Business Intelligence in The Real-Time Economy

Trends shaping the future of business intelligence

Johan Blomme

Circulation Manager, AMP

Lagardère SERVICES BELGIUM

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www.johanblomme.net

The changing role of business intelligence

Today's economic environment is marked by increased customer power and complex supply networks. In order to succeed, companies must innovate faster and collaborate with strategic partners. To do so, they need to bring information to a wider audience, do it in real-time and make BI part of ongoing business processes.

The role of BI has changed beyond its original purpose of supporting ad hoc queries and analysis on static historical information. Rather than reporting on the business, BI moves into the context of business processes. The classic batch-oriented approach is modified with event-driven processing models that deliver real-time information to users. By embedding BI-functionality into operational processes, BI transforms from a reactive to a proactive decision-making tool.

Introduction

Business environments are changing rapidly and face enormous challenges from an increasingly turbulent and highly competitive context. Globalization, mergers and acquisitions, the convergence of digital technologies and the search for economies of scale and scope open new avenues for expansion. However, lowered barriers to entry in nearly every industry also reshaped the business landscape. Therefore, a key challenge is to act proactively and to anticipate the needs of the marketplace before one's competitors.

As a result of the pressures transforming the business landscape, companies have to share control with global production networks, powerful retailers and - most importantly - empowered customers. Social networks enable customers to collaborate and share information, which reflects the knowledge transfer over the Internet[1]. Increasingly, companies embrace social networks to boost sales and brand awareness. Businesses must be able to sense and respond to customers' needs and desires. Customer expectations for higher service levels cause businesses to rapidly adopt business models and shorten time to market. This requires a more effective use of information for business decision-making.

Time and information drive the transition towards the Information Age. To stay competitive in what Peter Drucker calls "the age of discontinuity"[2], organizations transform themselves into agile enterprises acting on information in real-time. The real-time economy is a knowledge economy and the key assets of the organization are intangible intellectual assets.

To become proactive and information agile, organizations need BI-tools that transform large data repositories into actionable intelligence.

What follows provides a review of the emerging trends that shape the future of BI. The drivers for change are considered from the viewpoint of the changing economic environment and the increased competition through globalization that both result in the need for actionable intelligence and the pervasive use of BI to reach this objective.

Next-generation BI is marked by two areas of innovation. The first trend is about making BI more business-centric by focusing on decision-making as opposed to information delivery and reporting of traditional (IT-centric) BI.

The goal of BI-tools is to support operational activities by creating a seamless link between the latter and analytics. Business activity monitoring and predictive analytics are enablers in turning data into insights to make real-time decisions and to predict relevant events.

The second trend is about broadening the penetration of BI within and beyond the enterprise.

If analytics are drivers for operational execution, then analytics-derived insights must be disseminated to the right people at the right time. The future direction of BI will thereby be shaped by the new age of computing. In both their personal and professional lives, Web-savvy users have adopted the principles of interactive computing and have come to demand customizable BI-tools with high responsiveness. Business intelligence, and the insights it delivers, evolves towards an enterprise service with business users producing own reports and performing analytics on-demand.

Furthermore, Web 2.0 and social networks function as catalysts for highly intuitive user interfaces and the collaborative features of social computing allow users to share insights, which transforms BI from a solitary to a collaborative activity.

Meanwhile the delivery model of software-as-a-service (SaaS) provides a hosted platform for the deployment of BI in the cloud. As the Web becomes the dominant user-interface, cloud computing and SaaS gain prominence. Not only the economics of BI are changed, but open standards allow businesses to rapidly deploy BI-solutions that broaden the reach of BI, both within and beyond the corporate firewall.

1. Business intelligence for real-time data

More than ever, organizations are realizing that empowering employees at all levels with timely information and insights to make business decisions brings competitive advantage through improved performance, whilst the return on investment of BI-tools increases. However, the path to pervasive BI is not self-evident.

The history of BI shows we have moved through the stages of being able to organize data (data warehousing), to extracting useful information from it (reporting) and performing advanced analytics (data mining), to using real-time data to respond quickly to events as they happen (operational BI).

Traditional BI concentrates on information access and the use of sophisticated tools that analyze trends and patterns in large volumes of historical data to improve the effectiveness of strategic and tactical decisions. Historically, BI has been used by power users and management teams as a tool to view static performance metrics delivered from a data warehouse that was built for this purpose. Data warehouses are multidimensional structures for so called on line analytical processing (OLAP) to analyze information about past performance on an aggregate level. Traditional business applications help businesses understand what happened in the past. A problem inherent to reactive BI systems is that these tools are disconnected from the underlying business processes, while the management of these processes is essential in a real-time environment.

In the traditional model, transaction data from source applications (e.g. CRM, ERP, SCM) is captured in an operational data store (ODS) through a batch process. Data from the ODS is transferred (also in batch) to the data warehouse through an extract, transform and load process (ETL). Analytical applications capture the consolidated data from the data warehouse or data marts for reporting and analysis. This process is *time-driven* and *data-centered*.

"If you really want to put analytics to work in an enterprise, you need to make tem an integral part of everyday business decisions and business processes – the methods by which work gets done and value gets created. … When embedded in processes and workflow, analytics shift from being an ancillary activity to being a consistent, routine, and natural part of doing business. Embedding analytics into processes improves the ability of the organization to implement new insights. It eliminates gaps between insights, decisions, and actions".

Davenport, Harris & Morison, Analytics at work, 2010, pp.121

To address the increased demand for operational efficiency as well as effectiveness, a shift is taking place towards the convergence of BI and business processes. The goal is the deployment of analytics within operational business processes to make decisions in real-time. The challenge to use up-to-the-minute information is twofold : information in disparate systems must be integrated and enterprise software should be able to access and analyze information and deliver it in an actionable form. To support real-time analysis and action, the batch approach (ETL) is replaced with processes that continuously monitor source systems and capture changes as they occur. The technology enabling the event-driven integration of real-time data between applications is enterprise application integration (EAI). EAI is the process of integrating data across company applications, thereby enabling client applications to operate on a unified view of data. With EAI, transaction data is directly and automatically captured. This process is *event-driven* and *process-centered*.

Accordingly, there is a trend to expand the field of BI beyond data warehousing. Traditional BI-applications predominantly use historic data from large repositories. These applications are constrained by the limited service-level capabilities of static data. The latency inherent to static data implies that there is no real-time connection between the data and its operational sources. The goal of the transition to real-time analytics is to reduce latency. BI 2.0 extends the definition of BI beyond the traditional data warehouse and query tools to include event processing. The challenge is to turn real-time data into actionable information to enhance operational decision-making.

As BI is becoming a part of operational decision-making, BI also embraces closed-loop performance management. New applications emerge by embedding analytics in business processes. To streamline their operational efficiency, companies need to monitor business operations. What is needed is real-time visibility of performance ("what is happening now ? "). Business metrics enable operational business intelligence. A zero-latency environment is created that offers closed-loop processing by rules engines that feedback the outputs of BI-tools into front-line operational processes, either on-demand or event-driven.

BI 2.0 incorporates real-time data from event streams and automated decisions are built into processes. Complex event processing (CEP, also in combination with predictive analytics, cfr. infra) is in line with the revival of decision-centric business intelligence. BI 2.0 is meant to provide information to a wider audience of business users. Real-time reporting and alerts are a means for business activity monitoring. For example, performance metrics empower employees to track business metrics against organizational goals. This enables corrective actions and faster reaction to business events, and thus the optimization of a variety of business activities (e.g. call center operations, supply chain tracing and tracking, fraud detection, claims processing, store inventory management). Real-time information is displayed through scorecards and dashboards and BI is deployed as a service towards its customer base.

2. Self-service BI

As a result of the increased use of embedded analytics to manage performance, there is a push to share information throughout and beyond the enterprise. This contrasts with the view that BI-tools are often confined to a small audience while the users that are most able to take action do not have access to the data. Besides accessing data and developing reports, competencies of knowledge workers are increasingly defined in terms of making sense out of seemingly disparate pieces of data and the conversion of insights derived from it into actions. However, many of today's BI-platforms rely on systems and tools that store and aggregate operational data and deliver scheduled reports at specifically defined intervals. The traditional approach of cleansing data, integration in a data warehouse and finally having IT create historical views of transactional data is much too slow for enterprises to keep pace with the business demands of today. What is needed in the current business environment is insight drawn from the analysis of granular data that delivers faster time-to-value. Information workers need access to up-to-date information and analytics that enable them to make adjustments immediately in frontline operations.

Information self-service

The new paradigm of a user-centric BI development is enhanced by technologies that sustain a model of self-service BI. What is often referred to as *the consumerization of IT* means that users of all levels expect to have access to business information in a similar way as they use the Internet and search the Web (sometimes called "the googlization of BI"). This places increasingly pressure on vendors and IT departments to respond more quickly to a growing demand from users for solutions that are easy to use and Web-based. Employees have strong expectations for a consumerized experience with technology that gives them access to dynamic content with a user-friendly interface. Organizations need to incorporate these user requirements. Self-service BI refers to a personalized and interactive BI interface that enables users to access and analyze data to help make better decisions faster (and reduce dependence on IT in building applications).

> *"BI 2.O marks BI becoming more interactive (not only consuming reports, queries and dashboards, but being able to find and analyze the right information), more collaborative (it offers tools to not only work with data, but work on it with others, share analysis, comment on performance indicators, and link indicators together to create causal effects between different business functions), and more personalized (BI tailored on the way how different people consume and work with information".*
>
> *J. Kopcke, Oracle Senior VP, BI and Enterprise Performance Management (quoted in Gandhi, 2008).*

A number of technological innovations and features contribute to self-service BI. One way to design a user-friendly BI environment is the "MAD"-framework that consists of three layers to meet the analytic needs of most users[3]. The monitoring layer lets employees view information about key performance indicators (KPI's). The root cause of problems can be explored from multiple dimensions or filters through the analysis layer and finally the drill-down layer lets identify customers or products to take action. User-centered application development benefits from the build-in drag-and-drop styles, the possibility to make calculations on the fly and the interactive visualization of multidimensional data.

Speed of analysis is powered by *in-memory analytics* that query data directly in RAM and results in a much faster performance than conventional disk-based approaches. In-memory solutions also eliminate OLAP-requirements around building multidimensional cubes and aggregate measures, resulting in analytics with far less complexity which allows users to slice and dice data in an intuitive way with fast response times.

Businesses collect and store massive amounts of data generated by customers, partners, suppliers and internal processes. Making this data available for timely and informed decisions is a critical step in any environment. The retail sector, for example, is a business where applications are created to support demand-driven decisions. The number of transactions occurring in retail through the use of RFID-devices, point of sales data and customer loyalty programs is huge. The type of data and the granularity of it vary by the role of the stakeholders in the organization. Retail BI should empower the stakeholders with actionable information to improve the performance of stores and categories, optimize promotions, improve inventory levels and reduce out-of-stock occurrences.

Faced with these challenges, a retail BI solution must provide end-to-end visibility across the supply chain, let information be exchanged between parties in real-time and integrate BI with business operations. In-memory analysis helps processing large amounts of data and allows insights to be available in real-time. Transactional data can be analyzed at a very granular level and provides a competitive advantage especially in retail where reducing latency between data/insights and actions is key to improve business performance (e.g. respond quickly to changes in inventory levels). BI solutions can be deployed that capture a set of KPI's that serve as business context information related to areas of responsibility. Members of the retail chain should monitor these metrics and take appropriate action. Other industries (e.g. logistics/supply chain, telecommunications, finance/insurance) benefit from reporting and analytics in a similar way[4].

Several products address the real-time monitoring needs of business users. For example, *IBM Cognos Now!* (www.ibm.com/cognos) delivers self-service, interactive dashboards to an organization's frontline. Time-sensitive KPI's are visualized and provide proactive alerting to take actions that have impact on business operations. For instance, by providing real-time transaction data from point of sale systems, FMCG-companies can help retailers avoid out of stock situations. Inventory tracking can invoke backorders through the replenishment system to improve revenue streams.

Pivotlink (www.pivotlink.com) is an on-demand application based on a software-as-a-service (SaaS) delivery model that offers role-based dashboards for its customers. Apart from monitoring operational processes, users can perform advanced analytics to discover underlying trends and anomalies in the data and to obtain answers to specific questions (this can range from drill-down in dashboards to sophisticated calculations and forecasts). Furthermore, Saas BI offers the possibility of collaborative information sharing. Since information is centralized, operations such as product and price updates, tracking of sales performance and automatic replenishment can be achieved in real-time. On-demand BI expands collaboration to the ecosystem of the organization. Organizing knowledge around business processes that the enterprise shares with suppliers, business partners and customers, increases the ability of the organization to meet market demands.

Figure 1 : Interactive dashboards illustrate the trend towards the consumption of analytical insights. These applications make use of in-memory processing and are characterized by their strong visualization capabilities and the possibility to share insights in a collaborative way. Increasingly, these applications are cloud-based.

Enterprise 2.0

There is no doubt that BI embraces Web 2.0-features that focus on the user experience. BI has been redefined along the lines of Web 2.0. The customer-centric focus of Web 2.0 has created a demand for applications that move from a traditional transaction platform to a model that is more accessible and personal for the user.

Enterprise 2.0 is a term used to describe the use of Web 2.0 techniques in the corporate context : "Through the adoption of Web 2.0 techniques, information workers, like their consumer counterparts, are able to control their own user experiences with less guidance from IT, and thus create for themselves a more intuitive and efficient work environment. The end result is improved worker productivity, morale, and satisfaction" [5] .

BI 2.0 implemented with Web 2.0-technology can deliver insights from large data sets to the average user. Web 2.0-applications represent an opportunity for BI to build Web-based collaboration. Reports can be published in blogs and wikis, which help construct a knowledge base to share interpretations. Users will learn to use information more dynamically which allows the generation of "crowd-sourced wisdom." Besides reporting and analysis, decisions are part of the BI delivery mechanism.

Web 2.0 represents a paradigm shift in three ways. First, there is a power shift from expert-generated to *user-generated content*. In the traditional BI environment, a separation exists between BI experts who have the technical knowledge of both the data and analytical tasks and business users who consume standard reports. Because markets are more volatile, businesses seek greater agility to respond faster to market requirements. This feeds the demand for self-service of business users. Tools like mashups (cfr. infra) empower business users to configure business data and create situational applications that support their specific needs.

Second, in order for more people to participate in content creation and to sustain self-service application development, the content creation tools have to be simple and interactive. Web 2.0-technology puts a high level of interaction into the browser. *Rich internet applications* (RIA's) enhance the user experience. The focus is on the development of highly intuitive user interfaces, including visualization capabilities that let users see the relationships between data and enables business users to interactively manipulate data using enhanced navigation and search techniques according to their needs. The interactive Web applications are user-centric (usability) and at the same time screen flows are designed and organized according to business process requirements (process-centric).

Finally, a Web architecture is necessary that sustains the requirements of RIA's. Ajax, for example, is a collection of technology standards used to provide dynamic browser-based systems enriching the user experience[6]. Ajax converts software applications into web-based services that are accessible by a Web browser. In that sense, Ajax helps building new business models like the one known as software-as-a-service. One of the main features of Web 2.0 is the flexible distribution of applications not packaged as software but delivered as a service through the use of the Web as a platform (from the user's point of view, services are important and not the software or hardware component that is used to implement the services). Total cost of ownership (TCO) is reduced by eliminating software installation on the client-side. At the same time, user experiences are richer because Web applications give the same look and feel as desktop applications in terms of intuitiveness, responsiveness and interactivity.

The convergence of structured and unstructured data

An important issue to be addressed within the context of self-service BI concerns the delivery of a composite view of the business to the knowledge worker. The majority of data contained in enterprise databases is structural data. Qualitative data (e.g. emails, office documents, presentations) from unstructured and semi-structured data sources as well as external data driven by Web 2.0 is in most cases left aside. Knowing that the ability to transform information into insight in response to the volatility of the business environment is a core differentiator, the integration of unstructured and semi-structured data with known data sources becomes an enterprise requirement.

Gaining insights from data to drive better decisions is no longer constrained by the limits of internal data. The open access to information in the Web 2.0-space allows users to combine existing information with customer-generated content form the social networking spectrum like blogs and wikis. Social media analytics presents a unique opportunity to treat the market as a “conversation” between customers and businesses. Companies that harness the knowledge of social networks compile enterprise data with streams of real-time data from Web 2.0-sources to better access marketplace trends and customer needs. The adoption of Web 2.0-technologies and applications can help businesses to expand the reach of BI and improve its effectiveness.

Technological efforts are underway to gain insights from unstructured and semi-structured data and to converge it with structural data sources. Search-based applications, for example, provide a way to collect data in any format from any source and transform it into a cohesive, meaningful information resource. The semantic technologies they use, help relate information across different data sources to act on it appropriately. A search-based infrastructure enables the construction of a variety of business applications. Capturing and correlating data from disparate sources and presenting the results of analytics in dashboards delivers actionable insights that traditional BI tools don’t provide. Applications not only benefit from a unified view of data but are also updated in real-time which improves the timeliness of information.

Cloudview (www.exelead.com), for example, is a platform for the extraction of high volumes of semi-structured and unstructured data (email messages, blogs, RSS-feeds, etc.) and the integration of these data with structured content. *Synaxio*, a joint venture between Capgemini and France's national postal agency, La Poste, has leveraged *Cloudview* to develop a search-engine based intelligence application in the postal service market. Real-time information from production equipment like sorting machines as well as archived data from data warehouses and legacy systems is unified by the system, that delivers information to internal and external users through customizable Web dashboards. Customer services benefit from the end-to-end visibility the system provides and real-time monitoring supports workflow processes.

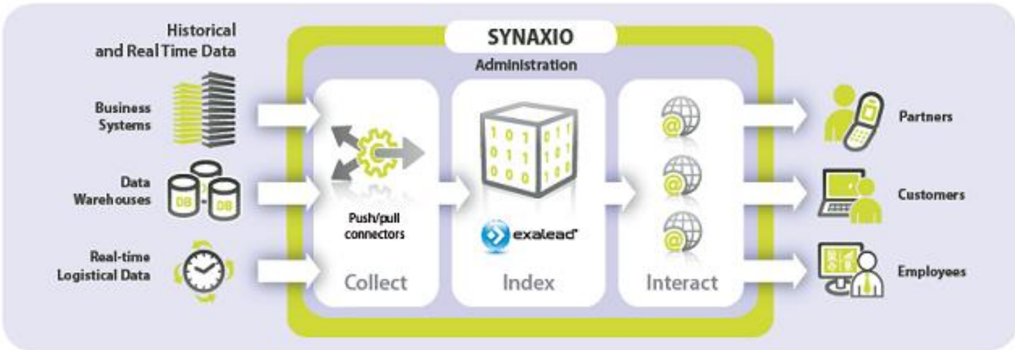

Figure 2 : *Synaxio* analytics automatically collects disparate data and transforms it into a single, structured information resource. This resource, which adapts in real-time, powers the system's customizable dashboards and provides a platform for constructing new applications (source : Exalead White Paper, 2010).

Another example of self-service technology empowering end-users is *Microsoft SQL Server PowerPivot* (www.powerpivot.com), which is an add-on to Excel. It allows users to bring data from a multitude of sources including corporate databases, spreadsheets, reports, text files and Internet data feeds into Excel. It then joins the data so users can pivot tables and derive insights in an intuitive way from the data. The results can also be published into Microsoft Sharepoint to collaborate with collegues.

On-demand BI

As explained in the previous sections, BI approaches evolve toward supporting an increasing number of users and provide access to a wide range of data sources. To deploy the self-service model many alternatives are available to corporations. Currently, traditional on-premise software installations still prevail but the model of hosted business intelligence offered by on-demand deployment versions increasingly gains acceptance. Moving BI to the cloud represents a new model making business intelligence affordable and scalable to include large data volumes from multiple data sources and to expand the reach of BI to users inside and outside the corporate firewall.

More and more datasets move to the cloud and the delivery of software functionality over the Internet (Saas), gives the Web the status of a BI platform that consists of a wide range of loosely coupled functionalities that are delivered as a service over a network. Cloud computing and SaaS emerge as a new deployment model for BI that is stimulated by the adoption of a service-oriented architecture (SOA) and other forces that drive a transformation in application architectures. Software applications evolve towards a service-oriented approach of which cloud computing is a new segment.

Cloud-based services emerge from several trends that reinforce one another[7]. A major shift in the BI industry is the transformation from stand-alone applications to *embedded BI-services*. The convergence of analytical and operational applications implies that the results of analytics are used directly in the workflow context to drive operational execution. Second, there is a transformation from dedicated applications (desktop-oriented) to *composite applications*. The latter prevent users from switching between several applications. Composite applications consist of loosely coupled applications that work together. Each component consists of loosely coupled application components that work together. Each component presents information from a separate application or data source. Composite applications require open access to information through a SOA and integrate content (structured, semi-structured and unstructured) from multiple sources. The application of a service-oriented architecture transforms data from an isolated resource to data as a service. Data interfaces are packed as Web services, whereby applications access the service instead of the data source. Finally, *collaboration capabilities* are incorporated into applications.

Cloud computing is an example of how the abovementioned trends converge to a new delivery model that is an important driver for self-service BI. The focus of cloud computing is the user experience. The delivery of computing services is decoupled from the underlying technology, making cloud computing user-friendly. Cloud computing brings together the core principles of Web 2.0-technology : engaging more users with the right information through a personalization of user interfaces that let them collaborate for decision-making.

3. The socialization of business applications

Increasingly business users have access to analytic information for decision-support, bringing the objective of "BI for the masses" within reach. With self-service gaining acceptance, the focus of BI shifts to take into account the requirements of users and the demands of interactivity. Furthermore, when software is intuitive to use, it fosters proactivity and employee productivity. An important aspect of self-service BI is the power of consumer-like tools to get new views of information and how this can lead to new insights and ideas. This is where Web 2.0 and social networks come in.

To organize BI in a pervasive way, enterprise applications follow the lead of Web 2.0 which is an important driver towards the socialization of business applications. Emphasis is not on the data itself but on how people are using it : "The focus, like Web 2.0, is on people, empowering users to express their creativity, allowing them to freely access information and produce something meaningful from it while focusing on information sharing, communication and collaboration"[8].

In the traditional RDBMS-model, BI tools rely on a centrally (IT-)managed process that provides structured and standardized (mainly) historical information for analysis. This infrastructure was not designed to support real-time views of operations. On the other hand, increasing data volumes and the proliferation of new types of data (e.g. unstructured business content and data in collaborative environments as the Web) are stretching the traditional enterprise infrastructure to its limits.

The issue of the integration of disparate data sources is addressed by considering Web 2.0-technology, hence the convergence of BI and collaborative technologies. At first sight Web 2.0 does not seem to fit with (traditional) BI because the lightly managed collaborative and easy-to-use technology it encompasses differs substantially from the structured context of enterprise business applications. Both BI and Web 2.0, however, are meant to increase the efficiency and effectiveness of information flows and complement each other. The integration of multiple data sources enriches enterprise applications with unstructured and semi-structured data from internal as well external systems, and Web applications are nurtured with real-time enterprise data.

Enterprise mashups : bringing SOA to the desktop

The combination of enterprise data with Web 2.0 information yields a unique business value. An evolving practice to provide real-time access to business information from any source is the enterprise mashup. Although mashups started in the Web 2.0 consumer space, they recently migrated into the enterprise space as well. According to Gartner, enterprise mashups will be the dominant model for creating composite enterprise applications by 2010[9]. The value proposition of enterprise mashups is clear : by making use of open standards to combine data into new applications, mashups directly address the daily business challenge of empowering users with timely information for decision support.

Mashups are associated with SOA which is a widely adopted open standard for enterprise data management. Enterprise mashups bring SOA-capabilities (packing applications as services) to the desktop to develop user-oriented applications and thus enable SOA to be more pervasive. Mashups integrate disparate data sources (internal and external, structured as well as semi-structured and unstructured data) and build relationships across these data to provide new holistic insights that were not possible before. The resulting composite data structures are accessible as Web services, API's or via query/search and can feed enterprise as well as Web applications.

Disparate data (content) and the interfaces (API's) that encapsulate these sources are the building blocks for mashups. The layer above provides a graphical user interaction mechanism to manipulate (via aggregation, transformation, filter and sort operations) the content of the underlying heterogeneous resources which results in the creation of so-called "widgets". Finally, end-users can combine and configure widgets according to their needs in a mashup.

Mashups have a broad application in the enterprise and affect many business functions (Gartner predicts that by 2012, one third of analytic applications applied to business processes will be delivered through mashups).

> *"The mash-up takes the dashboard to the next level, allowing the knowledge consumers themselves the ability to identify their own combination of analytics and reports with external data streams, news feeds, social networks, and other Web 2.0 resources in a visualization framework that specifically suits their own business needs and objectives".*
>
> Loshin, The analytics revolution, 2010, pp. 13.

Mashups and customer service. An obvious implementation area for enterprise mashups applies to customer service. CRM implies multiple processes (customer contact, sales, billing, support). Very often the delivery of a process like that of customer service relies on end-users accessing multiple applications. A major drawback is that customer-facing personnel (e.g. call center agents, sales representatives) lack a unified customer view which causes a poor quality of the customer experience. On the other hand, applications require a high involvement of IT in the lifecycle of each application.

Therefore, enterprise mashups can provide a solution to integrate disparate data sources into a composite application. This can be done by separating the design of end user applications from the underlying IT systems. End users can use en reuse application building blocks as "mashable" components to construct user-centric solutions. This not only reduces the cost and time to build and maintain applications, but also allows business users to create applications that are mapped with processes. Customer service processes are optimized because employees are able to service customers more efficiently.

Mashups and social media analytics. Increasingly, social media is empowering customers to reveal their thoughts and preferences through the Internet. At the same time, this also enables businesses to look for competitive advantages by monitoring and managing the many conversations that take place in the social media world. More and more customers create content on the Internet that is available in real-time. The unstructured data from various Web sources drives the demand for the extraction of social data and the incorporation of social media analytics into BI frameworks. Enterprise mashups can extend reporting and analysis capabilities by integrating social media metrics into dashboards.

Social media content can be tagged to look for pieces of information that are further mined and structured. The majority of services that can be monitored offer information pushing devices (RSS feeds) which can be classified, filtered and modeled to provide aggregate customer data revealing customer service issues, consumer attitudes and brand-related topics. Furthermore, sentiment analysis that extracts the semantics of user-generated content allows for the creation of mashups that identify trends in unstructured data.

For example, dashboards can use sentiment measures as key performance indicators to monitor product performance. Consumer sentiment can serve as an indicator of the performance of a new product that is introduced in the market ; sentiment measures can reveal the importance of product features and key customer needs ; changes in consumer sentiment can reflect quality issues ; retailers can estimate demand for products based on expressed satisfaction or discontent with products[10]. Streams of social media data thus provide an additional source of real-time data. While other data feeds (e.g. corporate research, point of sales data, call center logs) have an inherent time delay, the immediacy of the Internet allows to proactively identify issues and to respond to customer needs more quickly.

Social media analytics also help identify trends in consumer attitudes and behaviors. The identification of segments for business expansion and shifts in consumer demand across product categories is useful for product management. Consumer preferences can be broken down over time and according to a diversity of social-demographic criteria which offers the possibility to gain insights that otherwise remain unexplored in corporate market research.

The real business value of social media analytics is enhanced when the results are extended and mashable with other (external and internal) data sources. For example, the results of social media analytics can be combined with streams of real-time data from a hosted database from *Netsuite.com* or *Salesforce.com* and visualized with online maps using *Google Maps* (www.maps.google.com) or *Mapquest* API's (www.mapquest.com). This information can further be contextualized by integrating internal customer data.

Mashup vendor products enable access to corporate and external data sources with extensive transformation and enrichment processing, visualization and business analytics (e.g. www.denodo.com, www.jackbe.com, www.convertigo.com, www.kapowtech.com, www.ibm.com/software/info/mashup-center).

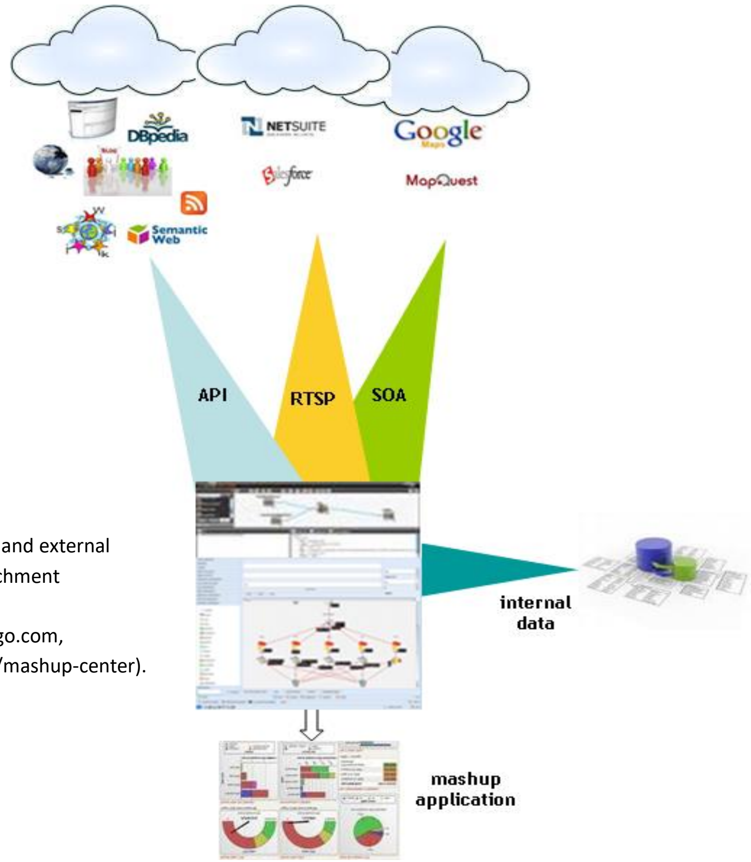

Figure 3 : Mashups dynamically combine different data sources

The mashup paradigm clearly illustrates the characteristics of “the new business intelligence”.

> *“This is the New BI – an emerging paradigm for analytics designed around the way people really work, share information and make decisions. … The New BI goes beyond analysis and reporting and ventures into the realm of true collaborative decision making. Web 2.0 social tools wrapped around the New BI have the ability to quickly collect and spread knowledge, connect people who would otherwise have remained unaware of each other, harness their collective intelligence and enhance individual decision making”.*
>
> blog Dough Henschen, February 12th, 2010

Mashups are an effective way for *the user-driven development of Web applications* that serve the information needs of business users. Mashups focus on self-service BI and make actionable intelligence broadly available (see figure 4).

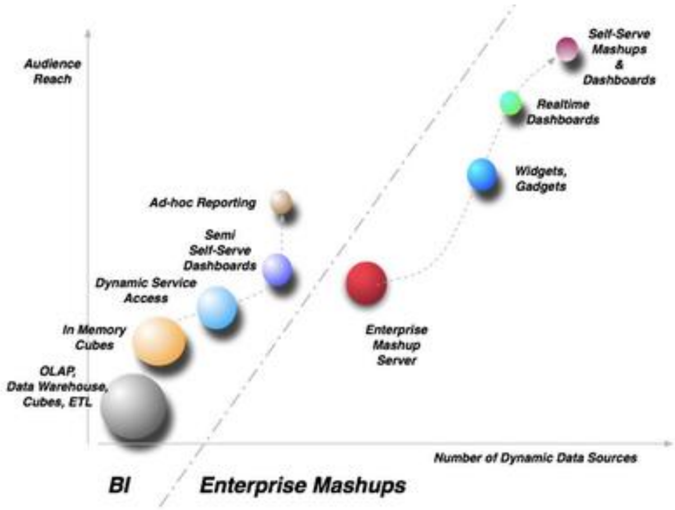

Figure 4 : Mashups broaden the reach of BI (source : Crupi, 2009).

Mashups don't follow the line of traditional software development. Through the use of enterprise mashups, *users create their own situational applications to reach the long tail of the application spectrum*. The reduced reliance on IT results in shorter implementation cycles and a rapid ROI of applications that address the user-needs in a continuous changing business environment (see figure 5).

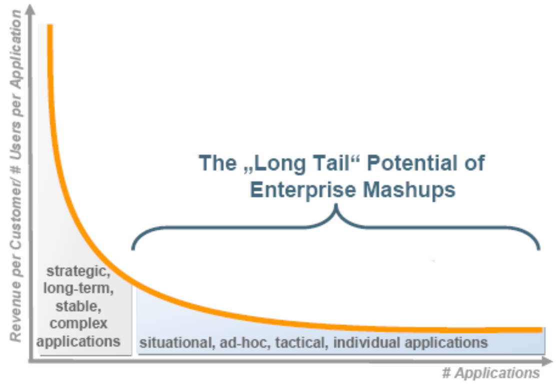

Figure 5 : The long tail of enterprise mashups

Mashups are about users designing information and show that *the future of data access is largely composed of real-time views of what's happening now*. Mashups provide an end-user's view on data integration that is made possible by the adoption of service-oriented architectures to integrate disparate data and applications

Through mashups, enterprises incorporate social computing features into BI applications. Basically, BI applications benefit from social media in two ways. First, mashups go beyond traditional reporting and analysis by combining information from multiple sources to deliver new insights. By capturing social data and getting relevant information from it, dashboards can provide meaningful insights from a variety of sources and identify business opportunities. Second, social computing tools can help build collaborative BI. It is not only the technological part of Web 2.0, but also the collaborative principles of it that are important for next-generation BI. When integrated with enterprise business processes, the social networking aspects of Web 2.0 let people socialize, collaborate and share information in new ways. Hence, the contribution of Web 2.0 to a BI strategy that is focused on decision-making as a core competency as opposed to just reporting measures.

Situational business applications like enterprise mashups drive the adoption of cloud computing and Saas BI. The digital economy generates more data than ever and corporations have to cope with the integration of social media into their BI solutions. Contrary to business applications that are based on structured data warehouse designs maintained by IT, the growing part of situational business applications use unstructured and semi-structured data from various sources. The value of the (real-time) information that feeds these long tail-applications decreases over time. These applications (which must be quickly developed and made available for a limited period) need an infrastructure to extract information from the massive amount of data available on the Web as a database. Therefore, situational business applications will continue to move to cloud computing infrastructures that provide the necessary processing power and storage[11].

4. Predictive analytics

In today's rapidly changing business environment, organizational agility not only depends on monitoring how the business is performing but also on the prediction of future outcomes which is critical for a sustainable competitive position. Traditionally, BI systems provided a retrospective view of the business by querying data warehouses containing historical data. Contrary to this, BI 2.0-systems analyze real-time event streams in memory. To perform operational monitoring and to support decision-agility, BI 2.0 is process-oriented. Analytics are embedded in business processes. At this point predictive analytics leverages actionable intelligence that can be integrated in operational processes.

Predictive analytics is aimed to shorten the distance between data and insights on the one hand and to close the gap between insights and action on the other hand[12]. Therefore, predictive analytics implies the use of advanced techniques to extract insights from data (shorten "the knowledge gap"), with the main purpose to direct decisions (shorten "the execution gap"). From an analytical viewpoint, predictive modeling refers to the use of techniques to capture historical and real-time data to make predictions about future events. Predictions rarely take the form of absolute statements and are expressed as the probability of an event or behavior to take place (or not) in the future. The analytic approaches used for "identifying valid, novel, potentially useful and ultimately understandable patterns in data"[13] rely on data mining techniques. These techniques are based on traditional statistical analysis (e.g. regression analysis) and tools associated with artificial intelligence (e.g. neural networks).

Forrester Research refers to predictive analytics as "the next generation of data mining"[14], meaning that predictive analytics goes beyond data mining to guide decisions in the workflow. Predictive models become part of business processes. For example, a predictive model might be built into a supply chain process to monitor stock levels. Based on historical demand patterns and real-time analysis of RFID data, predictions can be made of product demand and replenishment rules can be applied to optimize inventories. In operational settings (e.g. call centers) real-time predictive analytics can identify clients at risk and guide agents automatically to the next best action. The insurance and bank sectors use predictive models to detect fraud and assist in risk management (e.g. credit scoring). Telecommunication and service providers apply the results of churn analysis in operational decision-making to assess which customers are likely to remain as subscribers and which ones are likely to switch to a competitor.

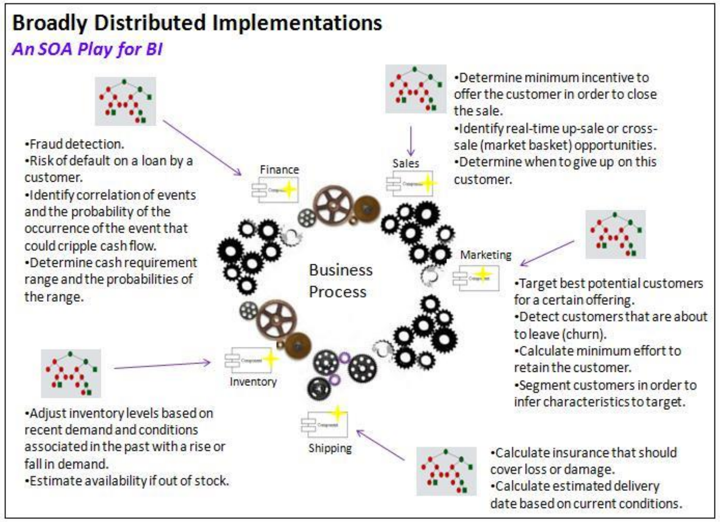

Figure 6 : Predictive analytics for the sales cycle applications (source : Asahara, 2009).

Closing the gap between analysis and action is related to service-oriented architectures that have become the norm for the design of modular, service-focused applications. A SOA facilitates the development of Web-based applications that are available on-demand and thus ease the use of predictive analytics in operational decision-making.

Current trends affecting predictive analytics center around standards for data mining and model deployment, advances in database technology, the growing importance of social media for predictive analytics and the proliferation of the cloud computing paradigm (and SaaS) for the deployment of predictive models. In their combination these factors support the new standard of self-service operational BI.

Standards for data mining and model deployment

Data mining has received considerable attention in public and private sectors. As part of the process that is often described as *Knowledge Discovery in Data* (KDD), data mining provides the power to discover and model relevant patterns and relationships in data. However, more is needed than just analysis. To deliver a measurable ROI, predictive analytics requires a focus on decision optimization to achieve business objectives. A key element to make predictive analytics pervasive is the integration with commercial lines operations. Without disrupting these operations, business users should be able to take advantage of the guidance of predictive models. For example, in operational environments with frequent customer interactions, high-speed scoring of real-time data is needed to refine recommendations in agent-customer interactions that address specific business goals, e.g. improve retention offers. A model deployed for these goals acts as a decision engine by routing the results of predictive analytics to users in the form of recommendations or action messages.

Operationalizing predictive analytics as part of a business process also implies that its impact on business results should be monitored. This can be done by tracking the results of models implemented against KPI's (e.g. the number of policies renewed versus the target value). Based on how business results are impacted, models can be calibrated (predictive models are thus not static, but dynamic).

A systematic approach to guide the data mining process has been developed by a consortium of vendors and users of data mining, known as *Cross Industry Standard for Data Mining* (CRISP-DM). The CRISP-DM standard provides a framework that encourages best practices in data mining to obtain reliable results and to establish a data mining process that is applicable in diverse industries. In the CRISP-DM model, data mining is described as an iterative process that is depicted in several phases (business and data understanding, data preparation, modeling, evaluation and deployment) and their respective tasks. Leading vendors of analytical software like *SAS* (www.sas.com) and *SPSS* (www.spss.com) offer workbenches that make the CRISP-DM process explicit : the user choses a phase to be addressed and a set of tools applicable to that phase are shown.

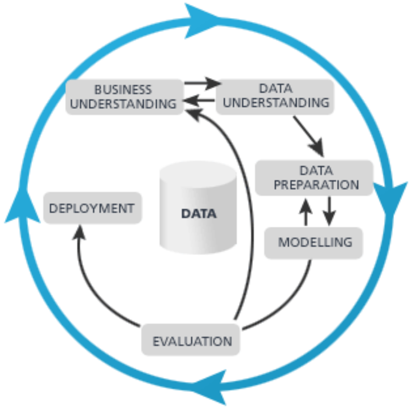

Figure 7 : The CRISP-DM model (source : Colin, 2000).

A major development for the integration of predictive models in business applications is the PMML-standard (*Predictive Model Markup Language*) that separates the results of data mining from the tools that are used for knowledge discovery. PMML is an XML-based language that describes the inputs to predictive models and the operations required for cleaning and transforming data, and provides support for several predictive algorithms (e.g. regression, decision trees, clustering, neural networks).

Developed by the *Data Mining Group* (www.dmg.org) the latest PMML-version (version 4, 2009) represents an open standard for interoperability of predictive models. Most development environments can export models in PMML and databases allow the deployment of PMML without technical hurdles. As analytics increasingly drive business decisions, open standards like PMML facilitate the integration of predictive models into operational systems. The deployment of predictive models in an existing IT-infrastructure no longer depends on custom code or the processing of a proprietary language.

Besides the flexible integration of predictive models into business applications, continuous analysis is key to enable business process optimization. The broad acceptance of the PMML-standard further stimulates the exchange of predictive models. The latest PMML-version supports an expanded list of predictive algorithms. Different models can be used to score an appropriate dataset and to select the most suitable predictive solution. *MicroStrategy* (www.microstrategy.com), for example, builds the PMML-standard into its analytics platform so that predictive models created with 3rd party data mining software are added to its XML repository. Predictive metrics are composed from PMML and users can select datasets for scoring against model parameters.

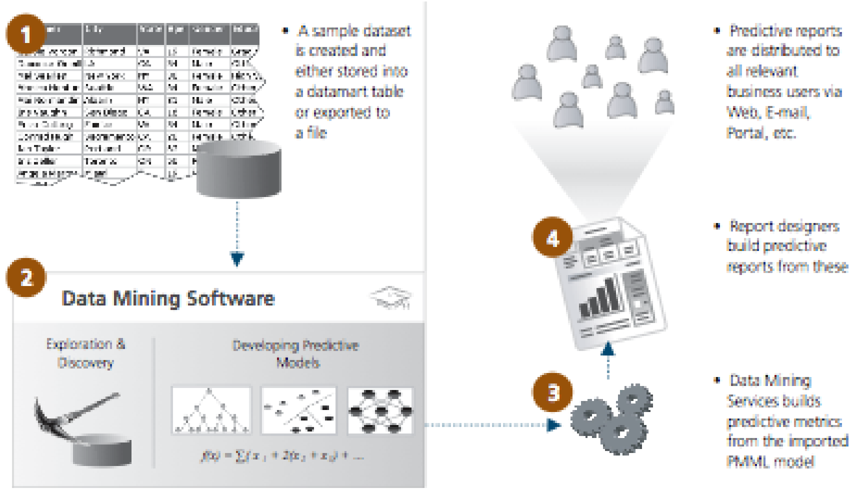

Figure 8 : Data mining with MicroStrategy (White Paper MicroStrategy, 2005).

Open standards like PMML contribute to the wider adoption of data mining and stimulate collaboration between stakeholders of a business process. In a similar vein, the increased use of open-source software can profit from PPML. Open-source environments like *Knime* (www.knime.org) and the *R-project* (www.R-project.org) can visualize and further refine predictive models that ware produced in a different environment.

Advances in database technology

A known practice is to build and test predictive models in a development environment that consists of operational and data warehousing data. In many cases analysts work with a subset of data through sampling. Once developed, a model is copied to a runtime environment where it can be deployed with PMML. A user of an operational application can invoke a stored predictive model by including user defined functions (UDF) in SQL-statements. This causes the RDBMS to mine the data itself without transferring the data into a separate file. The criteria expressed in a predictive model can be used to score, segment, rank or classify records.

Sampling is a valid option for data exploration and pattern detection but in most cases implies data to be moved from one location to another. An emerging practice to work with all data and directly deploy predictive models is *in-database analytics*. A number of factors contribute to the migration of advanced analytics from standalone applications towards the enterprise data warehouse. Advanced analytics are made more affordable by a drop in storage, computing and memory prices. This also enables smaller companies to make use of predictive models to react in an agile way to market trends. Computing-intensive applications profit from 64-bit memory processing which makes it possible to load large volumes of data in memory, making predictive analytics less time-consuming.

As a result vendors make predictive modeling functions available in relational databases by translating analytical functions in SQL extensions. For example, *Teradata* (www.teradata.com), integrates functions in its database management system for data description and transformation, the restructuring of tables, the application of various analytical algorithms, the visualization of models and the storage of scored models. Likewise, software vendors enable their graphical workflows to be integrated into relational databases, which increases the scalability of scoring tasks.

Another innovation in database technology is represented by *Mapreduce* and *Hadoop*. These two industry standards are gaining adoption for the massive parallel processing of huge datasets. Especially in the context of operational BI and complex event processing, there is a growing need for the storage of granular (detailed) data. Traditional data warehouse technology is optimized only for structural data stored in relational databases. *Mapreduce* and *Hadoop* do not impose a data model on information and have the potential to bring considerable innovation, not at least because both technologies work with structured as well as unstructured data (80 % of all enterprise data is unstructured data).

Social media analytics

The fact that the field of advanced analytics is moving towards providing a number of solutions for the handling of big data (data storage capacity, processing power), correlates to a large extent with the Web-based streams of information that are available. Gartner's Hype Cycle Report for 2010[15] identifies these new sources of information as an analytic challlenge for data-driven decisions. Characteristic for the new marketing data is its text-formatted content in unstructured data sources which covers "the consumer's sphere of influence" : analytics must be able to capture consumer-initiated communication in blogs and social network content.

By analyzing growing streams of social media content and sifting through sentiment and behavioral data that emanates from online communities, it is possible to acquire powerful insights into consumer attitudes and behavior. Social media content gives an instant view of what is taking place in the ecosystem of the organization. Enterprises can leverage insights from social media content to adapt marketing, sales and product strategies in an agile way. For example, in a study of the predictive validity of sentiment measures for the market success of new products, it was found that the number of messages in online social media (rather than positive or negative sentiment) was a useful predictor of total sales performance[16].

The convergence between social media feeds and analytics also goes beyond the aggregate level. Social network analytics enhance the value of predictive modeling tools and business processes will benefit from new inputs that are deployed. For example, the accuracy and effectiveness of predictive churn analytics can be increased by adding social network information that identifies influential users and the effects of their actions on other group members. Leveraging real-time customer data helps to predict the likelihood of defections. Workflow processes can be initiated to target retention efforts and to proactively allocate resources to prevent churn among the most valuable customers[17].

Predictive analytics in the cloud

While vendors implement predictive analytics capabilities into their databases, a similar development is taking place in the cloud. This has an impact on how the cloud can assist businesses to manage business processes more efficiently and effectively. Of particular importance is how cloud computing and SaaS provide an infrastructure for the rapid deployment of predictive models in combination with open standards. The PMML standard has yet received considerable adoption and combined with a service-oriented architecture for the design of loosely coupled IT systems, the cloud computing/SaaS model offers a cost-effective way to implement predictive models.

As an illustration of how predictive models can be hosted in the cloud, we refer to the *ADAPA* scoring engine (*Adaptive Decision And Predictive Analytics*, www.zementis.com). *ADAPA* is an on demand predictive analytics solution that combines open standards and deployment capabilities. The data infrastructure to launch *ADAPA* in the cloud is provided by *Amazon Web Services* (www.amazonwebservices.com, which also tracks usage for billing). Models developed with PMML-compliant software tools (e.g. SAS, SPSS, Knime, R) can be easily uploaded in the *ADAPA* environment.

Since models are developed outside the *ADAPA* environment, a first step of model deployment consists of a verification step to ensure that both the scoring engine and the model development environment produce the same results. Once verified, models are executed either in batch or in real-time. Batch processing implies that records are run against a loaded model. After processing, a file with the input and predicted values is available for download. Real-time execution of models in enterprise systems is performed through Web services that are the base for interoperability. As new events occur, a request is submitted to the ADAPA engine for processing and the results of predictive modeling are available almost instantaneously.

The on-demand paradigm allows businesses to use sophisticated software applications over the Internet, resulting in a faster time to production with a reduction of the total cost of ownership. Moving predictive analytics into the cloud also accelerates the trend towards self-service BI. The so-called democratization of data implies that data access and analytics should be available across the enterprise. The fact that data volumes are increasing as well as the need for insights from data, reinforce the trend for self-guided analysis. The focus on the latter also stems from the often long development backlogs that users experience in the enterprise context. Contrary to this, cloud computing and SaaS enable organizations to make use of solutions that are tailored to specific business problems and complement existing systems.

Predictive analytics increasingly plays a prominent role in day-to-day business operations. Users must make decisions with a future-focused frame. Consequently, user-friendly predictive modeling tools enter the workplace of the knowledge worker. For example, the *ADAPA add-in for Microsoft Excel* facilitates the broader accessibility of predictive analytics. Once the add-in is installed and data are selected, the user connects to *ADAPA* in the cloud to start scoring. The predictions are made available as new columns. Recently, *Predixion Sofware* (www.predixionsoftware.com) launced *Predixion Insight*, a cloud-based predictive analytics service that is fully integrated with the Microsoft BI platform. Predictive models can be created, managed and run with *Excel* and *PowerPivot* data.

Known software vendors as *SAS* (with Rapid Predictive Modeler) and *SPSS* (with IBM SPSS Decision Management) released lightweight versions of their analytic workbenches. These products bring predictive analytics functionality for non-technical users to address a range of business scenarios (e.g. campaign management, customer segmentation, churn analysis, risk analysis) with an intuitive and wizard-driven toolset. Before deploying models in an operational setting, “what if”-scenarios and simulations are run to test the best business outcomes. Predictive analytics gets pervasive. Either hosted (SaaS) or as packaged applications, a growing number of self-service predictive modeling options are available. The broader accessibility of predictive analytics also enhances collaborative decision-making. The insights gained by information workers can easily be published, shared and further validated through browser-oriented environments or within an Excel interface.

Conclusion

A majority of enterprises operate in a volatile business context where change is a constant and decision cycles are compressed. The ability to respond to change and to anticipate on market trends is a prerequisite for building a competitive advantage. Therefore, BI has become a corporate asset. More specifically, the ability to deliver actionable insights is an organizational differentiator. Technologically, BI platforms have migrated from client-server computing to Web-based architectures. This caused a change in focus from reporting on historical data to the analysis of real-time data and allowed the integration of decision-centric BI into business processes. Next-generation BI centers around fact-based decision-support and the empowerment of users with applications that foster productivity and overall business performance.

In this context the future of BI is shaped by three converging trends. First, the self-service model for the delivery of analytic capabilities is increasingly accepted across functions in the organization in general and front-line operational activities in particular. Second, the future of enterprise computing lies in applications that can capture, store and analyze large amounts of structural, semi-structured and unstructured data (from internal as well as external sources) to improve the decision-making process. Finally, cost-effective deployment models for the storage and processing of data gain acceptance. Like other enterprise applications (ERP, SCM, CRM), BI moves to the cloud.

NOTES & REFERENCES

The themes represented in this article draw on multiple sources. The articles, white papers and presentations consulted are listed below in alphabetical order of the authors. In this article reference is made to products in the BI marketplace. The examples are chosen at random and for illustrative purposes only.

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[5] Platt, 2007, pp. 4.

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[13] See Fayyad et al., 1996.

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