Techniques of Turnovers' Evolution and Structure Analysis Using SQL Server 2005

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Abstract. The turnovers' evolution and structure analysis can provide many useful information for the construction of a viable set of policies for products, prices and retail network. When the analysis deals with large quantities of raw data, one of the solutions that guarantees the rigorous treatment of the data is the use of a software system based on a data warehouse.

Key words: data warehouse; analysis; modeling; table; dimension.

SQL Server 2005 allows, through its *Business Intelligence* instruments, the use of specific financial analysis techniques on the data collected from the enterprise's information systems.

The general architecture of the software system used for the analysis of the turnover's evolution and structure is presented in figure 1:

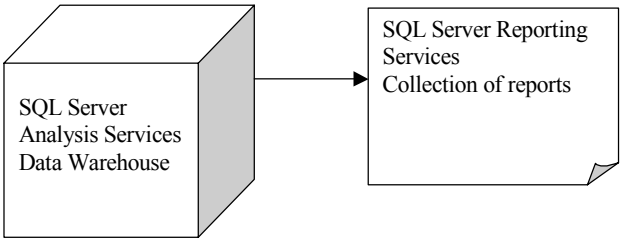

Figure 1. *The general architecture of the software system*

The software system is divided into two sub-systems:

a) A data warehouse, which contains the data to be analyzed;

b) A collection of reports, (stored inside a report server), which presents the results obtained from the turnovers' evolution and structure analysis.

1. The data warehouse

The data warehouse includes the following components:

a) The data source;

b) Data staging area;

c) The data warehouse.

a. The data source

The data source for the turnovers' analysis system is represented by the application used to manage the sales activity. This application has a SQL Server database as back-end.

b. The data staging area

The data staging area is represented by a relational SQL Server database, named *VANZARI_PREGATIRE*. The database diagram is shown in figure 2:

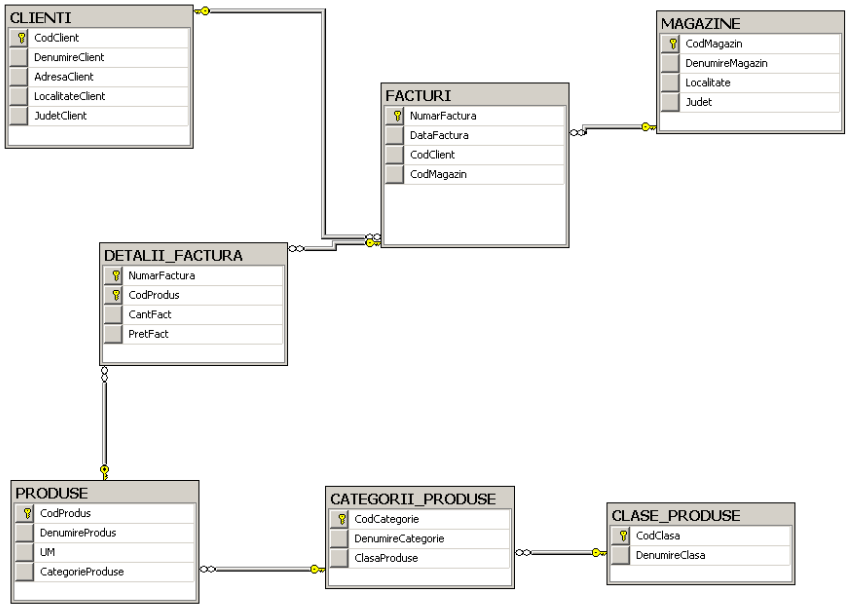

Figure 2. *Data staging area (database diagram)*

Upon completion of the data preparation operations, the database named *VANZARI_PREGATIRE* will become the data source for the data warehouse.

c. The data warehouse

In order to analyze the evolution and the structure of the turnover, I have built a data warehouse (named *ANALIZA_VANZARI*). I have used the principles of dimensional modeling for the definition of the data warehouse structure, considering the following aspects (determined by the characteristics of the activity in the studied enterprise):

- The turnover's evolution and structure analysis will focus on the sales revenue, so the facts will be represented by the individual sales operations, distinguished within two tables: *FACTURI* and *DETALII_FACTURA*. The measure of the activity will be the value of each operation (calculated as product between the quantity sold and the sales price);
- The dimensions of the data warehouse will include the criteria taken into account during the analysis (the products and the stores), as well as the time – a crucial element for any data analysis attempt, regardless what kind of methodology is used to support it (economical and financial analysis, statistics, etc.).

The conceptual model of the data warehouse is shown in figure 3:

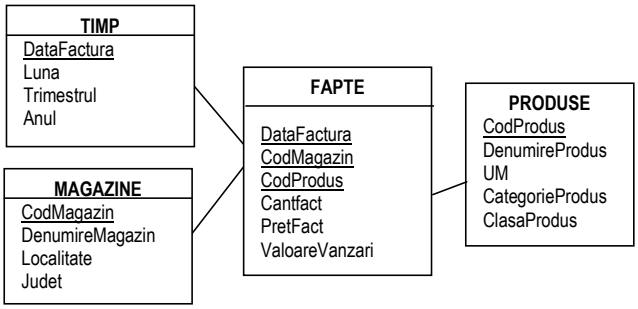

Figure 3. *Conceptual model for the ANALIZA_CA data warehouse*

The development of the data warehouse requires the construction of the dimensional and fact tables, inside the database used as data source (*VANZARI_PREGATIRE*). These operations are described in the following section.

- The creation of the table named *FAPTE_DS*, which will furnish the data for the fact table of the data warehouse. The following diagram shows the syntax of the stored procedure which accomplishes this operation:

```
CREATE PROCEDURE [dbo].[spGENERARE_TABEL_FAPTE]
AS
BEGIN
    SET NOCOUNT ON;
SELECT F.DataFactura, P.Codprodus, F.CodMagazin,CantFact, PretFact, CantFact*PretFact AS ValoareVanzari
INTO FAPTE_DS
FROM FACTURI AS F INNER JOIN (DETALII_FACTURA AS DF INNER JOIN PRODUSE AS P ON P.CodProdus=DF.CodProdus) ON
       F.Numarfactura=DF.Numarfactura
END
```

- The creation of the table that will become the source for the time dimension (*TIMP*). I have used a stored procedure (named *spGENERARE_TIMP*), which extracts the data of the operations from the fact table and generates the month, trimester and year for each data:

```
CREATE PROCEDURE [dbo].[spGENERARE_TIMP]
AS
BEGIN

    SET NOCOUNT ON;
SELECT DISTINCT DataFactura, MONTH(DataFactura) AS Luna,
    CASE
        WHEN MONTH(DataFactura)>=1 AND MONTH(DataFactura)<4 then 1
        WHEN MONTH(DataFactura)>=4 AND MONTH(DataFactura)<7 then 2
        WHEN MONTH(DataFactura)>=7 AND MONTH(DataFactura)<10 then 3
        ELSE 4
    END
    AS Trim,
    YEAR(DataFactura) AS ANUL
INTO DIMENSIUNEA_TIMP
FROM FAPTE_DS
ALTER TABLE DIMENSIUNEA_TIMP ALTER COLUMN DataFactura DATETIME NOT NULL
ALTER TABLE DIMENSIUNEA_TIMP ADD PRIMARY KEY (DataFactura)
END
```

- The construction of the table which will provide the structure and the members for the *PRODUSE* dimension. Since the conceptual model of the *ANALIZA_VANZARI* data warehouse is based on a star schema and the dimensional table named *PRODUSE* has not the same structure as the corresponding table from the source database, it is necessary to create a new table, in order to reflect all the levels of the hierarchy for the *PRODUSE* dimensions (including the product classes and categories).

```
CREATE PROCEDURE spGENERARE_PRODUSE
AS
BEGIN
    SET NOCOUNT ON;
SELECT P.CodProdus,P.DenumireProdus,P.UM,CP.DenumireCategorie,CL.DenumireClasa
INTO DIMENSIUNE_PRODUSE
FROM PRODUSE AS P INNER JOIN (CATEGORII_PRODUSE AS CP INNER JOIN CLASE_PRODUSE AS CL
        ON CL.CodClasa=CP.ClasaProduse) ON CP.CodCategorie=P.CategorieProduse
ALTER TABLE DIMENSIUNE_PRODUSE ALTER COLUMN CodProdus INT NOT NULL
ALTER TABLE DIMENSIUNE_PRODUSE ADD PRIMARY KEY (CodProdus)
END
GO
```

The creation of the data warehouse using SQL Server requires the following operations:

- Defining a data source connected at the *VANZARI_PREGATIRE* database
- Defining a data source view for the previously configured data source.
- Based upon the data source view that has been configured during the previous step, one or more cubes can be defined inside the data warehouse. For the proposed analysis, I have defined a cube named *cubANALIZA_DS_CA*, with the structure shown in figure 4:

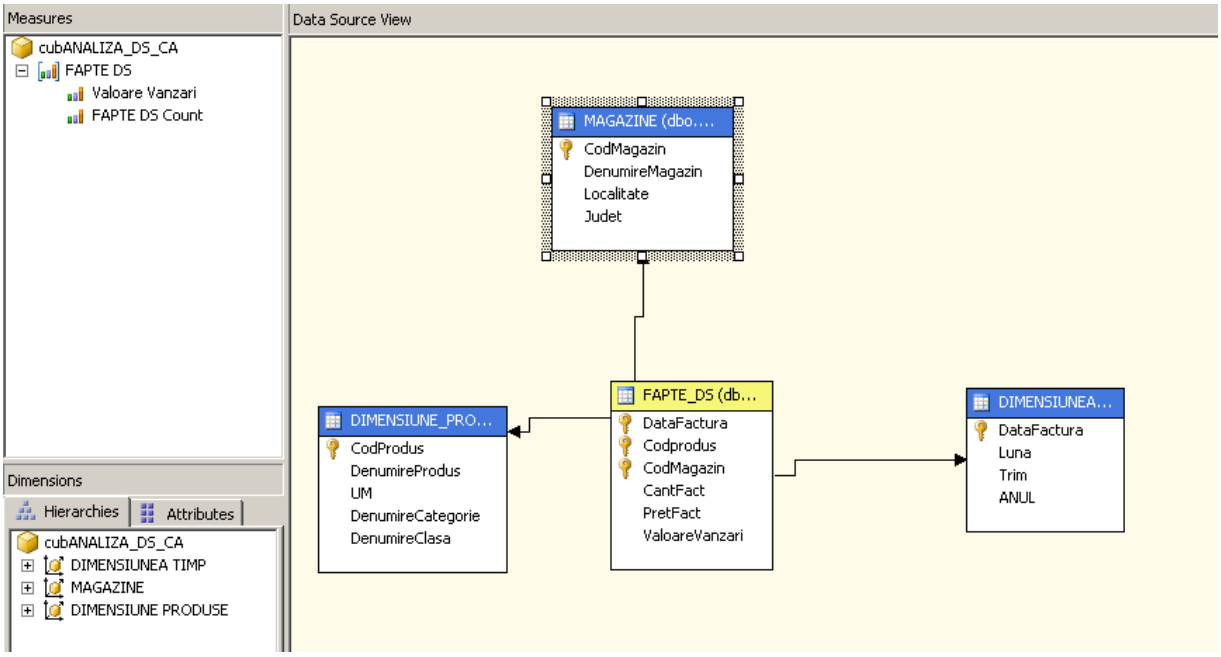

Figura 4. *The structure for the cube named cubANALIZA_DS_CA*

For the studied enterprise, the analysis will aim to describe the structure and the evolution of the turnover grouped by the products offered by the enterprise, grouped into two classes and six categories (each class includes three categories);

Remark: the customer-based analysis has an insignificant informational value, since the enterprise has many customers and the repeatability of purchase is reduced.

After the load of the data warehouse (operation named *cube processing* in SQL Server), the data can be analyzed using the available *Business Intelligence* instruments.

2. Data analysis

Data analysis is based on the methodology of turnover's evolution and structure analysis. The data are extracted using the MDX language (the used interface is the SQL Server Reporting Services query generator), and the results are presented in a set of reports.

a. The overall analysis of the turnover's evolution and structure

The following MDX query extracts from the *cubANALIZA_DS_CA* cube the values of the turnover for the three considered years, as well as the values representing the indicator's dynamics (2005 against 2004, respectively 2006 against 2005). For extracting the values representing the evolution, the query uses two calculated members *[DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2005]* and *[DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2006]*):

```
WITH MEMBER [DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2005] AS
[DIMENSIUNEA TIMP].[ANUL].[2005]-[DIMENSIUNEA TIMP].[ANUL].[2004]
MEMBER [DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2006] AS
[DIMENSIUNEA TIMP].[ANUL].[2006]-[DIMENSIUNEA TIMP].[ANUL].[2005]
SELECT {[MEASURES].[VALOARE VANZARI]} ON COLUMNS,
{[DIMENSIUNEA TIMP].[ANUL].[2004],[DIMENSIUNEA TIMP].[ANUL].[2005],
[DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2005],[DIMENSIUNEA TIMP].[ANUL].[2006],
[DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2006]} ON ROWS
 FROM [cubANALIZA_DS_CA]
```

Based on the query, I have built the report named *DINAMICA_CA_TOTAL*, whose preview structure is shown in figure 5:

Anul	Valoare Vanzari
2004	20,771,341.76
2005	21,394,367.27
2006	46,939,883.89
DINAMICA 2005	623,025.51
DINAMICA 2006	25,545,516.62

Figure 5. *Turnover's evolution, 2004-2006*

The report displays the values for the turnover during the three years for which the analysis is performed, as well as information about the turnover's evolution.

In 2005, the turnover has raised with 623.025,51 lei (3%). In 2006, the turnover was with 25.545.522 lei greater than in 2005 (1,19 times greater), following the significant development of the activity of the firm.

b. Product-based analysis of the turnover's evolution and structure

Considering the available data, the product analysis can be performed at three levels: product class, product category and product type. These three attributes reflects the three levels of the *PRODUSE* (products) dimension's hierarchy (as presented in fig. 6.):

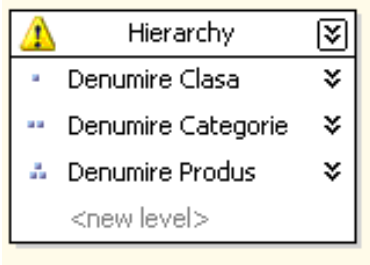

Figure 6. *The hierarchy for the PRODUSE dimension*

Taking into consideration these elements, the turnover's analysis methodology requires the drill-down from the level with the smallest granularity (product class) towards the level characterized by the greatest granularity (the product type). The definition of the hierarchy for the *PRODUSE* dimension is mandatory for the use of the *drill-up* and *drill-down* techniques, described in the following sections.

b1. Analysis of the turnover on product classes

In order to analyze the turnover on the product classes, I have used the following MDX query:

```
WITH MEMBER [DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2005] AS
[DIMENSIUNEA TIMP].[ANUL].[2005]-[DIMENSIUNEA TIMP].[ANUL].[2004]
MEMBER [DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2006] AS
[DIMENSIUNEA TIMP].[ANUL].[2006]-[DIMENSIUNEA TIMP].[ANUL].[2005]
SELECT {[MEASURES].[VALOARE VANZARI]} ON COLUMNS,
{[DIMENSIUNE PRODUSE].[DENUMIRE CLASA].[DENUMIRE CLASA].MEMBERS} ON ROWS,
{[DIMENSIUNEA TIMP].[ANUL].[2004],[DIMENSIUNEA TIMP].[ANUL].[2005],
[DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2005],[DIMENSIUNEA TIMP].[ANUL].[2006],
[DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2006]} ON PAGES
FROM [cubANALIZA_DS_CA]
```

As well as the query previously presented, this query uses two calculated members to reflect the evolution of the turnover. Also, the analysis for product classes has required the definition of the third axis of the query (the *PAGES* axis)

The report shown in figure 7 presents the data obtained through the analysis:

	2004	2005	2006	DINAMICA 2005	DINAMICA 2006
Materiale auxiliare finisaje	14,319,405.29	13,024,018.07	30,866,537.00	-1,295,387.22	17,842,518.93
Materiale finisaje	6,451,936.47	8,370,349.20	16,073,346.89	1,918,412.73	7,702,997.69

Figure 7. *Turnover's structure and evolution, detailed for each product class*

The report uses the conditional formatting options to emphasize the negative values. This way, the readers can easier observe the decrease of sales for the "*Auxiliary finishing materials" („Materiale auxiliare pentru finisaje"*) in 2005 against 2004.

In 2005, the sales value for "*Auxiliary finishing materials"* has decreased with 9,05%, generating a negative influence on the evolution of the turnover. If the sales amount for auxiliary materials had remained the same, the turnover had increased with 1.295.387,22 lei. The evolution of the sales amount corresponding to "*Finishing materials*" ("*Materiale pentru finisaje*") determined the rise of the turnover with 1.918.412,73 lei (29,73%).

In 2006, the sales amount for the "*Finishing materials*" class of products has recorded a 7.702.997,52 lei increase; and the sales for the „*Auxiliary finishing materials*" class have increased by 17.842.518,48 lei. The latest class contributed with 69,85% at the overall increase of the turnover, while the other class of products ("*Finishing materials*") had a contribution of 30,15% (their sales amount recorded a 92,03% growth).

As for the structural evolution, in 2005 the weight of the "*Finishing materials*" class has gained 8 percent points, while in 2006 the auxiliary materials gained 4,9 points in the structure of the turnover.

b2. Category-based analysis of the sales amount

While aiming to describe in detail the evolution of the turnover for each product category, it is necessary to use a drill-down operation for the "*DENUMIRE CLASA"* level of the *PRODUSE* dimension. The following query retrieves the necessary information from the data warehouse:

```
WITH MEMBER [DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2005] AS [DIMENSIUNEA TIMP].[ANUL].[2005]-[DIMENSIUNEA
 TIMP].[ANUL].[2004] MEMBER [DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2006] AS[DIMENSIUNEA TIMP].[ANUL].
[2006]-[DIMENSIUNEA TIMP].[ANUL].[2005]
SELECT {[MEASURES].[VALOARE VANZARI]} ON COLUMNS,
{[DIMENSIUNEA TIMP].[ANUL].[2004],[DIMENSIUNEA TIMP].[ANUL].[2005],[DIMENSIUNEA TIMP].[ANUL].[DINAMICA
 2005],[DIMENSIUNEA TIMP].[ANUL].[2006],[DIMENSIUNEA TIMP].[ANUL].[DINAMICA 2006]} ON ROWS,
DRILLDOWNLEVEL({[DIMENSIUNE PRODUSE].[Hierarchy].[Denumire Clasa].MEMBERS}) ON PAGES
FROM [cubANALIZA_DS_CA]
```

Following the usage of the *Drilldownlevel* function, the report that was build on the previously presented query offers to its beneficiaries the option to view either the grand totals (the amounts corresponding to the product classes), either the detailed information (at product category level). A set of expand-like buttons within the report allows the users to switch between the two options (a button is attached to the label of each category). The structure of the report is shown in figure 8:

		2004	2005	2006	DINAMICA 2005	DINAMICA 2006
⊟ Materiale auxiliare finisaje		14,319,405.29	13,024,018.07	30,866,537.00	-1,295,387.22	17,842,518.93
	Adezivi	9,063,603.02	8,119,280.87	14,438,038.92	-944,322.15	6,318,758.05
	Gleturi	2,286,529.68	1,678,834.43	4,939,387.78	-607,695.25	3,260,553.35
	Vopsele	2,969,272.59	3,225,902.77	11,489,110.30	256,630.18	8,263,207.53
⊟ Materiale finisaje		6,451,936.47	8,370,349.20	16,073,346.89	1,918,412.73	7,702,997.69
	Faianta	136,223.15	1,337,420.69	3,001,804.75	1,201,197.54	1,664,384.06
	Gresie	5,584,015.29	3,673,110.08	7,650,175.12	-1,910,905.21	3,977,065.04
	Parchet	731,698.03	3,359,818.43	5,421,367.02	2,628,120.40	2,061,548.59

Figure 8. *Turnover's evolution, by classes and categories of products*

For each class of products, the report shows on the first line the subtotals of the annual sales amounts and the dynamics corresponding to the product classes and the following rows describes the values for the product categories associated with the respective class. The negative values are emphasized (displayed using a different color).

In 2005, the sales for auxiliary materials have decreased by 1,295,387 lei. This evolution was mainly determined by the decrease (by 10 percents, 944,322.15 lei), of the sales for the "*Adhesives"* ("*Adezivi"*) products. The sales of the "*Gleturi"* category have decreased with 607,695.25 lei (26.58%, against the value from 2004, thus manifesting an unfavorable influence on the turnover's evolution). The only positive evolution was recorded for the "*Painting Materials"* ("*Vopsele"*) category, a growth of 256,630.18 lei (8.64%).

The sales corresponding to the finishing materials has increased with an amount of 1,918,412.73 lei. This happened largely due to the evolution of the sales for the "*Parquetry"* (*Parchet*) category, which have grown with 2,628,120.40 lei (more than 3.5 times), a value that is 1.36 times greater than the overall evolution for the entire product class. The evolution for the "*Faience"* ("*Faianță"*) category was also favorable, being recorded an increase with 1,201,197.54 lei (8.8 times grater against the value corresponding to 2004), which accounts for 62.61% from the overall evolution at class level. The sales for "*Gritstone*" ("*Gresie")*, have decreased with an amount of 1,910,905.21 lei, a value close to the evolution of sales for the entire class.

In 2006, the sales for auxiliary materials have grown with 17,842,518.93 lei. Same as in 2005, the most favorable evolution was the one for painting materials, whose sales amount increased with 8,263,207.53 lei (3.5 times), accounting for 46.31% from the evolution of sales of the entire product class (because the sales amounts for all of the three categories of products have increased, the weight of the dynamics of each category in the overall evolution can be quantified). The sales of adhesives have increased with 6,318,758.05 lei (77.82%), their contribution at the evolution of sales inside the product class was 35.41%. The sales for *Gleturi* have increased more than three times, by 3,260,553.35 lei, thus contributing with 18.27% at the evolution of sales for their class.

As for the finishing materials, their respective sales amount has increased with 7,702,997.69 lei against the values from 2005. The main factor that has determined this evolution was the growth with 3,977,065.04 lei of the sales for gritstone, which accounted for 51.63% in the total value of sales dynamics. The parquetry products have recorded an increase of 2,061,548.59 lei (61.36%), this growth representing 26.76% from the evolution of the class sales. The smallest influence has manifested for the category *Faience*, whose growth, 1,664,384.06 (124%) accounts for 21.6% of the total increase for the product class.

In 2006, for the finishing materials, the weight of the sales amount for *Parquetry* category increased (from 11.3% to 40.1%), also, the weight for the *Faience* category grew from 2.1% to 16%. In return, the weight for the *Gritstone* category decreased, from 86.5% to 43.9%.

The auxiliary finishing materials class has recorded the following structural evolutions:

- The weight for the painting materials has increased, from 24.8% to 37.2%;
- The weight corresponding to adhesives decreased (from 63.3% to 62.3%);
- The weight for the *Gleturi* category has decreased with 3.1 percentage points, from 16.0% to 12.9%.

In 2006 against 2005, inside the finishing materials class, the weight for the *Grtistone* category grew by 3.7 percentage points. The weight for the *Faience* category has increased by 2.7 percentage points, and the weight for the sales of *Parquetry* decreased from 40.1% to 33.7%.

As for the auxiliary finishing materials, it can be observed the decrease of the weight of the adhesives, from 62.3% to 46.8%. The sales for painting materials have accounted for a weight of 37.2%, a value greater than in 2005, when their weight was 24.8%. The weight for *Gleturi*, has reached a value of 16%.

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