CORPORATE MODELING WITH DSS AND ERP SYSTEMS

In recent years, corporate modeling within business organizations has moved from standalone database applications to integrated and flexible enterprise wide information systems. Computer modeling and planning tools such as management information systems (MISs) and decision support systems (*DSSs*) are widely used by corporate management to select alternatives based on key performance measures. The ability of DSS to model the real world systems and to predict system performance relies heavily on the capabilities of the model base of the DSS.

Each DSS is built primarily to optimize a particular business problem such as inventory ordering policy, job scheduling, or production planning. A typical supply chain system might involve more than one business operation and therefore require the development of multiple DSSs. Often, no link exists between the corporate DSS applications used by different departments. Data within each of these applications are confined to departmental or functional boundaries, rather than being integrated to be used by multiple users for multiple purposes and at multiple places (1). This lack of data collaboration and integration between business processes and functions has limited the organization's capability to evaluate the operational problems globally, which affects the competitiveness of the organization in the marketplace.

DECISION SUPPORT SYSTEMS (DSS)

Information system applications can be broadly classified into transaction processing and decision support. Transaction processing systems are used in almost all companies to store information about their daily activities. Using these systems, companies have accumulated huge amounts of data that can be used for making business decisions. A DSS deals with the design and use of computerized systems to assist managers in making more effective decisions concerning different tasks based on the accumulated data, such as inventory management. It is not practical to manually perform the classifications each time a decision has to be made. Therefore, a DSS is needed that has the ability to perform the calculations on its own whenever a change occurs.

Fundamentals of DSS

The basic components of a DSS include (1) Database Management Module, 2) Model Management Module, and 3) User Interface Module. The schematic representation of a DSS is shown in Fig. 1 along with direction of the data flow.

The database is the most important part of a decision support system, as all models developed use these data to generate decisions. The database can be accessed using a user interface module that is usually in the form of screens or forms. A database management system (*DBMS*) consists of a database and a set of programs to access the data in the database.

The model management module consists of algorithms that need to be executed to perform the analysis. The advantage of using a DSS is that it is capable of integrating data access and decision models. The database acts as an integration and communication mechanism between models. Both the model management module and the user interface module have access to the database. The results generated by the model management module can be viewed using the user interface module.

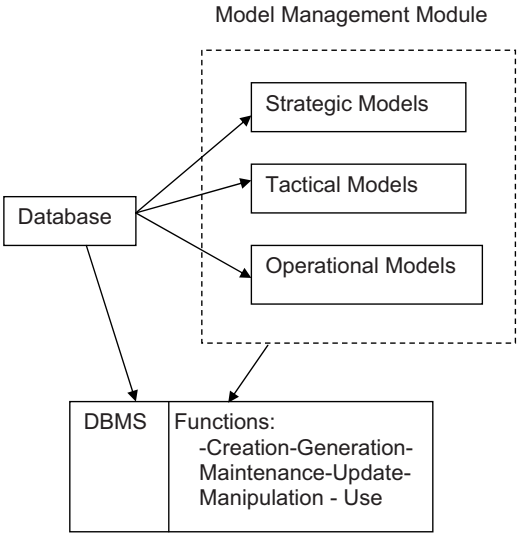

Figure 1. Components of DSS.

Material Requirement Planning (MRP) and Manufacturing Resource Planning (MRP II) Applications

Early business applications of DSS focus on MRP and MRP II. MRP is an inventory control technique that uses bills of materials, inventory, expected receipts, and a master production schedule to determine material requirements. The first MRP system was introduced in the 1960s. It brought innovational revolution to manufacturing and inventory management. In the 1970s, modern MRP systems emerged and strengthened several functions such as Master Production Scheduling (*MPS*) and Material and Capacity Planning (*MCP*), which are used to decide what, when, and where to make products based on forecasted demand and current inventory.

In the 1980s, the scope of MRP was expanded to integrate MRP with order processing, shop floor scheduling, and resource planning, including personnel and machine utilization analyses. These newer systems are called MRP II. Although the basic method used to generate MRP is the same, a typical MRP II system can also convert information from MRP into specific work schedules on the shop floor, evaluate workloads and capacity utilization, and generate shipping documents. The framework of an MRP II system is shown in Fig. 2.

CHARACTERISTICS OF ENTERPRISE RESOURCE PLANNING (ERP) SYSTEMS

The ERP system is a new form of corporate modeling that does the same thing as traditional DSS, but it is not confined to the boundaries of business applications. The intro-

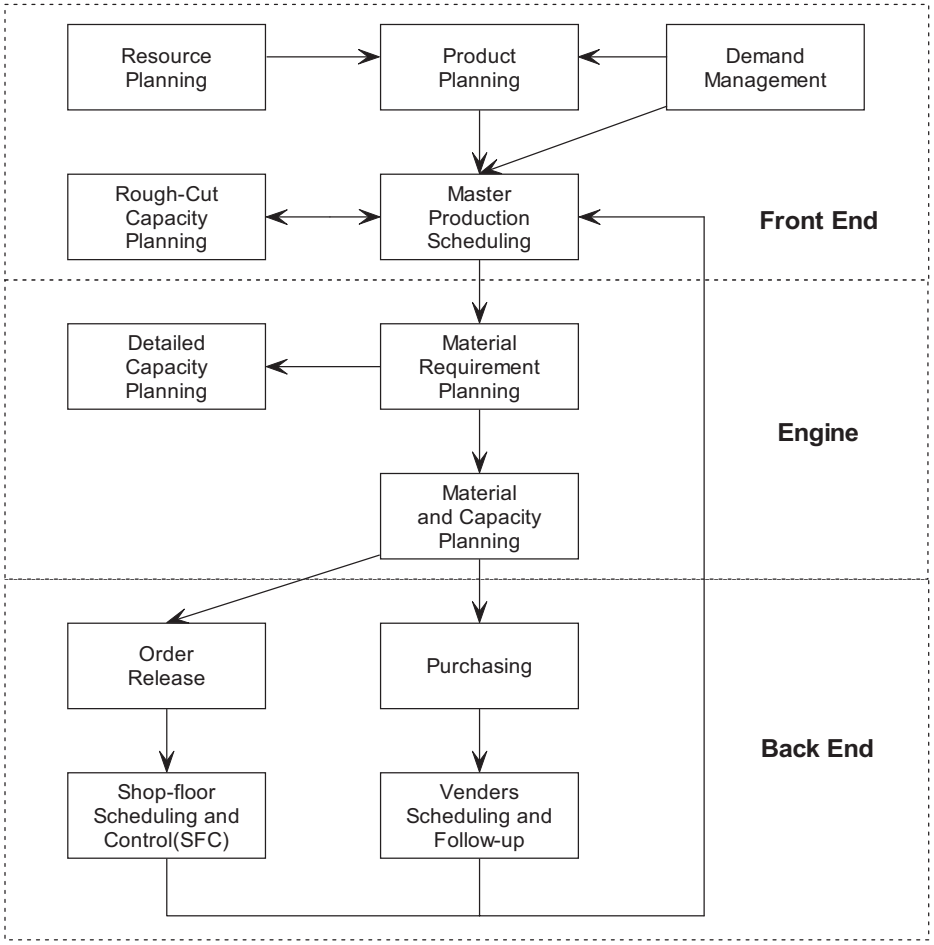

Figure 2. Framework of MRP II.

duction of ERP systems in the early 1990s stemmed from the continuous enhancements made to MRP and MRP II systems between 1960 and 1980 (2).

One study of mid-size to large companies conducted by AMR Research (3) found that 67% of the surveyed companies are implementing some form of ERP, whereas another 21% are evaluating potential ERP systems solutions. Independent surveys conducted by Morgan Stanley (4) and Deloitte & Touche/IDG Services Group (5) show that ERP system implementation and upgrades are identified as one of the top priorities among global Chief Information Officers as more companies are beginning to adopt ERP systems. A survey conducted by Deloitte Consulting in association with Benchmarking Partners, Inc. shows that 70% of the respondents out of the 164 individuals from 62 Fortune 500 firms interviewed expected that their ERP system would provide them with improved quality and visibility of information (6).

Integration of Business Functions

The rise of ERP systems has been the center of discussion in the software industry since the 1990s (7, 8). They are strategic tools that allow companies to gain a competitive edge in today's dynamic business environment by integrating all business processes and optimizing the resources available. ERP systems are not purely software systems; they affect how a business operates (9, 10). The enterprise must be closely linked to manufacturers, suppliers, and customers to produce goods tailored to customer requirements in the shortest possible time (1). To achieve this improved efficiency and effectiveness, ERP systems equip the enterprise with the necessary capabilities to integrate and synchronize the isolated functions into streamlined business processes.

Although the acronym "ERP" originated in the manufacturing and distribution industries (2), ERP systems typically attempt to cover all basic functions of an organization regardless of the type of industry. ERP is originally designed as a system that integrates all data and processes of an organization into a single unified system. A typical ERP system will use multiple components of computer hardware and software to achieve the integration. The key ingredient of ERP systems is the use of a single centralized database to store data for various system modules. To be considered an ERP system, a software package would need to replace two or more independent applications and eliminate the need for interfaces previously required between applications.

System Maintenance

ERP software is distinct from traditional in-house software in several ways (11, 12). Unique attributes of ERP software are as follows: (1) It is bought from a vendor versus built in-house; (2) helpdesk and maintenance support are available from the vendor versus being entirely internally-supported maintenance activities; and (3) the installed version is replaced by choosing from readily available versions versus reengineering or rewriting the whole system internally (11). ERP maintenance and upgrade are not purely internal issues nor are they 100% external matter controlled entirely by the vendor or a third party outsourcer, although the ERP software vendor has significant influence on ERP client maintenance and upgrade activities.

Carney et al. (13) discusses the contractual details on the vendor's long-term responsibility for maintenance, emergency upgrades (in case of patches to repair bugs), and policy of expected upward compatibility of future releases of the software. Contractual agreements between ERP vendors and organizations allows the organization to spell out all the benefits and costs of a maintenance project and reduce the risks involved in maintenance projects.

ERP I Systems

Early ERP systems (ERP I) have focused on optimization of the business operations and have attempted to integrate functions from all departments into a single computer system. Each system uses a single database so that the various departments can easily share information and communicate with each other (1, 2). To successfully implement ERP, all processes in a company must conform to the models describing the best practices in the industry (9). It involves reengineering the existing business processes to the best business process standard (14). One weakness of ERP I systems is that they do not share corporate information with external parties. Firms face a variety of demands from an increasingly competitive business environment, and these demands are forcing decision makers to share information beyond the confines of their internal environment.

Firms are looking more into multi-enterprise collaboration with their external partners across their supply chains. This shift in focus and needs is not only from the perspective of the firm itself but also from all its associated partners. Shafiei and Sundaram (2) consider ERP II as an application and as a strategy to include participation of all relevant partners of the firm across its supply chain, enabling collaborative commerce. The main reason why ERP II came into existence was the need to look at a way to give customers and partners access to scheduling, delivery, inventory, manufacturing, invoicing, and planning information. ERP II is further empowered by new technologies like the Internet and Web services, and this has made usage convenient for users in remote locations (15, 16).

ERP II Systems

ERP II emphasizes open architecture and vertical-specific functionality. Lin et al. (17) report that most ERP I solutions provided by vendors in 2000 were proprietary and differ from each other significantly. In ERP II systems, data can be reviewed and evaluated both internally and externally. This type of data sharing has caused vendors to shift focus from developing an all-in-one solution toward developing best-of-breed applications based on different types of industry.

ERP vendors began breaking up and componentizing their suites to make them easier to integrate with each other and with legacy systems. The most popular applications within ERP II that benefit companies include customer relationship management (*CRM*) and supply chain management (*SCM*). The relationships between the business functions are shown in Fig. 3.

Most of the leading ERP vendors offer Web enabled packages and Web services for companies to provide real-time information collected from these applications to their external suppliers and end-users. Deployment of ERP II systems takes place through a single vendor with a variety of best-of-breed application vendors. The integrated ERP II systems usually have a base system that enables the installation of additional application modules either from its own product line or from different application vendors.

INFRASTRUCTURE OF ERP SYSTEMS

From the viewpoint of information technology infrastructure, ERP systems have three major components: enterprise-wide database, application modules, and client/server system (19). The enterprise-wide database in a particular ERP solution varies from one ERP vendor to another depending on the data structure and database schema. Commonly used databases include IBM DB2, Microsoft SQL Server, Oracle Database, and mySQL AB. Database repositories check for redundancies of data collected from different applications throughout the enterprise and store them in a standardized format readable and accessible by each of these applications. Application modules may include SCM, CRM, PLM, and many others. The user interface is one characteristic of the client/server model and is usually graphical and interactive, which allows end-users to retrieve data from the back-end and to perform reporting services.

Open Source Development

Open source development in information technology has evolved from traditional client/server computing to Web-based Internet platforms. It is a practice that promotes access to an end product's source materials, typically the source code. It gained popularity with the growth of the Internet by enabling diverse production models, communication paths, and interactive communities. This shift of focus has changed the ERP system architecture to a 4-tiers Web-based architecture (17): Client, Web server, application server, and database server. Software vendors are adapting to this architecture by developing Web services.

Typical Web services consist of plug-in modules that can be installed on any Web portal using the same programming language. Some of these programming languages such as PHP and J2EE are open source languages licensed under the GNU General Public License (16). Many open source software companies began developing ERP software

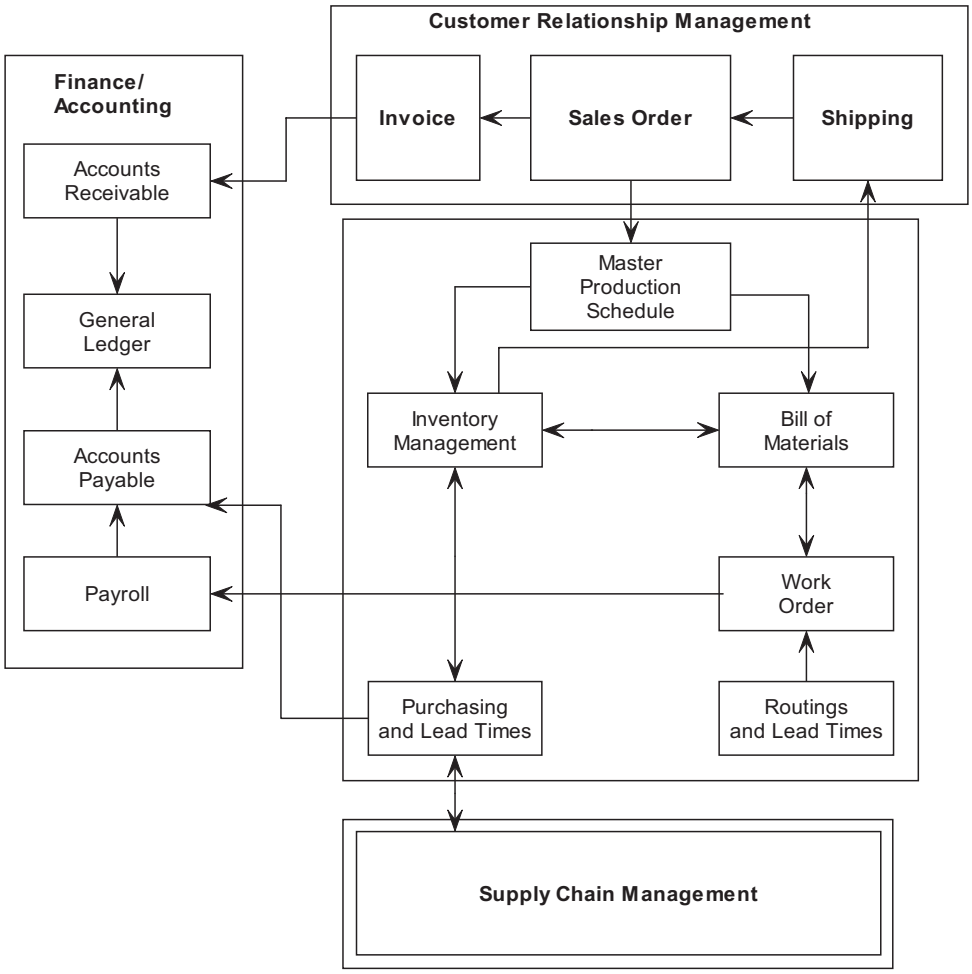

Figure 3. Applications of the ERP system (source: Reference 18).

built on these open source platforms. The increased adaptability and decreased reliance on a single supplier and reduced costs are the main reasons open source ERP has been developed.

Web-Based Systems

Web services are the most preferred ERP modules developed today both commercially and through the open source community. The usage of Web-based ERP portals provides transparency of usage to suppliers and end-users alike without having to install additional software packages in their machines. This portal is accessible anywhere within the local area network (*LAN*) using an Internet browser as long as the end-users are granted the appropriate access to the portal. The same Web portal can be configured to be publicly accessible from the Internet, thus giving external suppliers and end-users the ability to modify and view real-time corporate data using an Internet browser or an enabled mobile device.

The efficiency of an enterprise depends on the quick flow of information across the complete supply chain, from the manufacturers to the suppliers. One instance of an ERP solution that achieves high efficiency is an integrated Web-based logistics management system for agile supply demand network design (20). The presented solution is a Web-based software that provides on-demand and real-time availability of information to all members of a manufacturing system, enabling them to react quickly and efficiently.

CONCLUSIONS

An ERP system should be sufficiently versatile to support different manufacturing environments like make-to-stock, assemble-to-order, and engineer-to-order (20). Well-planned implementations of ERP systems have rich functionality across all areas like sales, account receivables, engineering, planning, inventory management, production, purchase, accounts payable, quality management, production, job scheduling, and distribution planning.

It is expensive and time consuming for companies to implement ERP systems; companies can take many years to implement ERP systems, and the costs ranges from $10 million for a moderate size company to over $100 million for large international enterprises (22, 23). Product selection for ERP packages is difficult because of the continuous evolvement of ERP's technology and functionality. Statistical analysis techniques such as regression analysis, logis-

tic models, discriminate analysis, and data envelopment analysis can be used to analyze empirical data from an enterprise survey to provide important insights into ERP implementations (24).

There are many different approaches exist to implementing the proper ERP solution and customizing the system to match the organization's business requirements. For example, see References (2, 8, 10, 14, 25, 26). The interoperability of the ERP systems armed with a wide selection of open-source software and commercial packages has enabled organizations to use this form of corporate modeling to improve long term productivity and efficiently manage its business operations in the coming years.

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