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Supple Database design for Enterprise Resource Planning (ERP) Application

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Abstract– Enterprise Resource Planning (ERP) software presents a frame for organizations to better utilize their process and business. Early generation of ERP systems utterly focused on infrastructure renewal and creating efficiencies in back office operations around key functional areas such as finance and production management. These systems, while useful, did not address the mission critical issues such as supply chain management (SCM), customer relationship management (CRM), and knowledge management (KM). New generation systems have sought to address these short-comings in a variety of ways. Implementation of ERP software is the process of adaptation of the frame to the organization. Therefore, implementation process should be good managed in order to achieve the targeted results of ERP philosophy. To facilitate these implementation projects, ERP software should be supple enough to meet extra data requirements of implementation domain. In this paper, a case study is constructed to denote implementation problems arisen from inflexible design.

Index Terms– Enterprise Resource Planning (RP), Database Design, Application Domain, Implementation Domain, Suppleness and Supple Database Design

I. INTRODUCTION

IN today's competitive market, organizations have to adapt themselves into the continuously changing and evolving conditions in order to survive and develop. Therefore, during the adaptation process the organization's decisions are critical. During that process, in order to take appropriate decisions, the organization should have a good understanding of its own system dynamics, its current place and state in the market as well as ever changing dynamics which impact and affect the world, the country, the sector and finally the organization itself.

Management Information System (MIS) implementation throughout the organization would help them to better cope with those issues by the help of business intelligence and decision support systems. Within this scope, in order to implement the MIS, it is necessary to establish a common information system infrastructure and to integrate the corporation business workflows to this system. The software providing this infrastructure for MIS is called as Enterprise Resource Planning (ERP).

Main aims of an ERP application can be summarized as:

- i) To expedite, integrate and maintain the standardization of business workflows
- ii) To provide the coordination, cooperation and integration among the functional units
- iii) To interfere the repetitive data entry within the organization

The organizations which implement an ERP system also accept main aims stated above. ERP has a distinction from other software systems, because modules (application domains) in ERP packages are free from the implemented organizations. Thus, customizations are inevitable through the implementation. For example, an important step in implementation is to compare business processes embedded in the ERP package with organization's business processes. In order to manage this change, by bringing business processes to the same platform, organization should become aware of the organizational change and needs. Such a change leads customization. The short and not fitting aspects in the ERP package may increase risks in the success of implementation. Accordingly, risk management is an important factor for the success of such a project. Especially for the ERP package, risk management concentrates on the solutions and business processes that are available in the package but disregarded by the organizations.

In order to increase the flexibility and extendibility of an ERP package, one should increase the flexibility available at the interface design and the conceptual design of the system.

From the software engineering point of view, an ERP package should consist of two main components:

- Programs units that constitute the business intelligence
- Database that holds the setup and transaction information specific to the organization. Since the conceptual design of a system is the state of an information system where early implementation decisions are made, it is important to meet the requirements of a flexible implementation in that stage [2], [15]. Within this context, the database design which the ERP package is built on, should consider the employment of the package modules (application domains) considering requirements of different implementation domains.

As there is a need for building a flexible ERP application, thus flexible database design, it is clear that, we need new ideas for constructing database design in a flexible manner. The focus of this study is discussing the implementation

problems that arise from non-flexible database design and offering techniques to solve them.

II. LITERATURE REVIEW

A. ERP

ERP systems should cover major business processes in an organization. Therefore, ERP software mainly consists of 7 parts [1]:

- Finance- Accounting
- Production Management
- Purchase Order Management
- Sales Management
- Inventory Management
- Quality Management
- Human Resources Management

The degree of relationship between these modules is derived from the implemented organization's requirements. For example, definition of an inventory item has been done in Inventory Management module. But its transaction about purchase and sales are have tracks on Purchase Order Management and Sales Managements modules. Also, these transactions have account balance changes in Accounting Management module.

There is a management module for ERP systems. Its main mission is to hold the features of modules, tables, columns and security data. Any of these objects should have been defined to this management schema in order to be recognized by the ERP system. As we mentioned ERP systems provide an authentication and authorization mechanism. This mechanism is in the management schema [16]. This management schema covers all security needs of modules. It is similar to the metadata of a database system. Why ERP systems do not use database security mechanisms of database system that it is installed on? Because it is much simpler to install access protection measures on the level of the ERP itself as they must be integrated with other services in the ERP system [12], [7], [8].

In following figure authentication and authorization of ERP systems are explained:

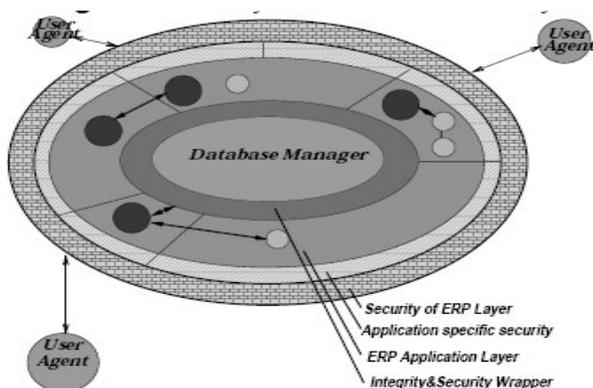


Fig. 1: Security Layer in ERP Systems [12]

B. Evaluation of Flexibility in Generic Design Process

Adding new step(s) or evaluating needs in generic step of database design was mentioned in earlier studies for different aims. To evaluate the requirements of modularization, Ferreira and Busichia [5] have added two sub steps to the generic design process.

Collection and Analysis of Modularization Requirements: aims to identify and understand the application's modularization requirements, defining the subsystems it is composed of and associating the transactions defined in the phase of Requirements Collection and Analysis to each one, according to its functions.

Modularization Design: aims to modularize the database, associating the data to the subsystems that make up the application according to the transactions carried out by these subsystems, taking into consideration the need for information sharing and interoperability. Considering that, in order to be divided, the data schema has to have been built according to a data model attributing semantics to modeling; the Modularization Design must be made during the Conceptual Design, using the conceptual global schema to carry out partitioning. Because Modularization Design generates the conceptual data schemas of each module, the Logical Design phase must be applied to each of these conceptual schemas, generating logical data schemas for each module.

C. Adding a New Step to Generic Design Process

Tim Martyn [6] was interested in database design process. His aim was adding a new step for obtaining a pragmatic version of the logical design. Thus, an extra step "implementation design" comes on the scene. According to him, implementation design techniques are very different from the design transformations applied during logical design, the techniques also differ from a physical design, because physical design does not consider internal, DBMS-specific facilities [6].

III. CASE STUDIES

There is a strict difference between a software development project and an ERP implementation. Software development is preparing your own cloth according to your needs. But implementing ERP is working within a well-defined design framework, which is already designed and developed by someone else [11],[13]. Therefore, ERP software is standard software and there would be some problems while implementing it.

Our method to identify implementation problems of an ERP system is to setup a case study. This case study consists of implementation of an ERP module (application domain) in two related phases [14]. At the first part, we have designed a database for chosen application domain (budget), in order to satisfy specific needs of an organization in defense industry. At the second part, we have collected the requirements of another organization in construction industry. Then we analyzed the requirements of the second organization with our first database design. We assume that,

choice of two different industries (implementation domains) will help us to catch more problems. At that point we can analyze problems that arise from inflexible structure of database design.

A. BUDGET

Budget application domain has been chosen for application domain to express the implementation problems in different areas of industry. But what is budget, why it is important and why organizations desire to make a budget? Budget is a powerful management and planning tool to express what the organization will do in the related period [9]. It is important because it emphasizes detailed resource allocation according to the business plan that is constructed in related period. Related period always means a year, therefore budgeting always mentions annual budget. Organizations make budgets and report expenses to identify performance of business plan and department managers. Good budgeting leads to good management, which leads to good business performance [9]. Budget preparation is directed by top management but whole organization would have contributions to it. Department managers must have important input in budgeting because they are directly involved and knowledgeable about their departments' activities and familiar with operations [10]. Budget and budgeting process may have differences according to countries, industries, organizations but the philosophy remains the same.

B. Budget Application for Defense Industry

1) Requirement Collection and Analysis

We have chosen a sample firm to get requirements of budget applications in defense industry. First of all, we started to interview with specialists in the Budget and Finance Department. Notes based on the interview are as follows:

Budget of the firm consists of two main parts:

- Cost Center Budgets
- Project Budgets

There are various cost centers in the organizations. Each employee in the firm belongs to a cost center. Each cost center has its own budget to arrange expenses planned. There is a responsible person for preparing each cost center's budget. Therefore, owner of the budget is the cost center which has prepared it. Expenses of these cost centers are not related to any of the projects that the firm is concerning with.

Firm has projects for saving money. These projects are grouped as:

- Production Projects
- Research and Development Projects
- Service Projects

All projects have their own budget in order to identify and group the expenses. These expenses are also identified by cost centers with the coordination of project management departments. Project management departments are organized based on the type of project we mentioned above. But owner of these project budgets is not the cost center that has

prepared it. Project budgets are owned by Project Management Departments according to its group [3].

Firm budget is prepared by cost centers in three states:

Preparation State: During the budget preparation period each cost center and each project related with the cost center builds their own planned expense list. This is a draft version of the budget. Projects and cost centers validate and may add or extract some of the items into the list.

Freeze State: After the preparation is done, the budget would be ready for board of director's approval. As the Board of Director's approval is done, then the budget passes to the definite state. If any exception occurs budget returns to the preparation state.

Definite State: When the budget is approved, no insert or update is allowed. As the budget period starts, cost centers and projects can have purchase orders that are identified in the budget.

After the Definite State, (in which year the budget is valid) there may be new requirements or change of requirements which have not considered during the preparation of the budget. Under the control of Budget and Finance Department, these requirements are handled by adding new expense lines or transferring planned expense lines to each other. Cost Centers prepare the purchase orders from their budget or their budget line from related project budget.

Budgets are basically lines of expenses with amount and currency of money with its period. There are specific properties of these budget lines:

- Type of expense
- Description and Reason of expense
- Preparer Cost Center
- Currency code of expense

Also periods, total money and total quantity that you plan for this budget line will be entered. Firm also budgets its employees in numbers of personnel and work hours for each month. Personnel budget is prepared in detail of cost center, position and work hour budget is derived from personnel budget in monthly work hours. Work hour budget is also detailed in cost center, position and projects. Time sheet fill is a property for positions and cost centers to calculate work hour. Work hour budget is only done for positions and cost centers which have time sheet fill property.

2) Summary of Requirements

We can summarize these requirements as follows:

- The company has a Budget and Analysis Department.
- Budget and Analysis Department has authority to control all budgets.
- Budget and Analysis Department observe the budgets of Cost Center and Projects.
- Budget and Analysis Department defines the budget of the firm.
- Budget definition consist of project, owner cost center, name ,status, related year and the type of the budget
- There are 3 states of budget definition; Preparation, Freeze, Definite

- During the Preparation state budget is determined and lines expenses are entered. During the preparation state cost centers prepare the lines of expense.
- During the freeze state no update or insert into budget is allowed. During the freeze state it is decided if the whole company budget is accepted or not.(until the beginning of the budget related year)
- During the definite state no update or insert into budget is allowed also requisitions from this budget starts. During the definite state related year's budget is published and became certain.
- Each Cost Center has specific name, code and time sheet fill.
- Each Project has specific name and code.
- Each position consists of position code, time sheet fill and position_name.
- New cost centers and projects would be added in life cycle of the firm.
- There are two types of budgets; Personnel and Expense.
- In the Personnel Budget the number of staff with positions for each department in relevant month and year is determined.
- For the related year's budget, work hour per month is calculated as follows: Each month's workday X work hour.
- Time sheet fill property assigned to positions and cost centers for calculating work hours.
- Yearly work hour budget for cost centers consist of work hours determined in the name of position and project for the relevant month.
- In the Expense Budget planned expense of the firm is determined.
- Expense Budget is divided into two categories. Project budgets and Cost Center budgets.
- Every expense is relevant with a cost center. This is required for project budgets. Project budgets are prepared by one or more cost centers.
- Budget and Analysis Department defines the other cost centers which can have expense items in the project budget.
- During the preparation time Project budget can be observed by Projects owner cost center but every cost center can only change its own written requirement.
- Expense consists of definition, reason, unit of measure, currency code, expense cost center, expense type and inventory item.
- Expense type consists of code, description and type.
- Each expense must have one or more expense period (year, month) and expense amount (quantity, money) related with this period.
- Cost Centers prepare the purchase orders from their budget or their budget line from related project budget.
- In the related year under the control of Budget and Analysis Department any expense line of a budget can be transferred into other expense line of budget in terms of money. History of the transferred information is reserved

with the details of; from which budget, from which expense line, from which period and to which budget, to which expense line, to which period.

3) Conceptual Design

According to the requirements we can pass to the second phase of the design; conceptual design phase. First we will identify the entities of our mini-world.

•*Entity:* Project
Attributes: NAME, CODE

•*Entity:* Cost Center
Attributes: NAME, CODE, TIME SHEET FILL

•*Entity:* Purchase Orders
Attributes: DATE, QUANTITY, UOM, DESCRIPTION, CURRENCY, REASON, STOCK_NO

•*Entity:* Expense Budget
Attributes: NAME, DEFINITION, YEAR, PERIOD, CURRENCY CODE, AMOUNT, UOM, REASON, EXPENSE LINE TYPE (definition, group, code), INVENTORY ITEM, STATUS, CHANGE HISTORY (date , from budget, to budget , amount),

•*Entity:* Personnel Budget
Attributes: YEAR, PERIOD, POSITION (name, code, time sheet fill), QUANTITY, WORKHOUR, PROJECT

Top-down strategy is used for the schema design. Top-down strategy is primitively a decomposition of an entity type into several entity types [4]. High level entity types are specified and then these entities are split into lower-level entity types and relations with the help of normalization rules. In Figure 2 , ER schema of the budget system can be seen. According to the entities, attributes and relationships are identified during the requirements collection step, schema has been constructed.

4) Logical Design

In the logical database design phase, the data model mapping of the system which is defined in the conceptual database design, is used. ORACLE database has been chosen for the system setup. Fig. 3 shows logical design of the budget system, with relations and keys.

5) Physical Design

In logical design, we have mentioned that commercial database management system was chosen as ORACLE. Created tables and table definitions are given below:

BUDGET_DEFINITIONS table

Budget definitions and management will be done by this table. This table manages the state and identifies the owner cost center of the budget. Also validation period and type of budget is determined.

BUDGET_ASSIGNED_COST_CENTERS table

This table defines the authorization to cost centers for

budgets which have defined in the table BUDGET_DEFINITIONS. Cost centers authorization definitions could be disabled without deleting the record from the table; it can be done by column OPEN_FLAG.

EXPENSE_LINES table

This table stores the expense lines with relation of budget definitions table. (BUDGET_DEFINITIONS)

EXPENSE_LINE_TYPES table

This is the definition of expense line types. Expense line types are necessary for grouping expenses lines.

EXPENSE_LINE_PERIODS table

This table stores the detail information in period and amount according to expense lines with the relation of EXPENSE_LINES.

EXPENSE_CHANGE_HISTORY table

This table stores change history of expense lines after the budgets definite state.

POSITION_DEFINITIONS table

This table stores the definitions of positions.

POSITIONS_BUDGET table

This table stores budget details for positions defined in POSITION_DEFINITIONS

This table stores the definitions of positions.

POSITION_CC_ASSIGNMENT table

This table stores the cost centers that will positions assigned to. Therefore, budgeting any position and any work hour for a cost center requires a setup in this table.

ANNUAL_WORKHOUR table

This table stores amount of total work hour for the related month and year. This table records is determined by Budget and Analysis Department.

WORKHOUR_BUDGET table

This table stores work hour budget information according to project, position and cost center.

PURCHASE_ORDERS table

After the definite state of budget, purchase order starts. Purchase order records are stored in this table.

IV. CONCLUSION

Implementation of ERP systems is a problematic process. ERP system is a well prepared suit, but this suit may not fit every organization. Thus, ERP software has to be flexible enough to meet the organization's requirements. In this paper, a case study is constructed to identify the implementation problems that arise from inflexible structure of database design. In the first phase of the case study, a database design has been done according to the specific

needs of an industry. Then, the designed system has been implemented to a different industry to observe implementation problems. Analysis of implementation problems has been done.

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