Business Intelligence in Telecommunications Industry

by
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*Abstract***.** In today business, meeting customer satisfaction is a must. The organizations have to integrate the large volumes of data available and to use this information to support the quality of their decision-making, in order to stay at a competitive advantage and to increase profit. This paper presents a log data analytical process in telecommunication industry, for business intelligence interested in analyzing customer and behavioral data to improve their understanding of customer loyalty and customer preference. A data mining process to achieve key customer management objectives is presented. This paper provides a proven data analytical method used to identify variety kinds of characteristics in telecommunication industry.

*Key words***:** business intelligence, customer satisfaction, data warehouse, data mining, customer management, data analysis
JEL Classification**:** M21, C88, I31, O33

1 Introduction

The interrelationships with suppliers, customers, distributors, and other business that are needed to design, build and sell a product make up the network of business entities, relationships, and processes that is called a supply chain. Business Intelligence (Castellanosm and Dayal, 2008) involves the integration of core information with meaningful business information to detect significant events, discover new business scenarios and predict business situations. It includes the ability to monitor business trends, to evolve and adapt quickly as situations change and to make intelligent business decisions on uncertain judgments and contradictory information. The paper tries to identify the role of business intelligence in supply chain management.

While studying the role of business intelligence applied to supply chain management I understood that it is about more than just simple reporting, the key to creating a truly successful strategy is through a blend of business intelligence and data integration technologies.

Business intelligence techniques are finding their applicability in various fields like: government, financial services, retail and telecommunication industry. Among these we have chosen to illustrate the role of business intelligence in telecommunications. BI therefore does improve profitability in the telecommunication industry and can help management to define strategies, support decision making, search for opportunities, identify problems and substantiate actions.

The main goals of this paper are to help monitor, analyze and provide key performance indicators (KPIs) on sales by product, region, distributor, partner, or sales representative using personalized BI dashboards and intuitive business intelligence reports. First, we will describe the importance of supply chain management and how it can be improved through the key performance indicators.

On the route between source represented by supplier and destination represented by customer are defined a set of key performance indicators related to: the availability to customer, inventory and supply chain costs optimization in our telecom group extended network and robustness, efficiency and agility of supply chain framework. We compare the efficiency of these indicators by taking in consideration their critical levels. The data are from the internal database of one telecom group. Second, we examine the evolution of these indicators during the last years and the effect of the measures taken in order to improve them. Finally we provide a list of reports showing the results of the improvements year by year and we try to find out the causes that

prevent the obtaining of optimal values of the indicators.

Our results based on reports, forecasts and information regarding sales, inventory, estimates, trends based are designed to help us in taking decisions in order to respond accurately to business needs and to ensure customer satisfaction. Afterwards, the results of our decisions will be reflected in terms of profitability and smooth running of the company. The results during the last years prove us an increase of expected values of KPI followed by material gains and a diversification of customer portfolio.

The paper has the following structure: Section 2 describes the BI technologies and their evolution followed by the fields of applicability. In Section 3 the role of supply chain management is presented and how its importance has increased in the last years. Section 4 offers a view of telecom industry in Romania and its evolution. In Section 5 the case study is presented starting with the description of software used, the database schema and continuing with the reports generated and the decision taken based on them. Section 6 concludes and it offers suggestions for future investigation.

2 Literature review

In today business, meeting customer satisfaction is a must. The organizations are becoming more and more conscious about the advantages of data and information kept in their organization, the need to integrate these large volumes of data and to utilize these information to support the quality of their decision-making, in order to stay at a competitive advantage and to increase profit.

In this paper a comprehensive literature review for supply chain improvements is proposed and applied to a case study in telecom industry. Most of the literature has focused on coordinating pricing and replenishment decisions. This paper provides a proven data analytical method used to identify variety kinds of characteristics in telecommunication industry.

The increased globalization, demand oriented customers, and tougher competition have forced companies to focus their attention on the strategic issues of planning, controlling and designing a supply chain as a whole rather than on effectiveness and efficiency of separate business functions within its own.

With true business intelligence, the supply chain manager and other teams and individuals engaged in aspects of the supply chain can create reports and personalized dashboards and alerts to establish objective goals and key performance indicators (KPIs) and monitor shipment systems and other enterprise applications using an integrated, single view of data.

The popularity of data mining in the telecommunications industry can be viewed as an extension of the use of expert systems. Data mining in the telecommunications industry faces several challenges, due to the size of the data sets, the sequential and temporal nature of the data, and the real-time requirements of many of the applications. Weiss presets new methods developed and the existing ones that have been enhanced to respond at these challenges. The competitive and changing nature of the industry, combined with the fact that the industry generates enormous amounts of data, ensures that data mining will play an important role in the future of the telecommunications industry.

In his research, Singh shows that data mining tools are capable of discovering patterns in data in few hours those expert human quantitative analysts might not find in years of work to help make decision in complex supply chain management, customer relationship management collect and analyze transaction records continuously. It is focused on mainly on automated methods for extracting patterns or models from data.

Telecommunication companies today are operating in highly competitive and challenging environment. Data Mining and BI applications (Vercellis, 2009))play a significant role in the telecommunication industry due to the availability of large volume of data and the rigorous competition in the sector. Joseph

(2013) presents in his paper the primary application areas including marketing and Customer Relationship Management, Fraud detection and Network Management. The recent developments in the Data Mining and BI fields and the implementation and enhancement of existing techniques and methods ensure the continuous growth and compatibility of telecommunication companies that make use of them.

Choy, Kenny and Victor (2003) found that the long-term success of a firm depends on the reliability of its suppliers and level of satisfaction of its customers. Collaborative relationship between customer and supplier has positive significant influence to SCM performance improvement.

Inventory reduction is one of the main objectives of SCM (Pagel 1999). It is also the most commonly shared data among the supply chain partners (Lee & Whang 2000). Therefore, several researchers have explored the ways to reduce the inventory in a supply chain.

Regarding order fulfillment, Sahay (2003) observed that it was the second most important supply chain issue in Indian companies. Companies were paying maximum time and attention to improve order fulfillment.

Yao (2005) investigates the impact of providing a return policy for unsold goods to two competing retailers facing uncertain demand. Adopting the classic newsvendor problem model framework and using numerical study methods, the study finds that the provision of a returns policy is dependent on the market conditions faced by the retailers.

The main purpose of the literature review is to look at some major issues in business intelligence and supply chain management literature and to present a framework for classification and analysis. The objective is to highlight how different subject literatures have contributed work in BI and supply chain management from different perspectives.

3 Methodology

The increased globalization, demand oriented customers, and tougher competition have forced companies to focus their attention on the strategic issues of planning, controlling and designing a supply chain as a whole rather than on effectiveness and efficiency of separate business functions within its own. The ultimate success of a company depends on how the company integrates its supply chain. It is the capability of the supply chain that determines the competency to get the customer orders and meet customers' requirements.

Many companies have made efforts to improve their managerial capabilities in supply chain management to tackle the supply chain problems. As organizations recognize the expense, importance and value hidden along the steps in the supply chain, most enterprises have turned to supply chain reporting and enterprise analysis in an attempt to establish goals and metrics, and monitor results – all in an effort to control costs, optimize resources and ensure customer and partner.

With true business intelligence, the supply chain manager and other teams and individuals engaged in aspects of the supply chain can create reports and personalized dashboards and alerts to establish objective goals and key performance indicators (KPIs) and monitor shipment systems and other enterprise applications using an integrated, single view of data.

In telecom industry BI is used to monitor, analyze and provide key performance indicators (KPIs) on sales by product, region, distributor, partner, or sales representative using personalized BI dashboards and intuitive business intelligence reports.

On the route between source represented by supplier and destination represented by customer are defined a set of key performance indicators related to: the availability to customer, inventory and supply chain costs optimization in our telecom group extended network and robustness, efficiency and agility of supply chain framework.

The supply chain performance can be improved through the key performance indicators.

They refer to:

- supply performance (supply chain lead time as average, variability, service level,

procurement lead times, production lead times, distribution lead times, inventory levels, inventory coverage, work in process levels, stock out levels or product availability)

- customer oriented performance (delivery lead time, average, variability, service level, various service levels)
- supply chain costs (manufacturing and assembling costs, transportation costs, warehousing costs)
- supply chain processes performances (forecasting accuracy, inventory accuracy)

The essential steps towards efficient KPIs implementation are to: choose the right KPI depending on the goal associated with the performance measurement define the KPI precisely and without ambiguity, make sure the KPI is measured accurately according to the definition.

Measures and key performance indicators:

- Inventory coverage, slow moving stock and sales trend
  - How many days of sales are covered by actual inventory:

Inventorycoverage = inventory/last week sales average

It is indicated to be less than 17.

- salestrend = moving average on 1 week sales;
- slow moving stock = stock with no sales during the last 15 days;

- Sold out rate represent the percentage of sales entailing a stock out during a day.

$$\frac{\sum \text{Sales on product th at lead to a stock} = 0 \text{ at end of the day}}{\text{Total daily sales}} \quad (2)$$

The value of sold out rate is indicated to be less than 5%.

- Non-deployment rate means the non-availability of the product range (for a given product category all phones enable to ordering from central warehouse) at the beginning of the day.

$$\frac{\sum \text{Products x } \sum \text{Point of sale with stock} = 0 \text{ at the beginning of the day}}{\text{Total combinatio n of PoS x products in a given day}} \quad (3)$$

The value of sold out rate is indicated to be less than 5%

- Stock ageing label purpose of the KPI is to monitor overall inventory management condition through stock ageing structure analysis.

The KPI follows ABC classification principles,

where Class A: 80%, Class B:15%, Class C: 5%, Obsolete> 0%.

$$AST_{class} = \frac{\sum \text{Inventory of the class}}{\sum \text{All inventorie s}} \quad (4)$$

$$DEL_{\%Total} = \sum AST[\text{Absolute value}] \quad (5)$$

- Inventory Coverage label monitor working capital evolution in country central warehouse.

$$\frac{\sum \text{Stock on hand : end week [units]}}{\text{Past shipments 3 weeks average : weekly [units]}} \text{ x \# of week days} \quad (6)$$

The value of inventory coverage is indicated to be less than 20 days.

- Pre-shortage rate label is calculated weekly when stock on hand < 5 days on phone (SKU) level.

$$\sum \frac{\sum \text{Shipment [average 3 weeks]} - \text{End of week stock level}}{\text{Total Shipment [average 3 weks]}} \quad (7)$$

The pre-shortage rate is indicated to be less than 5%.

An approach of measurement and of monitoring of indicators is a prerequisite to the achievement of an enduring performance within the company.

Data mining tools are capable of discovering patterns in data in few hours those expert human quantitative analysts might not find in years of work to help make decision in complex supply chain management, customer relationship management collect and analyze transaction records continuously.

A database containing these indicators will be processed using Qlikview, a business intelligence software which combines the features of dynamic presentations, instantaneous data manipulation, and real-time data analysis. Further data will be analyzed and as a result will be provided reports, forecasts and information regarding sales, inventory, estimates, and trends based on which people like the supply chain manager, an executive or an end user with a role in the supply chain will take decisions in order to respond accurately to business needs.

4 Empirical study

For drawing up reports in QlikView can be used various data sources from Excel to SAP tables. The application was built from several Excel files that simulate a complex database of a telecommunication company. Each table contains a total of 50 records, registered in from 1st of March to 18th of April 2013.

Loading data and linking tables represent the most important steps. As can be seen in annex 1, the database consists of 5 tables. Central table is the table of facts and is the source of the cube measures and dimension tables are the sources of sizes. The significance of the attributes in each table is explained in detail in annex 2. Star schema is the most common data model, where the data warehouse contains a central voluminous table (facts table) and an accompanying set of tables (dimension tables) for each dimension. Facts table contains most of the data with no redundancies. The associated graph resembled a star in which dimension tables are displayed radial around the central fact table.

Database schema has four dimensions: time, products, customers and stores. The scheme includes a central table that contains key performance indicators for each of the four dimensions. In this star schema each dimension is represented by a single table and each table contains a set of attributes.

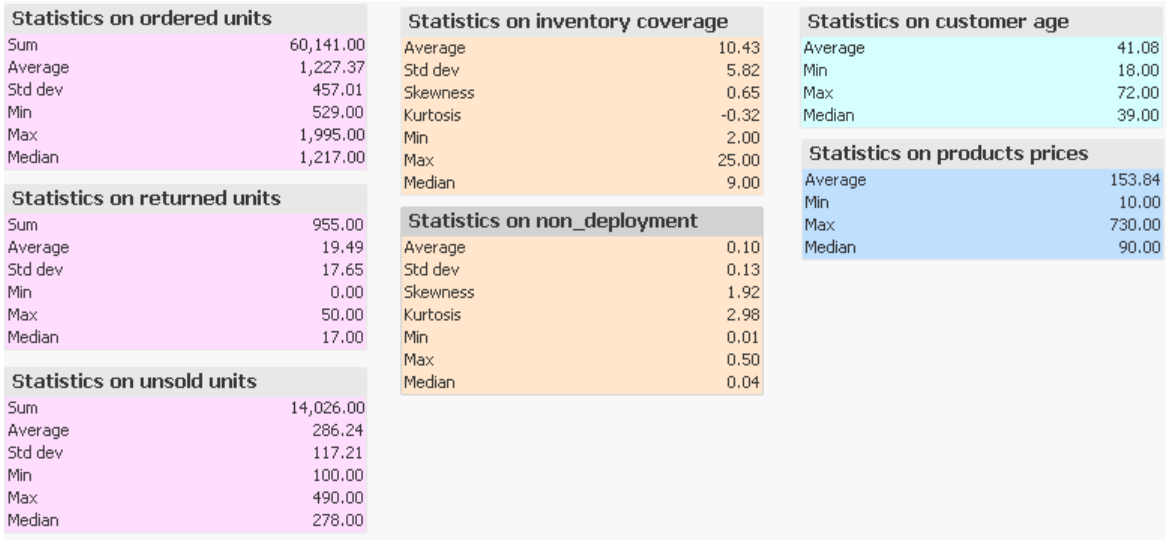
Analyzing the summary statistics of each attribute is an essential step in data mining process. However, this is insufficient as it does not consider the correlations that may exist between variables which are the most important.

Since we have a large number of attributes, we will perform the descriptive analysis on the most important KPI as: ordered units, returned units, unsold units, inventory coverage and non-deployment rate. These indicators are really essentials in supply chain process. The attributes regarding the customer age are of key importance to identify the target market in order to best serve and advertise directly to the real customers. In addition the most important attribute of the product, the price has to be considered and adjusted to attract customers on the one hand and drive to make profits on the other hand.

Analyzing the summary statistics table it is revealed that during 50 days (from March to April 2013) the total value of products ordered was 60,141 units, with a daily average of 1227 pieces. The minimum value of sold pieces is 529 pieces and the maximum value is about 2000 units. The value of the median is very close to the average, and therefore we can say that in 25 days the number of products sold is under 1217 units daily, and in the other 25 days analyzed the number of products sold daily exceeds this value.

On average, 286 products per day remain unsold taking into consideration that the number of sold products is 1227 pieces, which indicates a high degree of sales.

In terms of the products that register malfunctions we find an average of 20 pieces representing a rate of 1.6% of the sold products.



Statistics on ordered units	
Sum	60,141.00
Average	1,227.37
Std dev	457.01
Min	529.00
Max	1,995.00
Median	1,217.00

Statistics on returned units	
Sum	955.00
Average	19.49
Std dev	17.65
Min	0.00
Max	50.00
Median	17.00

Statistics on unsold units	
Sum	14,026.00
Average	286.24
Std dev	117.21
Min	100.00
Max	490.00
Median	278.00

Statistics on inventory coverage	
Average	10.43
Std dev	5.82
Skewness	0.65
Kurtosis	-0.32
Min	2.00
Max	25.00
Median	9.00

Statistics on non_deployment	
Average	0.10
Std dev	0.13
Skewness	1.92
Kurtosis	2.98
Min	0.01
Max	0.50
Median	0.04

Statistics on customer age	
Average	41.08
Min	18.00
Max	72.00
Median	39.00

Statistics on products prices	
Average	153.84
Min	10.00
Max	730.00
Median	90.00

Figure 2: Summary statistics
Source: data processing using QlikView Software

This indicator confirms quality of products provided by the telecommunication company. Although reducing the number of returned products cannot be controlled because already records a very low value, accepted both by client and by the company, its can only focus on solving technical problems as quickly, optimizing product route from client to services in order to repossess the product as quickly as possible.

Inventory coverage is a measure of the number of days of sales covered by the actual inventory. The value of inventory coverage is indicated to be less than 17 days. In this way the availability of the products can be ensured, a long period of storage can be avoided and also the depreciation costs of goods through technological devaluation can be removed. In the analyzed period the average of this indicator reaches 10 days, with a minimum of 2 days and maximum 25 days. Half of the values of this indicator are less than the median value (equal to 9 days) and the other half is above the median value. Given these values, we can say that the indicator is within normal limits.

Non deployment rate as a measure of the non-availability of the product range at the beginning of the day has to be as minimal as possible to assure the permanent availability of the products. The value of non-deployment rate is indicated to be less than 5%. Statistics show us that the medium value of this indicator during the analyzed period is 10%, being a little higher than the expected value. Also the maximum value of 50% is greater than the allowed. The significance is that one of the two clients cannot find the desired products in store. The median is another indicator which shows that the values of this indicator are ineffective. Thus, half of the values recorded meet the condition to be low values (below 4%), but the other half exceeds this level. The adoption of measures to reduce the values of this indicator are absolutely necessary, increasing in this way the availability of the products.

Availability is a particularly potent supply chain measure because ensuring that items are available when a customer wants them directly influences companies' short-term revenues. Increased collaboration with suppliers and external business partners is among the best ways for companies to improve availability without continuing to undermine turns or inflate inventories. Utilizing collaborative practices can drive down costs across the supply chain; companies that master this capability have an opportunity to create competitive advantage.

Considering statistics on client's age and on products prices we can easily find that both customer segment and products offered by the company enjoy variety. But considering business needs a recommendation would be to promote products of the latest technology that can offer a variety of features at competitive

prices.
We further consider a number of graphs and tables from which we can obtain information on the company's activity such as:

- graph on units ordered by supplier;
- graph on returned units by shop region;
- graph on ordered units by shop region;
- graph on percentage of customers per region;
- graph on unsold products per supplier;
- table with subtotals of ordered and unsold products grouped by region and supplier.

The following graph displays the total of ordered units by each supplier during the analyzed period of 50 days. It shows us consumer preferences for some suppliers over others.
This notes that Nokia with 20595 products ordered and Samsung with 19017 products ordered are the most popular among consumers. These products offer essential features at affordable prices. The fact that Apple products are not as ordered (only 2050 products sold) does not mean that they are not powerful enough or reliable. One explanation for this could be that Apple products are quite expensive, for which addresses a specific customer segment, namely the field of business. Correlating these results with the database we have notice that compressed air users are people with higher education.

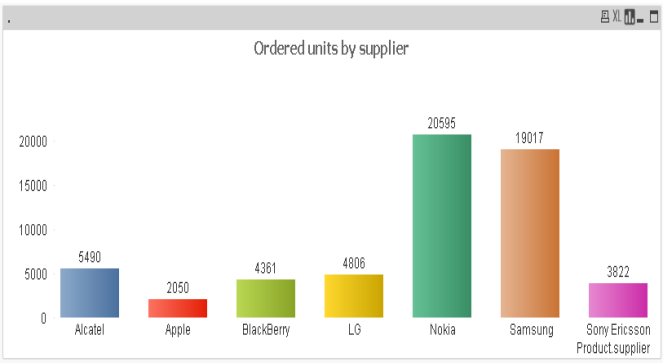


Figure 1: Ordered units by supplier
Source: data processing using QlikView Software

The second graph is also on ordered units considered this way on another dimension: that of the region of the shop where products have been sold. It can be observed that there are no great differences between sales by region, excepting Banat where recorded sales are significantly lower during the analyzed period: 815 products compared to other regions where sales exceed more than 1000 products. This can be explained by the non-availability of products that is felt especially in this area. Also, competition among telecommunications companies in this area is quite tight. It is therefore important to focus on providing our customers the products they need.

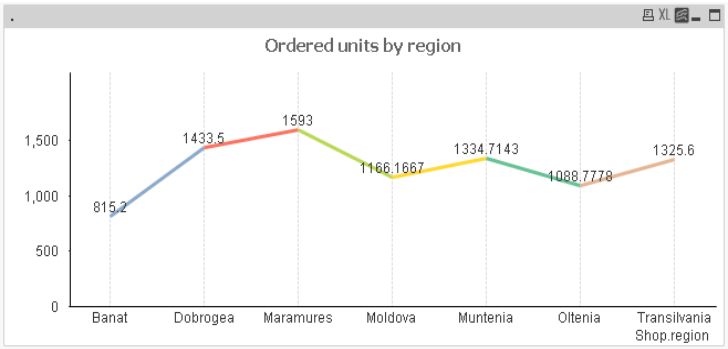


Figure 2: Ordered units by region
Source: data processing using QlikView Software

The graph on returned products presents their average number of each region. We can see that there are no large deviation between the average number of products returned for each region, for which we can affirm that it as a random factor and not a specific one related to the firm activity.
The two regions: Dobrogea and Muntenia where the average on returned products is slightly higher approximately 28 and 14 are regions that record the highest sales and hence a justification for this fact.

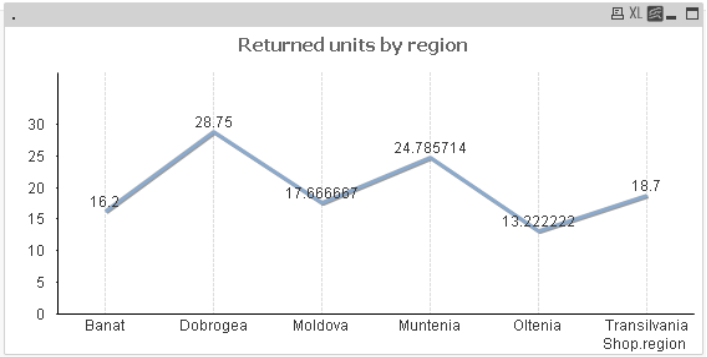


Figure 3. Returned units by region
Source: data processing using QlikView Software

The percentage of customers by region can be

of real help in identifying where exactly must use promotion techniques. We note that 86% of our customers are concentrated in regions from central-east and central-south. The company has to focus in order to gain new customers in north-west and south-east of the country first of all by ensuring the availability of the products, promoting products and services and providing a competitive report quality-price.

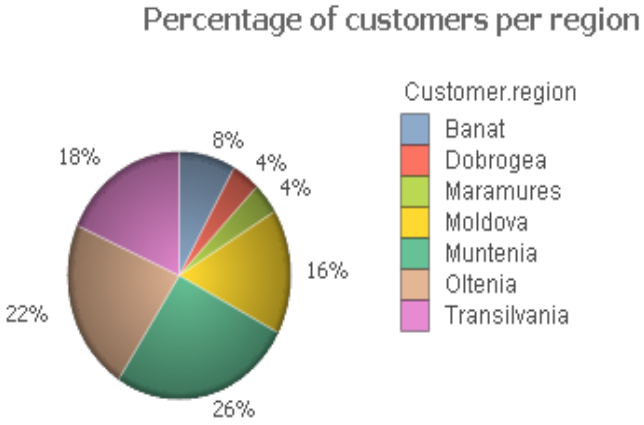


Figure 4: Percentage of customers per region.Source: data processing using QlikView Software

The graph presented below illustrates the percentage of unsold products per each supplier. The percentages are subject to normal limits and did not cause problems for any of the suppliers. The best percentage: 12.12% is recorded by Sony Ericsson as a result of its products at low prices. It is followed by BlackBerry with 16.5% due to its great demand among companies.

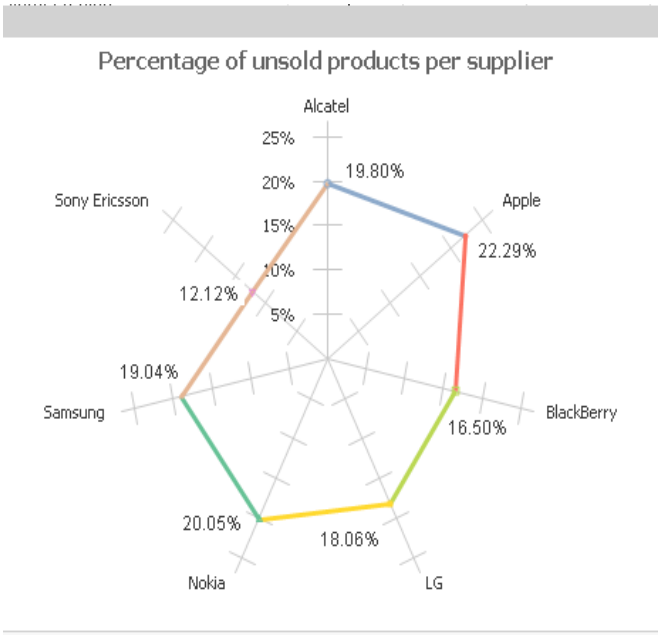


Figure 5: Percentage of unsold products per supplier Source: data processing using QlikView Software

In the following is presented a complex report which gives us access to the values of ordered and unsold products aggregated by region and supplier.

The purpose of this application is to create complex and dynamic reports that allow real-time access to information.

Table 1. Subtotals of ordered and unsold products grouped by region and supplier

supplier / Data	Alcatel		Apple		BlackBerry		LG	
region	Sum of ordered_units	Sum of unsold_units	Sum of ordered_units	Sum of unsold_units	Sum of ordered_units	Sum of unsold_units	Sum of ordered_units	Sum of unsold_units
Banat					529	204		
Dobrogea	1517	413	1346	209			876	124
Maramures								
Moldova	563	298			1962	401	1349	430
Muntenia	1856	281					2581	505
Oltenia	1554	363	704	379				
Transilvania					1870	257		
Grand Total	**5490**	**1355**	**2050**	**588**	**4361**	**862**	**4806**	**1059**

Nokia		Samsung		Sony Ericsson		Total Sum of ordered_units	Total Sum of unsold_units
Sum of ordered_units	Sum of unsold_units	Sum of ordered_units	Sum of unsold_units	Sum of ordered_units	Sum of unsold_units		
677	466	1858	290	1012	116	4076	1076
1995	474					5734	1220
		1593	173			1593	173
1480	259	1643	444			6997	1832
8908	2321	5341	1259			18686	4366
3878	734	2587	761	1076	133	9799	2370
3657	910	5995	1544	1734	278	13256	2989
20595	**5164**	**19017**	**4471**	**3822**	**527**	**60141**	**14026**

Source: data processing using QlikView Software

It enables to make discoveries in the data by choosing from a large variety of interactive visualizations. Once build, the application can be quickly and easily extended and enhanced to meet changing business needs. New data sources can be integrated, third-party or custom visualizations and images, and QlikView dynamically updates to reflect the changes.

5 Conclusions

Customer satisfaction is related with various factors such as: hope, loyalty, and complaint. Previously, surveying customer opinion in experiencing the products or services is a main tool to collect and analyze the data. Mobile market is becoming saturated and competitive in telecoms industry.

The activity in telecommunication industry takes place in real time, where no delays or misunderstandings are allowed. If these errors occur, they can cause the decreasing of the number of customers, complaints and a negative impact on the business process or on the normal workflow. That's why a good management in supply chain activity is crucial. It is important for our customers to find anytime the needed products. Also the return policy of products and guarantees must operate as efficiently. Attention is focused on minimizing both time and storage costs of products.

This paper presents a log data analytical process in telecommunication industry, for business intelligence interested in analyzing static customer data and dynamic behavioral data to improve their understanding of customer loyalty and customer preference. Leveraging the data of information systems is a crucial way to support the customer management. A data mining process to achieve key customer management objectives is presented. From findings of data analysis, the important attributes of the valuable/loyalty customers are revealed. This paper provides a proven data analytical method used to identify variety kinds of characteristics in telecommunication industry.

The generated reports assists corporate managers and decision makers to make relevant, accurate, timely and smart decision in an organization and thus lead to increase in productivity and profitability of an organization. The research has investigated the key performance indicators that have to be improved in order to increase customer satisfaction.

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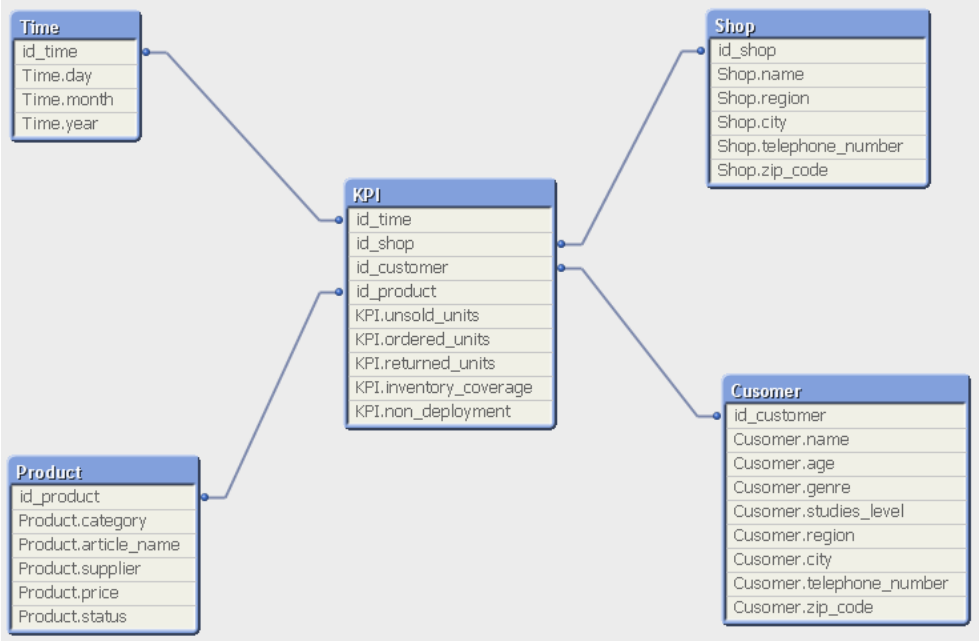
Annex 1: Star schema of data warehouse



Source: Relational database representation in QlikView Software

Annex 2. Attributes Description

1. Customer.xls - contains information relating to the clients of telecommunications company's products. Throughout we refer to the clients of products and not services. The file comprises the following attributes:
   - customer_id: each customer has an unique identifier. In this way the the connection whithin the database can be made.
   - name
   - age
   - genre
   - studies_level: education level of the client can be grouped into three categories: secondary education higher education or no education
   - region: region of the country where the customer originates
   - city: the city where the customer originates
   - telephone_number
   - zip_code

2. Shop.xls – contains data related to stores
   - id_shop: represent the unique identifier of the table
   - name: the name of the store
   - region: the region of the country where the store is located
   - city: the city where the store is located
   - telephone_number
   - zip_code
3. Time.xls – time is the dimension of the database that retains information structured in: day, month, year.

4. Product.xls – a table containing relevant data about the products.
   - Id_product: the key of the table
   - Category: this attribute represents the product category to which it belongs (eg phones, smartphones, accessories).
   - Article_name: the complete name of the product
   - Supplier: attribute that holds the name of the producing company
   - Price: the price of the product
   - Status: attribute that stores the phone status: sold, unsold or returned.
5. KPI.xls – is the most important table named the fact table that contains the foreign keys of the measures tables and also a series of measurable attributes. These attributes consist of relevant indicators calculated by the formulas developed in the methodology chapter. Values of the indicators were calculated based on data obtained from a telecommunications company.

- Id_time
- Id_shop
- Id_customer
- Id_product
- Kpi.unsold_units: represents the number of products available in stores
- Kpi.ordered_units: represents the number of products ordered and therefore sold
- Kpi.returned_units: represents the number of products returned due to technical malfunctions, which are forwarded to the services
- Kpi.inventory_coverage: represents slow moving stock and sales trend. It shows us how many days of sales are covered by actual inventory. It is indicated to be less than 17.
- Kpi.non_deployment: means the non-availability of the product range (for a given product category all phones enable to ordering from central warehouse) at the beginning of the day. It is indicated to be less than 5%.