# The use of information technology applyed to performance measurement systems

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## Summary

*To achieve competitive advantages, organizations have been using Performance Measurement Systems (PMS) to assess their business and Decision Support Systems (DSS) to help the decision making process. This article aims to introduce the PMS concepts and show how it can be combined with a DSS in an architecture based on Information Technology (IT) components. The proposed IT structure is capable of integrating the company's performance indicators into a single DSS to help managers to assess their business.*
*Keywords: Performance Measurement Systems, Decision Support Systems, Business Intelligence;*

## 1. Introduction

The increasing competition in the global market and the need for achieving competitive advanteges has forced organizations to find ways of measuring their performance in order to support decision making. In this scenario, the Performance Measurement Systems (PMS) have become the best alternative to monitor the business activites and suport the decision makers.

The PMS is an important tool to help managers in the proccesses of strategy deployment and improvement activities, due to the feedback and the variety of information it can provide. Once these systems need to be agile and analyze a great amount of data, an Information System (IS) may be the best way to make this work possible (Lima, Palma and Neri, 2005).

Bond et al. (2001) considers a hard job to define performance management, since it deals with a fisical/logical structure composed by equipments, people, data storage and data flux. A bad management of these components may lead to a inefficient PMS, where decision making will fail due to problems in the system architecture.

Therefore, this article aims to show how Information Technology (IT) can be used to improve the effectiveness of the PMS's. First is made a review about the principles of PMS, followed by some Business Intelligence (BI) technologies that are usually combined with the PMS to obtain better results from it. After is sugested an architecture that shows how IT and PMS can work together in general companies. Finaly, some considerations are discussed about the sugested structure.

## 2. Performance Measurement Systems

For many years, a lot has been discussed about how organizations should deal with the challenge of assessing their performance. In the beginning, financial measures were the only way to assess the performance of comercial organizations. According to Kaplan (1984), the financial measures fail to reflect changes in the competitive circumstances and strategies of

modern organisations. However, in the 1980's the companies started to realise that other types of performance indicators were needed because of the growing complexity of organisations and the market they compete (Kennerley and Neely, 2002).

The modern PMS's are composed by several kinds of performance indicators (PI). Gil (1992) explains that indicators can be used to measure the efficiency and effectiveness levels of a organisation or part of it. An indicator is a quantitative value realised for a certain period of time that provides informations about the characteristics, atributes and results of a product, service, process or system (Neely et al., 1997). Neely, Gregory and Platts (1995) presented the following classification for the performance measures:

- *Quality Measures*: indicators related to the conformance to specification, number of defects and cost of qualiy;
- *Time Measures*: measures related to production time, lead time, delivery, time-based costing, etc.
- *Cost Measures*: these measures were the first to be developed to assess business performance. They measure aspects such as value added, manufacturing cost, etc;
- *Flexibility Measures*: measures how efficiently the production system can change.

Other authors, such as Yoneda (2004), classify the performance indicators into five groups:

- *Quality Indicators*: measure the performance of the productive processes related to customer satisfaction. This indicator can be a numeric measure of the attributes and results of the processes that can be compared later with pre-established goals (Pegoraro, 1999);
- *Productivity Indicators*: measure the proportion of resources consumed and compare it with the obtained company's results. These PI's help to identify and prevent problems related with the quality indicators;
- *Strategic Indicators*: report the company's position in relation to the pre-established goals defined by the managers;
- *Effectiveness Indicators*: focus the results caused by the products or services;
- *Capacity Indicators*: measure the response ability of a process through the relation of the produced outputs per units of time;

One of the problem that must be taken into acount is the number of indicators to be used. Meyer (1994) insists that there's no reason to use dozens of indicators because many of them probably won't contribute, or even will mislead the performance measurement job. Other problem encountered by most companies is the low engagement of the managers in the development of the performance indicators.

The components and the structure of an PMS relies on the characteristics of the company, such as the tools, people and the form of organisation. Bititci, Turner and Begemann (2000) presented a list of components to build the basic structure of a PMS:

- An external monitoring system, that continuously monitors changes;
- An internal monitoring system, that keeps observing the changes in the internal environment. This system must send signals or alerts when an indicator reaches its limit value;
- A revision system to verify goals and priorities;
- An internal deployment system to implant the goals and priorities in critical parts of the system.

White (1996) reinforces the need to monitor the external environment. According to him, measures can have internal or external sources. The internal indicators are easier to obtain, but are limited in the way they look into the company. To have a complete view, it is necessary to consider the external sources of information. These indicators are harder to obtain, but they have the advantage of complementing the internal vision with the customer perspective.

## 3. Business Intelligence and Information Technologies

Business Intelligence is an important concept related to PMS's. Barbieri (2001) defines BI as the use of several sources of information to define competitive strategies for the company business. It can be considered a technique for creating rules to format properly a great amount of organizational data, aiming to transform them in a structured deposit of information.

Today, managers need informations to be available in the exact time they're needed and in a fast and easy fashion (Fortulan, 2006). Reports must be gererated quickly, using a great amount of data sources to provide a realiable analysis of the organization to the decision makers. To make this possible, the use of computer systems is essencial due to its processing and analysis capabilities. Some of the technologies used to implement PMS's and the BI technique are listed below:

- *Data Warehouse*: the objective of a Data Warehouse (DW) is to store and analyse great amount of data produced in different activities. Therefore, Data Warehousing is the process of gathering together, in an organised and efficient way, several sources of data in order to help managers in the process of decision making (Inmon, 1996);
- *Data Mart*: the Data Marts can be considered a subset of a Data Warehouse. While the DW involves all the dimensions of the organization, the Data Marts are specialized in some sectors. For example, a company can have several independent data marts, such as sales, marketing and finances (Delvin, 1997);
- *Data Mining*: the Data Minings can be used with a DW to find patterns that would be impossible to discover with ordinary search procedures. During the project of a company's DW, there must be considered the problems that can be solved only by data mining algorithms. These procedures are unique for each type of problem (Fortulan, 2006);
- *OLAP (On-line Analytical Processing)*: an OLAP is another tool used to analyse the data stored in a DW. It provides an interactive process of querying through the use of multi-dimensional visions of the results. Decision cubes are used to show the query's results, wich is a more natural way of looking into the data set and make decisions (Todman, 2001);
- *Expert Systems*: an Expert System is a computer program that tries to imitate the behavior of an human expert. These programs try to find solutions to problems through the use of logic, inferences and learning. Each problem requires a different expert system (Barrela, 2000).

The technologies mentioned here, when properly combined, can form a Decision Suport System (DSS). The DSS's are generaly implemented as computer systems to provide agile answers about all the aspects of the organization.

## 4. Proposed Architecture

In many companies, especially in Small and Medium-Sized Enterprises (SME), the existing scenario shows a complete lack of integration of the various departments. Davenport and Prusak (1998) and Cândido (2005) agree that in most organisations, the information system is chaotic and the computer resources can be allocated in a better way. Figure 1 shows how the information systems are usually organised in this kind of enterprises.

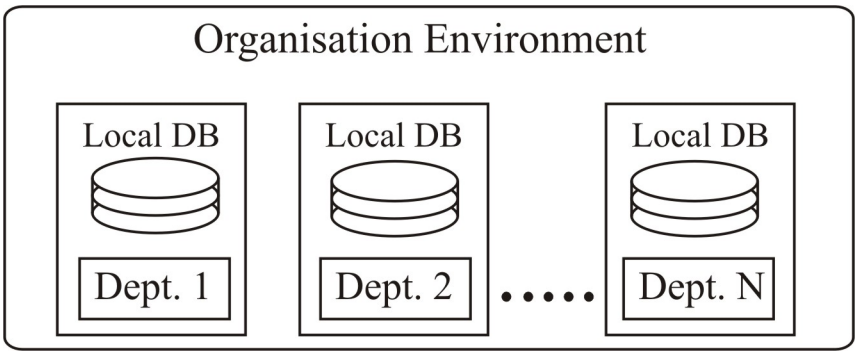


Figure 1. Present situation found in most companies

The situation presented in Figure 1 is characterized by:

- Great diversity of programs running independently to perform ad-hoc activities;
- Inexistence or lack of integration of the softwares among the departments;
- Local Database (DB) systems, wich may cause data inconsistence;
- Difficulty on generating broad reports that need data from different sources;
- Inexistence or inefficient collection of the exernal environment data;
- Inefficient processing of the performance indicators.

In this kind of enterprise, it is more difficult, if not impossible, to implement an effective performance measurement system. The process of data collection, report generation and data analysis becomes harder because there isn't a propper way to store and process information. Figure 2 sugests a better IT architecture to support a combination of PMS and DSS.

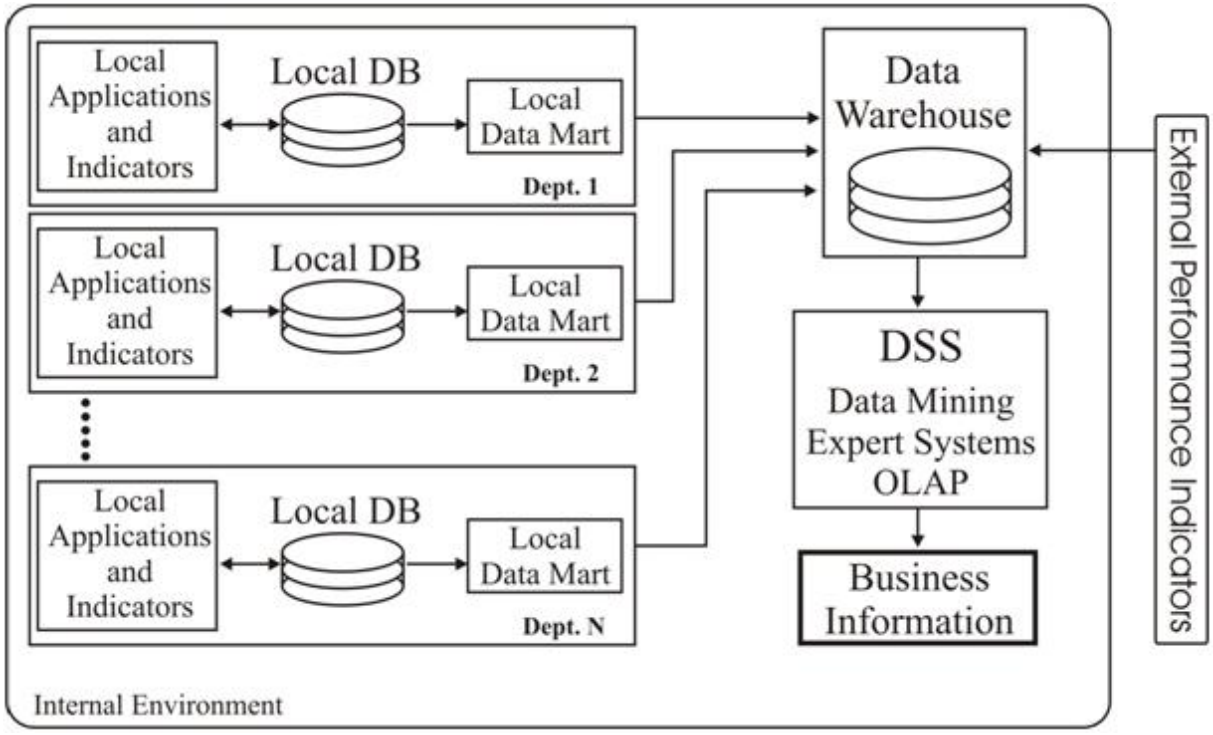


Figure 2. Proposed architecture for a PMS combined with a DSS

In the proposed architecture is easy to identify how the shortcomings of the structure in Figure 1 are eliminated. The inclusion of local and external performance indicators will enable the environment monitoring. The local indicators are related to the activities inside each sector of the company. One important point is to establish only a few, but relevant, performance indicators for all departments (Neely, Bourne and Kennerley, 2000). These indicators produce data that are stored in the department's local database, and decision support is done locally through a Data Mart.

The integration of all the organization's departments is done by a global data warehouse. The data marts are integrated through this DW to allow a vision of all the dimensions of the company. This DW can provide reports and valuable information to managers. Nevertheless, other tools, such as data mining, OLAP and expert systems, can be combined with the DW to provide a better way to analyze data and make decisions.

External performance indicators are used to monitor the external variables, such as market, competitors and global economics. These data are sent to the data warehouse in a way it can be used later to generate information through the use of BI techniques.

One important thing to note here is the meta-structure that involves the proposed architecture. Figure 3 shows how information is created with the use of the presented technologies.

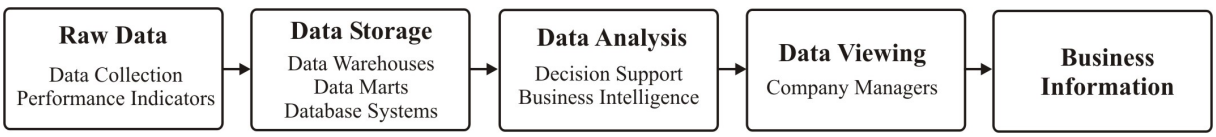


Figure 3. Meta-structure for the proposed architecture

First, the raw data obtained by the performance indicators is collected and stored into database

systems. Theses databases, connected to data marts or data warehouses, can provide data to the next step, wich is Data Analysis. At this point, the collected data has no meaning because they are just isolated facts that still need to be analyzed. The BI techniques can now be used to generate reports and decision cubes including different sources of data and several kinds of relationships between them. To complete the information generation process, managers must see, undersand and make inferences on the analyzed data, so they can comunicate and make decisions.

## 5 - Conclusion

The implementation of a performance management system can be done without a good IT structure. In fact, there is the possibility to check indicators manually, but this approach has some problems as shown on Table 1.

Companies with a non-organised IT structure can also develop a good performance measurement system, but they will face some of the problems discussed earlier. However, the use of information technologies can improve greatly the quality and agility of the results.

One of the problems of the sugested architecture is that it requires a great investment in infra-structure and people trainning. It also takes a long time to develop the data warehouse and the BI techniques. The use of diferent programs in each department is another problem, because it's a hard job to integrate a great number of programs into a data warehouse.

Some ERP's implement a similar architecture to deal with performance indicators and decision suport. The main advantage of these systems is the ease of integration of the various organization's sectors, because it eliminates the use of several different programs. Therefore, the sugested IT structure is valid to companies wishing to integrate their departments, and to software developers who need to implement performance measurement systems with support decision.

| Characteristics | Manual SMD | IT SMD |
|---|---|---|
| Data Collection | Use of paper forms, which are not reliable | Use of computers or terminals to send data directly into the database system |
| Report Generation | Manual generation takes too much time and is subject to errors | Automatic report generation is fast and error-free |
| Data Storage | The storage of paper forms requires a lot of physical space and is insecure | The database systems offer security and agility to store and find data |
| Data Querying | The execution of complex queries is impossible | Complex queries and patter recognition can be done in a relatively fast way |
| Data Analysis | The great amount of data makes analysis almost impossible | Intelligent tools, such as OLAP, Data Mining and Expert Systems, can perform complex Analysis with a larger amount of data |

Table 1: Shortcomings of the manual approach

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