Design and Delivery of Information System using ERP Database Management Software

Track: Enterprise Resource Planning

The importance of global trade has aroused interest in Enterprise Systems as catalysts to achieving integration and synchronization among businesses. Enterprise Systems encompass a total view of the enterprise with its technological and business capabilities. Therefore, the design and delivery of information for enterprise should emphasize technical and business decision-making capabilities. ERP database management software is built around learning "enterprise value chain", including development tools, such as "Open SQL" programming and software development kit. In this paper, the design of information for a test case supply chain network, utilizing the SAP (Systems, Applications, and Products in data processing) R/3 ERP database management software is illustrated.

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Introduction

Enterprise is a collection of entities (systems) assembled towards achieving shared goal(s). The design of information for an enterprise, therefore, must recognize interconnections of information among components of its various entities. The outcome of this design process is integrated information systems, a distinct shift from disjoint functional information systems. Enterprise Resources Planning (ERP) is a strategic activity for planning and monitoring all of the resources of a manufacturing company, including that of manufacturing, marketing, finance, and engineering functions (Rao 2000). ERP represents application of integrated information systems concepts to the manufacturing resources planning (MRP-II) model. It is a management system with planning and scheduling capability offering gains in productivity, customer service, inventory turns and reduction in material costs (Ng et. al. 1998).

This paper describes information systems development utilizing an ERP approach. First, a discussion on supply chain (SC) as a special type of enterprise that requires integrated information systems is offered. Next, an approach to design ERP system for a SC is elaborated. Its foundation is built on a three-tier SC enterprise design and modeling. Understanding information needs for a SC enterprise is achieved through process modeling techniques. A conceptual model of information for the SC enterprise is built utilizing object-oriented concepts. A logical database of a SC enterprise formalizes the conceptual model. Finally, emerging techniques for information management with ERP system are presented (Gibson et. al. 1999).

Supply Chain Enterprise and the Need for Integrated Information

The concept of SC is about managing coordinated information and material flows, plant operations, and logistics through a common set of principles, strategies, policies, and performance metrics throughout its developmental life cycle (Lee et. al. 1993). SC environment will make available to manufacture and assemble products at lower cost and higher quality with less risk and shorter lead times. Virtual enterprise (VE) is one of the SC structures, in which product, process and resource components of units are aligned to common objectives of the VE at a given, usually, short time interval. The entire domain of modeling, which to describe structures of enterprise units, contract with parties outside the enterprise and to differentiate business processes depending on the enterprise unit involved is called extended enterprise modeling (Wortmann et. al. 2000). The extended enterprise is a SC structure, which uses e-commerce technologies. It can be one of the different types of relations, for example, B-2-B (Business to business) as a relation between different organizations, B-2-M (Business to manufacturing) as a relation between supplying and manufacturing organizations, B-2-C (Business to consumer) as a relation between producer or distributor and consumer.

Value Chain Integration uses Internet technology to improve communication and collaboration between all parties within a SC. Value chain integration is necessary, if vendors are to coordinate between suppliers, internal operations, shippers and customers effectively. Effective service providers integrate their operations directly into the processes of their customers.

The concept of integrated system is expected to have major impact allowing companies to benefit from reduced inventories, cost savings, improved value added goods and services to customers, and tighter links with business partners. The convergence of information technology (IT) and telecommunications, and the availability of bandwidth supports and enables these new organizational design. The network organization, linkages of SC partners, and alliances exploiting uniquely grouped core competencies are all supported or enabled by modern IT (Papazoglou et. al. 2000).

Supply Chain Enterprise Integration Model

The major goal of the proposed approach is to offer a strategic decision modeling architecture. It is intended to develop mechanisms to model and evaluate strategic decisions for production network in various forms, such as vertical, horizontal, and regional networks in SC structures. General problems of this approach will consist of design and development of SC configurations based on various marketing and production strategies. Main components of the proposed approach are (Chandra, Smirnov, and Chilov 2000):

- *Macro-level Enterprise Models* to address enterprise-level needs supported by different levels of source information using Enterprise Integration tools.
- *Capability Representation Models* to represent capabilities and core competencies at the enterprise and an extended enterprise level.
- *Enterprise Model Library* that can be selected and tailored based on a user dialogue with the system.

For implementation of the above approach, process models for various supply chain structures are developed utilising software tools. These are analysed in a simulated environment through generic models.

Macro-Level Enterprise models are represented by multilevel aggregations of Generic Processes

(GP), proposed in (Chandra et al., 2000). GP can be combined in different ways to model various SC scenarios and structures. Essentially, any production system can be modelled via GP's using their aggregations. Each aggregation may consist of any number of GP's, connected both in parallel and sequentially.

In turn, GP is an aggregation of Generic Activities (GA). GA is the basic unit of the modelling approach presented. For a manufacturing environment, GA's can be categorised into four types: Inbound Logistics, Processing, Outbound Logistics and Control. GA can be both one-resource and multi-resource activity. GA's behaviour depends on several parameters namely, control parameter, resources available to activity, environment and objective function (for example, throughput maximisation, or cost minimisation). Products traverse through these GAs during simulation.

The Capability Representation Model for a SC provides the mechanism to integrate policies and strategies to be implemented, as the SC configures / reconfigures itself in response to market dynamics. These configurations are necessary for the SC to adopt, as it evaluates its product offerings, associated processes and resources required to manufacture these products. Models for evaluation implement various strategies related to system structure, and functional policies for management of forecasting, inventory, capacity, and production decisions.

The Enterprise Model Library for a SC acts as a repository providing the knowledge in the form of related models, frameworks, tools and techniques needed to solve SC problems in a specific domain.

Supply Chain Process Modeling

In order to understand information needs in an enterprise, it is necessary to identify and analyze relationships among its components. Process modeling is a technique that allows an enterprise to be decomposed into interconnected layers, with each layer identifying processes and associated attributes, organization structure, and data (information) flows.

Architecture of Integrated Information Systems (ARIS) is a process modeling technique and associated software, that offers a framework for developing, optimizing and implementing integrated application systems (Scheer, 2000). ARIS is used to develop a framework for describing (modeling) computer-aided information systems in their entirety from the requirement definition to the implementation description.

Models are used in ARIS to describe business processes. Over 100 different model types within the software support five ARIS views (output, data, function, organization and process). The hierarchical structure of an ARIS information framework is made up of a server, database, group structure, model(s) and object(s). ARIS is represented by numerous: model types, object types, connection types, attribute types and symbols. Depending on the defined project objectives, different ARIS pre-defined methods are applied. ARIS business process model is hierarchical, and more detailed business processes can in turn explain a function. For illustrative purposes, a Generic Supply Chain Structure modeling business processes is depicted in *Figure 1*.

The project database contains all information (models and objects) created during the project development process. Each model is represented uniquely in ARIS project database and is based on a model type. Business data is represented in each model. Each model type offers a selection of object types. Objects are connected through relationships. Connection types depend on types of source and target objects, as well as on the model type. To illustrate the process-modeling concept for an enterprise, two types of *value-added chain* objects were used.

ARIS framework includes infrastructure components such as, workflow systems, modeling tools and middle-ware, linking business objects into an application within the framework. The ARIS model type SAP, within the ARIS framework not only integrates SAP software solutions; but is also the key to providing comprehensive vertical market solutions. Also, users can use the SAP model type as a toolbox for developing their own SAP R/3 enhancements.

Object-Oriented Model for ERP Information Systems

Relational database systems have enabled users to create flexibility in terms of business logic and data structures to support parallel business practice implementation. For implementing object-oriented models in SAP R/3 relational database, table (relation) structures are needed which do not require any changes when changes are made to object structures. *Figure 2* illustrates a relational database prototype structure representing object-oriented (O-O) data model (Chandra and Chilov, 2001).

Utilizing these generic O-O structures, SC models as global enterprise models may be defined in various ways. O-O models are formal models of concepts that are used in SC model representation. The highest level of object abstraction is object Class, which shows an object's nature. The next level is Object type, which belongs to one of the classes of the system and contains objects with similar properties. Every object has set of attributes, which shows the next Attribute type level. Specific values for each object-attribute pair are stored at the next level of Values. These relations may show structure of object and sequence of operations in a production process.

Supply Chain ERP Database on SAP R/3

The SAP database systems are based on relational database management systems (RDBMS) technology. ERP systems built on this technology would support organizations with the need to set up distributed systems with less dependence on a central information resource location.

An O-O data model of a SC information model prototype is depicted in *Figure 3*. It is derived using the prototype described in the previous section and depicted in *Figure 2*. This technique allows flexible representation of a SC structure as it configures to its dynamic environment.

An information model representation for an automotive SC utilizing the above technique is described below. For purpose of illustrative, a car with four main components has been selected. These are -- Body, Interior, Under Carriage, Power Train, and several constructive elements within these components, as depicted in *Figure 4*. In order to manufacture this car, various automotive SC production models may be created. A Parallel Distributed Production Model is depicted in *Figure 5*. It has some processes, which are performed in parallel (or simultaneously).

Database for these production models will have the same structure, but since each model has different tiers and particular SC configuration, it is represented by appropriate relations between all production units at different tires. For example, in case of one-stage distributed production model, during the Body Assembly phase, assembly of all interior car components is performed and relations between all Tier-2 manufactures and Body Assembler are defined in the database. In case of parallel model, relations between production units of Tier-3, Tier-2 and Body Assembler are represented in the database. To implement sequential distributed production model of SC, relations between four level components of Tier-4, Tier-3, Tier-2 and Body Assembler is determined.

Information Management with ERP Systems

Enterprise systems use database technology and a single interface to control all the information related to a company's business – including customer product, employee, and financial data (Michel, 1999). ERP systems are built on a client / server hardware-software interface architecture. The technology includes the move to RDBMS, use of a graphical user interface (GUI) and client/server architecture. ERP software has advanced data definition language (DDL) and data manipulation language (DML) capabilities built in their SQL environment. ERP software is interoperable in various operating system, and server platforms.

SAP R/3 is one of the popular ERP systems, which uses above information technologies to offer SAP application development using ABAP language (based on modified Open SQL) and API functions and OLE automation technologies for communications with other software packages.

ABAP is the programming language used by SAP's developers to build and customize transactions that make up the R/3 applications. A transaction consist of ABAP code and an associated set of screens that can be used to enter, change, or display data; monitor events within the R/3 system; and change functionality in the R/3 system.

At the application level, generic business objects for functions, such as logistics solutions are provided. In addition, BAPI object interface provides data interchange capabilities between SAP R/3 and external software. Utilizing SAP R/3 allows performing many capital project functions, including cost management and materials and warehouse management.

Conclusion

The proposed methodology offers development of enterprise information systems and components in three basic stages: Process Modeling, Object-Oriented Modeling and Database Design. Utilizing ERP systems software, such as SAP R/3, allows information management for complex organizational forms such as, supply chain, virtual and extended enterprises that require unique data structures to support their decision-making environment.

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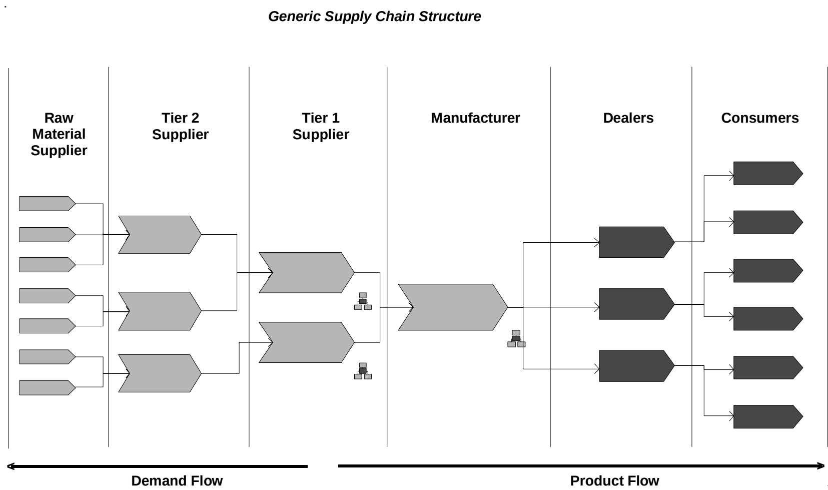

Figure 1. Generic supply chain structure.

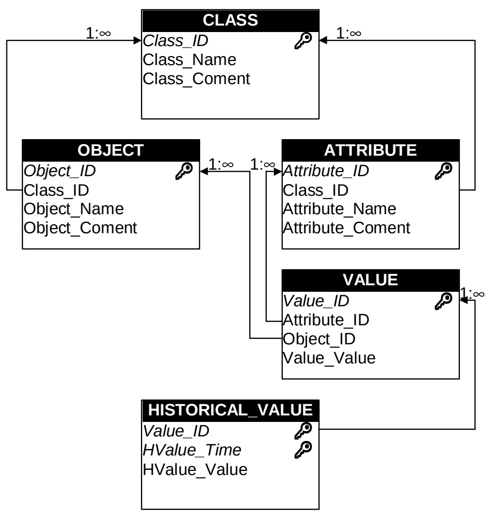

Figure 2. A relational database structure representing object-oriented data model

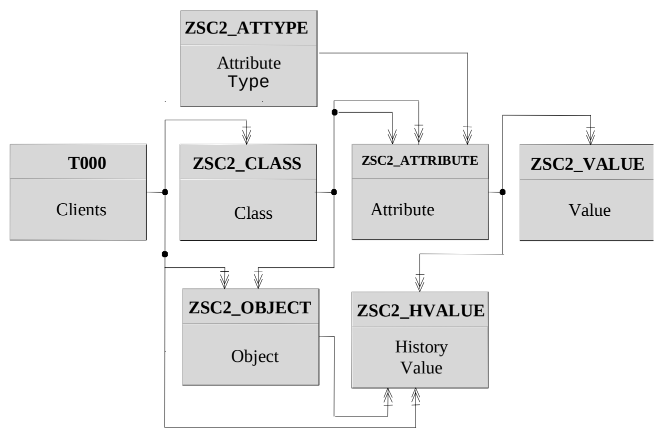

Figure 3. An object-oriented data model representation in SAP database structure

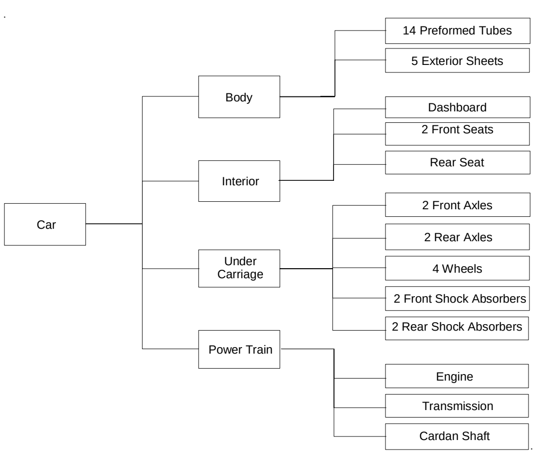

Figure 4. Car manufacturing components.

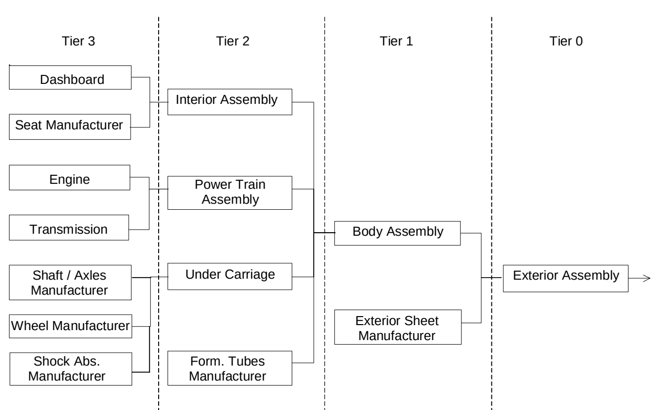

Figure 5. Parallel Distributed Production Model of a Car