are a number of "interfaces" by which BI can satisfy their needs. Reports can be daily, weekly, monthly, or on-demand documents that provide information in a pre-defined format. Dashboards and scorecards represent simple interfaces that allow users to monitor a small set of key performance indicators (KPIs) in near real time via a computer screen, Web page, or mobile device. Alerts are software programs that monitor KPIs and send an e-mail or some other kind of message when a condition is met, such as a KPI falling below acceptable levels.

Analytics/Cubes[2]

In addition to pre-defined reports, dashboards, scorecards, and alerts, business users also need to be able to ask one-off, "ad hoc" queries of the data, and receive answers on the fly. Some of the tools for this include data marts and online analytical processing (OLAP) cubes, bounded subsets of data prepared for specific types of questions, which can be queried much faster than the entire data warehouse. Power users and professional analysts have always demanded these capabilities, but the trend in BI software design is to try to make them more accessible to common users. Reports, dashboards, scorecards, alerts, and analytics interfaces like OLAP cubes serve different goals for different users. They may serve operational, tactical, and strategic purposes for everyone from line managers to executives, casual users to professional analysts.

Exhibit 4: The BI continuum



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.

A. 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.

B. 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.

C. 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.

D. 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 contains information that might be useful in your case analysis.

Yearly Average Exchange Rates for 1 USD			
Country	**Currency**	**2010**	**2009**
Euro Zone	Euro	0.755	0.719

Cost of Raw Material in USD per one thousand pounds of raw materials	
Country	**Cost**
Mexico	700

Operating Cost (Excluding Labor) in USD per one thousand pounds of Release Ease produced	
Country	**Cost**
Mexico	110

Japan	Yen	87.829	93.617
Mexico	Peso	12.645	13.518

Frankfurt	530
Gary	608
Sunchem	918

Frankfurt	90
Gary	150
Sunchem	400

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

Case Questions (70 Points) [Please complete part 1 through 7 individually. If your team is assigned case I, also finish part 8 in team.]

1. (10 points) For KPI #1 (Cost per Thousand Pounds of Release Ease Produced), provide the following information:
    a. A pivot table showing the average value of the KPI in each month of the year
    b. Does the average cost change over across different months?
    c. Are there differences in the cost across the four plants? Which plant consistently has the lowest cost? Which one has the highest cost? Show a plot of the average cost over time for each plant.

2. (10 points) For KPI #2 (Average Output per Time Period), provide the following information:
    a. A pivot table showing the average value of the KPI in each month of the year
    b. Does the average output change over across different months?
    c. Are there differences in the average output across the four plants? Which plant consistently has the lowest output? Which one has the highest output? Show a plot of the average cost over time for each plant.

3. (10 points) For KPI #3 (Average Output per Worker), provide the following information:
    a. A pivot table showing the average value of the KPI in each month of the year
    b. Does the average output per worker change over across different months?
    c. Are there differences in the average output per worker across the four plants? Which plant consistently has the lowest output per worker? Which one has the highest output per worker? Show a plot of the average cost over time for each plant.

4. (10 points) For KPI #4 (Average Input per Time Period), provide the following information:
    a. A pivot table showing the average value of the KPI in each month of the year
    b. Does the average input change over across different months?
    c. Are there differences in the average input across the four plants? Which plant consistently has the lowest input? Which one has the highest input? Show a plot of the average cost over time for each plant.

5. (10 points) As we have done in the lab, create a KPI Chart (aka Radar Chart) showing the average of the 4 KPIs for each of the plant. For graphing purposes, you might want to rescale the values so that all four KPIs have comparable magnitude.

6. (10 points) Consider the total outputs (in thousand pounds of Release Ease product) for each plant during each month of 2010.

    a. Create a Dashboard in Excel for a production manager showing the Trendline and Above-Below Average Sparkline Charts Your dashboard should indicate the movement of each data point using Conditional Formatting in Excel, using appropriate icon set.
    b. What insights can be obtained from the dashboard that you've created? Do see any pattern?

7. (10 points) Tim Wright has decided to create a Star Schema with 1 FACT table containing data about the outputs, inputs, raw materials, and wages. He has determined that Applichem should create 3 DIMENSION tables: Plant Dimension, Time Dimension, and Worker Dimension. Based on the case information, what variables would you put in each of the three DIMENSION tables?

8. Possible extension for team analysis. Please choose one of the following topics to extend the analysis.
    a. What other solutions are possible to overcome the IT infrastructure problem and Company lack of communication culture.
    b. Based on the data set, besides the current KPIs, do you recommend any other measure that will get valuable information from the data?

Conclusion:

Gathering and integrating data from this "extended enterprise" to create a successful business intelligence infrastructure is no easy task, and it has been an ongoing technical challenge. It is also an organizational challenge, as the control of information is intimately tied up with decision-making authority. For the first time, Applichem has realized the importance of information system infrastructure. Building a proper IS infrastructure with an appropriate business intelligence decision-making tool will help them to realize their hidden strengths and weaknesses and to optimize their resources and maximize the value of their firm.

Reference:

1. Joseph Clark. "Business Intelligence at Guthy-Renker: The Promise and Challenges of Sensing the Pulse." V 1.2. Los Angeles: Marshall School of Business, 2010, P. 14.
2. Joseph Clark. "Business Intelligence at Guthy-Renker: The Promise and Challenges of Sensing the Pulse." V 1.2. Los Angeles: Marshall School of Business, 2010, P. 15.
3. Joseph Clark. "Business Intelligence at Guthy-Renker: The Promise and Challenges of Sensing the Pulse." V 1.2. Los Angeles: Marshall School of Business, 2010, P. 19.