Executive Information Systems' Multidimensional Models

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Executive Information Systems are design to improve the quality of strategic level of management in organization through a new type of technology and several techniques for extracting, transforming, processing, integrating and presenting data in such a way that the organizational knowledge filters can easily associate with this data and turn it into information for the organization. These technologies are known as Business Intelligence Tools. But in order to build analytic reports for Executive Information Systems (EIS) in an organization we need to design a multidimensional model based on the business model from the organization.
This paper presents some multidimensional models that can be used in EIS development and propose a new model that is suitable for strategic business requests.
***Keywords**: Executive Information Systems (EIS), Decision Support Systems (DSS), multidimensional models, Business Intelligence tools, On-Line Analytical Processing (OLAP).*

Introduction

The main objective of EIS (Executive Information Systems) is to provide in real time representative information to the high-level or strategic management and to gather, analyze, and integrate internal and external data into dynamic profiles of *key performance indicators (KPI)*. Executives have to manage and manipulate very large sets of data. In essence, they can have a customized view that extracts information from disparate sources and summarizes it into meaningful indicators.

In order to provide aggregate information and indicators, EIS systems collect, transform and integrate data from various sources through Business Intelligence tools and technologies like: data warehouses, OLAP, data mining, analytic SQL reports.

But also, a major objective of EIS systems is to provide a friendly graphical interface and when this is customized for the individual manager, allows users to access corporate data and complements the executive's personal knowledge and provide quantitative diagnostics to monitor the progress of decisions.

EIS' Multidimensional Models

In order to gather data from various sources and ERP systems that are implemented in an organization from different functional areas or modules such as: financials, inventory, purchase, order management, production we need to analyze and design the business model and strategic requests. This model have to be mapped on a logical model and physical model in the data warehouse and also used for extracting and presenting data throught OLAP technology. These models are known as multidimensional models and basicaly they represent an extension of the relational model or ER schema or a multidimensional view over facts.

Multidimensional models *are classified in two major types*:

- *models that are an extension of ER model* are based on a star schema and consist in the relationship between some dimensions and facts or measures
- *n-dimensional cube based models* that use a multidimensional view over an individual situation or data.

Among ER extension models we can mention: Gray's model based on CUBE and ROLLUP operators with GROUP BY clause in SQL language that aggregate data over some attributes; Li and Wang's model or Gyssens and Lakshman's model that are an extension of relational schema [MUNT04]. But the most important model is Ralph Kimball's model described in [KIMB96] in which he proposed *the star schema* as a representation of a n-dimensional cube. This schema contains a central fact table with many rows and measures in relation with the smaller tables called dimensions. Basically

the joins between the fact table and the dimensions are similar with the ER joins. From this model later was proposed the *snow flake schema* with joins between dimensions not only between fact and dimensions. Later it was developed a *galaxy* or *a fact constellation schema* with many fact tables in relation with many dimension tables.
In the cube based models' area we can mention Agrawal, Gupta and Sarawagi's model with minimal set of relational algebra's operators, but in which data structure is based on one or more n-dimensional cubes. In Agraval's vision these cubes are made of dimensions defined by name and values and cube's elements defined through a function that associates values to a n-dimensional row represented by the cells of the cube.
Also, in this category we can mention Cabibbo and Torlone's model or Blaschka's model [MUNT04] that defines an extension of ER technique called ME/R technique. In his vision the model contains dimensional levels, a 1: n fact relationship and a binary relationship called classification relationship between two hierarchical levels.
In Executive Information Systems the multidimensional model that is used have to be able to overhear the business requests. All we need is a business vision over data structure so the star schema or the n-cube based models have to design and incorporate business aspects or demands not only the facts or the relationship between data. The executives request a synthetic view over facts and indicators and these key performance indicators are built from the entire organizational data or even external data.
Another request is to provide a friendly graphical interface with advanced capabilities of slicing and dicing through data and easily get a new perspective over data by rotating dimensions and drill down or roll up over hierarchical levels. So we need a multidimensional model in which these operations can be made easily, in real time and that can it overhead the entire business model with relationship between dimensions, facts and hierarchies and it is based on the entire organizational data at operational level, tactical level and strategically level.
Based on these considerations we propose an extension of the star or the constellation schema but with aggregate data and hierarchies in fact tables not only in dimension tables. The model is structured over three distinct levels and we can call it a pyramidal model with the following structure:
• *Organizational level (or the base of the pyramid)* – containing dimensions and facts with an organizational scope, at a general level, that shape and are common to the entire activities. Such dimensions can be: <time>, <zone>, <product>, <currency> and facts: production, purchasing etc. Data are at a detailed level with multiple hierarchies over each dimension table.
• *Departmental level*– containing dimensions and facts for the departmental levels of the organization and particular activities in these departments or field of interests, group by data marts or data centers. Such dimensions can be: <account>, <client>, <vendor> and facts: stocks, payments, sales etc. Data are at a detailed and aggregate level with specialized hierarchies over each dimension table.
• *Strategically level* – containing dimensions and facts derived from the base dimensions and facts, with specific elements for the strategic analysis, like <intercompany>, <plan>, <budget> and facts: cash-flow, kpi. Data are at a aggregate, synthetic level with specialized hierarchies over each dimension table.
The main characteristic of the model is that between the dimension tables and the facts from different levels of the architecture can be establish a relationship and also the fact tables can have hierarchies and class attributes that can be used for drill down or roll up.

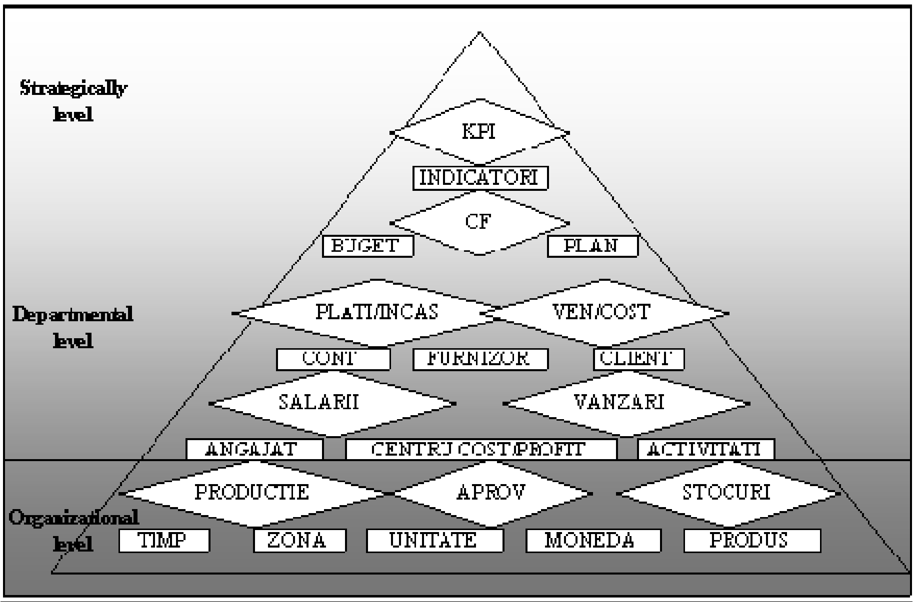

Figure 1: The pyramidal model for Executive Information Systems

<u>*Advantages of the model:*</u>
Flexibility – new elements or objects like new dimensions or facts can easily be included in the model without affecting the existing architecture or remodeling the system and the loading process for a specific level can be made without refreshing the whole data;
Real model of business requirements – the three level architecture is based on the real model of business requirements thus this model can be mapped on the each level of the pyramid;
Performance in the drill-down or roll-up operations – because the dimensions and facts are separated at each level we can easily navigate through hierarchies from a level to another;
Incremental development – the model can be build in stages and each stage can be validated and used before the next stage;
MIS and DSS support – the bottom and middle levels can be used for design and realized a Management Information System (MIS) or a Decision Support System (DSS) because these systems can use the specific dimension and fact tables from these levels.
<u>*Disadvantages of the model:*</u>
High complexity – because it is containing three different level the business model need to be careful analyzed and designed in order to identified the proper and suitable dimensions and facts and also the hierarchies at each level. An inadequate choice can have a major effect on the performance of the entire system;
Moderate performance of the interrogation process – in order to perform a complex query the model need to establish many relationships and joins between the fact and dimension tables and this can reduce the performance of interrogation;
Top-down and bottom-up development – In order to overhear the entire aspects of the business process we need to build the systems in two directions: first top-bottom to model the strategic requirements and second, bottom-up for validating and setting up the hierarchical flux of data.

Conclusions

Executive Information Systems improve the quality of management in organization through new type of technology and techniques for extracting, transforming, processing and presenting data in order to provide strategic information. Also EIS must have the ability to allow managers to view data in different perspective, to drill-down and roll-up to aggregate levels, to navigate and online query data sets in order to discover new factors that affect business process and also to anticipate and forecast changes inside and outside the organization. In order to satisfy these requirements we need to design and use a multidimensional model that is suitable for business model so we proposed in this paper a pyramidal model as an extension of the star schema or the galaxy schema but with different levels of representation and also with aggregate and hierarchies in fact tables. The advantages and disadvantages of the model are also discussed in this article.

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