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Aligning Process Automation and Business Intelligence to Support Corporate Performance Management

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ABSTRACT

In recent years, companies have tried to realize efficiency gains of business process orientation by implementing business process automation (BPA) systems coordinating the interaction of existing function-oriented enterprise applications according to the logic of specific business processes. Additionally, business intelligence (BI) applications have been installed to support management in measuring the company's performance and deriving appropriate decisions. BI and BPA initiatives are usually organized as separate IS projects that are not properly coordinated, leading in turn to an unsatisfactory alignment of strategic management and operational business process execution. The proposed article is to depict how new trends in the IS area can lead to a convergence of BPA and BI and therefore deliver appropriate support for an integrated corporate performance management (CPM). The utilization of IS in an integrated CPM solution is illustrated by an example from the telecommunications sector.

Keywords

Corporate Performance Management, Process Management, Business Intelligence, Enterprise Application Integration, Data Warehousing

INTRODUCTION

Performance management aims at the systematic generation and control of an organization's performance. From a pure management perspective, a performance management system consists of the four main activities (Spangenberg 1994) performance planning, taking action to control performance (management in the narrower sense), performance measurement, and performance rewarding. Like other management approaches, performance management can only be implemented successfully, if strategic planning is closely linked to operational execution. Therefore, it has to be ensured that strategy changes trigger modifications on the levels of business processes and information systems, and that innovations on the IS or the process level initiate the adjustment of the company's strategy. Although this topic is not new at all, its discussion is intensifying again, mainly influenced by recent work of IT analysts and consultants who stress the close relationship between current business requirements and newly developing IT enablers. In order to express the novelty of the approach, the label 'corporate performance management' (CPM) was coined (Geishecker 2002; Moncla and Arents-Gregory 2003), sometimes designated as business performance management (e.g. Baltaxe and Van Decker 2003, Brunner and Dinter 2003, Meta Group 2002). Used as an umbrella term for "methodologies, metrics, processes and systems that monitor and manage the performance of an enterprise" CPM comprises four major characteristics:

- *Process orientation*: CPM is based on a business-process-oriented view of the organization and has to be seen as a process itself that ensures the tight integration between the tasks of defining a company's strategy, implementing it into business processes, analyzing both the execution of the processes and the company's environment and taking appropriate actions to modify strategy or processes according to analysis results.

- *Goal and metrics orientation*: To enable both the measurement and management of a process-oriented company, clear business objectives have to be derived from the strategy and transformed into metrics both for steering and for measuring processes. CPM as a concept does not provide the goals and the metrics themselves but the processes as well as the IT support to formulate goals and metrics, and to collect and analyze the internal and external data that is required to compute the metrics.
- *Methodology support:* The integration of strategy formulation, business process design and business process execution, requires management methodologies like e.g. the Balanced Scorecard, Intellectual Capital or Value-based Management that provide a framework linking strategic goals to metrics for steering the execution of business processes and for measuring their performance. CPM delivers the process and IT infrastructure that can be utilized to implement the methodology (or a combination of methodologies) that best suits the individual company.
- *IT support*: CPM is supported by a set of software tools for integrating and analyzing performance-relevant data, for supporting decision making and for facilitating the communication of decisions.

Especially from an IT perspective, CPM represents an advancement of the business intelligence (BI) concept. Coined by Gartner in the early 1990s, the term BI denotes on the one hand an analytic process that transforms internal and external data into information about capabilities, market positions, activities, and goals that the company should pursue in order to stay competitive (Weber et al. 1999; Grothe and Gentsch 2000). On the other hand BI stands for different IS concepts like Online Analytical processing (OLAP), Querying and Reporting, or Data Mining that provide different methods for a flexible goal-driven analysis of business data, which is provided through a central data pool (Chamoni and Gluchowski 2004). CPM enhances BI in two directions: First, CPM is more targeted to support process-oriented organizations than BI. Second, CPM aims at providing a closed-loop support that interlinks strategy formulation, process design and execution with business intelligence. With respect to the development of CPM solutions, we recognize three interesting IT trends that could foster the convergence of Business Intelligence (BI) and the two other support technologies of Business Process Modeling (BPM) and Enterprise Application Integration (EAI):

- *Business Process Automation (BPA)* links process design to application integration services in order to foster the automation of business process implementation and to allow for the execution of workflows that involve multiple heterogeneous applications.
- *Real-time analytics* allow for the reduction of latency times in decision support by combining the integration capabilities of EAI with the analytic capabilities provided by Business Intelligence, thereby moving analytics closer to the operative business.
- *Process Performance Management (PPM)* closes the loop between process design and business intelligence by enabling the comparison of process execution data with data of previously designed to-be processes in order to identify potential for process improvement.

By combining the different IS support facilities for process modeling, application integration and business intelligence, it becomes possible to dynamically reflect changes on the business process level to the IS level and vice versa. Hence, the IT trends could provide sufficient support for integrating strategies, organizational structures, business processes and information systems in order to adequately support corporate performance management.

Figure 1 shows the relations between the support technologies, the depicted trends and the concept of corporate performance management. The three trends are explained in more detail in the following related work section. Afterwards, the technological enablers leading to the trends are explained and the aspects necessary to establish an integrated IT-enabled corporate performance management solution are illustrated by an example from the telecommunications sector. The paper concludes with a short summary and the suggestion of future work.

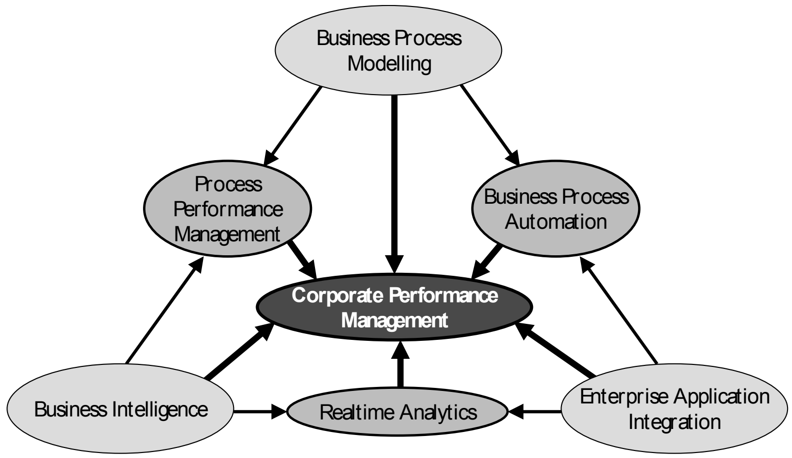

Figure 1. Converging technologies for Corporate Performance Management

RELATED WORK

Business Process Automation: Convergence of Business Process Modeling and Enterprise Application Integration

The IS architecture of an organization usually comprises a large number of heterogeneous applications, each one of which specialized on supporting particular business processes. As most business processes have to be supported by more than one application, interfaces between applications have to be established in order to support process execution. This has led to the proliferation of bilateral interfaces, each one of them contributing to increased complexity and maintenance effort. In order to overcome these integration problems, many companies implemented dedicated EAI middleware that provides a common integration infrastructure, allowing any connected system to communicate with any other connected system over just one dedicated interface to the integration infrastructure (Johannesson and Perjons 2001). While the term EAI usually refers to integration on the IT level, corresponding integration needs also occur on the IS architecture and especially the business process level. The need for a close alignment of business process integration and integration capabilities on the IT level has lead to a convergence of business process modeling and enterprise application integration software in the shape of business process automation. Operational specifications derived from business process modeling can be transformed into more technical workflow specifications which are executable using an EAI framework that is enhanced with a workflow engine (IDS Scheer AG 2003). Taking this idea a step further, it becomes imaginable that applications provide their functionality through well-defined services with standard interfaces to an EAI platform. This would allow for a dynamic integration of application services based on the logic of individual business processes.

Real-time Analytics: Convergence of Business Intelligence and Enterprise Application Integration

In order to increase their competitiveness, companies always strive towards reducing the time needed to react to relevant business events. An ideal state would be reached if reactions were possible in real-time, i.e. without any latency between recognizing a relevant business event and taking an appropriate action.

A major enabler for reducing latency times is information integration in real-time. EAI suites provide a popular solution for integrating heterogeneous applications in or near real-time because they are able to seamlessly publish any kind of data updates to every subscribing ('listening') application (Johannesson and Perjons 2001). However, this integration usually is only achieved between operational systems and involves only little data consolidation. When it comes to extensive data analysis, Business Intelligence will be used to produce the information that is necessary to decide and take appropriate actions. The main drawback of BI solutions is that they usually do not work on real-time data as the data warehouse as their primary data provider is only updated periodically (Bruckner, List and Schiefer 2002).

With real-time decision making becoming more important to companies, the vendors of BI and data warehousing solutions tend to enhance their products by mechanisms for real-time data integration and real-time analysis. This leads to the convergence of EAI and BI solutions in order to provide so-called 'real-time analytics' functionality. Two different movements can be observed (Martin 2003): Firstly, data integration platforms are extended by a connector that allows the event-based population of EAI data into the data warehouse (Schiefer, Bruckner 2003). Secondly, vendors of BI software offer new mechanisms for providing true real-time analysis or for doing real-time exception reporting.

Process Performance Management: Convergence of Business Process Modeling and Business Intelligence

Initiated by the works of Hammer and Champy (1993), Davenport (1993) and others, companies have redesigned their organizations around business processes and deployed specific business process modeling (BPM) tools to create, maintain and communicate business process specifications. In order to adequately support the business processes with information systems, the functionalities of different mainly function-oriented applications have to be integrated and aligned. This requires the use of specific BPA systems that allow for a flexible interaction of applications based on well-defined business process models (Becker, zur Muehlen and Gille 2002). While BPA is mainly used for functional integration on the operational level, management decisions on the strategic level mainly require the integration of decision-relevant information. Therefore, the operational data from different applications have to be collected, integrated and prepared for data analysis. Today this is mainly achieved by using data warehouse systems and business intelligence tools (e.g. reporting tools, managed query environments, online analysis tools, data mining tools) (Williams and Williams 2004). In most cases, the resulting management information systems are not primarily targeted on measuring the performance of business processes but on fulfilling traditional reporting requirements (e.g. financial reporting) (Fitzpatrick 1994). With process orientation gaining importance, the need for effectively controlling all business processes is increased. Responding to that need, a convergence of BPM and BI can be observed under the label of 'Process Performance Management' (e.g. IDS Scheer AG 2002) or 'Business Process Intelligence' (Grigoria et al. 2004). By collecting and reconciling all operational data related to a certain business process, it becomes possible to measure process performance and identify opportunities for process improvement.

IT ENABLERS FOR CORPORATE PERFORMANCE MANAGEMENT

In coherence with the structure of the introduction, this section will depict recent concepts and tools in the information systems area that have the potential to enable the dissemination of BPM in organizational practice.

Business Process Automation

The growing importance of business processes orientation in organizations has fostered the usage of business process modeling suites during the last years. While the main reason for starting process modeling usually is documentation – typically in the context of business process reengineering or improvement projects – many organizations later recognize that process models play an important role in the realization of adequate IS support for business processes. In this regard, a process model can be used as blueprint for the design of a workflow that coordinates activities, resources, and data according to the underlying business process (zur Muehlen 2004). In order to avoid discrepancies between documentation and execution of business processes, a tight integration of process modeling and workflow definition is required in the first place. Hence, process specifications have to be transferred from process modeling to workflow management tools. Open standardized formats for business process definitions like e.g. the Business Process Modeling Language (BPML, cf. BPMI 2000) can facilitate this information exchange.

The defined workflows can be executed using a workflow management system (WFMS), the functionality of which is nowadays – due to close relationship between application integration on the technical level and activity coordination on the process level – integrated into many EAI solutions. By using an EAI solution with a standard interface for process definitions, it becomes technically possible to use a process model not only as a blueprint for workflow design but also for building the application integration scenario necessary to execute the workflow. This holds true especially for workflows representing so-called software processes, i.e. processes that can be automated using software applications (Becker et al. 2002).

Besides the theoretical feasibility of process-model-driven EAI, the task of integrating applications usually involves a great deal of manual configuration or even programming work. To allow for further automation of integration tasks, functionalities of applications have to be provided as services, i.e. self-contained software modules, which can be connected more easily through well-defined standardized interfaces. This approach is usually denounced as service-oriented architecture (SOA, cf. Natis and Schulte 2003). Available standards like e.g. the Business Process Execution Language for Web Services (BPEL4WS, cf. OASIS 2003) can serve as a foundation for true process-driven application integration.

On the software market, vendors like SAP, Siebel and Sun follow the idea of service-oriented integration architecture by introducing integration platforms such as SAP Netweaver, Siebel Universal Application Network or SunOne (Genovese, Hayward 2003). From a BPA point-of-view, the integration of process modeling and application integration is fostered by approaches like ARIS Process to Application, which allows to use business process models for the configuration of workflow-enabled EAI software (ARIS P2A, cf. IDS Scheer AG 2003). The announcement of the strategic cooperation of SAP and IDS Scheer in the area of business process management solutions indicates the convergence of SOA and BPA, for which Gartner coined the term 'Business Process Fusion' (Hayward 2003).

Realtime Analytics

Real-time analytics aim at shortening the period of time between the occurrence of a business event that requires an appropriate action by the organization and the time the action is finally carried out. According to Hackathorn (2002), the additional business value of an action decreases, the more time elapses from the occurrence of the event to taking action. The elapsed time is called action time and can be seen as the latency of an action (see Figure 2). Action time comprises three components:

- *Data latency* is the time from the occurrence of the business event until the data is stored and ready for analysis.
- The time from the point when data is available for analysis to the time when information is generated out of it is called *analysis latency*.
- *Decision latency* is the time it takes from the delivery of the information to taking the appropriate action. This type of latency mostly depends on the time the decision makers need to decide and implement their decisions.

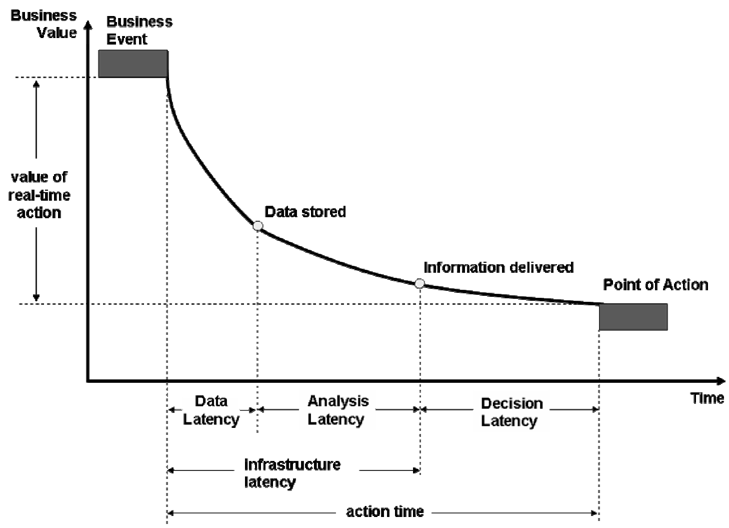

Figure 2. Value of reducing the action time (Hackathorn 2002)

In order to reduce action time, latency has to be reduced in all of the three components.

Data latency is usually mainly influenced by the refresh cycle of the data warehouse system in which the data is stored for analysis purposes. Data warehouse systems are widely accepted as a middleware layer between transactional information systems and decision support systems, thereby decoupling systems focused on efficient handling of business transactions from systems focused on efficient support of business decisions. A main drawback of the data warehouse concept is the time consuming and resource-intensive process of extracting data from operational systems, transforming it and loading it into the data warehouse database. Due to this fact, the so-called ETL processing is often executed in batch mode at non-peak times (e.g. over night), causing time-lags between the recognition of a business event and its delivery for analysis purposes.

A widely adopted approach to reduce data latency is an operational data store (ODS). In contrast to the data warehouse system that requires extensive data cleansing, data consolidation and data quality management, an ODS stores a limited scope of data with only basic (or even none) consolidation and data quality management, thereby allowing real-time or near real-time updates and faster data distribution (Kimball et al. 1998; Imhoff 1999).

Another way of reducing data latency is to change from a periodic batch-oriented to an event-driven update of the data warehouse by using EAI technology. By doing this, data representing a certain business event will be populated into the data warehouse as soon as the event is recognized in an operational system (Schiefer and Bruckner 2003). With EAI platforms becoming more important to organizations, many vendors of ETL software tools react by offering corresponding interfaces that allow the extraction of data from popular EAI solutions.

A third alternative might be seen in the concept of business activity monitoring, which mainly deals with the direct analysis of data collected via an EAI platform, hence avoiding the additional data storage in a data warehouse or ODS (Nesamoney 2004).

Analysis latency is mainly determined by the time it takes to inform the person in charge of data analysis that new data has to be analyzed, the time needed to choose appropriate analysis models and the time to process the data and present the results. Latest approaches that deal with the reduction of analysis latency are provided by BI software. A prominent BI concept is Online Analytical processing (OLAP), which concentrates on reducing the time needed for analyzing the data by providing powerful user-interfaces that let the analyst explore the data along previously defined analysis dimensions (Codd, Codd and Salley 1993). In contrast to the fixed dimensional structures necessary for doing OLAP, Data Mining as a more flexible BI approach allows the application of different data exploration techniques to a large amount of data in order to discover unknown relationships between variables or single data items (Berry and Linoff 1999). While pure data mining is mainly focused on reducing the time for data processing by applying efficient data exploration algorithms, data mining software tools like SPSS or IBM intelligent miner also facilitate the process of selecting and adapting a data mining technique that is suitable for a given problem. In order to reduce the time for notifying the analyst of business events, the approach of automated exception reporting can be used.

Although BI tools can help to significantly reduce the analysis latency, the limit of this reduction can be seen in parts of the analysis process that require manual intervention. Further improvements in this area can be achieved by automating additional analysis activities. An example could be the reuse of data mining models that were specifically tailored to the analysis requirements of an organization. To allow for a better tool support, analysis processes have to be documented in a standardized manner, e.g. by using the eXtensible Business Reporting Language (XBRL) to formulate financial reports or the Predictive Modeling Markup Language (PMML) to document data mining models (Schwalm and Bange 2004).

The least IT support can be identified in the area of *decision latency*. In most cases the interpretation of analysis results and the derivation of appropriate actions are seen as manual processes that have to be carried out by knowledge workers and are therefore time consuming. Newest advances especially in the area of Business Activity Monitoring try to improve this situation by automating certain decision processes with the help of rule-based decision engines. Based on the real-time analysis of data from an EAI platform, the decision engine checks for predefined business rules and notifies responsible people or triggers other tools for conducting further actions (White 2002).

Process Performance Management

The main idea of process performance management is to control the execution of business processes by comparing process models (i.e. to-be models of business processes) with data collected during process execution (i.e. as-is-models of business processes) in order to identify potential for improving process execution and to recommend the appropriate modifications to the processes. In order to make this concept work, two mechanisms are needed:

Firstly, a mechanism for measuring process performance has to be established. Kueng and Krahn (1999) recommend a nine-step model for getting from a process model to a process performance measurement system that automatically collects both financial and non-financial performance-relevant data from operational information systems, populates them into a dedicated process data warehouse and provides mechanisms for flexible analysis of business processes. A very important part of this nine-step process is the definition of performance indicators and process goals for each process that is to be analyzed (e.g. Österle 1995). State-of-the-art business process design (and maybe simulation) tools allow for the integration of performance indicators in process models. The model database should be accessible via an integration platform using a specific adapter that transforms the tool specific process specifications into a standardized format like e.g. the Business Process Modeling Language (BPML, cf. BPMI 2002).

Secondly, a mechanism has to be installed that allows for the translation of process analysis results into recommendations for appropriate improvements of the process design. Improvements are implemented by refining the respective process models, which in turn trigger another design-implementation-execution-analysis cycle.

The above described concept of process performance management is exemplary implemented in ARIS Process Performance Management by using the modeling suite ARIS toolset and a special purpose process data warehouse (ARIS PPM, cf. IDS Scheer AG 2002).

EXAMPLE FOR AN IT-ENABLED CORPORATE PERFORMANCE MANAGEMENT

In this section, we will provide an example from the telecommunications sector that illustrates how a CPM solution could look like and how the depicted IT enablers can be utilized in this context. We choose a simple incident management process that specifies the actions to detect, to analyze and to resolve faults in the telecommunication network. Figure 3 depicts the process as well as its relationships with strategy- and system-related aspects that will be discussed below. The process is initiated by a customer reporting a fault incident to a call center agent who then tries to provide initial support. If the problem cannot be solved directly, the agent specifies the detected fault, records the incident and initiates a problem diagnosis. In this step, a technician analyzes the recorded incident and issues an order to the Telco's service staff to resolve the analyzed problem. A service technician fulfils the ordered service at the customer site and concludes the incident by producing an incident resolution report. In case the incident is not covered by warranty, the customer will be sent an invoice. In this example we assume that the Telco considers customer service as a dedicated business area and tries to reach the goal of service leadership by delivering high quality service and being profitable at the same time. Corresponding to these goals strategic key performance indicators like e.g. the share of incident management on overall revenues, the ratio of the Telco's process cycle time and the cycle time of competitors on the market, or the percentage of satisfied service customers are specified. These strategic KPI are linked to process KPIs that can be used to monitor and control the performance of the corresponding business processes. The relations between business goals, strategic KPIs and process KPIs can be derived by applying a specific management methodology like e.g. the Balanced Scorecard.

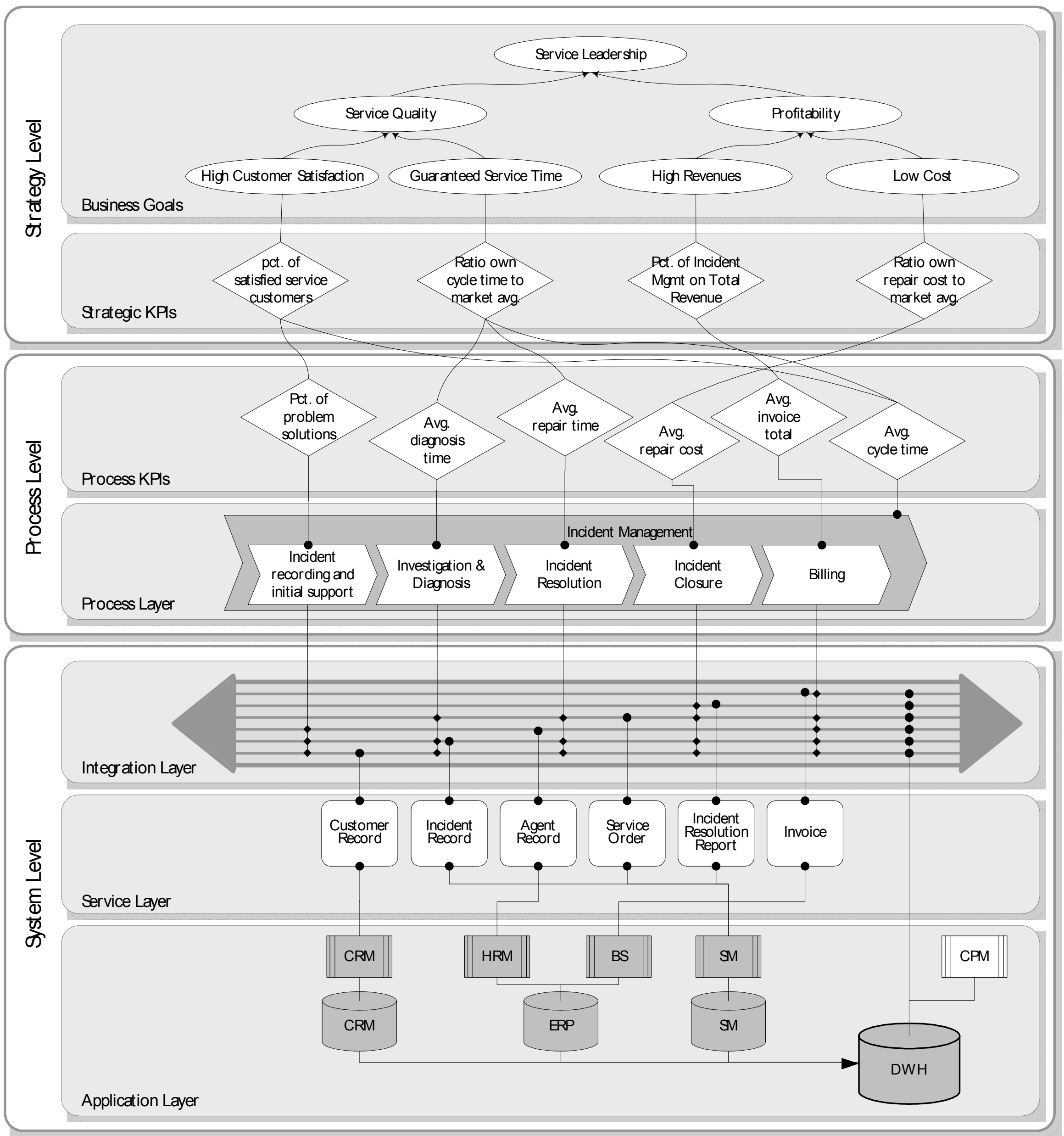

Figure 3. Static view of a CPM solution (example)

The business process and the process KPIs are specified using a business process modeling application that automatically generates the corresponding workflow definitions. The process is supported by different applications like e.g. a Customer Relationship Management (CRM) application for customer interaction, a service management (SM) application to coordinate service orders, a billing system (BS) for invoicing and a Human Resources Management (HRM) system for administering the employees. In order to properly support the business process, the application functionalities have to be integrated according to the process logic. This is achieved in two steps: First, all applications are connected to the same integration platform by supplying uniformly defined services. Each application can publish data messages of the format specified in the interface and subscribe to messages of other applications. The integration mechanism redirects all published messages to all applications that have subscribed to the corresponding message type. Second, the workflow engine of the integration platform uses the workflow definition generated from the process model to coordinate the application messages with respect to the process logic. In this example the CRM application provides a service to manage the customer records, the SM application provides different services for managing incidents, service orders, and incident resolution reports, the BS application offers an invoicing service and the HRM application provides a service for managing records of call center agents. The workflow definition specifies which functionality is needed to execute a specific process step. For instance, during incident resolution functionality is needed to access the incident record, the customer record, and the service order. The integration platform will coordinate the services according to the workflow definition and attaches different time stamps to each coordinated message to allow for monitoring of the process activities. In addition, a specific listening application collects all messages containing performance-relevant data and populates them into the Data Warehouse (DWH). In the DWH performance data is consolidated and prepared for performance analysis purposes.

Performance management can be separated into an operational level and a strategic level (cf. Figure 4). While on the strategic level business goals and strategic KPIs have to be defined and process redesign has to be initiated, the operational level concentrates on monitoring, controlling and optimizing processes (e.g. zur Muehlen 2004).

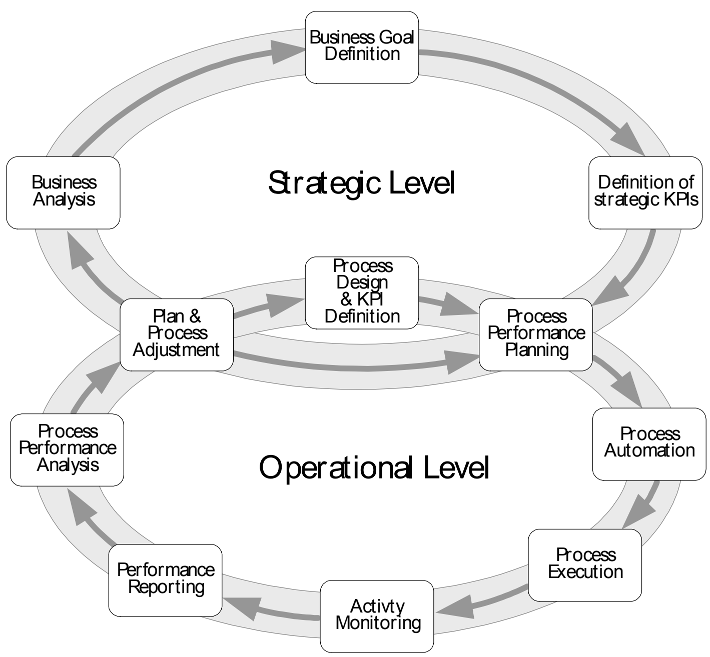

Figure 4. Two levels of Performance Management

On the *operational level* the performance analysis can be divided into two parts. First, classic business intelligence information can be generated to analyze the performance of the business area *service management* by performance indicators like e.g. “average repair cost per incident” or “average number of incidents per customer”. Second, the collected activity data allows for analyzing process performance, containing performance indicators like e.g. “average repair time”, “average process cycle time”, “average slack time”, “ratio of diagnosis time and resolution time”. In addition, as-is process models can be generated from the activity monitoring data using a specific model generator application. The as-is process models may be compared to the to-be process model in order to identify possible weaknesses in process execution. For example, the as-is process model may indicate that 20% of the average cycle time is due to a certain part of the diagnosis process where two sequential problem checks are carried out. While the first check takes 1 hour on average and helps to identify 15% of the problems, the other check identifies 80% of the problems in an average time of 30 minutes. By generating separate as-is models for different service centers it would become possible to identify the most efficient process execution variant, which can in turn be used as input for a process improvement.

Since strategic KPIs, processes and process KPIs were designed using a top-down methodology, there is no logical gap between BI information and process intelligence. This allows for integrated performance reporting and analysis using classical BI applications in combination with special tools for process analysis. The detected gaps between planned performance and measured performance can be addressed with two measures that may be combined:

First, the performance plan and the performance rewarding system can be modified. For example, if customer satisfaction is low due to high incident management process cycle times, it could be defined as target to reduce cycle time by 20 percent. To achieve this target, measures and actions have to be developed and to be taken by the process owner and the people who execute the process, e. g. if diagnosis time is the bottleneck of the process this time has to be shortened. Short diagnosis times could be rewarded by a bonus system.

Second, the to-be process model can be modified. Returning to the example of the diagnosis process, the to-be-model could be modified in way that allows the parallel execution of the two sequential checks in order to allow for a significant reduction of the average diagnosis time and therefore the average cycle time of the process. The adapted process model can be used as a blueprint for an adapted workflow implementation.

On the *strategic level*, the strategic key performance indicators are analyzed. They are based on process performance indicators and external data, e.g. the market share or a product quality index. A deviation of current values from target values can be caused by bad internal processes as well as by an inadequate business strategy. If process analysis shows that processes are not the cause for missed targets, business strategy and therefore business goals have to be adapted. This can demand new strategic and process performance indicators and initiate a complete redesign of the business processes.

CONCLUSIONS

The article depicts how the long-time technical and conceptual boundaries between standardized business software packages, workflow engines, business process modeling tools, business intelligence tools and integration frameworks begin to be surmounted by means of service orientation, integration middleware, standards for process specification and execution, as well as reference models for metrics and standardized process repositories. It is shown, how this trend of convergence can build the foundation for a better alignment of strategic decision making and operational business process management in the shape of a new management concept denounced as corporate performance management. But in order to implement the necessary IT infrastructure, organizations need a better understanding of the IT processes supporting CPM. Therefore, next steps have to address the processes for adequate IT support of CPM. In addition, future research has to examine the practicability of the proposed CPM approach with the help practical implementations.

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