2010

Towards an Understanding of Business Intelligence

Arisa Shollo
Copenhagen Business School, Department of Informatics, as.inf@cbs.dk

Karlheinz Kautz
Copenhagen Business School, Department of Informatics, karlheinz.kautz@rmit.edu.au

Towards an Understanding of Business Intelligence

Arisa Shollo
Copenhagen Business School, Department of Informatics
Howitzvej 60, DK-2000 Frederiksberg, Denmark
Email: as.inf@cbs.dk

Karlheinz Kautz
Copenhagen Business School, Department of Informatics
Howitzvej 60, DK-2000 Frederiksberg, Denmark
Email: khk@cbs.dk

Abstract (Heading – abstract)

Given the wide recognition of business intelligence (BI) over the last 20 years, we performed a literature review on the concept from a managerial perspective. We analysed 103 articles related to BI in the period 1990 to 2010. We found that BI is defined as a process, a product, and as a set of technologies, or a combination of these, which involves data, information, knowledge, decision making, related processes and technologies that support them. Our findings show that the literature focuses mostly on data and information, and less on knowledge and decision making. Moreover, in relation to the processes there is a substantial amount of literature about gathering and storing data and information, but less about analysing and using information and knowledge, and almost nothing about acting (making decisions) based on intelligence. The research literature has mainly focused on technologies and neglecting the role of the decision maker. We conclude by synthesizing a unified definition of BI and identifying possible future research streams.

Keywords

Business intelligence, literature review, decision making, definition

INTRODUCTION

The recent global financial crisis revealed not only a need for business efficiency, but more than ever a need for effectiveness. Wrong or poor decisions could easily threaten the organization's survival in this fragile environment. Hence, managers are required to make high quality decisions that will steer businesses out of the crisis and thrive. Since ancient times, humanity has developed processes, techniques and tools for collecting and analyzing intelligence to support decision making, especially during times of war (Gilad and Gilad 1986; Kinsinger 2007). In this context, the concept business intelligence has acquired a wide recognition in the business world in recent years. The term business intelligence (BI) was used for the first time by Hans Peter Luhn, an IBM researcher. In his article, (Luhn 1958) described an "automatic method to provide current awareness services to scientists and engineers" who needed help to cope with the growth of scientific and technical literature. However, it was only in the 1990s that the term was widely used, after BI was used by Dresner, a Gartner analyst (Dekkers et al. 2007), to convey the idea that the information in IT systems could be exploited by the business itself.

In this paper, we are interested in exploring the concept of BI and how has it evolved over time. From a first look in the literature (Davenport and Prusak 1998) one understands that BI is related to strategic management and performance management. Wearing managerial lenses, questions like, how do managers use BI, for what purposes it is used, and how does BI affect performance and strategies in an organization, come forward. Looking at BI from this specific angle, we performed a literature review to investigate the current state of BI in relation to strategic management, performance management and decision-making.

The purpose of this review is twofold: first, to provide an overview of the state of the art on BI research and second, to identify critical knowledge gaps (Webster and Watson 2002) in BI research from a managerial – use perspective, drawing upon previous literature. We want to discuss the different definitions of the term BI and how the concept has evolved over time. Moreover, we synthesize a new BI definition that is up to date and encompasses future trends.

The remainder of the paper is structured as following. Section 2 describes the methodology we used to conduct the literature review. Section 3 presents the results of the research and section 4 discusses the findings of the research and provides future research directions.

METHODOLOGY

Following a combination of the strategies of Webster and Watson(2002), Mathiassen et al. (2007) and Dybå and Dingsøyr (2008), we conducted the literature review in two main phases: a search phase and an analysis phase. The purpose of the search phase was to identify the literature (articles) related to Business Intelligence. The search process was comprised from the following 5 phases: 1. Identify Keywords, 2. Identify Journals and Databases, 3. Conduct Search, 4. Scan Abstracts and 5. Create Final Article Pool.

The keywords used in the search phase were: Business Intelligence; Strategic Management; Performance Management; Decision-Making. The keywords were used in the following combinations: BI , BI AND Strategic Management, BI AND Performance Management, BI and Decision Making, BI AND Strategic Management AND Performance Management, BI AND Performance Management AND Decision-Making, BI AND Strategic Management AND Decision-Making, BI AND Strategic Management AND Decision making AND Performance Management. First, a search with the keyword BI was conducted, and then a second search was conducted with the specific keywords in order to identify articles that were focused on the specific angle that we were interested: BI from a managerial perspective. The searches were conducted for the period of 20 years from 1990 – 2009.

The next step was to define the target databases and journals for the search. Based on the MIS Journal Rankings on the AIS (Association for Information systems) website (AIS 2009) we selected the top eight IS journals (MIS Quarterly (MISQ), Information Science Research (ISR), Communications of ACM (CACM), Management Science (MS), Journal of Management Information Systems (JMIS), Artificial Intelligence (AI), Decision Sciences (DSI) and Harvard Business Review (HBR), plus the IS Senior Scholar Basket Journals that were not already included in the top eight: European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), Journal of Association for Information Systems (JAIS), Journal of Information Technology (JIT) and Journal of Strategic Information Systems (JSIS). The choice of the leading journals was intentional, in order to create a base of mainstream journals. In addition to the journal-based search, we searched well-established databases, namely, EBSCOhost, Web of Science and IEEE, to include articles from other disciplines and obtain a broader view of BI and decision-making.

The output of the search phase both from the top journals and the databases resulted in the creation of an article pool. When the results from the searches reached more than 200 articles, a new filtering mechanism was entered. We kept only the results that contained BI in the abstract or in the title. Next, all the abstracts of the articles were scanned in terms of relevance with the subject matter (BI from a managerial perspective). During the abstract scanning, filtering for duplicates took place since some of the articles from the top journals pool appeared in the database search as well. The process ended by identifying the final pool of relevant articles.

The identification of the final article pool signaled the beginning of the analyses phase. In this phase a. all the articles were read thoroughly, b. as we examined the articles one by one, we identified topics that were discussed across articles with the intention to identify BI research focus topics and c. once the topics emerged and we agreed upon, we categorized the articles on the emerged topics.

RESULTS

The output of the search phase resulted in a pool of 103 articles as shown in Table 1[1]. The first column shows the results from the search accomplishment, while the second column shows the results after abstract scanning.

Table 1. Search Results

	Search results	Abstract Scanning	Final Article Pool
Top Journals	152	47	103
Databases	3542	56	

In Figure 1 below, one can see the number of papers per journal. While most of the journals have one article, it is interesting that the journal of Decision Support System (DSS) while not a top 10 IS journal, comprises 10% of all the articles. Moreover, DSS together with MISQ, HBR and JMIS have addressed the topic more frequently and make the bulk of the articles, 33% (34 out of 103) as shown in Figure 1. The abbreviations in Figure 1 refer

[1] Due to space restrictions a list of the 103 articles is not included in this article; only those articles which are directly referenced here are included in the reference list. A complete list can on demand be acquired from the authors.

to Information Systems Management (ISM), Business Intelligence Journal (BIJ), International Journal of Business Intelligence Research (IJBIR), Production, Planning and Control (PP&C).

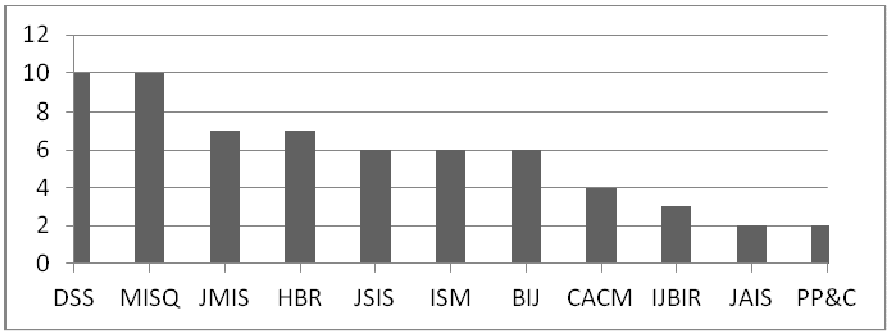

Figure 1. Number of articles per journal

In the DSS field, BI is considered as a relatively new research sub-field where not many studies have been done (Arnott and Pervan 2008). During the 2000s, it was commonly held that industry was leading the BI field, and that academic research was lagging behind (Arnott and Pervan 2008). Combined with the increased investments in the BI field that followed, even in times of crisis, doing research on BI became fashionable (Pirttimaki 2007). That could explain the peak of published papers on 2007/08 as depicted in Figure 2.

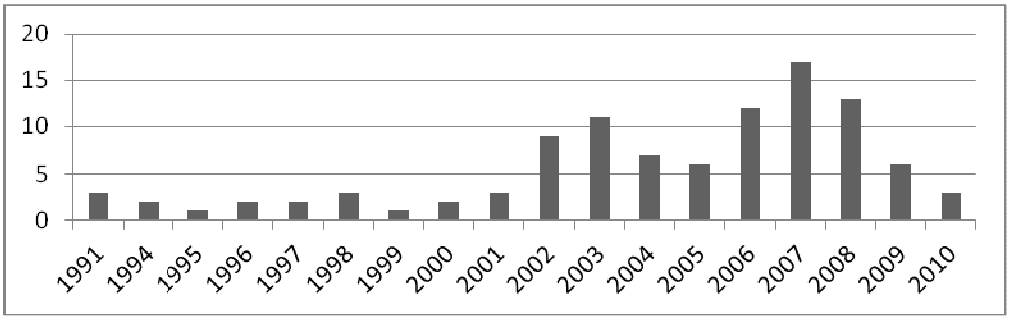

Figure 2. Number of BI articles published per year

BI scope

In an attempt to find a basis for a scholarly discourse, our first goal during the analysis phase was to identify all the definitions of BI and synthesize a unified definition.

One of the first things we noticed in the literature was the confusion between BI and competitive intelligence (CI). In the literature, authors such as Calof and Wright (2008), Kisinger (2007), Martinsons (1994) and Vedder et al. (1999) use the term BI to convey the concept of competitive intelligence. Specifically, for such authors BI has the same meaning in the definition of CI provided by Vedder et al. (1999): "Competitive intelligence (CI), also known as business intelligence, is both a process and a product. As a process, CI is the set of legal and ethical methods an organization uses to harness information that helps it achieve success in a global environment. As a product, CI is information about competitors' activities from public and private sources, and its scope is the present and future behavior of competitors, suppliers, customers, technologies, acquisitions, markets, products and services, and the general business environment" (p. 109). CI covers the entire competitive environment by collecting internal and external information to identify business opportunities and threats (Calof and Wright 2008). However, the concept of CI reached popularity only in the marketing intelligence literature together with the concept of marketing/market intelligence (Calof and Wright 2008).

BI started as a utilization of all the transactional data accumulated in the organization, mainly internally produced information (Yermish et al. 2010). As such, BI at that point was quite different from CI in scope. However, today things have changed. The transactional systems include a lot of external data and with the growth of WWW the potential of BI systems has expanded significantly (Negash 2004). Competitive intelligence is now considered as a subset of BI or a "specialized branch of BI" (Negash 2004). BI is about knowing both an organization's strengths and weaknesses as much as knowing the competitors state or other external factors (economic and political environment) (Negash 2004).

Our study shows that BI is defined as a process, a product and a set of technologies. Also, the review shows that with time the definition has evolved from a one-dimensional definition to a multidimensional definition. The

most recent papers describe BI as a process, a product, and as a set of technologies, or a combination of these (see Tables 2, 3, 4).

Heering (1998) views intelligence as a process in which "information is subject to systematic examination and determination of significant relationships". Authors such as Dekkers et al. (2007), Herring (1998) and Lawton (2006) describe BI mainly as a process or a set of concepts, methods and processes aimed at improving business decisions. Golfarelli et al. (2004), on the other hand, defines BI as a process, which involves the transformation of data into information, and then the latter into knowledge. However, common to these authors' conceptions is the notion that BI is a *continuous* process. Initially data is *gathered* and *stored,* then *transformed* into information by *analysis*. This information is then *transformed* into knowledge to support *decisions*.

Table 2. Definitions of BI as a process

"…a process in which information is subject to systematic examination and determination of significant relationships" (Herring 1998, pp.)
"Business Intelligence (BI) can be defined as the process of turning data into information and then into knowledge. Knowledge is typically obtained about customer needs, customer decision making processes, the competition, conditions in the industry, and general economic, technological, and cultural trends." (Golfarelli et al. 2004, pp.1)
"Business intelligence has long offered the promise of letting companies gather, store, access, and analyze huge amounts of data so that they can make better decisions regarding customers, suppliers, employees, logistics, and infrastructure." (Lawton 2006, pp.14)
"…as the continuous activity of gathering, processing and analyzing data - supported by a BI system." (Dekkers et al. 2007, pp. 626)

The notion of BI as both a process and a product is stated by the following authors, Jourdan et al. (2008), Länngvist and Pirttimäki (2006), Martinsons (1994), Vedder et al. (1999) and Yi-Ming and Liang-Cheng (2007). According to these authors, BI as a process is composed of methods that organizations use to develop and harness useful information or intelligence, that can help organizations make better decisions. As a product, BI is *relevant information* and *knowledge* that enables organizations to predict the behavior of their internal and external environment with a degree of certainty.

Table 3. Definitions of BI as process and a product

"Business intelligence must be considered as much a process as a product. The product is the documentation, cataloging, and dissemination of actionable information for strategic decision making. The process is the systematic production of such intelligence and its delivery to those who can benefit from it. Team work among information gatekeepers is vital to success." (Martinsons 1994, pp. 19)
"The term BI can be used to refer to: 1. Relevant information and knowledge describing the business environment, the organization itself, and its situation in relation to its markets, customers, competitors, and economic issues 2. An organized and systematic process by which organizations acquire, analyze, and disseminate information from both internal and external information sources significant for their business activities and for decision making." (Länngvist and Pirttimäki 2006, pp. 32)
"BI is "both a process and a product." The process is composed of methods that organizations use to develop useful information, or intelligence, that can help organizations survive and thrive in the global economy. The product is information that will allow organizations to predict the behavior of their "competitors, suppliers, customers, technologies, acquisitions, markets, products and services, and the general business environment" with a degree of certainty." (Jourdan et al. 2008 pp. 121)

The most recent papers define BI as a three-dimensional concept. Shariat & Hightower (2007) characterize BI as a composition of *processes*, *technology* and *products*; processes for collecting and analyzing business information; technology used in these processes; and the product is the knowledge obtained from these processes. On the same track, Baars & Kemper (2008) understand BI "to encompass all components of an integrated management support infrastructure". According to this approach, *technology* is an important component of BI, because it is the integration of different technologies that enabled and continues to facilitate BI today.

Table 4. Definitions of BI as process, a product and technologies

"BI converts data into useful information and, through human analysis, into knowledge". Negash 2004. pp.180). BI systems combine data gathering, data storage, and knowledge management with analytical tools to present complex internal and competitive information to planners and decision makers." (pp. 178)
"Business intelligence (BI), as the combination of DM, data warehousing, knowledge management and traditional decision support systems, becomes a very popular investment for corporations in the developed countries." (Cheng et al. 2006, pp. 588)
"The term "business intelligence," which first popped up in the late 1980s, encompasses a wide array of processes and software used to collect, analyze, and disseminate data, all in the interests of better decision making. Business intelligence tools allow employees to extract, transform, and load (or ETL, as people in the industry would say) data for analysis and then make those analyses available in reports, alerts, and scorecards." (Davenport 2006, pp. 106)
"Business Intelligence (BI) represents a set of business information processes for collecting and analyzing enterprise (business) information, the technology used in these processes, and the information (knowledge) obtained from these processes. BI is frequently referred to as an umbrella term that brings together almost all of the data disciplines of an organization." (Shariat and Hightower 2007, pp. 42)
"Business intelligence encompasses all of the software applications and technologies that a company uses to gather, provide access to, and analyze data and information about its operations." (Pemmaraju 2007, pp. 14)
"Business intelligence encompasses a set of tools, techniques, and processes to help harness this wide array of data and allow decision makers to convert it to useful information and knowledge." (Clark et al. 2007, pp. 589)
"A broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions is referred to as business intelligence." (Jermol et al. 2003, pp. 122)
"Intelligence is rooted in acquiring the appropriate data (environmental scanning). Business intelligence is rooted in interpreting that data with respect to a business task (contextualization). Once the data acquisition and integration systems are implemented, the procedures for effectively using the resultant information to derive business intelligence must be put into place." (March and Hevner 2007, pp. 1041)

Despite the evolution of the concept of BI through time some key elements are mentioned continuously by the authors in their definitions of BI. The building blocks of BI as they result from all the above definitions are *Data* mentioned e.g. by Dekkers et al. (2007), Yi-Ming and Liang-Cheng (2007) and Davenport (2006); *Information* mentioned e.g. by Herring (1998), Martinsons (1994) and March and Hevner (2007); *Knowledge* e.g. as in the definitions of Golfarelli et al.(2004), Jourdan et al. (2008) and Clark et al. (2007); *Decisions* as stated e.g. by Lawton (2006), Lännqvist and Pirttimäki (2006) and Jermol et al. (2003). The most important phases are the gathering and storing of data, analyzing data and information, using information and knowledge and acting (making decisions). In the next paragraphs, we describe each of these phases.

Gathering and storing data

Negash (2004) distinguishes two main dimensions of data, the source of data and the type of data. There are two main sources of data: internal data about the internal environment of an organization and external data about the external environment of an organization (Kinsinger 2007; Negash 2004; Yi-Ming and Liang-Cheng 2007).

Internal data are produced internally, either by the transactional systems the organization owns (Kinsinger 2007) or data included in documents, email, and intranet communications produced by the organization's employees. Internal data relates to data about the organization itself, its processes, products, employees and performance. External data are data about customers, competitors, markets, products in the market, environment, technologies, acquisitions, alliances, and suppliers (Negash 2004). These could be in different sources such as information or media published on-line, contacts outside the firm, contacts inside the firm, and online databases (Vedder et al. 1999). Yi-Ming and Liang-Cheng (2007) emphasize the importance of external data and specifically, the industry level and the external environment level (political, economic, social and technological).

There are also two types of data, structured data and unstructured data. Structured data are understood to be data that resides in predefined fields within a record or file, and thus can be processed by computing equipment (Baars and Kemper 2008). Relational databases and spreadsheets are examples of media to structure data. Traditionally, BI tools are developed for gathering and storing structured data (Blumberg and Atre 2003; Baars and Kemper 2008).

However, for many application domains, especially, strategic domains and areas outside the organization, gathering and analyzing only structured data is not satisfactory because large amounts of unstructured data are in documents, emails, presentations and web pages (Baars and Kemper 2008; Negash 2004). Unstructured data are those which do not reside in fixed locations, (i.e., fields or tables). Free-form text in a word document is a typical example of unstructured data. Furthermore, according to Shim et al. (2002), to make better decisions, managers now need to consider a much broader range of factors, such as cultural, organizational, personal, ethical and aesthetic concerns. Therefore, BI systems should be capable of handling more unstructured information and much broader concerns than knowledge-based systems were capable of doing in the past (Shim et al. 2002).

Negash (2004) states that only the combination of structured and unstructured data will provide users with actionable information because "unstructured data are equally important, if not more, as structured data for taking action by planners and decision makers". Negash (2004) bases his claim on the study of Blumberg and Atre (2003). Their survey underlined the crucial role of unstructured data in BI, purporting that around 85% of all business information exists as unstructured data, while 60% of CIOs and CTOs considered unstructured data as vital for improving procedures and creating new business opportunities.

Analyzing data and information

Analyzing data and information refers to the ways data are analyzed and transformed into information, which is then filtered, aggregated and provided to the users.

Goal-oriented methods and metric-driven methods are methods to analyze data and filter and organize information (Golfarelli et al. 2004; Yi-Ming and Liang-Cheng 2007). These methods support managers to collect and analyze data and information that is relevant to their strategic goals. More specifically, Olszack and Ziemba (2003) and Yi-Ming and Liang-Cheng (2007) suggest the Balanced Scorecard for controlling the performance of an organization by analyzing internally developed enterprise information. The balanced scorecard is a performance tool where the most relevant information is identified and displayed in four main perspectives, namely, financial, customer, internal business processes, and learning and growth. For each perspective indicators and target values are defined to show the performance of an organization, unit or department and data are collected to measure each indicator.

Corporate performance management (CPM) is another approach used to analyze data and extract information (Golfarelli et al. 2004). The activities involve the same steps as in the balanced scorecard: the definition of goals, metrics and target values to monitor the activities and processes. The difference between the two approaches is that CPM has no specific perspectives. One can define goals, metrics and target values for anything that should be monitored.

The exploration method is yet another method to analyze and scrutinize data and filter information in order to discover new relationships (Chung et al. 2005). This method is employed by analysts when they are interested in an unknown area that they want to explore to reveal new patterns and relationships. Techniques for exploration include data mining, text mining, document visualization, browsing methods, web community, and knowledge maps (Blumberg and Atre 2003; Baars and Kemper 2008; Chung et al. 2005; Negash 2004).

Using Information and Knowledge

To use information effectively, an individual needs knowledge to interpret the information (Choudhury and Sampler 1997). Information by itself will not provide any brilliant insights, but it will point towards answers that require judgment and insight (Martinsons 1994). Knowledge provides the basis for effective business activities (Olszack and Ziemba 2006). According to Davenport et al. (1998), knowledge is "a fluid mix of framed experience, values, contextual information, and expert insights that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms." This means that knowledge is a personal matter and it differs from individual to individual, from time to time and from situation to situation (Cheng et al. 2006). Although, the nature of knowledge is very particular, it is considered to be a potential source of sustainable competitive advantage (Davenport and Prusak 1998). Hence, it becomes strategically imperative to enhance and develop the analytic capabilities of knowledge workers (Nonaka 1991). Techniques like data mining, predictive analytics and trend analysis using mainly historical and current data enhance the understanding of fact-based interrelationships (Steiger 2010). These techniques have the ability to run analysis in huge datasets and discern common patterns that are not visible. By making visible these patterns, decision-makers are able to generate new insights and develop causal relationships and subsequently, transform these new insights into intelligent knowledge that will support their decisions (Cheng et al. 2006). March and Hevner (2007) state that "the ability to generate BI can be assisted by computational methods such as data mining, genetic algorithms, neural networks, and case-based reasoning". These computational methods enhance the transformation of information into knowledge.

However, because knowledge exists in the minds of the employees (Nemati et al. 2002), all the aforementioned technologies can analyze only data and information available in systems. This addresses the balance between objectivity and subjectivity, objectivity gained from the information in the systems and subjectivity, the interpretation of the information (use of knowledge) by the decision-maker or knowledge worker (Schultze 2000). Nemati et al. (2002), highlights the need for a new generation of knowledge-enabled systems that will "capture, cleanse, store, organize, leverage and disseminate the knowledge of the firm". It is necessary to capture this knowledge also from the employees themselves.

Acting – Decision Making

This phase emphasizes how and where the information and knowledge, obtained from the BI process, is used in organizations. *Acting* in a managerial context involves *making decisions*. To act, an individual needs knowledge to interpret the information correctly and the decision authority to act (Choudhury and Sampler 1997).

According to Arnott and Pervan (2008) and Yi-Ming and Liang-Cheng (2007), most of the studies about BI have focused on design, development and application of BI tools, neglecting the use of information and knowledge. While there is a consensus among the authors of all reviewed articles that BI supports decision making*, no studies in any way couple the development or the use of information with the decision making process itself. There are no studies that address how BI as a product addresses the needs of the decision making process. Moreover, no studies were found that focus on how the intelligence provided was used in decision making and what processes are in place to ensure the use of intelligence in the decision making process.* However, as Fuld (2003) states "Intelligence is an asset only if it is used". One reason for this could be that BI is not a very mature field and "current research is largely focused on technology and getting the data right" (Arnott and Pervan 2008).

Davenport (2010) is the first to explicitly make an attempt to describe how decisions and information are related. He describes three approaches for how organizations link information and decisions. The most common approach is to loosely couple information with decision making. Information, usually from a specific domain, is made accessible to analysts and decision makers. This information can be utilized in more than one decision. Tools to analyze and present the information are provided as well. However, the actual use of the information depends on individual initiative. Since the information is offered for supporting a range of different decisions, there is no transparency as to what information was used for which decisions. The second approach is a more structured decision environment where specific information is identified "to improve targeted decision processes" (Davenport 2010, pp. 5). This environment is created by not only using specific tools and applying analysis to support the specific decisions, but also by making use of organizational and behavioral techniques and additional efforts to improve the accuracy of information provided. The third approach is the automated decision approach, where all necessary information is identified and rules are determined so decisions can be made by a machine.

In his work Davenport (2010), proposes that "organizations must have a strong focus on decisions and their linkage to information. Businesses need to address how decisions are made and executed, how they can be improved, and how information is used to support them" (pp. 2). In this vein Davenport (2010) outlines a four-step process for connecting decisions and information in organizations. During the first step, organizations must decide which approach will be applied for each decision. The second step involves the development and provision of information needed for each decision according to the approaches selected in step one. In order to link information to decisions there is a need to explicitly design decision processes, which is the third step. The final step involves executing the decision and assuring that information is used by decision makers to make better decisions. It is worth noting that although Davenport (2010) writes about information in his final step, we would think that knowledge would be more appropriate and also be in accordance with Choudhury and Sampler (1997).

Technology support

Technology is an integral component of BI (Blumberg and Atre 2003). Some authors (Cheng et al. 2006; Jermol et al. 2003; Pemmaraju 2007), even define BI as being nothing else but a combination of different technologies. BI combines data warehouse technology with on-line analytical processing (OLAP) and data mining, and also has an input from knowledge management systems, decision support systems and other information systems present in an organization (Negash 2004).

More specifically, data warehouse technology is used to systematically collect and store relevant business data (internal and external) into a single repository (March and Hevner 2007) in the gathering and storing phase. However, data warehousing only involves the collection and storage of structured data (Baars and Kemper 2008). Document and content management systems or document warehouses are used to collect and store

unstructured data, although they are not widely used (Baars and Kemper 2008). The integration of these systems still poses a challenge (Baars and Kemper 2008).

Once the data are gathered and stored in a warehouse they are ready for analysis and presentation in a form that is useful for business decision-making. BI tools such as reports, (OLAP), and data mining assist in the analysis of the collected data. These analytic tools have the potential to provide actionable information (March and Hevner 2007). However, according to Negash (2004) and Baars and Kemper (2008), business intelligence tools are mainly concerned with the analysis of structured data. The analysis of unstructured data continues to be an issue in BI (Chung et al. 2005; Negash 2004).

The next phase involves using knowledge, where technology provides support in facilitating the transfer and dissemination of knowledge by enhancing the understanding of fact-based interrelationships. Some of these technologies are: knowledge-based expert systems, neural networks, case-based reasoning and intelligent agents (Fowler 2000). According to Lawton (2006) and Yermish et al. (2010), the integration of BI tools with other information systems is still a problem and a focus shift is needed from a black-boxing perspective (problem centric) to a human-centric perspective.

Summary

Based on the above analysis, Figure 3 (below) presents the three pillars of the BI concept: products, processes and technologies. Our conceptual framework starts with the gathering and storage data. These data are analyzed and transformed into information. Information is further analyzed and transformed into new information or knowledge. Both information and knowledge are used when action is required. However, we agree with the contention of Martinsons (1994) and Davenport (2010) that it is not enough to analyze data, to provide information, and to use knowledge. Organizations should look into decision processes in order to deliver useful information to the decision makers. It is necessary to act upon the information and knowledge obtained; *intelligence* is only produced through action (making decisions). In many cases information that has been produced is not used, is unsuited for decision purposes, or is ambiguous and interpreted differently across different contexts (Davenport 2010). In our conceptualization of BI, the processes are supported by a set of technologies as data warehouse to collect and store data, OLAP and analysis tools to analyze data and extract information. Decisions are made using information and knowledge provided by systems like knowledge management systems (KMS) and decision support systems (DSS).

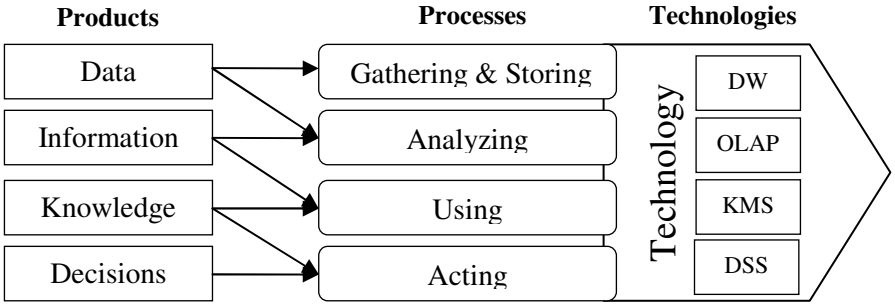

Figure 3. Conceptualizing BI

CONCLUSION

In this paper we have analyzed the concept of BI by conducting a review of the literature from a managerial perspective. We found that the scope and definition of BI as a concept has evolved over time from firstly conceptualizing BI as a process, then extending to include products, and now currently broadening to include technology. From this background of the literature, we argue and define BI as a process where data are gathered, stored and transformed into information through analysis, and where information is transformed into knowledge which is used when acting (making decisions). Ultimately, the product of this process is better decisions. Technologies used in the process support the transformation from one phase to another.

The results of this literature review show that there is a gap in research that explores the role of acting (decision-making) within BI. While all the articles we reviewed acknowledge that BI aims to support and improve decision making processes, none of the studies describe how BI is used and how intelligence is acted upon in decision making processes.We also identified a gap in the literature that addresses technology support. Despite the fact that there is a considerable body of literature on technology support, authors focus mainly on technology having a problem-centric perspective and overlooking the decision-makers' perspective. These are possible streams of future research.

REFERENCES

AIS. 2009. "Association for Information Systems," http://home.aisnet.org/displaycommon.cfm?an=1&subarticlenbr=345 (Accessed 20-12-2009).

Arnott, D., and Pervan, G. 2008. "Eight Key Issues for the Decision Support Systems Discipline," *Decision Support Systems* (44:3), pp 657-672.

Blumberg, R., and Atre, S. 2003. "The Problem with Unstructured Data," *DM Review Magazine*).

Baars, H., and Kemper, H.-G. 2008. "Management Support with Structured and Unstructured Data - an Integrated Business Intelligence Framework," *Information Systems Management* (25:2), Spring2008, pp 132-148.

Calof, J.L., and Wright, S. 2008. "Competitive Intelligence: A Practitioner, Academic and Inter-Disciplinary Perspective," *European Journal of Marketing* (42:7-8), pp 717-730.

Cheng, S., Dai, R., Xu, W., and Shi, Y. 2006. "Research on Data Mining and Knowledge Management and Its Applications in China's Economic Development:: Significance and Trend," *International Journal of Information Technology & Decision Making* (5:4), pp 585-596.

Choudhury, V., and Sampler, J.L. 1997. "Information Specificity and Environmental Scanning: An Economic Perspective," *MIS Quarterly* (21:1), pp 25-53.

Chung, W., Hsinchun, C., and Nunamaker Jr, J.F. 2005. "A Visual Framework for Knowledge Discovery on the Web: An Empirical Study of Business Intelligence Exploration," *Journal of Management Information Systems* (21:4), Spring2005, pp 57-84.

Clark, J.T.D., Jones, M.C., and Armstrong, C.P. 2007. "The Dynamic Structure of Management Support Systems: Theory Development, Research Focus, and Direction," *MIS Quarterly* (31:3), pp 579-615.

Davenport, T.H. 2006. "Competing on Analytics," *Harvard Business Review* (84:1), pp 98-107.

Davenport, T.H. 2010. "Bi and Organizational Decissions," *International Journal of Business Intelligence Research* (1:1), pp 1-12 pp.

Davenport, T.H., and Prusak, L. 1998. "Working Knowledge: How Do Organizations Manage What They Know," *Harvard Business School Press*).

Dekkers, J.V., Johan; and Batenburg, Ronald. 2007. "Organising for Business Intelligence: A Framework for Aligning the Use and Development of Information," *BLED 2007*

Dybå, T., and Dingsøyr, T. 2008. "Empirical Studies of Agile Software Development: A Systematic Review," *Information and Software Technology* (50:9), pp 833-859.

Fowler, A. 2000. "The Role of Ai-Based Technology in Support of the Knowledge Management Value Activity Cycle," *The Journal of Strategic Information Systems* (9:2-3), pp 107-128.

Fuld, L. 2003. "Be Prepared," *Harvard Business Review* (81:11), pp 20-21.

Gilad, B., and Gilad, T. 1986. "Smr Forum: Business Intelligence - the Quiet Revolution," *Sloan Management Review* (27:4), pp 53-61.

Golfarelli, M., Stefano, R., and Iuris, C. 2004. "Beyond Data Warehousing: What's Next in Business Intelligence?," in: *Proceedings of the 7th ACM international workshop on Data warehousing and OLAP*. Washington, DC, USA: ACM.

Herring, J. 1998. " What Is Intelligence Analysis?," *Competitive Intelligence Magazine* (1(2)), pp 13-16.

Jermol, M., Lavrac, N., and Urbancic, T. 2003. "Managing Business Intelligence in a Virtual Enterprise: A Case Study and Knowledge Management Lessons Learned," *Journal of Intelligent & Fuzzy Systems* (14:3), pp 121-136.

Jourdan, Z., Rainer, R.K., and Marshall, T.E. 2008. "Business Intelligence: An Analysis of the Literature," *Information Systems Management* (25:2), Spring2008, pp 121-131.

Kinsinger, P.C. 2007. "The Business Intelligence Challenge in the Context of Regional Risk," *Thunderbird International Business Review* (49:4), pp 535-541.

Lawton, G. 2006. "Making Business Intelligence More Useful," *Computer* (39:9), pp 14-16.

Luhn, H.P. 1958. "A Business Intelligence System," *IBM Journal*).

Lännqvist, A., and Pirttimäki, V. 2006. "The Measurement of Business Intelligence," *Information Systems Management* (23:1), Winter2006, pp 32-40.

March, S.T., and Hevner, A.R. 2007. "Integrated Decision Support Systems: A Data Warehousing Perspective," *Decision Support Systems* (43:3), pp 1031-1043.

Martinsons, M.G. 1994. "A Strategic Vision for Managing Business Intelligence," *Information Strategy: The Executive's Journal* (10:3), Spring94, p 17.

Mathiassen, L., Saarinen, T., Tuunanen, T., and Rossi, M. 2007. "A Contigency Model for Requirements Development," *Journal of the Association for Information Systems* (8:11), pp 569-597.

Negash, S. 2004. "Business Intelligence," *Communications of AIS* (2004:13), pp 177-195.

Nemati, H.R., Steiger, D.M., Iyer, L.S., and Herschel, R.T. 2002. "Knowledge Warehouse: An Architectural Integration of Knowledge Management, Decision Support, Artificial Intelligence and Data Warehousing," *Decision Support Systems* (33:2), pp 143-161.

Nonaka, I. 1991. "The Knowledge Creating Company," *Harvard Business Review* (69), pp 96-104.

Olszack, M.C., and Ziemba, E. 2006. "Bi Systems in the Holistic Infrastructure Development Supporting Decision-Making in Organizations," *Interdisciplinary Journal of Information Knowledge, and Management* (1), pp 48-58.

Olszak, C.M., and Ziemba, E. 2003. "Business Intelligence as a Key to Management of an Enterprise," *Informing Science*, Puri, Finland, pp. 855-863.

Pemmaraju, S. 2007. "Converting Hr Data to Business Intelligence," *Employment Relations Today* (34:3), pp 13-16.

Pirttimaki, V.H. 2007. "Conceptual Analysis of Business Intelligence," *South African Journal of Information Systems* (9:2).

Schultze, U. 2000. "A Confessional Account of an Ethnography About Knowledge Work," *MIS Quarterly* (24:1), pp 3-41.

Shariat, M., and Hightower, J.R. 2007. "Conceptualizing Business Intelligence Architecture," *Marketing Management Journal* (17:2), Fall2007, pp 40-46.

Shim, J.P., Warkentin, M., Courtney, J.F., Power, D.J., Sharda, R., and Carlsson, C. 2002. "Past, Present, and Future of Decision Support Technology," *Decision Support Systems* (33:2), pp 111-126.

Steiger, D. 2010. "Decision Support as Knowledge Creation: A Business Intelligence Design Theory," *International Journal of Business Intelligence Research (IJBIR)* (1:1), pp 29-47 pp.

Vedder, R.G., Vanecek, M.T., Guynes, C.S., and Cappel, J.J. 1999. "Ceo and Cio Perspectives on Competitive Intelligence," *Communications of the ACM* (42:8), pp 108-116.

Webster, J., and Watson, R.T. 2002. "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly* (26:2), pp 13-23.

Yermish, I., Miori, V., Yi, J., Malhotra, R., and Klimberg, R. 2010. "Business Plus Intelligence Plus Technology Equals Business Intelligence," *international Journal of Business Intelligence Research* (1:1), pp 48-63 pp.

Yi-Ming, T., and Liang-Cheng, C. 2007. "Dynamic Interactive Framework to Link Business Intelligence with Strategy," *International Journal of Information Technology & Management* (6:1), pp 2-2.

COPYRIGHT