

# Business intelligence gap analysis: A user, supplier and academic perspective

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## ABSTRACT

Business intelligence (BI) takes many different forms, as indicated by the varying definitions of BI that can be found in industry and academia. These different definitions help us understand of what BI issues are important to the main players in the field of BI; users, suppliers and academics. The goal of this research is to discover gaps and trends from the standpoints of BI users, BI suppliers and academics, and to examine their effects on business and academia. Consultants also play an important role since they can be seen as the link between users and suppliers. Two research methods are combined to accomplish this goal. We examine the BI focus of users and suppliers through a survey, and we gain insight to the BI focus of academics, vendor-neutral consultants (typical representatives like Forrester, Gartner and IDC) and vendor-specific consultants (typical representatives like IBM, Information builders, Microsoft, Oracle and SAP) through their publications. Previous studies indicate that similar article analyses often focus on academic research methods only. That means that the results so far often reveal the academic perspective. Unlike these previous studies, the perspective of this research is not limited to academics. Our results provide insight of the BI trends and BI issue ranking of BI users, suppliers, academics, vendors neutral consultants and vendor specific consultants.

## Categories and Subject Descriptors

H Information Systems, H.0 General and H.4 Information Systems Applications

## General terms

Management

## Keywords

Business intelligence, business intelligence tools, monitoring, analysis, reporting, BI portals, dashboards, scorecards, data mart, data warehouse, real time data, visualization, data integration, ad hoc query, data mining, multidimensional analysis, OLAP.

## 1. INTRODUCTION

Business intelligence (BI) has been around for several years and has taken many different forms. These different forms are indicated by the varying definitions of BI that can be found in industry and academic research. The founder of the term, Howard Dresner, refers to BI as “applied analytics” [21]. Wayne Eckerson [8], director of the TDWI, an educational institute for BI and data warehousing, defines BI in a more technical manner, as an umbrella term covering data warehousing, data integration combined with query, reporting and analysis tools. Thomas Davenport [6] explains BI more as a set of technologies and processes to collect and analyze data for better decision making.

We survey BI users and publications to understand current trends in BI implementations and usage, from the standpoints of users, vendors, consultants, and academic researchers. We then use this information to identify gaps between current implementations and research topics and the needs of business users.

### 1.1 Business intelligence definition

For the purpose of this research, we define Business Intelligence as:

*Business intelligence consists of monitoring and analysis technologies that will enable business users to turn data into information and information into knowledge, in order to optimize decision making and manage business performance with the goal to improve profitability and competitiveness of the business.*

Monitoring technologies include BI portals, dashboards, scorecards, data marts, data warehousing, real time data, visualization and data integration. Analysis technologies include ad hoc queries, data mining, multidimensional analysis, OLAP and reporting.

As mentioned by Arnott and Pervan [2], there is a link between Business Intelligence and Decision Support Systems (DSS). Knowledge based or intelligent DSS is founded on artificial intelligence techniques. In this study we do not focus on classical DSS or Knowledge Management Systems (KMS), as they already attracted much attention in literature. We do focus on support systems using BI monitoring and analysis techniques such as described above.

### 1.2 Research motivation

We identify three major stakeholders in the field of BI; users, suppliers and academics. Software suppliers provide users with BI

tools and it can be assumed that they have distinct views of what BI means. We also consider the viewpoint of consultants, who serve both users and vendors.

The articulated requirements of users are typically based on and limited by their experiences and their business needs. With the results of this research, BI users will be more aware of the business intelligence opportunities and possibilities. BI users will in the end decide which BI features are truly valuable and which are not. BI consultants may have a better understanding of the market state and movement.

This market movement is indicated by Arnott and Pervan [2] with a 12% growth of BI software from 2003 to 2004 with the expected growth of 7.4% to 2009. The role of BI is changing because of technological developments of applications, data and hardware [14]. According to Negash and Gray [17], BI systems are widely used in industry, but improvements are still needed.

The goal of this research is to discover matching and non-matching BI issues among users, suppliers and academics. Consultants also play an important role as they can be seen as the bridge between users and suppliers; they are able to moderate the gaps between the groups. We include BI users, suppliers and academics because they are the main players in the field of BI. The view of vendor-neutral and vendor-specific consultants is also considered to gain insight into gaps between users and suppliers that are covered by consultants.

The BI issues as mentioned in the definitions are structured into five categories; BI goal, monitoring, analysis, management and tool attributes [8]. Monitoring, analysis and management application categories are based on the theory of Wayne Eckerson [8]. He explains the three application layers of dashboards as 1) monitoring application supplies critical information with the use of timely and relevant data, usually together with graphical elements, 2) analysis application enables users to analyze and explore performance data across multiple dimensions at different detail levels to trace the cause of problems and issues, and 3) management application fosters communication of executives, managers and staff and provides executives continuous feedback to lead their organization in the right direction [8].

The following section discusses related work, followed by a description of research methods. Research outcomes provide an overview of the BI issues, gaps, and trends by category: BI goal, monitoring, analysis, management and tool attributes. We also give insight in the possible causes of these matching and non-matching BI issues. Finally, we conclude by discussing possible effects of this work on business and science.

## 2. RELATED WORK

Search results with the keyword “business intelligence” often include articles about decision support systems (DSS). The link between BI and decision support systems (DSS) is explained by Arnott and Pervan [1] in an analysis of then-current DSS research. Knowledge based or intelligent DSS have evolved into executive information systems (EIS). In the 1990’s EIS became a part of the IT portfolio of almost any reasonable sized organization. In the late 1990’s EIS moved towards enterprise wide reporting systems, including dashboards and balanced scorecards [1]. In a more recent research, Arnott and Pervan [2] analyzed the academic field of decision supplier systems by analyzing academic DSS articles. This resulted in eight key issues for DSS [2]. Several researchers have analyzed citations and mapped the intellectual structure of

DSS to understand current state and trends of DSS research [8, 2, 1,]. Benbasat and Nault [3] have reviewed DSS research, giving an overview of the empirical studies about information technologies that support management: DSS, group decision support systems (GDSS) and expert systems. Pervan [19] did a literature analysis about group support systems (GSS); this resulted in an overview of GSS articles published from 1984 to 1996. These previous researches indicate that this type of academic research is often applied within the field of DSS or on a DSS focus area such as GDSS. Results so far often reflect the academic perspective more than the perspectives of users and suppliers. Unlike these previous researches, the perspective of this research is not limited to academics.

## 3. RESEARCH METHODS

The research methods consist of a survey and an article analysis. The goal of the survey was to examine the BI focus of users and suppliers. The article analysis examined the BI focus of academics, vendor neutral consultants and vendor specific consultants.

### 3.1 Survey

The survey examines the experiences and expectations of BI users and suppliers. It contained 42 questions divided in BI user questions, supplier questions and questions for both groups. The survey asked questions in categories about BI goals, monitoring, analysis, management and BI tool attributes. The questions also asked about which BI issues will become more important in the future, BI tool usage, supply, and requirements and information sharing between users and vendors.

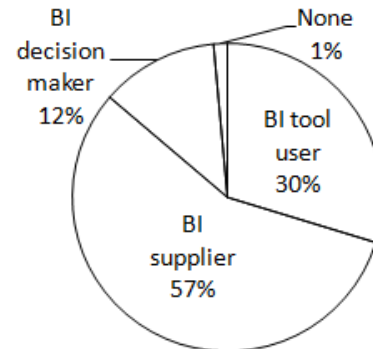


Figure 1 Role of survey respondents

The survey was online for five months from September 2009 until January 2010. People who are related to BI or had experience within the field of BI were identified through social networks, including LinkedIn and a large number of personal contacts from faculty and consultants. Each received a survey invitation, and they were encouraged to forward the survey link to their own contacts. The survey produced a total of 111 respondents of which 63.1% finished the survey. The survey was spread out globally, with respondents located in: The Netherlands, India, Australia, US, Germany, Russia, UK, Brazil, Canada, France and Denmark. As shown in Figure 1, the largest group of respondents is BI suppliers (57%), followed by BI users (30%). Respondents who indicated that they have no connection to BI are excluded; these respondents provided almost no response in any case. The group of decision makers was added after the pilot version, to make sure

that this group was covered. However, most BI decision makers are also BI users; only 5% is neither a supplier nor a user but only a decision maker. This group did not complete the entire survey; significant data of this group could not be collected and is therefore excluded.

### 3.2 Article analysis

The purpose of the article analysis is to examine the BI focus of academics and consultants. In paragraph 3.2.1 we describe the analysis on 127 academic articles. In paragraph 3.2.2 we review 51 vendor specific whitepapers and 46 vendor neutral whitepapers, as a comparison to the academic literature.

not discuss a monitoring or analysis technology as given in the BI definition are excluded; for example, articles about managerial decision making without the use of BI tools, or articles that discuss a BI technology but not applicable to business are excluded.

The article search was performed by a number of keywords, including monitoring and analysis issues as mentioned in the BI definition. However, more keywords are used than these issues to ensure that the search results contained the majority of BI articles.

The most comprehensive search code included the following keywords: "business intelligen\*" OR intelligen\* AND monitor\*

**Table 1 Article sample by academic journal**

Journal	Total no of articles published	No of BI articles published	Years of published BI articles	BI articles as a percentage of published articles
Decision Sciences (DS)	886	1	2005	0.11%
Decision Support Systems (DSS)	1,362	33	1997-2009	2.42%
European Journal of Information Systems (EJIS)	412	2	2005	0.49%
Group Decision and Negotiation (GD&N)	326	7	1998-2008	2.15%
Information and Management (I&M)	4,079	2	2005-2008	0.05%
Information Systems Research (ISR)	318	6	2001-2008	1.89%
Information and Organization (I&O)	627	0	-	0.00%
Information Systems Journal (ISJ)	240	1	2002	0.42%
Journal of Information Technology (JIT)	361	4	2005-2008	1.11%
Journal of Management Information Systems (JMIS)	312	18	1995-2008	5.77%
Journal of Organizational Computing and Electronic Commerce (JOC&EC)	141	0	-	0.00%
Journal of Strategic Information Systems (JSIS)	210	3	2000-2003	1.43%
Management Science (MS)	2,652	0	-	0.00%
MIS Quarterly (MISQ)	1,300	37	1979-2007	2.85%
Other	-	13	2003-2008	-
<i>Total</i>	<i>13,226</i>	<i>127</i>		

#### 3.2.1 Academic Article Analysis

The article sources used for academic articles are ISI web of knowledge, Google scholar and a number of academic BI articles selected by SAP. ISI web of knowledge is a research platform that provides access to leading citation databases [13]. Google scholar is a free searching service for scholarly literature. Google scholar cooperates with universities to make use of their library containing electronic journals and papers [11]. Google scholar is added as an additional source to find more articles. E.g. ISI web of knowledge provides MIS quarterly articles from 2002, while Google scholar also has MIS quarterly search results earlier than 2002.

We selected 14 scientific journals as indicated in Table 1. The group of "other" journals contains academic BI articles selected by SAP, coming from different academic journals. We selected these journals because of BI relevance; this article sample was also used by Arnott and Pervan [2] in their DSS research analysis. The article filter is based on BI relevance and application to business, determined by screening keywords, abstract and content of the article. Most excluded articles are removed because they were not applicable to business or related to BI. Articles that did

OR analys\* OR management OR "ad-hoc quer\*" OR agent OR tool OR data-warehouse\* OR "decision making" OR "decision support" OR DSS OR OLAP OR report\* OR mining OR "business performance management" OR BPM OR dashboard OR scorecard OR "bi portal". If this code resulted in more than 10.000 results, the code was shortened by deleting keywords like "analysis", "decision making" and "management": " "business intelligen\*" or intelligen\* AND monitor\* OR "ad-hoc quer\*" OR DSS OR agent OR tool OR data-warehouse\* OR OLAP OR report\* OR mining OR "business performance" OR BPM OR dashboard OR scorecard OR "bi portal".

Table 1 shows that there are differences between journals in total number of published articles, number of published BI articles and years in which these articles are published. Some journals have a few hundred published articles and some have published more than 1,000 articles. Some journals have published BI articles in one year while others published them in the period of more than 10 years. Note that if one BI article was published in 1998 and the last one in 2008, the years indicate 1998-2008. It could be that no BI articles are published in this journal from 2000 to 2005. The results indicate that the following academic journals are the best

sources for BI articles applicable on business: JMIS (5.77%), MISQ (2.85%), DSS (2.42%), GD&N (2.15%), ISR (1.89%), JSIS (1.43%) and JIT (1.11%).

### 3.2.2 Analysis Whitepapers

Consultancy whitepapers are coming from Google scholar and BusinessWeek. BusinessWeek is an online global source of business insights for business leaders. BusinessWeek provides a technology research library including business whitepapers of popular IT reports on technology products and services [4].

To gain insight in the BI focus of consultants, we selected the whitepapers of vendor specific and vendor neutral consultants as indicated in Table 2 and Table 3. The total number of whitepapers published is based on the oldest article per consultant/vendor that could be found on BusinessWeek and Google scholar. Vendor specific whitepapers are articles sponsored by vendors with a strong and leading position according to Gartner [20]. Vendor neutral articles come from Forrester, Gartner and IDC. Forrester is an independent research company that provides advice to global leaders in business and technology [9]. Gartner is a world leading IT research and advisory company for business and IT leaders [10]. IDC is a global provider of market intelligence and IT advisory for IT professionals and business executives [12]. These vendor neutral analysts are selected because they provide whitepapers and global IT advice for business.

For the vendor specific and analysts' whitepapers we did a comparable search. Tables 2 and 3 indicate the BI articles published in whitepapers.

**Table 2 Vendor specific whitepapers**

Whitepaper	Total no of whitepapers published	No of BI whitepapers published	Years of published BI whitepapers	BI articles as a percentage of published whitepapers
IBM	103	3	2008-2009	2.91%
Information builders	8	5	2006-2009	62.50%
Microsoft	356	2	2007-2008	0.56%
Oracle	149	35	2007-2009	23.49%
SAP	191	6	2008-2009	3.14%
<i>Total</i>	<i>807</i>	<i>51</i>		

The best sources for vendor specific or vendor neutral BI whitepapers applicable on business are: Information builders (62.5%), Forrester (25.97%) and Oracle (23.49%). The software specific vendors and vendor neutral consultants provide a more appropriate range of BI articles applicable to business, than academics. However, the academics started publishing BI related articles years earlier. Whitepapers are a better source for BI articles applied to business, although the time range is less extensive than academics.

**Table 3: Analysts whitepapers**

Whitepapers	Total no of whitepapers published	No of BI whitepapers published	Years of published BI whitepapers	BI articles as a percentage of published whitepapers
Forrester	77	20	2004-2007	25.97%
Gartner	416	24	1996-2009	5.77%
IDC	171	2	2003-2005	1.17%
<i>Total</i>	<i>664</i>	<i>46</i>		

### 3.3 Results of survey and article analysis: Gaps and trends per BI category

The results of the survey and article analyses are added in Appendix I: BI ranking for each category for each group. The ranking of users and suppliers is based on the issue that has been ranked the most on each position. E.g. "Improve business performance" and "decision making" are the most mentioned BI issues ranked as most important; number one position.

We see non-matching BI issues between BI users, suppliers and academics. These non-matching issues can result in a gap between the groups if a group thinks that the issue will become more important. The gaps are determined by ranking of issues in order of importance by users and suppliers in the survey. This ranking is composed for academics by the number of articles per BI keyword/issue.

The trends are determined by combining the issues that are mentioned more than three times by users and suppliers in the survey, as becoming more or less important issues in the future. The trends for academics and consultants are determined by observing the number of BI article publications per issue from 2006.

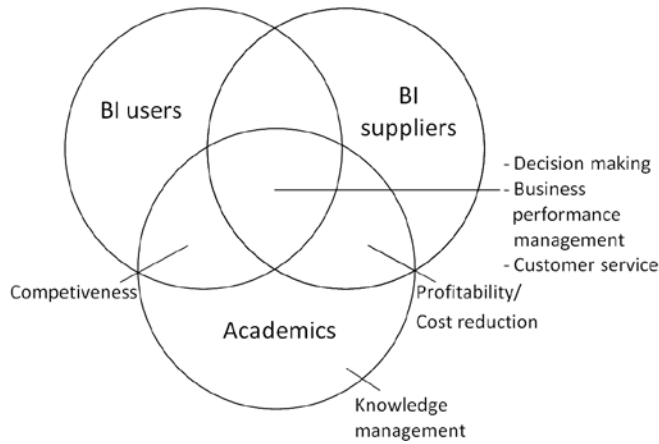
The size of the gaps can be reduced when consultants are able to bridge it. To what extent the gaps are bridged can be indicated by the focus on these BI issues in the vendor specific and vendor neutral whitepapers. The next sections discuss the matching and non-matching BI issues per group in the five categories identified by Eckerson [8].

#### 3.3.1 BI goal

This section describes the research results about the goals of BI. Figure 2 indicates the focus of each group on each BI goal.

Users do not think that profitability/cost reduction is an important BI goal now, but it will become more important to them in the future. To cope with this trend, users could ask their suppliers and use scientific articles and whitepapers as an information resource, because these groups do think that profitability is an important BI goal.

Users agree with suppliers, academics and consultants, that decision making, business performance management and customer service are important BI goals. BI suppliers, academic articles and whitepapers should be good sources to find more information about these BI goals. Users also think that competitiveness is a BI goal, information about this goal can be found in academic articles and whitepapers.



**Figure 2 (Non-)matching BI goal issues**

Suppliers indicate that (better) decision making, customer service, (forecasting and improving) business performance management and competitiveness will become more important. Users, academics and consultants think that these BI goals are also important; suppliers could gain information about these BI goals from these groups.

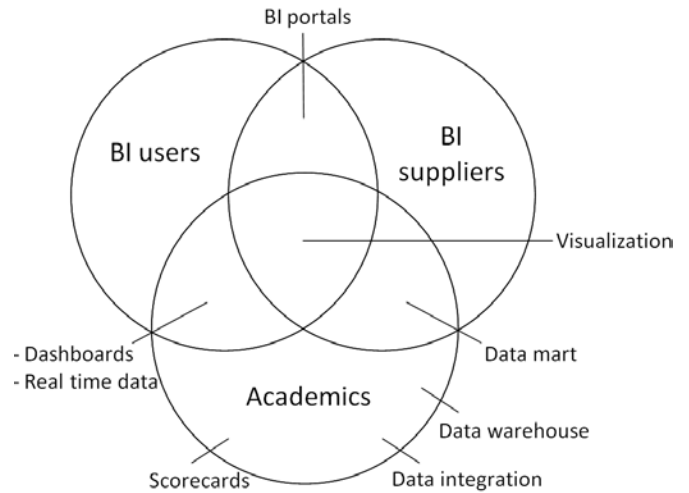
Most of the academic BI articles discuss decision making. However, the number of BI articles that discuss decision making and profitability is declining since 2006. Therefore, academics should be aware that (better) decision making, (forecasting and improving) business performance management, customer service and competitiveness will become more important BI goals to suppliers. Profitability/cost reduction will become more important to users. This indicates that users and suppliers might require more scientific information about these issues. In order to do this, academics might find inspiration published in whitepapers.

Knowledge management is not mentioned as a BI goal or a trend by users and suppliers, consultants do not put much focus on this goal either. This indicates that the field of BI is not really eager to read about knowledge management as a BI goal in academic articles, while academics do put focus on this issue. This may not necessarily lead to a gap between academics, users and suppliers, as long as academics focus on more issues than pure knowledge management.

The consultants provide information about the BI goals shared by users, suppliers and academics. However, consultants should be aware that (better) decision making, (forecasting and improving) business performance management, customer service and competitiveness will become more important to suppliers. Profitability/cost reduction will become more important to users. Consultants could make use of information published in academic articles about these BI goals.

### 3.3.2 Monitoring

This section describes the research results of monitoring issues. Figure 3 indicates the focus on monitoring issues of each group. Unfortunately, there was not enough data available to determine the monitoring trends for BI users and suppliers.



**Figure 3 (Non-)matching monitoring issues**

The survey results indicate that the most frequently used BI tool is dashboards. Users can find information about the monitoring issues; dashboards and real time data, in academic articles and whitepapers, because academics and whitepapers put focus on these issues too.

The survey results indicate that dashboards are the most used and applied BI tool. However, suppliers do not indicate dashboards as an important BI issue but users do. Suppliers could refer to academic articles and whitepapers to meet users need in (information about) dashboards.

Suppliers and academics both indicate data marts as a BI issue. Therefore suppliers could refer to academic articles to find information about data marts, some information can also be found in whitepapers.

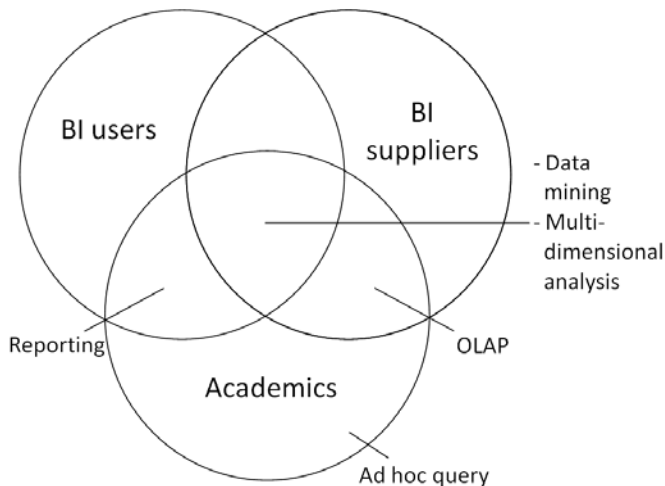
Among the monitoring issues, academics focus the most on data warehousing. There is a declining trend of all the BI issues at monitoring level in science since 2006. Academics should be aware that BI portals are important monitoring issues for users and suppliers. However, there is not much information available in neither science nor whitepapers about this issue.

BI users and suppliers do not indicate scorecards as an important monitoring issue. This indicates that business does not require much scientific information about scorecards. Also because dashboards are the most often used and applied BI tool.

Consultants should be aware that both users and suppliers think that BI portals are important BI tools. However, there is not much information available in neither science nor whitepapers about this issue. Users and suppliers might require more information about BI portals. Consultants might also consider putting more focus on dashboards, since this is the most used and applied BI tool. Information about BI at monitoring level can be found in academic articles, except for BI portals.

### 3.3.3 Analysis

This section describes the research results of analysis issues. Figure 4 indicates the focus of each group on analysis issues. Unfortunately, there was not enough data available to determine the analysis trends for BI users and BI suppliers.



**Figure 4 (Non-)matching analysis issues**

Users share their opinion with suppliers and academics that data mining and multidimensional analysis are important BI issues at analysis level. Therefore, they could refer to suppliers, academics and modestly whitepapers for information about these issues. Users also share their opinion with consultants that reporting is an important issue; users could therefore find information about this issue in academic articles and also in whitepapers. Suppliers share their opinion with users and academics that data mining and multidimensional analysis are important BI issues at analysis level. Therefore, they could refer to their users, academics and modestly whitepapers for information about these issues.

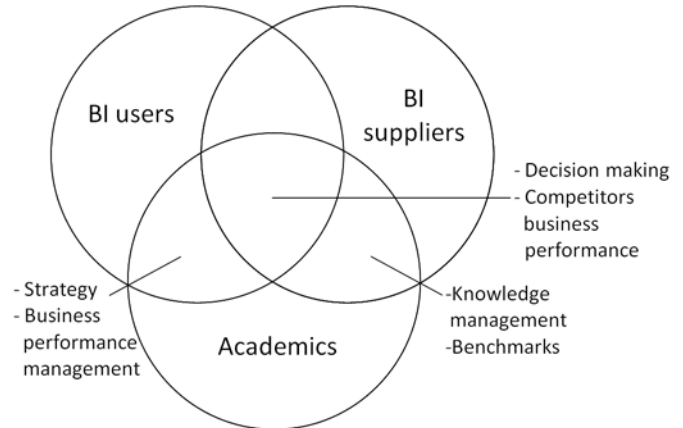
Suppliers also share their opinion with academics that OLAP is an important BI issue at analysis level; suppliers could therefore find information about OLAP in academic articles and also in whitepapers.

Academics put most of their focus on ad hoc query and data mining. They share their opinion with users and suppliers that data mining and multidimensional analysis are important analysis issues. However, academics focus on ad hoc query, while users and suppliers do not indicate this as an important analysis issue. Academics publish a decreasing number of articles about these analysis issues between 2006 and 2009, suggesting that the added value for academics on ad hoc query is decreasing as well.

Consultants put most of their focus on reporting. Users and academics share their opinion that reporting is an important monitoring issue; therefore consultants could use scientific information to serve users with information about reporting. Consultants can also use scientific articles about OLAP to apply on suppliers, who think that OLAP is an important monitoring issue.

### 3.3.4 Management

This section describes the research results of BI management issues. Figure 5 indicates the focus of each group on BI issues at management level.



**Figure 5 (Non-)matching management issues**

Users, suppliers and academics agree that decision making is the most important issue at management level now. Users and suppliers also think that decision making will become more important to them in the future. If users would like to develop this trend, they could do this in cooperation with suppliers, academics and consultants. Strategy and business performance management will also become more important to users and suppliers; information about these issues can be found in academic articles and whitepapers. Benchmarks are not an important management BI issue to users yet, but this will become more important to them. BI benchmark information can be found at their supplier and in academic articles.

Suppliers, users and academics agree that decision making is an important issue at management level. Suppliers and users even think that decision making will become more important in the future. If suppliers would like to develop this trend, they could do this in cooperation with users, academics and consultants. Strategy and business performance management will also become more important to suppliers and users, information about this issue can also be found in science and whitepapers. Suppliers should be aware that benchmarks are not an important issue to users yet, but this will become more important to them in the future. Academic articles can help suppliers with this increasing importance of this issue to users.

Academics put most of their focus on decision making and strategy. However, during 2006-2009, the number of academic BI article publications that discuss decision making and strategy decreased. However, academics should be aware that decision making, strategy and business performance management will become more important to users and suppliers. Academics could use whitepapers as an additional information source. Academics should also be aware that benchmarks are not an important management issue to users yet, but this will become more important to them in the future. However, consultants do not provide much information about this issue.

Consultants should be aware that decision making, strategy and business performance management will become more important to users and suppliers. Also, benchmarks will become more important to users. Consultants could use academic articles as an information resource concerning these issues.

### 3.3.5 Tool attributes

This section describes the research results for BI tool attributes. Figure 6 indicates the focus of each group on each tool attribute.

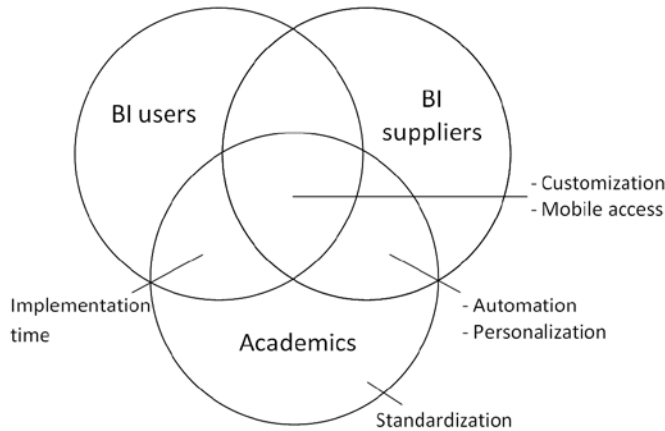


Figure 6 (Non-)matching BI tool attributes

Users, suppliers and academics share their opinion that the ability to customize a BI tool is an important issue. The results of the survey acknowledge this fact, because the majority of the BI tools are customized (51%) next to self developed (28%) and pre built (21%). Customization will also become more important to users. Users could consult their suppliers, academic articles and whitepapers to cope with this trend. Personalization is not yet an important issue to users, although they indicate that this will become more important to them in the future. Users can read about this issue in academic articles; whitepapers on the other hand do not put much focus on this issue.

Suppliers do not indicate implementation time as an important BI tool attribute yet. However, they do think that this will become more important in the future. Suppliers could cooperate with the user, because the user already indicates implementation time as an important issue. Some information about implementation time can be found in science and whitepapers. Suppliers should be aware that customization will become more important to users. In addition, the survey results indicate that BI tools are most often customized instead of self developed or pre built. Suppliers could support the user with information about customization coming from science and whitepapers.

Academics focus the most on automation. Academics put less focus on customization, standardization and personalization in their BI articles from 2006-2009. However, they should be aware that customization will become more important to users. To cope with this trend, academics might publish more BI articles that will discuss customization. In order to do this, they could consult consultancy whitepapers. Also, personalization will become more important to users. However, not much information about this issue can be found in whitepapers either. Users and suppliers agree on the fact that standardization will become less important to them. Academics already put less focus on this in their articles; this indicates that the demand for standardization information will possibly decrease.

Consultants should be aware that customization will become more important to users. The survey results indicate that the majority of the BI tools are customized next to self developed and pre built.

Personalization is not an important issue to users yet, but this will become more important in the future. For suppliers, implementation time and mobile access will become more important. To cope with these trends, consultants could use scientific information, since these issues are also discussed in academic articles.

## 4 ANALYSIS

Now the gaps and trends are revealed, it is useful to explore what the possible causes of these gaps are. The previous section gave some advice to gain information from other groups who agree on the importance and/or trends of those BI issues. In practice this is indicated by the degree of information sharing about BI tool requirements and application of users' feedback in the BI tool. Therefore, the survey asked about the application of users' feedback in the BI tool, to what degree the BI tool meet users' requirements and how users and suppliers share information.

### 4.1 Application of users feedback

The survey asked users in the survey to indicate to what extent their BI tool meets their requirements. The results of this question are indicated in Figure 7.

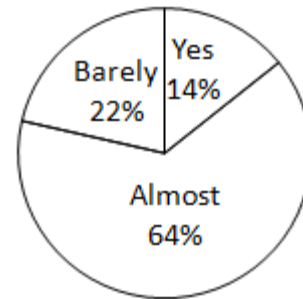


Figure 7 BI tool meets user requirements

The survey asked suppliers to indicate to what extent the users' feedback is applied in the BI tool. Figure 8 indicates the responses for this question. E.g. 26.7% of the suppliers answered that they apply 50% of user's feedback in their BI tool.

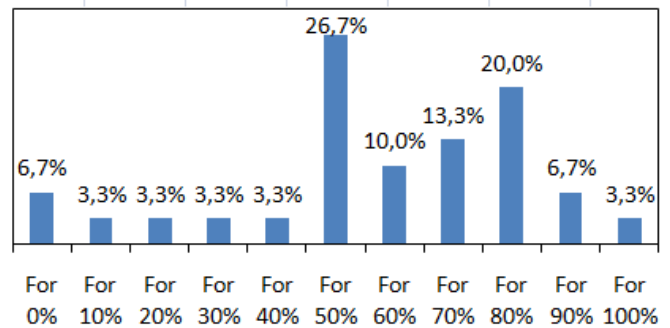


Figure 8 Users feedback applied in BI tool

The majority of the users (86%) indicate that their tool almost or barely meets their requirements. This can be explained by how much of this feedback is used by the supplier. 10% is using users feedback for more than 90%, the majority of 70% is applying user's feedback for 50-80%. However, 20% of the suppliers are applying user's feedback for less than 40% in the BI tool.

BI suppliers should be aware that the majority of users are not entirely happy with their existing BI tools. In addition, the majority of suppliers indicate that their BI tools are customizable. Suppliers could apply more users' feedback in the customized BI tool, in order to better meet their requirements.

#### 4.2 Information sharing

The previous section described to what degree suppliers use the feedback of their BI tool users. The next question is: do users and suppliers share information at all? If they do, how are they sharing information?

The survey asked suppliers how they share information with their users; the responses are indicated in Figure 9. Most of the information sharing between BI tool user and supplier occurs by e-mail. Some users and suppliers do not share information at all. More users than suppliers indicate that they do not share information with the other party.

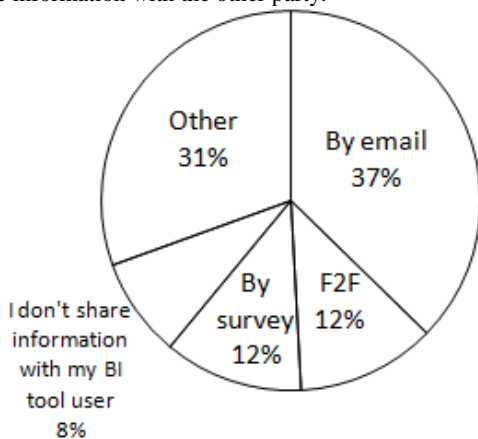


Figure 9 Information sharing with users

The survey asked users too how they share information with their suppliers; their responses are indicated in Figure 10.

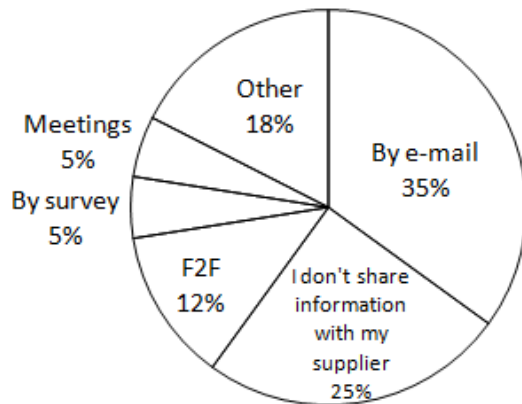


Figure 10 Information sharing with suppliers

Even though suppliers assume that they share information with their user, a higher percentage of the users think that they do not share information with their supplier. Information sharing could be the cause of the gaps between users and suppliers. Suppliers could share information with their BI tool users about their BI tool, to better be able to meet users' requirements.

#### 4.3 Viewpoints to Consultants

Vendors and vendor-specific consultants focus mainly on solving the client's requirements with one vendor suite of choice of the client. This influences the feasibility of solving the non matching issues during the implementation carried out by users and consultants. Non-traditional vendors are moving into the BI space by deploying open source (Pentaho, Good Data) or cloud platforms (Google Public Data). Vendor-neutral consultants are trying to solve issues by moving to building applications by mashing up services of multiple vendors and bringing those applications in 'the cloud'. New BI platforms put the user in a centralised position. Real time integrated intelligence (Tibco) will become a next goal. The user driven applications will evolve more and more towards agent technology. This all together should lead to solving most non matching issues. [22] [18]

### 5. CONCLUSIONS AND FUTURE WORK

This study provides insight in the current state and trends of BI issues of BI tool users, suppliers, academics and to what degree consultants are able to bridge the gap between users and suppliers. These results could have a possible effect on business and science.

#### 5.1 Effect on business

Overall, BI users and suppliers have about the same focus on BI issues. The non matching BI issues between these groups are for the most part covered by consultants. Except for the focus on BI portals, information about this issue can be found in neither academic articles nor whitepapers. Apart of that, academics and whitepapers could be a good BI information source for users and suppliers. In the future, BI users will possibly focus more on profitability/cost reduction, decision making, benchmarks, strategy, business performance management, customization and personalization. Suppliers will possibly focus more on competitiveness, decision making, business performance management, strategy, implementation time and mobile access. Some issues are already important to users and will become more important to suppliers and vice versa. One way to cope with this is by improving information sharing and by applying (more of) customers' feedback in the BI tool.

Consultants are playing a major role between users and suppliers; they could focus on improving information sharing between these groups also. In order to better understand the coherence of BI supply and demand. The vendor specific whitepapers are putting more focus on BI, looking at the number of BI whitepapers published per issue during 2006 to 2009. In contradiction, vendor neutral consultants publish less whitepapers related to BI during the last years. Therefore, vendor neutral consultants should be aware that some BI issues will become more important to users and suppliers. That means that more whitepapers, which discuss BI portals, should be published for both users and suppliers. There should also be more focus on benchmarks and personalization for BI users. For suppliers articles should focus more on implementation time and mobile access, but consultants should be aware that this could be not that important to users. Overall, consultants should be aware that academic BI information could help bridging the gap between users and suppliers.

#### 5.2 Effect on science

In general, the number of BI related academic articles is declining since 2006, similar to the vendor neutral consultant. Academics should publish more BI articles that are applicable on business.



Whitepapers of vendor neutral and specific vendors could be a good source for BI information to academics. By applying their articles on business, academics should provide more information about BI portals since this is an important monitoring issue to users and suppliers. Academics should also be aware that they are putting focus on some BI issues that are not very important to business and might not become important either. These issues are knowledge management (as a BI goal), scorecards, data marts, ad hoc query and standardization.

### 5.3 Suggestions for improving BI research

A better insight in BI trends could be established by extending the time range (earlier than 2006); this might be accomplished by combining more whitepaper sources, if there are BI related whitepapers earlier than 2006. The main advice is to be aware that BI information can be found at different groups and in different sources. However, this research did put focus on information sharing between users and suppliers but not on how these groups use academic articles and consultancy whitepapers. To which degree academics use whitepaper information and vice versa could have more focus. In the next steps we are planning to analyze the features of data integrity (important for the drill-down capabilities of dashboards), IT distribution /deployment model (client vs. web / local license vs. BI-as-a-Service) and standard compliance, and how they fit in our BI framework. The movements of non-traditional vendors and vendor-neutral consultants should also be analyzed. Given our article and survey results we envision collaborative business intelligence systems, such as reported by Ketter et al. [15], where highly personalized software agents work together in concert with human decision makers to facilitate decision making. As a result we have extended the traditional view of BI, as represented with the two overlapping ovals in Figure 11, with the area of autonomous decision making as represented by the Decision oval. This area is essential for the future of BI and is already tested in various competitions such as the Trading Agent Competition for Supply Chain Management (TAC SCM) [5].

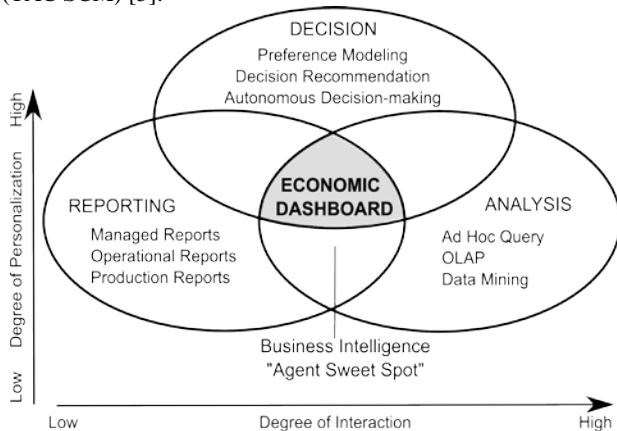


Figure 11 Extended BI Framework

### Acknowledgements

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## Appendix I: BI ranking

	Academics	BI articles	BI users	BI suppliers	Vendor specific consultants	White papers	Vendor neutral consultants	White papers
<b>BI goal</b>	1. Decision making 2. Knowledge management 3. Profitability 4. Competiveness 5. Business performance management 6. Customer service	112 52 47 35 31 26	1. Improve business performance and decision making 2. Analyze business performance 3. Forecast business performance 4. Gain competitive advantage 5. Customer service	1. Make better decisions 2. Forecast business performance 3. Visualize business performance 4. Improve customer service and cost reduction 5. Make quicker decisions	1. Decision making 2. Business performance management 3. Profitability 4. Competiveness 5. Customer service 6. Knowledge management	36 35 22 14 10 4	1. Decision making 2. Business performance management 3. Competiveness and profitability 4. Customer service 5. Knowledge management	34 30 27 10 9
<b>Monitoring</b>	1. Data warehouse 2. Data integration 3. Real time data and visualization 4. Data mart 5. Scorecard 6. Dashboard	60 36 26 25 18 7	1. Visualization 2. BI portals 3. Real time data 4. - 5. Dashboard	1. Visualization 2. BI portals 3. Data mart 4. BI portals	1. Dashboard 2. Data integration 3. Visualization 4. Data warehouse 5. Real time data 6. Scorecard 7. Data mart	22 21 20 18 18 6 5	1. Real time data 2. Data warehouse 3. Dashboard 4. Data integration 5. Scorecard and visualization 6. Data mart 7. BI portal	30 27 23 22 17 16 5
<b>Analysis</b>	1. Ad hoc query 2. Data mining 3. Multidimensional analysis 4. OLAP 5. Reporting	62 61 55 33 27	1. Multidimensional analysis 2. Reporting 3. Data mining	1. Multidimensional analysis 2. OLAP 3. Data mining	1. Reporting 2. Ad hoc query 3. OLAP 4. Data mining 5. Multidimensional analysis	30 13 10 7 5	1. Reporting 2. Ad hoc query 3. OLAP 4. Data mining 5. Multidimensional analysis	26 18 15 13 12
<b>Management</b>	1. Decision making 2. Strategy 3. Knowledge management 4. Business performance management 5. Benchmarks 6. Competitors business performance	112 83 52 31 22 7	1. Business performance and decision making 2. Decision making 3. Strategy 4. Competition 5. Competition	1. Decision making 2. Knowledge management 3. Competition and benchmarks 4. Competition and knowledge management 5. Knowledge management	1. Decision making 2. Business performance management 3. Strategy 4. Benchmarks 5. Knowledge management 6. Competitors business performance	36 35 25 10 4 2	1. Strategy 2. Decision making 3. Business performance management 4. Knowledge management 5. Benchmarks 6. Competitors business performance	41 34 30 9 2 1
<b>Tool attributes</b>	1. Automation 2. Customization 3. Standardization 4. Personalization 5. Mobile access 6. Implementation time	47 19 14 9 5 3	1. Customization 2. Implementation time 3. Mobile access 4. - 5. Mobile access	1. Customization 2. Automation 3. Personalization 4. Mobile access 5. Mobile access	1. Automation 2. Customization 3. Standardization 4. Implementation time and personalization	15 8 5 3	1. Automation 2. Standardization 3. Customization and implementation time 4. Personalization 5. Mobile access	21 8 5 4 1