Key Performance Indicators used in ERP performance measurement applications

A.Selmeci, I. Orosz, Gy. Györök and T. Orosz

Óbuda University – Alba Regia University Center
Budai str. 45, H-8000 Székesfehérvár, Hungary
Applied Informatics Doctoral School
E-mail selmeci.attila@arek.uni-obuda.hu; orosz.istvan@arek.uni-obuda.hu;
gyorok.gyorgy@arek.uni-obuda.hu; orosz.tamas@arek.uni-obuda.hu

Abstract—**The performance measurement in the World and especially inside the companies' boundaries are getting more important. The ERP applications like SAP and MS Dynamics are applied to several functional areas such as finance, logistics, human resources, etc. As long as diversity and complexity of such ERP applications are increasing in an organization there is a need of successful performance measurement. Different methods and tools are available for analyzing the effectiveness of ERP processes, technologies or even the users, employees. Usage of OLAP Information Cubes in MS AX for information collection and aggregation to define basis for business metrics called Key Performance Indicator (KPI). Similarly, SAP provides BI (Business Intelligent) based solutions for collecting performance relevant information for the business processes, employees, activities or even technical system level measurements. The paper gives definition and a classification of performance indicators, and toward it shows the usability of KPIs in business environments as well.**

Keywords: **Key Performance Indicator, Enterprise Resources Planning Systems, Sustainability, Innovation, Software development**

I. INTRODUCTION

Measuring in our World is declared over years by measurement units, like kilogram, meter, and so on. But the measurement of a system, a tool, a technology or even people is nowadays handled by specifically designed measuring indexes, which have not predefined units and quantities, but different value ranges and meanings. Not all of the measuring indexes are good for everything and not each of them are always used in a given measurement.

Our study aims to give some performance measurement directions using business systems and analyze ERP solutions, technologies to offer differentiators and focus points for decision makers. The measures are selected from different areas and points of view according to some directions, like:

- Current opportunities of front-end design: different front-end (know as user interface or UI as well) technologies for the same solution can require different resources, maintenance, development efforts, etc.

- Development techniques and methodologies: some solutions, systems offer parallel available development environments, tools and technologies, which require sometimes similar, sometimes distinct design, method of development or implementation project, knowledge, preparation

- Operation and technology performance (availability and speed): the previous topic referred to implementation, but this one is dealing with operation, but only from the technology performance point of view, having user acceptance from speed or response time point of view. We can consider the interface techniques, the database access times and other HW, and low layer technology levels.

- Sustainability of a solution: the operation and maintenance costs, resource requirements, flexibility, changeability of a solution or application is interesting. If a solution is implemented will it bring acceptable innovation or return on investment in a given time.

This list is not planned to be a full and comprehensive enumeration, it is only a starting point and example.

In this paper we wanted to show some example through OLAP (Online analytical processing) system delivered by Microsoft as part of the Microsoft Dynamics AX solution. The OLAP system collects the performance information and generates reports on measurements. This kind of system is used generally in a business environment as an executive information system detailing the actual states of the subject to be analyzed.

The other example direction comes from SAP solutions. SAP is one of the leading ERP (Enterprise Resource Planning) system providers. The different SAP solutions offer various and special tools, applications, opportunities, development tools, technologies for customers. The decision is on the customer what to use for a given purpose, but many measurement objects should be taken into consideration for a good selection. The SAP offers so many opportunities, that it can be used as a good example to show the measurement indexes. As the expectation and assessments commonly are coming from leaders of an organization, these tools are designed to help their daily providing high level, executive information systems with dashboards using progress indicators and strategic enterprise management functions, or for technical

performance measuring the Corporate Performance Monitor solution can be used.

As a summary we collected tools, methods and indexes for ERP performance measurement to help managing strategies at a company.

II. WHAT IS THE KPI

For measure the performance some indexes or indications should be defined. The performance indicator is a type of performance measurement. KPIs (key performance indicator) are selection of general performance indicators evaluating the success, performance of a solution or an activity. KPIs are commonly used to evaluate an organization's success or product's success, but sometimes it is defined in terms of progress to a strategic goal or as repeater measurement and result of some level of an operational, implementation goal. This last one can be imagined like measuring the user acceptance regularly and the predefined goal is achieved 8 times from 10 measurements.

From ERP point of view, it is important to choose the right KPIs after having a good understanding of what is important to the organization. 'What is important' often depends on the department measuring the performance - the KPIs useful to finance will be quite different than the KPIs assigned to sales or human resources, not even speaking about information technology or application support. Because of the need to develop a good understanding of what is important, performance indicator selection is often closely associated with the use of various techniques, activities to assess the present state of the business or product, and its key activities. These assessments often lead to the identification of potential improvements or bottlenecks; and as a consequence, performance indicators are routinely associated with 'performance improvement' initiatives, like organizational restructuring, defining new developments, enhancements, etc. A very common way for choosing KPIs is to apply a management framework such as the balanced scorecard.

Key Performance Indicators (KPI) is an inexpensive, powerful, and deceptively simple management tool to help focus people's activities or even state of products. It is not a detailed and deeply analyzed information, rather it can be considered to be big picture about what is important and it suggests how to deal with daily issues. Properly identifying KPI, help people distinguish the important from the trivial, the "must be done" from the "could be done" and allow employees to set their own priorities or egg product owners, developers on to do acceptable, more user friendly, etc. products that are in keeping the company's goals and objectives.

Academically KPIs are tools and targets that show performance to a particular goal or objective and the distance between the objective and the current state. For example, a common KPI in manufacturing (main part of ERP solutions) and distribution organizations (common todays company picture) is an assessment of the accuracy of the inventory. The KPI also states what the target value for that objective is and plots regular progress toward the goal. In the above example the management team would define a target value for the goal of Inventory Accuracy of say 92% that means there are only 8 goods, objects in 100 that do not have the accuracy (up or down) stated in the

computer. Management negotiates this value with the team responsible for maintain that portion of the system.

If we map this theory to a project, the project management needs status, progress information from the specific teams, groups and the whole project as well. With predefined KPIs they attain enough information on the state, but they will not get information how to solve an issue detected by the KPIs.

Key performance indicators define a set of values (target values or goals) used to measure against. These raw sets of values, which can be collected on paper, or uploaded to systems in charge of summarizing and in better case analyzing the information, are called indicators. Indicators can be grouped in various ways. One of these categorizations is listed here:

- − Action based indicators: these kinds of indicators are triggers for changes in control of an organization.
- − Value based or quantitative indicators: a measurable quantitative value, a number defines the indicator.
- − Goodness or directional indicators: it specifies whether an organization, tool or even employee work is getting better or not; it describes the direction (up, down) of the status.
- − Financial indicators: used in performance measurement and when looking at an operating index.
- − Process based or practical indicators: these kinds of indicators are related to business processes.

There are many more possibilities to classify the indicators, but these can be used as best once in ERP environments. In case of applications, business environments, and company organizations the indicators derived from any category listed above can be grouped according to the measured object. It means in practice that the performance indicators should be defined for a specific object and the people, organization or even an application executing the measurements should select a specific set of indicators from the group to define key performance indicators.

The results of the measured performance indicators are used not only for improving processes, product manufacturing, application programming, employee activities, etc., but they can be used for preparing decisions in enterprise management as well.

A very simple tool for decision makers is the so-called decision matrix. This is as its name determines an array or table containing e.g. in rows the possible options, alternatives, like supplier in a procurement (or bid) question, goods, marketing ideas, development tools, technologies. Each of these alternatives are evaluated regarding a preselected list of criteria (key performance indicators in our example), like prices from the alternative suppliers (as a quantitative indicator) or friendliness in an employee measurement (as a directional indicator). In many ways each of the indicators coming from any category are translated to quantity base indicators, because the importance of the given indicator can be weighted in this way and the results, scores can be calculated easily. In a real decision matrix these criterion or better to say these indicators can have predefined compliance points up to a maximum determining the relative importance in the real

decision. These assigned weights can be configurable if a tool or in simple case a table calculator (like MS Excel) is in use.

Many changeable points are in a decision or score matrix. The only stabile points are the option axis containing the to be compared alternatives. But the indicators and the ratings (weights) can be defined separately. Retrieving the results from the KPIs (criteria list) define an unchangeable input value set. A defined rating set determines a solution score. For simulation purposes, e.g. cost or headcount planning these rating scenarios give different comparable opportunities as well. In this case the rows of the matrix are not alternatives, but departments for example.

The bigger ERP vendors realized the requirements of such performance measurements, and provide different solutions, tools to support the planning, decision-making and control the company in a strategic way.

In the next capitals some tools are presented, which are prepared for such performance indicator implementations or they provide indicator information.

III.   DYNAMICS AX OLAP AND KEY PERFORMANCE INDICATORS

Key performance indicators are not part of the standard AX implementation, one has to customize AX to be able to use them. To complete the task, the following tools are needed: SQL Server Business Intelligence Development Studio (BIDS) and Analysis Services extensions for Microsoft Dynamics AX. The default online analytical processing (OLAP) cubes that are provided with Microsoft Dynamics AX require full license and configuration keys. A Key Performance Indicator (KPI) in AX is a business metric that can be displayed in places like reports and role center pages. They are often used with connection of decision cubes and business intelligence tools. A cube is defined in AX by its measures and dimensions. A measure is quantifiable, like sales, receivables, or item quantities. Dimensions are used to slice measures. For example, sales by quarter, sales by payment group, or sales by customer group. One can specify measures and dimensions to model a cube in the Application Object Tree (AOT). A perspective is a container for the tables and views that contain the measures and dimensions for a cube. For this purpose, a perspective has to be created, add Microsoft Dynamics AX tables and views to the perspective, and then define measures and dimensions by using the views and table in the perspective.

Microsoft Dynamics AX includes standard cube definitions, or cubes that have already been constructed. Standard cube definitions, when they are processed, return data about customer revenue, inventory transactions, ledger transactions, and sales margins (to name some). Some of the standard cube definitions might work for an organization without changes; that is, one can import the definitions, process them, and analyze the data to obtain meaningful results that will be of value to the business decision makers. However, other standard cube definitions require editing to make them suitable for a specific organization.
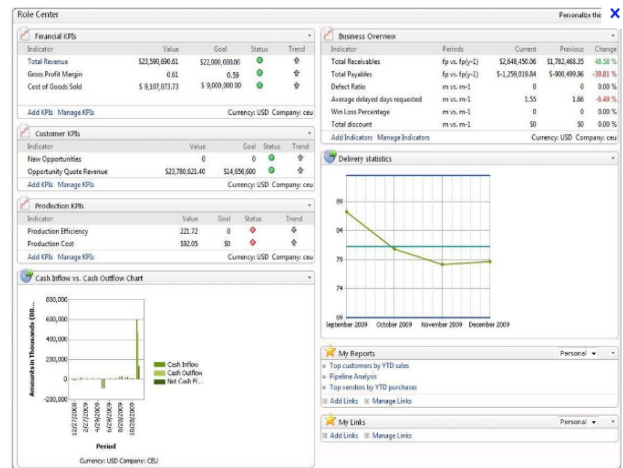

Fig.1. Dynamics AX Role Centre

After having created an analysis cube and defined KPIs for it, the KPIs can be displayed in a Business Overview web part in a Role Center or Enterprise Portal. The Business Intelligence infrastructure enables to generate Unified Dimensional Models (UDMs) by using metadata from the Microsoft Dynamics AX relational data model. Measures and dimensions can be specified in the Application Object Tree (AOT) to define an analysis cube. Cubes, dimensions, and data source views can be browsed in SQL Server Business Intelligence Development Studio (BIDS). Key Performance Indicators (KPIs), and organization hierarchies in BIDS can be modified as well.

The Role Center is essentially a preconfigured home page that provides an overview of information and processes for a specific job role, including work lists, activities, frequently used links, and key business intelligence information. People can use their Role Centers to access information and processes and prioritize their work. They also can personalize them to fit their specific requirements. For instance, they can add KPIs or links to reports, like in Fig.1. The next generation of Dynamics AX 2012 contains a new framework of user interface, which is called Role Tailored User Experience, like in Fig.2.
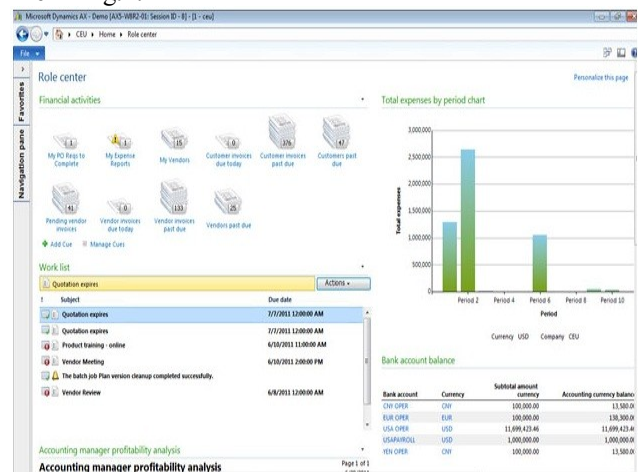

Fig. 2. Role Tailored user homepage

This approach makes the user interface more friendly and useable for experienced Windows and Office users. The familiar experience extends even further to drive productivity for analysts working with data from Microsoft Dynamics AX 2012, interoperability with Microsoft Excel spread sheet software and PowerPivot brings that data into those tools that analysts expect, with a native, natural experience enabling rapid, effective access to business system data.

Another way of analyzing data is to use Microsoft Office Excel to connect to a Microsoft Dynamics AX analysis cube.

To analyze cube data in a pivot table, these steps are to be taken: in Microsoft Office Excel start the Data Connection Wizard, and on the Connect to Database Server page, enter the name of the server that contains the Analysis Services database for the General Ledger cube, enter credentials used to access the server. On the Select Database and Table page, select the Dynamics AX database, select General ledger cube. After you set up a data connection to a cube, that connection can be reused to connect to the cube in the future.

An instance of Analysis Services can contain multiple databases, and a database can have OLAP objects and data mining objects at the same time. Applications connect to a specified instance of Analysis Services (Fig.3.) and a specified database.
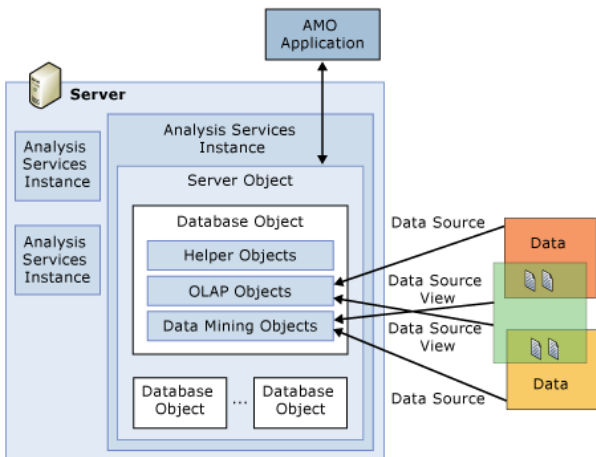

Fig.3. Analysis Services

To set up and configure Microsoft SQL Server Analysis Services and Microsoft Dynamics AX for online analytical processing (OLAP) reporting, the following procedures are included: install Analysis Services for OLAP reporting, create an OLAP database in Analysis Services, add users to the list of OLAP administrators in Analysis Services, create an OLAP server and an OLAP database in Microsoft Dynamics AX, and set up OLAP parameters.

Basic classes are the minimum set of objects that are required to build a cube. This minimum set of objects is a dimension, a measure group, and a partition. Dimensions are built from attributes and hierarchies. Hierarchies are formed by an ordered set of attributes, where each attribute of the set corresponds to a level in the hierarchy. Each instance of Analysis Services is seen as a different server object in Analysis Management Object (AMO);

each different instance is connected to a Server object by a different connection. Each server object contains one or more data source, data source view, and database objects, as well as assemblies and security roles. Each database object contains multiple dimension objects. Each dimension object contains one or more attributes, which are organized into hierarchies.

Each database object contains one or more cube objects. A cube is defined by its measures and dimensions; these are derived from the tables and views in the data source view on which the cube is based, or which is generated from the measure and dimension definitions. The ASSL object model contains many repeated element groups. To explicitly override properties inherited from a higher-level object, an object does not need to repeat explicitly the entire structure and properties of the higher-level object.
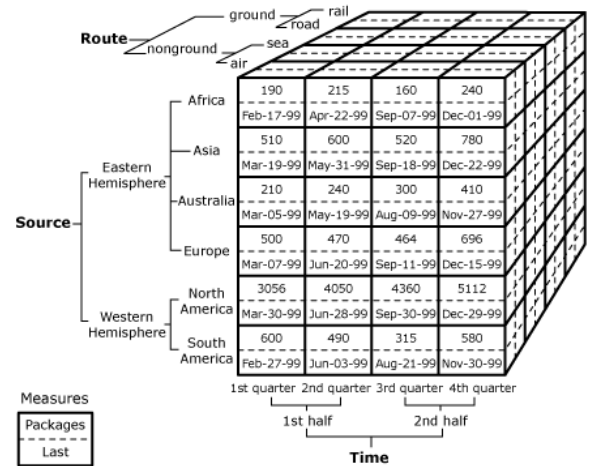

Fig. 4. Imports cube example

The only properties that an object needs to state explicitly are those properties that the object wants to override. For example, a CubeDimension may list only those Hierarchies that need to be disabled in the Cube, or for which the visibility needs to be changed, or for which some Level details have not been provided at the Dimension level. Some properties specified on an object provide default values for the same property on a child or descendant object. For example, Cube.StorageMode provides the default value for Partition.StorageMode. For inherited default values, ASSL applies the same rules as used in Decision Support Objects (DSO) 8.0. The following list describes these rules for inherited default values: when the property for the child object is null in the XML, the property's value defaults to the inherited value. However, if you query the value from the server, the server returns the null value of the XML element.

Example: The Imports cube contains two measures, Packages and Last, and three related dimensions, Route, Source, and Time Fig.4. The smaller alphanumeric values around the cube are the members of the dimensions. Example members are ground (member of the Route dimension), Africa (member of the Source dimension), and 1st quarter (member of the Time dimension).

The values within the cube cells represent the two measures, Packages and Last. The Packages measure represents the number of imported packages, and the Sum function is used to aggregate the facts. The Last measure represents the date of receipt, and the Max function is used to aggregate the facts.

The Route dimension represents the means by which the imports reach their destination. Members of this dimension include ground, no ground, air, sea, road, or rail. The Source dimension represents the locations where the imports are produced, such as Africa or Asia. The Time dimension represents the quarters and halves of a single year.

Business users of a cube can determine the value of any measure for each member of every dimension, regardless of the level of the member within the dimension, because Analysis Services aggregates values at upper levels as needed. For example, the measure values in the preceding illustration can be aggregated according to a standard calendar hierarchy by using the Calendar Time hierarchy in the Time dimension as illustrated in the following diagram.

IV. KPIs FOR ENTERPRISE STRATEGIES

SAP as a company has its own KPIs defined for development and support purposes as well to measure the quality, and level of deliveries. These are important, because SAP wants more money for delivering so-called Enterprise support. For this support level the customers want of course to have higher level of services. To achieve the higher level, and to be able to figure out the difference KPIs are used. The SAP User-group (a customer movement to build a community) defined these indicators as follows:

- − Business Continuity
- − Business Process Improvement
- − Protection of Investment
- − Total Cost of Operations

These KPI indexes are measured by formal benchmarking program implemented at certain customers.

SAP has its own OLAP architecture called Business Warehouse (SAP BW), which is part of the Business Intelligent (BI) solution. This system can collect, analyze and evaluate defined performance indications as described in case of MS Dynamics AX OLAP. Here so-called InfoCubes and aggregates are defined in the BW. SAP went further one step. SAP realized that customer and the market requires perfect strategies and the strategic decisions can drastically change the market penetration for example. The strategy is not enough it should be implemented properly. SAP created a BW based Strategic Enterprise Management (SEM) application to support performance management lifecycle for the whole ERP solution. From KPI and decision making point of view the SEM contains planning, forecasting and budgeting functions (SEM-BPC) and corporate level performance management (SAP-CPM) and scorecard tools. SAP deliver with SAP-CPM several predefined KPIs as well, which can be configured and used in the system. The data is collected from the ERP applications and technology component as well. The Fig. 5 shows the main process flow implemented in the system.
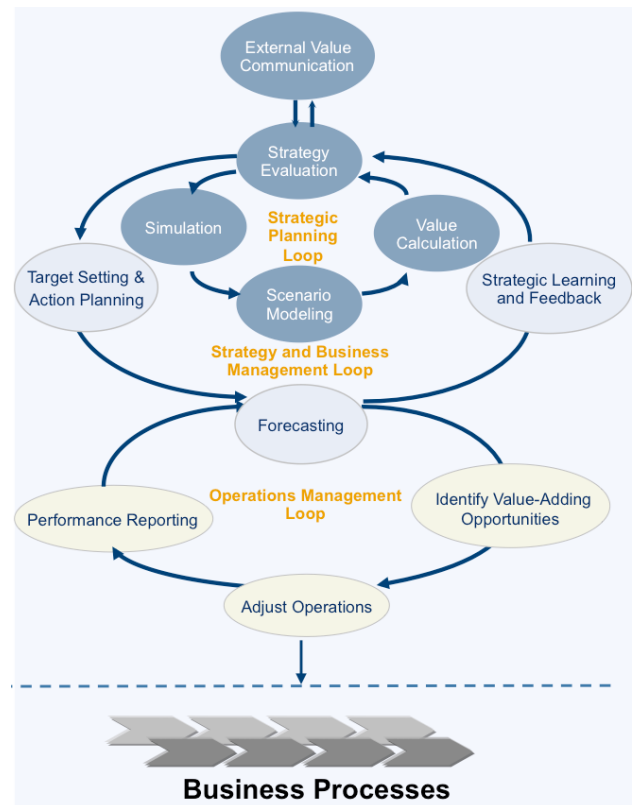

Fig.5. Business Performance Management Process

The SAP SEM solution covers both strategic and analytical processes in the collaborative environment: model and simulate different possible strategies, choose the most promising one; evaluate the performance in the respective business units and departments or projects both from overall and business unit views (SEM-CPM); analyze processes for further improvement possibilities; adapt the processes and if necessary the strategy according to the analysis findings; communicate the results and the future goals to your stakeholder community; use integrated planning and budgeting processes for both top-down and bottom-up planning (SEM-BPS=Business Planning and Simulation, and Business Analytics); execute the plan in operations and collect both internal (SEM-BCS=Business Consolidation, BW) and external (Internet) information for further evaluation.

The required KPIs are shown as dashboard elements as referred in Fig. 6 below. (The Fig. 6 is only an illustration; the content of it is not relevant.)

Fig.6. Performance Management illustration

In the daily life of companies the ERP applications contain Human Capital Management (HCM) solution as well. This module contains not only payroll and

administration, or organizational data, but also employee qualifications, events, trainings and evaluation capabilities. The companies using ERP solutions and having huge number of employees want to measure the employees as well beyond the IT infrastructure and the business processes. This time we can think about the KPI, that this is a tool to "Keep People Involved." One measurement point, which is balancing on the edge of IT, business and employee activity is the Workflow execution. The Workflow (automated business processes in the system) steps require sometimes human activities (e.g. decision). The systems provide information on the performance of workflow steps, like execution time, late starting, etc., which are performance indicators in this area. These information are collected in a Workflow information system to provide performance reports to the managers about the proper employee steps.

The other measurement is really based on predefined KPIs. The managers can select from KPI groups for their workers to measure them. These KPIs are publicized and at the time of measuring an IT-based application (usually running in the HCM environment) collects the KPI values set by the employee and the manager and evaluates the result to show the employee performance. This kind of KPI management is requested by the todays companies, so the ERP providers try to implement them in their software.

V.   CONCLUSION

We collected in this article some example of implemented KPI collector and evaluator solutions in ERP environments to show that they are really important in this area as well.

On the other hand this writing is not intended to define KPIs for ERP systems, but it defines the performance indicators, a possible categorization of them and the usability of them in ERP applications.

We figured out that the indicator information can be used in ERP environment to improve the value, quality of a process, product, tool or even an employee, etc. But the performance indicators can be used in decision-making processes as well.

As a further researching possibility KPIs can be developed, defined for ERP application or module development as well using criterion from different approaches as well.

VI.   ACKNOWLEDGEMENT

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