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# Business Intelligence

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# BUSINESS INTELLIGENCE

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## Abstract

*Business intelligence systems combine operational data with analytical tools to present complex and competitive information to planners and decision makers. Their objective is to improve the timeliness and quality of the input to the decision process. Business Intelligence is used to understand the capabilities available in the firm; the state of the art, trends, and future directions in the markets, the technologies, and the regulatory environment in which the firm competes; and the actions of competitors and the implications of these actions.*

*The emergence of the data warehouse as a repository, the advances in data cleansing, the increased capabilities of hardware and software, and the emergence of the web architecture all combine to create a richer business intelligence environment than was available previously.*

*Although business intelligence systems are widely used in industry, research about them is limited. The objective of this tutorial is to describe the state-of-the-art of business intelligence and to suggest potential IS research topics.*

## Introduction

Demand for Business Intelligence (BI) applications continues to grow even at a time when demand for most IT products is soft (Soejarto, 2003; Whiting, 2003). Yet, IS research in this field is, to put it charitably, sparse.

While the term Business Intelligence is new, computer-based business intelligence systems go back, in one guise or other, for close to forty years.<sup>1</sup> BI as a term replaced decision support, executive information systems, and management information systems (Thomsen, 2003). With each new iteration, capabilities increased as enterprises grew ever-more sophisticated in their computational and analytical needs and as computer hardware and software matured. Figure 1 shows the variety of information inputs available to provide the intelligence needed in decision making.

## Definition

BI systems combine data gathering, data storage, and knowledge management with analytical tools to present complex and competitive information to planners and decision makers.

Implicit in this definition is the idea (perhaps the ideal) that business intelligence systems provide actionable information delivered at the right time, at the right location, and in the right form to assist decision makers. The objective is to improve the timeliness and quality of the input to the decision process, hence facilitating managerial work.

Sometimes business intelligence refers to on-line decision making. Most of the time, it refers to shrinking the information time window so that the intelligence is still useful to the decision maker when the decision time comes. In all cases, business intelligence is viewed as being proactive. Essential components of proactive BI are (Langseth and Vivatrat, 2003):

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<sup>1</sup>For a history of business intelligence, see <http://dssresources.com/history/dsshistory.html>, a web site maintained by Dan Power.

- real-time data warehousing
- data mining
- automated anomaly and exception detection
- proactive alerting with automatic recipient determination,
- seamless follow-through workflow,
- automatic learning and refinement,
- geographic information systems (Sidebar 1)
- data visualization (Sidebar 2)

## What Does BI Do?

BI assists in strategic and operational decision making. A Gartner survey ranked the strategic use of BI in the following order (Willen, 2002):

1. Corporate performance management
2. Optimizing customer relations, monitoring business activity, and traditional decision support
3. Packaged standalone BI applications for specific operations or strategies
4. Management reporting of business intelligence

The implication of this ranking is that ordinary reporting of your own and your competitors' performance, which is the strength of many existing software packages, is not enough. A second implication is that too many firms still view business intelligence (like DSS and EIS before it) as an inward looking function.

BI converts data into useful information and, through human analysis, into knowledge. Some of the tasks performed by BI are:

### SIDEBAR 1. A TECHNOLOGY FOR BUSINESS INTELLIGENCE: GEOGRAPHIC INFORMATION SYSTEMS (GIS)

In the narrow sense, a geographic information systems (GIS) is a software package that links databases and electronic maps. At a more general levels, the term GIS refers to the capability for analyzing spatial phenomena. These systems are an important business intelligence tool for exploiting and presenting the increasing amount of two (and more) dimensional data available in a form that can be understood by analysts and managers.

In addition to collecting, storing, and retrieving spatial location data, GIS are used to identify locations which meet specified criteria (e.g., for new store location), exploring relations among data sets, assessing alternatives and aiding in decision making, and displaying elected environments both visually and numerically. In practice, a GIS consists of a series of layers, each presenting a particular two-dimensional feature, that can be superimposed accurately on top of one another. Some examples:

- a marketing group overlays customer locations, school locations, distribution centers and existing retailers selling their own and/or their competitors products.
- a telecommunications company selects the number and location of switching centers and routes in a communication network. The system displays such quantities as traffic, costs, and transmission times. Users can redefine the network on the screen, can create multiple views, see the effect of 'what if' changes and new data because the system re-computes for each change, take constraints into account, and see where the proposed solution fails to meet criteria.

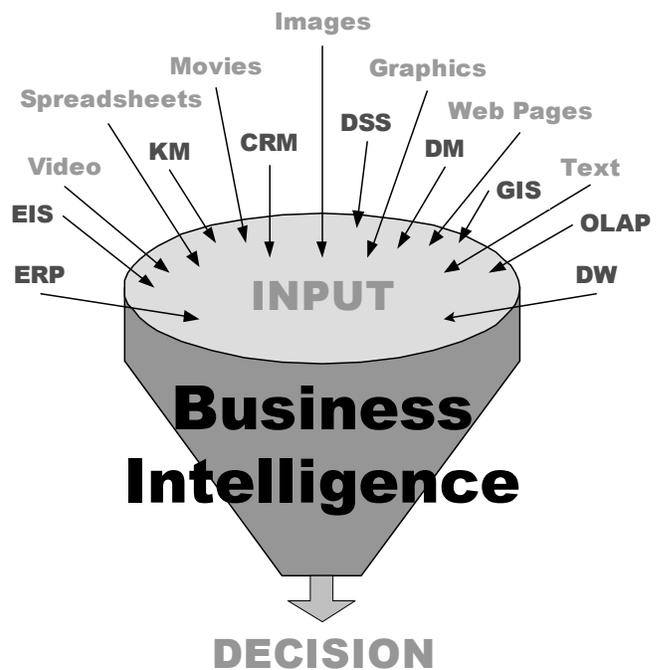


Figure 1. Inputs to Business Intelligence Systems

## SIDEBAR 2. A TECHNOLOGY FOR BUSINESS INTELLIGENCE: VISUALIZATION

With the flood of data available from information systems, business intelligence analysts and decision-makers need to make sense out of the knowledge it contains. Visualization is the process of representing data as visual images. Unlike geographic information systems which typically deal with physical spaces, the underlying data could, for example, represent abstract objects, such as profit, sales, or cost. If the data is abstract, then a visual analog must be created. Visual analogs today go far beyond the pie chart and the bar chart (Tegarten, 1999).

Visualization is used to create advanced dashboard in which large amounts of information are presented on a single screen. Today's results are far advanced over early dashboards such as those shown by Houdeschel and Watson in 1987 (Houdeschel and Watson, 1987).

Visualization:

- Exploits the human visual system to extract information from data,
- Provides an overview of complex data sets,
- Identifies structure, patterns, trends, anomalies, and relationships in data,
- Assists in identifying the areas of "interest"

That is, visualization allows bi analysts to use their natural spatial/visual abilities to determine where further exploration should be done and where action is required.

Visualization technologies are deployed in finance, litigation, marketing, manufacturing, training, and organizational modeling.

- Creating forecasts based on historical data, past and current performance, and estimates of the direction in which the future will go.
- "What if" analysis of the impacts of changes and alternative scenarios.
- Ad hoc access to the data to answer specific, non-routine questions.
- Strategic insight (e.g., item 3 in Sidebar 3)

## SIDEBAR 3. BI APPLICATIONS

1. A company that provides natural gas to homes created a dashboard that supports operational performance metric management and allows real time decision making. In one application of the dashboard, the number of repeat repair calls was reduced, resulting in a saving of \$1.3 million
2. At a large member-owned distributor to hardware stores, using a dashboard reduced the amount of inventory that must be liquidated or sold as a loss leader from \$60 million to \$10 million. Their BI system also allows their member stores to see their own performance relative to similar stores.
3. The Dallas Teachers Credit Union wanted to expand. It asked two questions of its BI system:
  - Who are our most profitable customers?
  - How far will they drive to reach our outlets?

Once they found the answer to these two questions, they were able to select branch sites that were within the buying radius of the preferred customers.

## Competitive Analysis

“Next to knowing all about your own business, the best thing to know about is the other fellow’s business.”  
John D. Rockefeller

Competitive intelligence (CI) is a specialized branch of Business Intelligence. It is “no more sinister than keeping your eye on the other guy albeit secretly” (Imhoff, 2003). The Society of Competitive Intelligence Professionals (SCIP) defines CI as:

Competitive Intelligence is a systematic and ethical program for gathering, analyzing and managing external information that can affect your company’s plans, decisions and operations.

In other words, CI is the process of ensuring your competitiveness in the marketplace through a greater understanding of your competitors and the overall competitive environment. “You can use whatever you find in the public domain to ensure that you will not be surprised by your competitors.” (Imhoff, 2003).

CI is not as difficult as it sounds. Much of what is obtained comes from sources available to everyone, including (Imhoff, 2003):

- government sources,
- online databases, interviews or surveys,
- special interest groups (such as academics, trade associations, and consumer groups),
- private sector sources (such as competitors, suppliers, distributors, customer) or
- media (journals, wire services, newspapers, and financial reports).

The challenge with CI is not lack of information; it is the ability to differentiate useful CI from chatter or even disinformation.

Of course, once you start practicing competitive intelligence, the next stage is to introduce countermeasures to make the CI task about you more difficult for other firms. The game of measure, countermeasure, counter-countermeasure, and so on to counter to the  $n^{\text{th}}$  measure is played in industry just as it is in politics and in international competition.

Sidebar 4 presents examples of competitive analysis.

### SIDEBAR 4. EXAMPLES OF COMPETITIVE ANALYSIS

- Texas Instruments made a \$100 million acquisition based on their knowledge of a competitors potential bid, (Lavelle, 2001).
- Merck & company developed a counter strategy to its competitor’s forthcoming product based on competitive intelligence reports, a savings of \$200 million, (Imhoff, 2003).
- Illuminet, a company that delivers advanced network, data base, and billing services, stayed a step ahead by using a vendor (QL2 software) to retrieve information posted on their competitors web sites (Moore, 2002).
- Most grocery chains sell their bar code scanner data to organization such as Information Resources Inc. (IRI) who, in turn collates the data and sells it to grocery wholesalers and vendors. Individual firms want to find out how well their (and their competitors) special offers, such as a 20 cent off coupon, worked in the marketplace. By examining how well the offer worked previously, how well it worked in the current situation, and forecasting the future effects of the promotion, a firm can decide whether to continue the offer or change it. If it is a competitor’s offer, the forecast is used to decide whether to match or exceed the competitor. Thus, the forecasts based on the data are converted into policy at the tactical level.

## Markets and Vendors

The size of the business intelligence market can be seen from the published forecasts. For example, AMR research estimates the current BI market at \$6 billion with projection to reach \$12 billion by 2006 (Darrow, 2003). Intelligent Enterprise’s study for the 2003 editor’s choice award for BI identified 12 firms to watch in 2003 including Adaytum, Brio Software, Cognos, Crystal Decisions, E.Intelligence, Fair Issac & Co., Hyperion Solutions, Information Builders, MicroStrategy, ProClarity, Siebel Systems, and Spotfire (Kestelyn, 2003). It also named 12 vendors as most influential in the overall category including Teradata, SAS, IBM, OutlookSoft, Business Objects, Microsoft, Manhattan Associates, PeopleSoft, Oracle, Ilog, Insight Software, and Open Source/Linux (Stodder, 2003).

Gartner research found a reduction in the number of firms that plan to manage their BI integration internally dropping from 49% in 2001 to 37% in 2002 (Soejarto, Alex, 2003). A study by IDC on OLAP investment over 5-years indicated a \$2.1 million investment in building OLAP solutions in house resulted in 104% return on investment (Morris, 2003). The same study indicated a \$1.8 million investment in buying pre-built OLAP solutions resulted in 140% return on investment. Indicating buying BI solutions cost less and have a higher return on investment (Morris, 2003).

The traditional custom design, build, and integrate model for BI systems takes long (at least six months) and is high cost (\$2-3 million) (Rudin and Cressy, 2003). Therefore, many firms are going to pre-built analytic applications to achieve lower total cost of ownership, quicker implementation, rapid return on investment, and yet obtain underlying structure for performance, scalability, and flexibility (Rudin and Cressy, 2003).

## Data Sources and Architecture

As shown in Figure 2, to provide actionable information, BI includes structured and unstructured data (Rudin and Cressy, 2003; Moss, 2003). An example of structured and unstructured metadata is shown in Table 1. For BI, Organizations need both a technical and a nontechnical architecture. Technical architecture includes hardware, middleware, and data base management systems. Nontechnical architecture includes standards, definition of metadata, business rules, and policies (Moss, 2003).

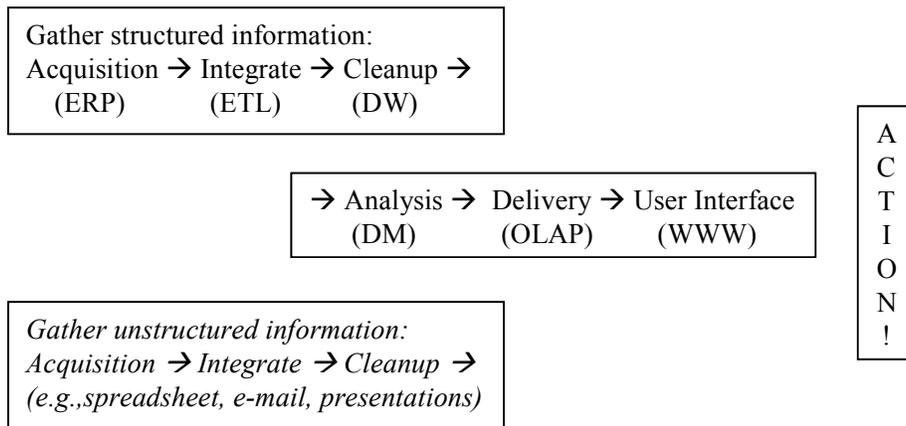


Figure 2. Combining Structured and Unstructured Data

## Return on Investment

BI projects are not immune from the requirement for ROI analysis. After installation surveys show that the returns on investment in BI can be substantial. An IDC study on the financial impact of business analytics, using 43 North American and European organizations indicated a median five-year ROI of 112% from an investment of \$2 million (Morris, 2003). Return ranged from 17%-2000% with an average ROI of 457%. However, a correlation between BI budget and ROI was not found (Morris, 2003; Darrow, 2003).

The problem comes before investment. There is a paradox in the statement “If a product can’t survive an ROI analysis without a ‘measurable’ return, then companies shouldn’t buy it” (Greenbaum, 2003). Computing anticipated return on investment for business intelligence is a difficult problem. Like most information systems, BI up-front costs are high as is upkeep. Unfortunately, although reductions in information systems costs from efficiencies<sup>2</sup> can be forecast, the IT savings are only a small portion of the payoff (Sidebar 3). It would be rare for a BI system to pay for itself through cost reductions.

**Table 1. Structured and Unstructured Forms of Metadata**

<b>Meta Data</b>	<b>Definition</b>	<b>Transformation/ Derivation</b>	<b>Management/ Administration</b>
Business (mostly unstructured)	<ul style="list-style-type: none"> <li>▪ What does it mean?</li> <li>▪ Where can I find it?</li> </ul>	<ul style="list-style-type: none"> <li>▪ How was it calculated?</li> <li>▪ What were the sources?</li> <li>▪ What business rules were applied?</li> </ul>	<ul style="list-style-type: none"> <li>▪ What training is available?</li> <li>▪ Who’s on the steering team?</li> <li>▪ What’s the easiest way to get to it?</li> <li>▪ How fresh is the information?</li> </ul>
Technical (mostly structured)	<ul style="list-style-type: none"> <li>▪ format</li> <li>▪ length</li> <li>▪ domain</li> <li>▪ database</li> <li>▪ catalog</li> </ul>	<ul style="list-style-type: none"> <li>▪ filters</li> <li>▪ aggregates</li> <li>▪ calculations</li> <li>▪ expressions</li> </ul>	<ul style="list-style-type: none"> <li>▪ capacity planning</li> <li>▪ space allocation</li> <li>▪ indexing &amp; reindexing</li> <li>▪ disk utilization</li> <li>▪ production job scheduling</li> </ul>

### **Costs**

Most firms do some form of business intelligence, although only a few have complete BI systems. To simplify the cost discussion, consider a firm starting from scratch. Putting a BI system in place includes

- **Hardware costs.** These costs depend on what is already installed. If a data warehouse is in use, then the principal hardware needed is a data mart specifically for BI and, perhaps, an upgrade for the data warehouse. However, other hardware may be required such as an intranet (and extranet) to transmit data to the user community.
- **Software costs.** Typical BI packages can cost \$60,000. Subscriptions to various data services also need to be taken into account. For example, firms in the retail industry buy scanner data to find out how their products and their competitor products respond to special offers, new introductions, and other day to day changes in the marketplace (See Sidebar 4).
- **Implementation costs.** Once the hardware and software are acquired, a large on-time expense is implementation, including training. Training, however, is an ongoing cost as new people are brought into the system and as the system is upgraded. In addition, annual software maintenance contracts typically run 15% of the purchase costs.

<sup>2</sup>For example, time saved in creating and distributing reports, operating efficiencies, ability to retain customers.

- Personnel costs. Personnel costs for people assigned to perform BI and for IT support personnel, needs to be fully costed to take into account salary and G&A, space, computing equipment, and other infrastructure for individuals. A sophisticated cost analysis also takes into account the time spent reading BI output by and the time spent searching the internet and other sources for BI.<sup>3</sup>

### Benefits

Most BI benefits are soft. An empirical study for 50 Finnish companies found most companies do not consider cost or time savings as primary benefit when investing in BI systems (Hannula and Pirttimaki, 2003). The hope is that a good BI system will lead to a “big bang” return at some time in the future. However, it is not possible to forecast big bangs because they are fortuitous and infrequent.

### Curriculum Offerings

BI is being taught at the university level in only a few schools. Table 2 shows the places where it is being taught.

**Table 2. Universities Teaching BI**

University of Technology Sydney, Australia	Two BI courses in its e-Business masters: Business Intelligence 1: Advanced analysis (#22797) and Business Intelligence 2: Advanced planning (#22783).
Northwestern Polytechnic University, UK	1 course in MBA program
Tilburg University, Netherlands	1 course by Prof. H.A.M. Daniels
Claremont Graduate University	Included in 1 course in executive MBA program.
Univ. of California at Irvine	1 course covering Business Intelligence and Knowledge Management at the graduate and at the undergraduate level.

With the exception of Moss and Atre (2003) and Power (2002), we did not find BI mentioned in current DSS texts.

### Research Issues

The number of articles about BI and CI in the academic literature is few. The current references we found are shown in Table 3. Of the ten listed in the table, eight deal with competitive intelligence (One of the eight (Rouibah and Old-Ali) contains BI in its title but is really about CI).

**Table 3. Academic Articles on Business Intelligence and Competitive Intelligence**

Cody et. al. (2002) Hall (2000) Markus and Lee (2000) Powell and Bradford (2002)	Rouach and Santi (2001) Rouibah and Ould-ali (2002) Teo and Choo (2001)	Vedder and Guynes (20002) Weir (2000) Wiggins (2001)
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Thus, although the vendors are pushing BI, and trade magazines such as *Intelligent Enterprise* and *DM Review* are full of it, business intelligence seems to have flown under our radar as academics.

Clearly, a lot of research opportunities exist in this field. Here are a few that occur to us:

<sup>3</sup>Data on time spent looking for BI was not found. However, the magnitude of expenditures is implied by data on Internet search in general. Office workers in 2002 spent an average of 9.5 hours each week searching, gathering and analyzing information, and nearly 60 percent of that time, (5.5 hours a week), was spent on the Internet. The average annual cost of per worker was \$13,182 (Blumberg and Atre, 2003).

- Managing unstructured information. BI relies heavily on unstructured information. Yet little research is reported in the IS literature. Topics include (1) searching unstructured data, (2) classification and taxonomy for unstructured data, and (3) measuring the level of subjective values such as severity or sentiment in documents (e.g., a customer letter not pleased with company service.)
- Real-time enterprise: What types of decisions require real-time BI? How do we achieve real-time BI? Infrastructure for real time BI
- BI challenges for knowledge workers: Training in skills needed to deliver “BI for the masses”. Closing the gap between available data and available resources (people) for analysis.
- Architecture: Building a BI information architecture (business architecture) and integrated model for BI.
- The security of mission-critical corporate intelligence systems
- The scalability of Web-based systems when large volumes of BI information are exchanged between databases and Web clients.
- The integration of BI systems with corporate mainstream IT.
- What is involved in business performance management?

This list is indicative of the many research problems that need work. Many involve taking existing work and expanding it into the BI realm.

## Managerial Questions

1. *Is business intelligence an oxymoron? A shorthand for cloak and dagger spying on competitors and government? An important, legitimate activity?*

Despite its name, business intelligence is about trying to understand your own position, your customers, and your competitors. It is neither ethical nor legal to spy on competitors. It is an important part of a firm’s planning and operational decision making.

2. *What is new about today’s business intelligence compared to previous systems?*

Business intelligence is a natural outgrowth of a series of previous systems designed to support decision making. The emergence of the data warehouse as a repository, the advances in data cleansing that lead to a single truth, the greater capabilities of hardware and software, and the boom of Internet technologies that provided the prevalent user interface all combine to create a richer business intelligence environment than was available previously

3. *What types of BUSINESS intelligence are there?*

Business Intelligence is used to understand: The capabilities available in the firm; the state of the art, trends, and future directions in the markets, the technologies, and the regulatory environment in which the firm competes; and the actions of competitors and the implications of these actions.

4. *What will you be able to do if you invest in BI?*

The main use of BI was explained in its definition at the beginning. Business Intelligence systems present complex corporate and competitive information to planners and decision makers. The objective is to improve the timeliness and quality of the input to the decision process. The top five reasons for choosing OLAP products were functionality, ease of use for end users, integrates with other products already in use, price, and performance (Pendse2003).

5. *Who uses BI?*

Business intelligence is used by managers throughout the firm. At senior managerial levels, it is the input to strategic and tactical decisions. At lower managerial levels, it helps individuals to do their day-to-day job.

6. *How do you gather and transfer BI?*

Business intelligence is a form of knowledge. The techniques used in knowledge management for generating and transferring knowledge (Davenport and Prusak 1995) apply. Some knowledge is bought (e.g., scanner data in the food industry) while other knowledge is created by analysis of internal and public data. Knowledge transfer often involves disseminating intelligence information to many people in the firm. For example, sales people need to know market conditions, competitor offerings and special offerings.

7. *Do you need a separate organization for it?*

Most medium and large firms assign people, often full time, for planning and for monitoring competitor action. These people are the ones who form the core groups for business intelligence initiatives. Whether they are centralized or scattered through SBU's is a matter for organizational style.

8. *What technologies are available?*

Most of the technologies needed for business intelligence serve multiple purposes. For example, the World Wide Web has been adopted for both knowledge generation and knowledge transfer. However, specialized software for doing analysis is the heart of business intelligence. This software is an outgrowth of the software used for decision support and executive information systems in the past.

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