BUSINESS INTELLIGENCE FOR A SUPPLY CHAIN MANAGEMENT SYSTEM

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ABSTRACT

Business intelligence is becoming more necessary for supply chain managers to make good decisions. Because software tools are becoming less expensive, it is more practical to set up analysis capabilities for supply chain information, but there is little available guidance on how to design these capabilities. Therefore we present an example based on real supply chain software that illustrates a worthwhile approach.

Keywords: Information Systems, Business Intelligence, Supply Chain Management

INTRODUCTION

Business Intelligence (BI) is a relatively new term for the development of knowledge about the enterprise. BI systems typically support querying, reporting, and multidimensional analysis of company data. It could be considered a performance management framework that helps companies set their goals, analyze their progress, gain insight, take action, and measure their success. BI is especially relevant to management of supply chains, an issue that has become increasingly important in commerce [2, 3, 8]. Because there is little available guidance on how to set up business intelligence capabilities for supply chain management, this paper presents a practical approach based on an application to a real supply chain.

Organizations often employ BI tools to assess the business environment in ways such as marketing research [4], competitor analysis [1], business process reengineering [6], and customer relationship management [5]. In this paper we are interested in using BI to assess performance of an organization, specifically with respect to supply chain issues.

There are more than two dozen commercial tools for business intelligence, some of which are appropriate for supply chain management [9]. For example Ottawa-based Cognos is an industry leader, and they address performance measurement, the focus of this paper [7].

Some organizations have hesitated to develop BI systems because of the high cost and complexity of software tools. For example, a recent study found the average 3-year cost of a Cognos deployment was almost $1 million, including the costs of software licenses, software maintenance, consulting, personnel, and training [7].

Recently lower cost alternatives have become available. For example, the project reported here employed the BI tools built in to SQL Server 2005. To a company who uses this database management software already, there is little marginal cost for employing the BI features and no need to buy a separate BI software package.

Because products like SQL Server 2005 can be provided to students at very low cost, university professors should consider including BI in the computer information systems curriculum. One can see from the example reported here that it is not very complex to set up a BI system that illustrates the main concepts and could provide real value to a company.

EXAMPLE SYSTEM

For this project we wanted an example system whose database would be available to us to add BI. We chose software from Balanced Flow, LLC that manages a supply chain. This software is produced by a small company building upon concepts developed in DoD-funded projects at Clemson University. One of its applications is a supply chain providing uniforms to the U.S. armed forces that involves manufacturers, distribution centers, and retailers. For brevity, we consider the business intelligence needs of only one of the participating firms—a manufacturer.

The Balanced Flow software supports managing a supply chain on a days-of-supply basis. Each participating firm decides on an appropriate target level for days of supply for their inventories. This decision is influenced by factors such as their confidence in the forecast and in the variability of lead times for suppliers. The software recommends

what to make (for manufacturers) or order (for distribution centers and retailers) to maintain the specified days of supply. There are features for exchanging information among firms in the supply chain to help keep overall supply chain inventories balanced. For example, if the supply chain handles apparel, the software avoids large differences in days-of-supply for the various styles and sizes.

The overall business intelligence question for a particular firm such as a manufacturer is "how well are we doing?" The Balanced Flow software does not provide a satisfactory answer. Every time it runs, it reports the current status, but there is no provision for analyzing trends or for doing any analysis over time. Therefore there is not a satisfactory way to evaluate performance or to decide whether system parameters such as the target days-of-supply need to be changed.

PERFORMANCE INDICATORS

One of the difficulties in getting started is determining what information is useful and relevant to a decision. BI solutions at the enterprise level are charged with collecting and reporting a company's most important metrics, sometimes called key performance indicators (KPIs).

For a manufacturer in a supply chain, performance indicators include measures of stock outages and measures of balance. Compare the situations in Figure 1, showing stock outages and imbalance, and Figure 2, showing no stock outages and good balance. In the figures the lower level dark bars represent inventory on hand, the middle light colored bars are work-in-process, and the upper dark bars are production orders already released. The black horizontal line represents the target inventory level, 30 days-of-supply. Figure 2 shows a more desirable situation, but in Figure 1 several items are below zero (back ordered) and the overall height of some of the bars is well above the target level while some are below.

We could set up performance measures as follows. For stock outage we could compute the percentage of items having a stock outage. For balance we could compute the number of items whose virtual on hand (actual on hand plus work-in-process plus released production orders minus due-outs) is within certain percentages of the target. For example we could count how many items have virtual on hand up to 5% less than the target, 10% less than the target, etc

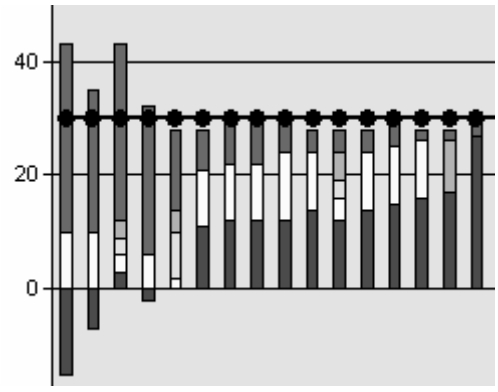

Figure 1. Example of Unbalance Among SKUs

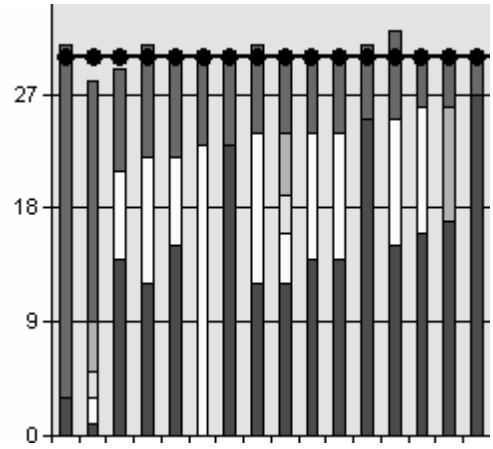

Figure 2. Example of Balance Among SKUs

DATA STRUCTURE

Because a company's supply chain management systems generally focus on operational control of supply processes the databases of these systems are not suitable for supporting business analysis, especially when the analysis requires compiling data from multiple data sources.

To overcome the limitations of operational systems, a company may gather data from their operational systems and store it in a collective repository called a data warehouse that is designed to support BI.

For this project we employed a data warehouse, because the main database was not designed to store time-varying data. We set up the database to handle multiple firms in a supply chain, although here we are discussing a single firm. We adopted a star schema that is typical for databases supporting BI

systems (Figure 3). In the middle is a fact table that is surrounded by dimension tables. (Thus such a schema is sometimes called a snowflake.) In this case the fact table stores summary information about the firm. Specifically, it stores summary information about the stock keeping units (SKUs). Dimension tables include the following: Date, Firm, SupplyChain. The purpose of the star schema is to support fast queries and analyses that would be slower if applied to normalized data in the original system database.

This rather simple schema is sufficient to support many useful BI features. For example a manager could ask to see for a selected moment of time the percentage of SKUs having a stock outage (PctSkuStockOut). Also a manager could ask to see these values during a specified period of time. Similarly a manager could see the percentage of SKUs that were a specified percentage below the target level (PctSkuVirtualOnhand_0_to5_PctBelowTgt), either at a specific time or during a period of time. Using queries like these can help identify trends that call for management action. They can help determine aspects of the performance of the supply chain.

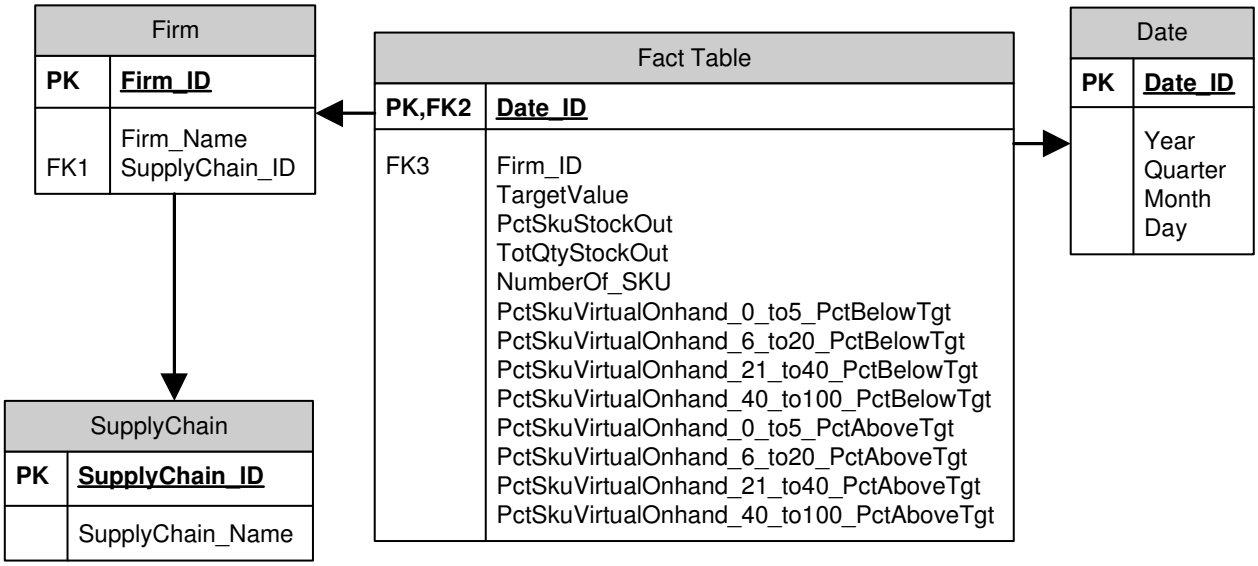

Figure 3. Star Schema for Data Warehouse

SYSTEM DEVELOPMENT

We used new business intelligence features of Microsoft SQL Server 2005. To extract data from the original supply chain management system and put it into the star schema (Figure 3), we used SQL Server 2005 Integration Services that can import, export and transform data. The first step is to graphically outline the data extraction and conversion.

Next we created a cube using Analysis Services. A cube is a star shaped schema that facilitates analysis.

After connecting to the database, we created the data source view, which is very similar to our star shaped schema. A wizard allows us to select tables we are interested in working with. Then a cube wizard allows us to specify facts and dimensions. In our example a fact is a column (other than foreign keys) of our main table "Firm." A dimension is a measure such as "Date" that may be used in analysis to identify trends or to do classifications. The facts are also called measures. One may define measure groups of related measures.

A time dimension is a special one in SQL Server. The Business Intelligence Wizard allows defining this dimension and associating it with a table, the Date table in this project.

SQL Server allows defining key performance indicators (KPIs) by specifying for each four values:

Value Expression, Goal Expression, Status and Trend. We defined several associated with the aforementioned measures in our star schema. SQL Server supports sophisticated reporting of KPIs in ways such as the "traffic light." For each KPI a report could show a traffic light whose color represents the status (where green means satisfactory).

Finally, we used the Reporting Services designer that is hosted in the Business Intelligence Development Studio, to develop reports. This designer works much like the one provided by Microsoft Access that is familiar to most information systems professionals.

Access to a report can be fine-tuned for specific groups or users by creating item- level roles that grant different permissions to different users. Roles define what item-level actions and permissions a group of users is allowed. This includes permissions to manage a report's history, subscriptions, data sources, folders and security.

CONCLUSIONS

The BI tools in SQL Server are certainly appropriate for supporting the needs of many companies. In particular they are appropriate for supporting supply chain management. Because they are easily available to students and not difficult to learn, they are appropriate for students in information system courses.

One of our difficulties was the lack of detailed guidance on the business intelligence features. However, this problem will be resolved when new books are available.

If a company or an academic department already has SQL Server 2005, then the marginal cost and marginal difficulty of installing and learning BI is very low compared to acquiring a separate BI software package.

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