Knowledge management and business intelligence: the importance of integration

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Abstract

Purpose – *The purpose of the paper is to provide a thorough analysis of the difference between business intelligence (BI) and knowledge management (KM) and to establish a framework for relating one field to the other.*

Design/methodology/approach – *A review of the literature from approximately 1986 through 2004 served as the basis for analysis and comparison of BI and KM. The theoretical scope of the paper is to distinguish between BI and KM to clarify the role of each in a business environment.*

Findings – *BI focuses on explicit knowledge, but KM encompasses both tacit and explicit knowledge. Both concepts promote learning, decision making, and understanding. Yet, KM can influence the very nature of BI itself. Hence, this paper explains the nature of the integration between BI and KM and makes it clear that BI should be viewed as a subset of KM.*

Originality/value – *This paper establishes a clear distinction between two important fields of study, BI and KM, establishing an expanded role for BI. That is, the role of BI in knowledge improvement. This expanded role also suggests that the effectiveness of a BI will, in the future, be measured based on how well it promotes and enhances knowledge, how well it improves the mental model(s) and understanding of the decision maker(s) and thereby how well it improves their decision making and hence firm performance. The need for the integration of KM and BI is clear.*

Keywords *Organizations, Information systems, Knowledge management, Integration*

Paper type *Research paper*

Many in industry confuse knowledge management (KM) with business intelligence (BI). According to a survey by OTR consultancy, 60 percent of consultants did not understand the difference between the two. Gartner consultancy clarifies this by explaining BI as set of all technologies that gather and analyze data to improve decision making. In BI, intelligence is often defined as the discovery and explanation of hidden, inherent and decision-relevant contexts in large amounts of business and economic data (Hameed, 2004).

KM is described as a systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest. KM helps an organization to gain insight and understanding from its own experience. Specific KM activities help focus the organization on acquiring, storing and utilizing knowledge for such things as problem solving, dynamic learning, strategic planning and decision making (Hameed, 2004).

Conceptually, it is easy to comprehend how knowledge can be thought of as an integral component of BI and hence decision making. This paper argues that KM and BI, while differing, need to be considered together as necessarily integrated and mutually critical components in the management of intellectual capital.

Background

KM has been defined in reference to collaboration, content management, organizational behavioral science, and technologies. KM technologies incorporate those employed to

create, store, retrieve, distribute and analyze structured and unstructured information. Most often, however, KM technologies are thought of in terms of their ability to help process and organize textual information and data so as to enhance search capabilities and to garner meaning and assess relevance so as to help answer questions, realize new opportunities, and solve current problems.

In most larger firms, there is a vast aggregation of documents and data, including business documents, forms, data bases, spreadsheets, e-mail, news and press articles, technical journals and reports, contracts, and web documents. Knowledge and content management applications and technologies are used to search, organize and extract value from these information sources and are the focus of significant research and development activities.

BI has focused on the similar purpose, but from a different vantage point. BI concerns itself with decision making using data warehousing and online analytical processing techniques (OLAP). Data warehousing collects relevant data into a repository, where it is organized and validated so it can serve decision-making objectives. The various stores of the business data are extracted, transformed and loaded from the transactional systems into the data warehouse. An important part of this process is data cleansing where variations in data schemas and data values from disparate transactional systems are resolved. In the data warehouse, a multidimensional model can then be created which supports flexible drill down and roll-up analyses (roll-up analyses create progressively higher-level subtotals, moving from right to left through the list of grouping columns. Finally, it creates a grand total). Tools from various vendors provide end users with a query and front end to the data warehouse. Large data warehouses can hold tens of terabytes of data, whereas smaller, problem-specific ones often hold 10 to 100 gigabytes (Cody *et al.*, 2002).

BI/KM or KM/BI?

McKnight (2002) has organized KM under BI. He suggests that this is a good way to think about the relationship between the two. He argues that KM is internal-facing BI, sharing the intelligence among employees about how effectively to perform the variety of functions required to make the organization go. Hence, knowledge is managed using many BI techniques.

Haimila (2001) also sees KM as the ''helping hand of BI''. He cites the use of BI by law enforcement agencies as being a way to maximize their use of collected data, enabling them to make faster and better-informed decisions because they can drill down into data to see trends, statistics and match characteristics of related crimes.

Marco (2002) contends that a ''true'' enterprise-wide KM solution cannot exist without a BI-based meta data repository. In fact, a metadata repository is the backbone of a KM solution. That is, the BI meta data repository implements a technical solution that gathers, retains, analyses, and disseminates corporate ''knowledge'' to generate a competitive advantage in the market. This intellectual capital (data, information and knowledge) is both technical and business-related.

Marco says that most magazines that discuss KM fail to mention a meta data repository. He believes this ''glaring oversight'' exists because most KM professionals focus on a limited portion of the KM equation. However, implementers, he asserts, realize that a meta data repository is the technical solution for KM.

Cook and Cook (2000) note that many people forget that the concepts of KM and BI are both rooted in pre-software business management theories and practices. They claim that technology has served to cloud the definitions. Defining the role of technology in KM and BI – rather than defining technology as KM and BI – is seen by Cook and Cook as a way to clarify their distinction.

Cook and Cook assert that the attraction of BI is that it offers organizations quick and powerful tools to store, retrieve, model, and analyze large amounts of information about their operations, and in some cases, information from external sources. Vendors of these applications have helped other companies and organizations increase the value of the information that resides in their databases. Using the analysis functions of BI, firms can look

at many aspects of their business operation and identify factors that are affecting its performance.

The Achilles heel of BI software is, according to Cook and Cook, its inability to integrate nonquantitative data into its data warehouses or relational databases, its modeling and analysis applications, and its reporting functions. To examine and analyze an entire business and all of its processes, one cannot, they argue, rely solely on numeric data. Indeed they note that estimates from various sources have suggested that up to 80 percent of business information is not quantitative, or structured in a way that can be captured in a relational database. This is because these documents, that contain information, knowledge, and intelligence, are not to unstructured or semi-structured and hence not well suited to the highly structured data requirements best suited to the database software application.

Text mining, seen primarily as a KM technology, adds a valuable component to existing BI technology. Text mining, also known as intelligent text analysis, text data mining or knowledge-discovery in text (KDT), refers generally to the process of extracting interesting and non-trivial information and knowledge from unstructured text. Text mining is a young interdisciplinary field that draws on information retrieval, data mining, machine learning, statistics and computational linguistics. As most information (over 80 percent) is stored as text, text mining is believed to have a high commercial potential value.

Text mining would seem to be a logical extension to the capabilities of current BI products. However, Its seamless integration into BI software is not quite so obvious. Even with the perfection and widespread use of text mining capabilities, there are a number of issues that Cook and Cook contend that must be addressed before KM (text mining) and BI (data mining) capabilities truly merge into an effective combination. In particular, they claim it is dependent on whether the software vendors are interested in creating technology that supports the theories that define KM and providing tools that deliver complete strategic intelligence to decision-makers in companies. However, even if they do, Cook and Cook believe that it is unlikely that technology will ever fully replace the human analysis that leads to stronger decision making in the upper echelons of the corporation.

However, Kadayam (2002) claims that as the fields of BI and KM have evolved over the last two decades, they have done so until recently in seemingly parallel universes. BI, relying on traditional business tools and searching well organized and structured data, has emerged over 20 years as a well-established niche in which information is readily accessible, most players understand each other's languages and processes, and a return on investment (ROI) is easy to define and calculate. However, the KM field (now appearing to overlap with enterprise content management), he states, has been more nebulous. Younger by at least a decade than BI, KM revolves around suites of products, from full-text indexing and search to information filtering and natural language processing. KM often presents the more challenging task because it exists without commonly accepted terminologies, and ROI for such initiatives are often harder to define.

However, Kadayam asserts that several technological developments, including those spurred by Intelliseek, Inc., are building bridges between KM and BI, with obvious benefits. Two factors fueling this emergence of what Intelliseek calls ''new business intelligence'' (NBI) are the growth of internet information and evolving technologies that aggregate, analyze and report data from a variety of previously incompatible sources. Accepted business tools that traditionally are used to find and lever-age BI data are now, he says, crossing over into the KM field, able to find more and better information, make it actionable quickly and offer the promise of greater ROI for strategic planning, sales, decision making and competitive or strategic advantage.

Kadayam believes this trend bodes well for any business, agency, enterprise or brand interested in a comprehensive 360° view from the richest data available. In the current separate-silo universe, BI usually has access to about 20 percent of available information from databases, online analytical processing, supply chain management, data warehouses, and the like, but it commands roughly 80 percent of the relevant budget for business purposes. By contrast, NBI can benefit far more knowledge workers and reach a far larger

> **"KM and BI, while differing, need to be considered together as necessarily integrated and mutually critical components in the management of intellectual capital."**

pool of data, perhaps 50 percent to 60 percent of available information in product documents, research reports, employee records and the like, but it attracts perhaps 20 percent of the traditional budget for IT-related purposes.

Kadayam states that the convergence of the KM and BI deepens and broadens the amount of searchable knowledge and information – simultaneously increasing the value, actionability and ROI on the intelligence gained. He asserts that the greatest value of unstructured data comes when it is converted to intelligence that can then be mined, sliced and diced by traditional business tools – Business Objects®, MicroStrategy®, Cognos®, Informatica®, Oracle®, Microsoft®, etc. When KM and BI converge to create NBI, Kadayam maintains that the resulting intelligence involves broader insights, not just raw data. It provides trends, not just raw statistics. It includes historical context, not just a shallow examination of what is apparent and easily accessible. Instead of nuggets or pockets of information from corporate databases, it provides a true 360° view of attitudes and behaviors, combines structured and unstructured data, meshes solicited and unsolicited feedback, and keeps a real-time pulse on business.

Tacit knowledge and BI

When Karl-Erik Sveiby (1997) created the first framework defining intellectual capital, he defined three elements:

1. employee competence (the capabilities of people in an organization – its human capital);
2. internal structure (structured or organizational capital, including patents, documented processes, computer-based data, and the vision, strategy, and policies created by leadership); and
3. external structure (customer or relationship capital – the value of a firm's relationships with the people with whom it does business).

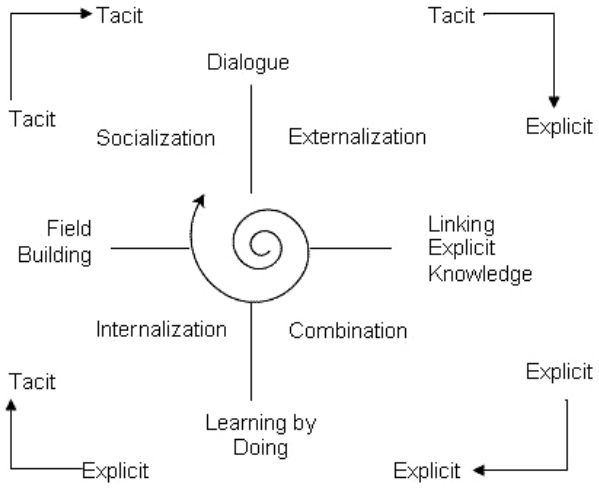
It is clear that BI can help firms analyze transactions within each element, but it only partially explains its relationship to KM. To really understand and learn from a firm's value network, one must also examine tacit behaviors, that is, the nature of behavioral exchanges occurring and the content of information and its value relative to firm performance. Here the role and contribution of BI becomes constrained.

Nonaka and Takeuchi (1995) developed the knowledge spiral model to represent how tacit and explicit knowledge interact to create knowledge in an organization. The framework for a learning organization (see Figure 1) identifies four knowledge conversion processes or patterns:

1. socialization (tacit to tacit);
2. externalization (tacit to explicit);
3. combination (explicit to explicit; and
4. internalization (explicit to tacit).

The implication of this model is that KM comprises activities in all four processes, whereas BI directly may affect combination, and to a lesser extent, socialization, externalization and internalization but indirectly. However, the same may be true of KM if its definition is limited to a technology-restricted, explicit knowledge-based definition (e.g. text management systems).

Figure 1 Framework for a learning organization



Source: Nonaka and Takeuchi (1995)

The KM literature and practices have not been restricted to issues of explicit knowledge. Hasanali (2004), for example, identified five primary categories of critical success for KM, all of which suggest the importance tacit knowledge as well:

1. leadership;
2. culture;
3. structure, roles, and responsibilities;
4. IT infrastructure; and
5. measurement.

In 1998 Gartner Group defined KM as follows:

> Knowledge Management promotes an integrated approach to identifying, capturing, retrieving, sharing, and evaluating enterprise information assets. These information assets may include databases, documents, policies, procedures, as well as the un-captured tacit expertise and experience stored in individual heads (see *Oracle Magazine*, 1998).

Based on this definition, both BI and explicit KM technologies address only a subset of the prescribed KM approach. Because KM encompasses both explicit and tacit knowledge, as well as the interaction between them, it is a more profitable pursuit to explore how BI integrates with KM.

How BI integrates with KM

As explained above, new knowledge is created through the synergistic relationship and interplay between tacit and explicit knowledge, specifically, through a four-step process of socialization, articulation, integration, and understanding/internalization (see the Figure 1 (Nonaka and Takeuchi 1995)). Nemati *et al.* (2002) discuss how this is accomplished.

Socialization is the process of sharing with others the experiences, technical skills, mental models, and other forms of tacit knowledge. For example, apprentices learn a craft not through language, but by working with their masters; i.e. observing, imitating and practicing under the master's tutelage. On-the-job-training (OJT) provides this mode of sharing tacit knowledge in the business world. OJT is complemented with explicit film clips of the expert performing the task, virtual reality representations, and kinematic analysis (from the field of robotics).

Articulation is the process of converting tacit knowledge to explicit knowledge. In the decision-making process, articulation may include, but is not limited to, one or more of the following:

- specifying the purpose of the decision, e.g. to understand how the number and locations of warehouses influence supply costs in a new marketing area;
- articulating parameters, objective functions, relationships, etc., in a BI mathematical model (i.e. building a model);
- articulating ''what-if'' model cases that reflect existing and potential decision-making situations; and
- evaluating the decision alternatives, given the uncertainty in the decision-making environment.

In other situations (e.g. those requiring the analysis of complicated physical movements), articulation may take the form of kinematic analysis; i.e. attaching sensors to various key appendages and then digitizing and recording the movements of interest. Articulation may also include knowledge extraction in expert systems, determination of causal maps, brainstorming, etc.

Integration is the process of combining several types of explicit knowledge into new patterns and new relations. The *Gestalt* theory of learning literature (e.g. Perkins, 1986) states that all problems with which we may be confronted, and also the solutions of such problems, are matters of relations; not only does our understanding of the problem demand our awareness of certain relations, but also we cannot solve the problem without discovering certain new relations. One potentially productive integration of explicit knowledge is the analysis of multiple, related ''what-if'' cases of a mathematical model to find new relationships, or metamodels, that determine the key factors of the model and show how these key factors interact to influence the decision.

Understanding is the process of testing and validating the new relationships in the proper context, thereby converting them into new tacit knowledge. Perkins's theory of understanding, from the theory of learning literature, suggests that understanding involves the knowledge of three things:

1. the purpose of the analysis (i.e. what the decision maker wants to understand);
2. a set of relations or models of the process/system to be understood; and
3. arguments about why the relations/models serve the purpose.

Internalization is the process of using the new patterns and relations, together with the arguments of why they fit the purpose, to update and/or extend the decision maker's own tacit knowledge base, thus creating a spiral of learning and knowledge that begins and ends with the individual.

While KM encompasses explicit and tacit knowledge, Malhotra (2004) explains how explicit-oriented BI could be construed as KM. He suggests that it depends on how a firm defines its world. That is, it depends on whether the firm adopts a model of KM for routine and structures information processing (see Figure 2) or whether it subscribes to a model of KM that focuses on nonroutine and unstructured sense making (see Figure 3).

Malhotra (2004) notes that because business environments include a combination of stabilizing and destabilizing factors, real world KM implementations should contain combinations of characteristics of both models. The process of knowledge reuse and knowledge creation needs, he asserts, to be balanced by integration of routine and structured information processing (e.g. BI and explicit KM) and nonroutine and unstructured sense making (e.g. tacit knowledge exchanges such as mentoring, story telling, etc.) in the same business model.

It can be argued that there exists an interaction effect between KM activities and BI efforts. For example, as Malhotra notes, artificial intelligence and expert systems are intended to

Figure 2 Model 1: knowledge management for routine structured information processing

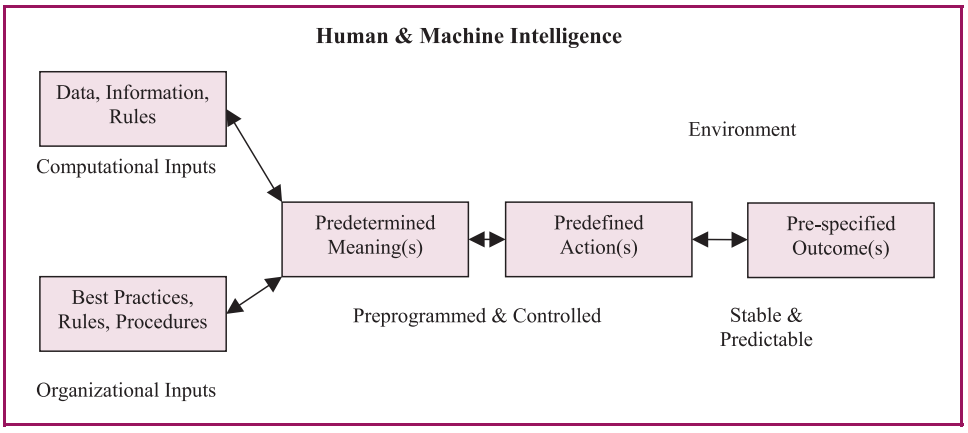
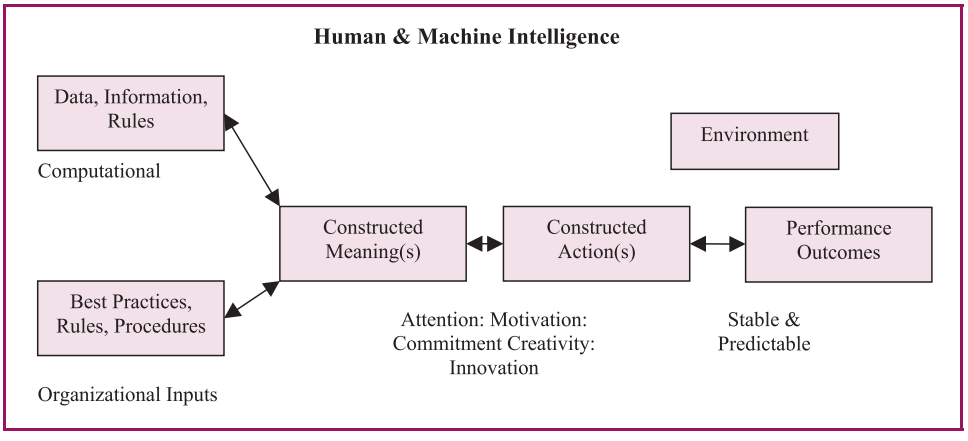


Figure 3 Model 2: knowledge management for non-routine and unstructured sense making



help deliver the ''right information to the right people at the right time''. However, this can only happen if the right information and the right person to use or apply it, and the right circumstance and appropriate time are known in advance. Detection of nonroutine and unstructured change depends on the sense-making capabilities of knowledge workers for correcting and validating the computational logic of the business and the data it processes. Further complicating this issue is the realization that the same assemblage of data may evoke different responses from different people at different times or in different contexts.

Attempts at coding sense making capabilities are made suspect by the fact that articulation of tacit and explicit knowledge can both be elusive – people may know more than they think they know – or less. Therefore, storing explicit static representations of individuals' tacit knowledge in databases and algorithms may not be a valid surrogate for their dynamic sense making capabilities.

The importance of culture on KM and BI efforts

Both KM and BI are deeply influenced by the culture of the organization, especially leadership, groups and opinion leaders, as well as organizational values (Scheraga, 1998, Pan and Scarbrough, 1999, Reisenberger, 1999). Since culture is a KM critical success factor and is largely expressed through tacit behavior, we can examine issues that culture can have on both KM- and BI-related efforts.

> **"Up to 80 percent of business information is not quantitative, or structured in a way that can be captured in a relational database."**

For example, Thong's (1999) study of technology adoption in small businesses showed that the CEO's views on innovativeness and their views on the value of technology affected the nature of a firm's technology adoption decisions. Also, Scheraga (1998) found that unless a company encourages its workforce to contribute to its knowledge-to-knowledge exchange and the decision-making processes, putting KM or BI solutions in place could prove useless. He notes that workers are often reluctant to share information or to articulate their decision-making schemas, because businesses often reward people for what they know.

Reisenberger (1999) also found employee resistance to sharing knowledge in cultures where most people have gotten ahead by keeping knowledge to themselves. He suggests that this can cause managers to adopt and maintain their use of flawed heuristics and decision models that fail to encompass new realities. To change this, he sees the need for top management to develop new cultural and reward systems; to recognize and reward new learning behaviors in front of the entire organization as well as to endorse, participate, and lead in knowledge sharing and challenging the status quo. He stresses that top leaders must lead the effort, becoming change agents within the organization who model knowledge sharing, fostering a culture of continuous learning and improvement to enable successful KM and BI. Confirming Reisenberger's findings is a paper by Elliott and O'Dell (1999) which cited the American Productivity and Quality Center's (APQC's) findings that what is critical is to fit KM and BI approaches to the culture and tie them strongly to the organization's core values, rather than expecting knowledge-sharing initiatives and BI activities to change the culture.

Pan and Scarbrough (1999) found that within the context of organizational culture, trust must be one of the company's core values. Trust is reflected in employee willingness to exchange knowledge to solve company problems. Barker and Camarata (1998) also assert that the preconditions necessary for a learning organization that shares knowledge includes the elements of trust, commitment, and perceived organizational support. They found that using positive reinforcement techniques rather than punishment proved to be an effective technique in a change effort to a knowledge-sharing learning organization. When employees felt trusted, empowered, and free from the fear of negative consequences associated with sharing their knowledge and decision making, the attitudes and cultures within those organizations slowly changed to enable open discourse.

In McGee's (1999) research on Proctor & Gamble, she found that their cultural change required not only a shift in internal values, but changes in attitudes about external beliefs as well. She notes that Proctor and Gamble was pursuing aggressive use of KM and BI technology in its supply chain. To be successful, McGee says that the organization must change their cultural beliefs about sharing information and decision-making techniques with outsiders. That is, the company must change its relationships with its suppliers and with its customers, from one of passive market acceptance to one of proactive sharing of knowledge and data.

Another dimension to culture and its relationship to information and knowledge sharing is group dynamics. Okhuysen and Eisenhardt (2002) contend that while knowledge is ''owned'' at the individual level, the integration of this knowledge at a collective level is also necessary. Knowledge is often the most important strategic resource within organizations and yet knowledge usually resides with individuals (Nonaka, 1994). This implies that knowledge disclosure and integration are critical components by which firms enhance the

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potential utility and benefits from KM and BI efforts. They note that simple formal interventions by management can improve knowledge integration within groups with specialized knowledge by helping group members to self-organize attempts at improving their information exchange processes and to pace those attempts with task execution.

Okhuysen and Eisenhardt (2002) state that formal interventions that focus on the improvement of group processes are a potential way to achieve superior knowledge integration so as to improve KM and BI efforts. These formal interventions provide explicit instructions for the group to follow and help guide the discussion among members. Hence, small group interactions and information sharing are influenced by organizational culture via effective leadership, which in turn affects the utility and impact of KM and BI systems.

Conclusion

KM technologies, described earlier as being in some ways less mature than BI technologies, are now capable of combining today's content management systems and the web with vastly improved searching and text mining capabilities to derive more value from the explosion of textual information. Ideally, this explicit information will be blended and integrated with the data and techniques used in BI to provide a richer view of the decision-making problem sets and alternative solution scenarios. However, even if this is accomplished, mitigating, intervening variables called ''tacit'' knowledge, leadership, culture, structure, roles, and responsibilities, IT infrastructure, and performance measurement must be recognized and their affect on the decision-making process assessed.

Programmable decisions can always be affected by both objective and subjective factors. Failure to recognize this fact may have contributed to the devaluation of ''operations research'' efforts and could spell the same fate for BI, if the field is not careful. While BI has become a ''buzz word'', its objectives overlap with those of operations research (OR) that Horner (2003) states has languished in the shadows of the corporate world – unappreciated by some, unknown and thus unused by most. He also notes that lack of demand for OR in the business world has trickled down to the business schools, where one OR course after another has disappeared from the curricula.

To avoid a similar fate as OR, BI must be careful to not oversell its capabilities and relevance. While certainly it provides useful tools and techniques for decision-making, it should not claim that it is a field that encompasses of KM. This is a tactical and factual error. Instead, BI must be seen as an integral part of a larger KM effort.

This perspective is apparently being realized in some quarters. For example, the web site for the 3rd Conference of Professional Knowledge Management*:* ''Experiences and Visions Knowledge Management and Business Intelligence (KMBI 2005)'' explains that the term business intelligence accompanied a change of focus within management support systems (MSS). They explain that in the early 1980s, MSS was established as a concept for integrated reporting and analysis tools to support management tasks. However, they state that MSS was implemented in primarily a passive, retrieval-oriented way and based on past data.

In contrast to MSS, BI is described as promoting an active, model-based and prospective approach that involves the discovery and explanation of hidden, inherent and decision-relevant contexts in large amounts of business and economic data and where

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the subsequent phases of business decision processes (e.g. in strategic planning and management) are also included. What is of particular note here is the acceptance of the notion that BI and KM do, in fact, need to be considered in terms of an integrated whole. The conference announcement makes this understanding clear:

> Both preceding workshops on WM'2001 and WM'2003 already evidenced the way how concepts and methods of knowledge management can be applied successfully to support similar problems and tasks of the abovementioned first MSS (management support system) generation. Thus, the goal of this subsequent workshop is to extend the spectrum of the ''integration of knowledge management and MSS'' to the focus of business intelligence.

BI systems are becoming increasingly more critical to the daily operation of organizations. Data warehousing can be used to empower knowledge workers with information that allows them to make decisions based on a solid foundation of fact. However, only a fraction of the needed information exists on computers; the vast majority of a firm's intellectual assets exist as knowledge in the minds of its employees. Nemati *et al*. (2002) effectively argue that what is needed is a new generation of knowledge-enabled systems that provide the infrastructure needed to capture, cleanse, store, organize, leverage, and disseminate not only data and information but also the knowledge of the firm. They propose, as an extension to the data warehouse model, a knowledge warehouse (KW) architecture that will not only facilitate the capturing and coding of knowledge but also enhance the retrieval and sharing of knowledge across the organization. The KW proposed suggests a different direction for BI. This new direction is based on an expanded purpose of BI. That is, the role of BI in knowledge improvement. This expanded role also suggests that the effectiveness of a BI will, in the future, be measured based on how well it promotes and enhances knowledge, how well it improves the mental model(s) and understanding of the decision maker(s) and thereby how well it improves their decision making and hence firm performance. The need for the integration of KM and BI is clear.

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