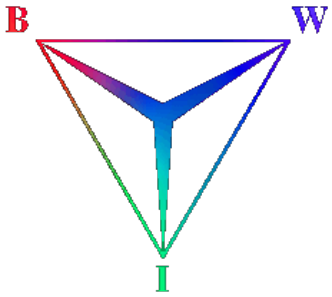
Benefits of Business Intelligence



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BMI Thesis

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Preface

The report that lies before you is the final report of a field exploration. This exploration is an important and compulsory element of Business Mathematics & Informatics, an education that aims to combine the fields of Economics, Mathematics and Computer Science. The goal is to take a topic related to at least two of these three fields, and investigate the existing literature on this topic. As Business Intelligence is clearly a topic related to Computer Science and Economics, these two fields are dealt with here.

This report is meant as a reference work for the staff members of the Department of Computer Science at the *Vrije* Universiteit (VU) and for future students who are in the process of writing their literature study.

In order to run a business effectively a manager needs insights in all kinds of aspects of the business. After recording, it is generally less simple getting these data available for taking strategic and tactical decisions. Business Intelligence (BI) can offer a solution by making this information available. The largest appreciation of this lies in the integration of data from several sources. When the correct resources are deployed, a complete picture of the own organization, the customer and the competition arises.

This paper focuses on the functional aspects of BI from a business point of view. It is not too much about *how* BI works but rather on *why* one should implement BI.

The core question during this paper will be:

> *"What is the business value of BI?"*

The stepping stones to answering this question are:

- What are the Critical Success Factors for a successful BI initiative?
- What are potential benefits of BI for an organization?
    - (How) can BI improve (strategic and tactical) management decision-making processes?
    - How does BI relate to existing methodologies?
    - (How) can BI improve internal business processes?
    - (How) can BI improve internal and external communication?
    - What impact does BI have on the value chain?
    - (How) can BI improve competitive advantage?
    - What are the benefits of BI from a financial point of view? Can BI help reduce costs and maximize profits?
- How to evaluate BI initiatives?
    - How to evaluate any IT investment?

The core question of this thesis will be specified for the VU with the help of a case study. The core question for the VU will be:

> *"What is the business value of BI for the Department of Computer Science at the VU?"*

The stepping stones to answering this question are:

- What is the information need of the academic staff and the department management?
- Is this information provided by the current information systems?
- Can BI fill the gap between the information needed and the information provided?
- What is the current situation at the department considering BI?
- What will the efforts for the department be in order to implement a BI solution?

I would like to express my thanks to professor Eiben (VU) who supervised me in my research and writing. Without naming persons I would also like to thank members of the staff of the Faculty of Science at the VU for the time and effort they spent helping me getting information for the case study.

Randy Braams

Amsterdam, December 2004

Executive Summary

In order to run a business effectively managers need insights in all kinds of aspects, such as inventory, costs, profits and return, staffing or performance. Organizations have been gathering a lot of data, but after recording it is generally less simple getting these data available for taking strategic and tactical decisions. Business Intelligence (BI) can offer a solution by making this information available. According to [19]

> *BI is a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions .*

The main objective of this thesis is to let the reader understand what the potential benefits of BI are. It focuses on the functional aspects of Business Intelligence from a business point of view. In the literature study Querying and Reporting is left out of the scope of this report.

The core question of the literature study is:

> *"What is the business value of BI?"*

The core question of this thesis will be specified for the VU with the help of a case study. The core question for the VU will be:

> *"What is the business value of BI for the Department of Computer Science at the VU?"*

Following is a short list of some advantages of BI:

- "Unique truth"
- Easy access to data
- Easy analysis
- Culture change

The case study showed the following benefits for the department that was subject of investigation:

- More and better information (dissemination)
- Culture change (performance measurement and monitoring)
- Optimal time spending of employees
- Improved image
- Customers (students) who are more satisfied

A rather more detailed list of the advantages of BI is:

- "Unique truth"
- Easy access to data
    - Extended *knowledge management* and *management of information systems.* Improved information dissemination, improved information access and propagation of knowledge about the organization;
    - Monitoring the *external business environment* ;
    - *Extremely fast monitoring;*
    - Better insights in *markets, suppliers, competitors and technology;*
    - *Complete end-to-end information* on the supplies and logistical data from the whole supply chain;
- Easy analysis
    - *Analyses and reports* on virtually all thinkable aspects of the underlying business;
    - A 360 degree *customer* view;

    - Tracing *opportunities and threats;*
    - Instant view on which *products*, customers and markets are most profitable;
- Culture change/ more efficient and effective business processes (measuring/monitoring performance)
    - A more collaborative *work environment;*
    - Improved strategic, tactical and operational *decision-making* processes;
    - Improved *business processes;*
    - Improved short- and middle long term *planning;*
    - Increased *revenues*. Total grip on *cash flow*. *Reduced costs*;
    - Improved *customer satisfaction.*
    - Anticipating the behaviour, wishes and possibilities of the customer in the use of different communication channels. Improved *websites;*
    - A more *transparent and calm supply chain;*
    - *Inventory reduction* on every point at the supply chain;

Following is a rather more detailed list of the benefits mentioned in the case study:

1. More and better information
    a. Consistent view (one single source of data)
    b. 360º view of the customer (student)
2. Culture change
    a. Mirror for the organization which improves measurable and measured performance
    b. Performance Indicators could eventually be produced, leading to benchmarks with which one could evaluate oneself more effectively and compare oneself to other departments, faculties or even universities
3. Optimal time spending of employees
    a. Less pressure on the Educational Office
    b. Greater satisfaction for employees over their work
4. Improvement of the image of the department, the faculty and the university as a whole;
5. Customers (students) who are more satisfied
    a. More effective PR policy and more effective and efficient marketing activities;
    b. Improving the filtering effect of the first study year and selection criteria of students
    c. Improving the quality of the product the VU offers (education and guidance) the students;
    d. Higher output and success rates of students. Lower drop-out rates

I could go on and on…

The largest appreciation of BI lies in the integration of data from several sources.
Before one rushes into developing and implementing a BI solution one has to make sure that the following requirements are met:

- high-quality (transaction) data should be in place
- there should be commitment of the (senior) executives

Other Critical Success Factors include:

- alignment of the information requirements with the strategic and operational focus of the business.
- highly skilled employees with analytical capabilities
- the organization should have a data-oriented culture
- those who need to perform should have a clear reason for new behaviours
- ACTION!! Without it one can't gain advantage.

When all the requirements are met and a BI solution is implemented, a complete picture of the own organization, the customer, technology and the competition arises. With this (actionable) knowledge better decisions can be made with more confidence leading to more efficient policies, improved

(decision-making) processes, better planning, more profits, reduced costs, competitive advantage and a greater market share or market value.

So, I would really recommend data-intensive organizations to consider BI. As we saw it can have a great business value.

I would really recommend the department to seriously take a look at the possibility to implement BI considering the magnitude of advantages this will have for (the image of) the department (and the VU as a whole), the students and the employees.

I estimate the costs for the project at between €20.000 and €40.000 if external consultants and developers are involved. One thing that should be remembered is that BI doesn't only consist of techniques and technology: the human factor is also very important and should not be underestimated. As an Afrikan proverb tells us: "It takes a village to raise a child".

Table of contents

Introduction

In this report I aim to show that Business Intelligence (BI) is more than a buzzword by showing what its business value is. I will start from the assumption that the reader has heard of Business Intelligence, knows of or isn't interested in how to create a DW or what the DM process is about, for instance, but rather what Business Intelligence is and what the benefits will be for his organization.

In order to run a business effectively managers need insights in all kinds of aspects, such as inventory, costs, profits and return, staffing or performance. Organizations have been gathering a lot of data, but after recording it is generally less simple getting these data available for taking strategic and tactical decisions. Business Intelligence can offer a solution by making this information available.

Structure of this report

This report is divided in two parts: the first part is a literature study on BI and contains 5 chapters.

The first chapter gives an introduction on Business Intelligence: what it is, its relation to other information access tool and its application areas. Chapter 2 is about the Critical Success Factors for successful BI initiatives. First go/no-go criteria will be discussed and then other requirements that have to be fulfilled in order for BI solutions to be a success in an organization. The following chapter, Chapter 3, is where the core question will be answered. This chapter gives per BI tool and for BI as a whole its business value. Chapter 4 addresses ways to evaluate BI initiatives. Finally, Chapter 5 gives an overall view of what has been discussed in the previous chapters.

The second part of this report contains a case study where, for a department at the VU, the potential business value of BI will be addressed.

Part I: Literature study

Chapter 1 Business Intelligence – the Umbrella term

1.1 Introduction

With this chapter I aim to give a brief overview of the concept *Business Intelligence(BI)*. According to [19]

> *BI is a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions.*

1.2 The BI pyramid

BI can be seen as an umbrella[1] that covers a whole range of concepts. BI can be approached roughly as being a Data Warehouse (DW), with three layers on top of it: Queries & Reports (Q&R), OnLine Analytical Processing (OLAP) and Data Mining (DM). Authors and companies adopt this ordering widely. However, other orderings exist as well, with the result that some contradict each other. This is simply because the boundaries between the different components are very vague. The following figure (figure 1) shows the BI pyramid consisting of the concepts described above:

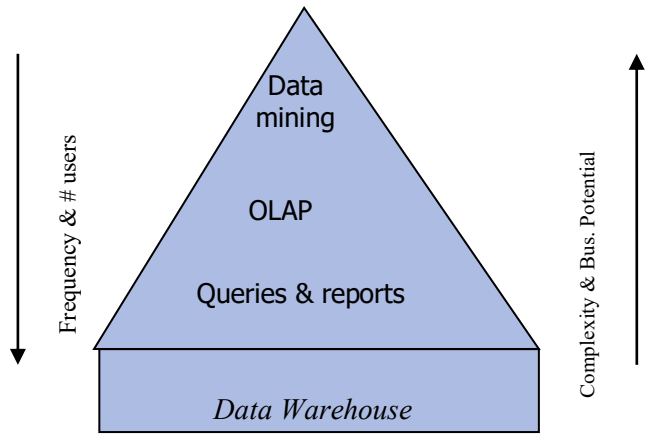

Figure 1: The BI pyramid

A DW consists of one or more copies of transaction and/or non-transaction data that have been transformed in such a way that they are suitable for querying, reporting and other data analysis. It forms the basis "on top of which" further analyses can be carried out.

The first level of analysis is Querying & Reporting. Querying means using a computer language to obtain immediate, online answers to user questions. Reporting refers to creating standard, point-in-time reports or generating reports by describing specific report components and features.

A level higher we have OLAP. This technology allows users to carry out complex data analyses with the help of a quick and interactive access to the information in DWs from different viewpoints. These different viewpoints are an important characteristic of OLAP, also called multidimensionality. The dimensions within the OLAP application usually reflect the different dimensions of an organization.

[1] The description of Business Intelligence in this chapter is for a great part derived from [14] and [1].

A definition of OLAP that is adopted across the whole world is the one by [12]:

> *Fast Analysis of Shared Multidimensional Information (FASMI).*

Another definition comes from [4]:

> *OLAP is a category of software technology that enables analysts, managers and executives to gain insight into data through fast, consistent, interactive access to a wide variety of possible views of information that has been transformed from raw data to reflect the real dimensionality of the enterprise as understood by the users.*

An advanced tool that uses the OLAP-methodology is the Balanced Scorecard (BSC).

The top layer is DM. A simple definition is: analyzing and finding patterns in large amounts of data in order to support decision making and predict future behaviour. Because DM is such an advance technique, the process not only involves applying tools to a collection of data, but it starts with business understanding, data understanding and preparation, and selecting the right modelling techniques, and ends with evaluation and deployment.

The information and knowledge that is "dug up" by DM can also be used to provide information about a web site and its visitors: Web Mining. When engaged in e-commerce activities it is the 'invisible' and 'not-straightforward' information that is most valuable, information hidden in the gigabytes of data generated each day that describe actions made by every visitor to the site.

With BI-tools it is possible to carry out analyses and reports on virtually all thinkable aspects of the underlying business, as long as the data about this business come in large amounts and are stored in a DW. Departments that are known to benefit most from BI are (Database) Marketing, Sales, Finance, Information Technology (especially the Web) and the Higher Management.

1.3 BI vs. other Information Access Tools

Considering the whole of Information Access Tools you could split them in two, namely in [11]:

1. Specific systems, Decision Support Systems (DSS) such as Executive Information Systems (EIS), Management Information Systems (MIS) etc.. and
2. Generic systems (tools/techniques) such as OLAP, DM, etc…

What is the difference between DSSs and BI?
According to [19]

> *A decision support system (DSS) is a computer program application that analyzes business data and presents it so that users can make business decisions more easily.*

and

> *BI is a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions.*

So, the general characteristics of a DSS which we also find within BI are:

- Support business decision making
- Based on data (from operational systems and/or a DW)

So, one could raise the question whether BI replaces data-driven decision support.

Well, DW and DM have two precursors[2]: DSS and EIS. DSS is focused on the lower and middle management and makes it possible to look at and analyze data in different ways. EIS is the precursor focused on the higher management. Given the fact that Data Warehousing and DM form a large part of BI, you could indeed see DSS as the precursor of BI.
There are a lot of MISs to gather data, but most of them are rather focussed on efficiency of existing processes and retrieve none or less actionable knowledge out of the data. MISs only give a fragmented view of business data, in stead of one integral and consistent view. With BI accurate, relevant knowledge is available on every level which can instantly be put in action in order to gain actual competitive advantage.

One thing that should be kept in mind is that, as [11] puts it:

> *BI is the information gathering/providing activity, not the intelligence/knowledge itself*

1.4 Application areas

Industries that are known to use BI are data rich industries, such as:
- Consumer goods
- Retailing industry
- Financial services
- Transport

Departments that are known to benefit most from BI are:
- (Database) Marketing
- Sales
- Finance
- IT(especially the Web) and the
- Higher Management

End-users:
- All types of end-users can use BI tools.
- End-users with different levels of expertise can apply BI applications to different levels of knowledge.
- With BI-tools it is possible to carry out analyses and reports on virtually all thinkable aspects of the underlying business, as long as the data about this business come in large amounts and are stored in a DW.

In the next chapter the Critical Success Factors (CSFs) of BI initiatives are discussed.

[2] See also [15]

Chapter 2 Critical Success Factors for BI Initiatives

2.1 Introduction

In this chapter I would like to address factors that influence the success of a BI implementation. Because of the fact that this is not the main focus of this report this chapter will be rather short, but big enough to give the reader a general overview of what one has to think about before rushing in to building or buying BI solutions.

I will first try to answer the question what the primary requirements are and will then present a model for building an analytical capability.

2.2 Go/no-go factors for a BI project

Although BI has high potential value, as we shall see in the next chapter, the results are often disappointing. Companies are investing billions of euros in technologies that generate huge volumes of transaction data. However, these investments do not live up to their full potential. What is the reason for this? What are the Critical Success Factors (CSF's)? In this section I will address two go/no-go factors that should be present before proceeding with any BI initiative.

As Peter Walzer puts it in [18],

> *What is required in a successful BI project is for key executives, managers and other members of the organization to want to make use of what a BI project delivers.*

So, commitment of the (top) management is an important requirement in other to have a successful BI implementation. They have to think that they can both improve their operations and get better and strategic information. In many of the BI projects better operational and strategic information never materialized [18]. Ways to achieve this commitment are, among others, through

- *showcases: successful stories of organizations or departments within the same organization that have implemented BI solutions and by*
- *ownership: make the end-users feel as if they 'own' the BI implementation and the information it produces*
- *education of the managers*
- *striking a balance between the financial measurement and the qualitative analysis*

Most - if not all - IT students, experts, teachers have at least ones heard of the phrase *"Garbage in = garbage out"*. With other words: with poor data, one can't expect to gain appropriate analysis. High-quality data is thus a go/no-go factor, next to supportive senior executives. If there is no such data new systems and data architectures should be implemented first. Otherwise the initiative is doomed to fail.

In the next section I will not only go on with the CSF's, but I will also present a model for building an analytical capability with which these and other requirements can be met.

2.3 A model for building an analytical capability

In the previous section I addressed two go/no-go factors for BI projects. In this section I briefly discuss headlines of a model for turning transaction data into knowledge into results, introduced by [2]. It provides a holistic framework that will help companies maximize this resource. By outlining all

the elements necessary to transform data into knowledge and then into business results, it helps managers understand that human performance elements must be attended in addition to technology.

The model consists of three major elements: context, transformation and outcomes. The contextual factors always underlie the processes actually used to transform data into business outcomes and include the strategic, skill-related (business expertise as well as IT expertise), organizational, cultural, technological and data factors that must be present for an analytical effort to succeed.

The *transformation* element is where the data is actually analyzed and used to support a business decision. *Outcomes* are the changes that result from the analysis and decision making. They include changes in behaviours, processes and programs and financial conditions. As we saw in the previous section, these two steps are most important for the BI solution to be a success.

2.3.1 Context

Decisions are made in the context of contextual factors mentioned above, yet most companies tend to focus on the elements technology and data alone. The importance of high-quality data is already discussed. The BI initiative should be technically very solid, because it will still fail if no one uses it.

But, for instance, another CSF is that the information requirements are in alignment with the strategic and operational focus of the business. It is very hard to get a reliable answer to the question of what kind of information a certain business person needs in order to improve how they do their job. The clearer and more detailed a firm's business strategy, the more obvious what data and analytical capabilities it requires. The Balanced Score Card (BSC) can be a unifying force in an environment where information delivered by BI are out of alignment with the strategic and operational information needs of the business. More on the BSC will be laid out in the next chapter.

Other contextual factors too often underestimated are the organization (structuring analytical resources) and a data-oriented culture. Important questions are: where should analytical resources be located in a company? Should they be centralized, decentralized or even outsourced? Any approach to structuring analytical resources has trade-offs. Considering the data-oriented culture one needs to keep in mind that for an analytical capability to really succeed, the entire organization needs to value data-based analysis and decision making.

2.3.2 Transformation and outcome

The analytical process makes (actionable) knowledge from data. Insight must be turned into action. The tools and techniques it employs include, among others, statistical analysis, generation and testing of hypotheses, construction of mental or mathematical models, and relating data-based knowledge to that derived from human interactions. The most important step in the data transformation process is the human realm of analyzing and interpreting data and then acting on the insights, because neither analytic findings nor decision themselves yield result.

It is the implementation process and the results thereof that determine the effect on business performance. Here, the employees who do the work are most important, because that is where improved (financial) outcomes depend on. One thing to consider is that new behaviours are most likely when those who need to perform them have a clear reason for doing so.

I will not go deeper into the *outcome* part of this model, because this is discussed in the next chapter.

2.4 Conclusions

In this chapter I briefly discussed the critical success factors for a successful BI initiative and a structured way to look at the things that have to be done in order to implement this initiative. We saw that the most important step in the data transformation process is the human realm of analyzing and interpreting data and then acting on the insights, because neither analytic findings nor decision themselves yield result.

Go/no-go factors are:

- high-quality (transaction) data
- commitment of the (senior) executives

Other CSF include:

- clearly defined strategy;
- the information requirements should be in alignment with the strategic and operational focus of the business;
- the BI solution should be technically very solid. The BI project will still fail if no one uses it;
- highly skilled employees with analytical capabilities;
- structuring analytic resources;
- a data-oriented culture;
- those who need to perform should have a clear reason for new behaviours;
- ACTION!!

In the next chapter the core question of this report - the possible outcomes of BI, its business value - will be addressed.

Chapter 3 Business value of BI

3.1 Introduction

In this chapter I will discuss the business value of BI[3]. For every layer of the BI pyramid I will give a short description followed by a discussion of the direct and indirect strategic and tactical advantages. I will start with the bottom layer, the DW, and work my way up to the top. The only layer which will not be discussed is Querying and Reporting.

Recalling the definition of BI:

> *BI is a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions.*[18]

A more business-like approach of BI, rather than this more technical definition, is that BI supports the decision making process, because users (among whom the management) use BI applications to extract knowledge from internal as well as external sources. BI provides actionable knowledge which supports the management with better decision making.

Today, leading companies need to access vital customer data, including order histories, delivery information, and pricing histories, in order to have a competitive value. Those companies that invested in BI software get a competitive edge.

The business environment changed in a way that led to the need of BI:

- Increased speed of business
- Information overload
- Increased globalization
- Increased complexity and dynamics of internal processes and of the environment
- Speed of technological changes

Industries that are known to benefit most from BI are data rich industries.
Departments that are known to benefit most from BI are: (Database) Marketing, Sales, Finance, IT(especially the Web) and the, Higher Management.

In the next section I will focus on Data Warehousing and its business value.

3.2 Benefits of a DW

Although the focus of this paper is more on the analysis side of BI, I will briefly discuss the basis on top of which this analysis is built on, namely the DW.

A DW consists of one or more copies of transaction and/or non-transaction data that have been transformed in such a way that they are suitable for querying, reporting and other data analysis. It can be regarded as the 'memory' of an organization. There are people who believe that the current model in which information is stored in a DW which is the basis for business analysis will disappear in the future. According to [16], for instance, the focus will be more and more on real-time analysis based on

[3] See also [3]

data streams. He introduced a concept called Information Provision In Time (IPIT). This is out of the scope of this report, so I will not discuss it here.

Now back to DWs. Important features of a DW are:

- Time dimension
- Uniformity
    - Data stored in the same units
- Data is not changeable

The reasons for building DWs were:

- Amount of data grew exponentially
- Amount of knowledge grew relatively slower
- Decision-time decreased
- Resulting in a need for bigger, more consistent and cheaper storing methods

The benefits of using a DW are:

- It supports management decisions
- It provides a cost-effective usage of IT resources
    - Cost reduction due to faster, automated search(one push on the button)
- It is linked to other sources
- It provides access to reliable, consistent and high-quality information
- It improves the information stream in an organization
- 'The unique truth':
    - everyone measures with the same units and
    - everyone has the exactly the same information
- Availability and access
    - Data are always available
    - Authority(different views)

3.3 Benefits of OLAP

OLAP or FASMI as it is often called, has proven to be the most extensive field in BI. OLAP is the concept that most authors have ventured to write about and most BI-companies claim to have in their portfolio of products and service. Without OLAP it would be quite a job to extract the right information using just regular Structured Query Language (SQL)-queries.

In this section I will try to isolate the OLAP benefits. I will mention the relationship between OLAP and three commonly used methodologies: Activity-based Costing (ABC), the BSC and Corporate Performance Management (CPM), but first I will discuss application areas of OLAP[4].

3.3.1 Application areas

OLAP technology can be used in a wide range of business applications and industries. The OLAP Report (Pendse, August 2001) lists the following application areas:

Application Area	***Description***

[4] For further reading on OLAP I would like to refer to [15] where a great part of this section is based on.

Marketing and sales analysis	Mostly found in consumer goods industries, retailers and the financial services industry.
Clickstream analysis	More on this can be read in 3.4.2
Database marketing	Determine who are the best customers for targeted promotions for particular products or services.
Financial reporting	Financial Modelling (budgeting, planning)
Management reporting	Using OLAP based systems one is able to report faster and more flexible, with better analysis than the alternative solutions.
Balanced Scorecard	See the next section.
Profitability analysis	Important in setting prices and discounts, deciding on promotional activities, selecting areas for investment or divestment and anticipating competitive pressures.
Quality analysis	OLAP tools provide an excellent way of measuring quality over long periods of time and of spotting disturbing trends before they become too serious.

Table 1: OLAP application areas

3.3.2 OLAP and three commonly used methodologies

This method of analyzing the inner processes of your company can deliver great value to your decision making process. Although many companies already have some sort of methodology of retrieving valuable information, OLAP can even enhance your current methodologies. Whatever methodology or system a company uses, OLAP can always be of additional value. That is, if some conditions are fulfilled, like the existence of a DW or Data Mart. A good working IT department which in fact is the backbone of any OLAP tool is also required.

We often see that companies think they know how their processes work. They use methodologies like ABC or the BSC to reduce costs and make information transparent.
What is the relationship between these methodologies and OLAP?

Well, let's begin with ABC. ABC relies heavily on OLAP. First ABC defines production steps that generate costs. These production steps are often referred to as activities. Then a product that passes this production step and uses this activity is assigned the appropriate costs. To make this assignation of costs possible, products have to be traceable throughout the production process. This is all done by OLAP.

Considering ABC OLAP is a facilitator: it makes assignation of costs possible, thereby making the cost structure transparent. It is also a monitoring tool: it shows where the product is, where it has been and what the production costs are. OLAP makes a total blueprint of a company. Without OLAP, this information would not be available. So, OLAP is in fact the facilitator of the whole process of implementing ABC.

The second methodology I would like to discuss is BSC. Applications based on the BSC methodology are often integrated with OLAP environments; therefore the section about BSC is included in this chapter.

BSC is a methodology which looks at an organization or project from four different perspectives; financial performance, customer knowledge, internal business processes and innovation & learning for employees.

According to [5] the use of BSC revolves around three questions:

- What do we want to achieve with the organization? (Strategic goals)

- In order to achieve our goals, what should we be good at? *CSFs*
- How can we measure that we are achieving what we want? *Key Performance Indicators* (KPIs)

The four perspectives mentioned above are recorded onto a card and on each of them progress is monitored. Main goal is to create a balance between them. In this situation OLAP functions as a monitoring tool. It extracts the values from a DW and puts them on the card. Then the card shows the overall performance of the project. OLAP also monitors the KPI's.

The third methodology I would like to address is CPM. CPM is an integral management concept that manages the strategic planning and -control. It is a method with the aim to achieve business performance by changing human behaviour. For CPM OLAP fulfils the role of monitoring the performance indicators from one perspective, i.e. the personal milestones. In this way each employee is monitored and the structural change of behaviour can be monitored through time. Within CPM there is also a big emphasis on making reports. These reports form an important element, because with these reports the management controls the progress. OLAP makes flexible reporting possible.

As we can clearly see, OLAP is in fact the facilitator of some of the methodologies and functions used and a monitoring tool to make the company performance clear.

3.3.3 Comments of managers and directors.

The financial benefits of OLAP are quite hard to determine. In this section [5] managers speak for themselves. Managers who have implemented OLAP software can be more convincing than just summing up a few benefits. The goal of these managers was Customer Service.

J.R. Simplot Co. (agriculture business) benefits:

- Accessibility: Brio Intelligence collects and tabulates information like "Are the placed orders also shipped? And if not, why? Where the goods damaged? Did a shortage occur?". These metrics help the company reach its goals of excellent and efficient customer service because everybody could access this information.
- Speed: Before the implementation there was a specific IS group who had to extract the information by hand using SQL-queries. Now around 410 users can do it themselves which saves a lot of time.
- Multidimensionality: The software enables to define key performance measurements, which allows measuring its customer service in key market segments.
- Transparency: Basically all employees now know the total impact of a price increase.
- Customer Service: "I can come up with an overall picture and the customer is impressed!" this was said by the director of order fulfilment & e-commerce of J.R. Simplot Co.

TruServ (hardware retailing company) benefits:

- Accessibility: Lowered IT support costs by two full-time employees. Every single one of the 300 users can operate OLAP tools and have access to the data in a fast way. Previously they had to wait up to two weeks to get the right information. Now, they only have themselves to blame if they do not get the answers they need!
- Accuracy: Accurately tracks retail promotions, which allows for increased customer service. During a promotion of paint in 600 stores, the software was able to obtain the information on

[5] Taken from [17]

what was sold as a result of that promotion. “Managers can literally run an ad promotion in Sunday’s newspaper, and know its success by Monday”.
- Multidimensionality: BI software helps TruServ determine what’s likely to appear in particular stores in certain regions.
- According to the Chief Information Officer (CIO) of TruServ “I like it to a gold mine. You see a vein of gold and as you dig, you realize there is a boat load of gold back there”.

Brayton (furniture manufacturer) benefits:

- Fast, accurate sales and marketing reports. “Sales have reaped time-savings and revenue generating benefits. Year-to-date bookings, for example, took two to four hours to generate. Now three years worth of sales information can be extracted in 10-15 seconds.” “And time-savings are dollar-savings”, says the manager of information technology.
- Unanticipated and valuable product development information
- Accessibility: Solid foundation for Web-based (Cognos Powerplay web-based) data access for dealers and customers.
- Traditionally, the furniture industry has not been at the forefront of information management. But they wanted to prove that data warehousing technologies would serve them into the 21st century. And it did.
- According to the manager of information technology the big benefit of OLAP (Cognos Powerplay 7) is “it gives us a consistent source of information, a place where we can derive reports from and its changed how we do reporting inside the company”
- Finally he says “Companies that can’t support their business strategy with well-managed information are dead in the water”.

3.3.4 Conclusions

Without OLAP it would be quite a job to extract the right information using just regular SQL-queries.

OLAP is a monitoring tool for performance indicators. Because of OLAP, monitoring can be done in an extremely fast way. The most obvious OLAP benefits are the multidimensionality, the fast data access, wide accessibility and the user friendliness. Almost every end user can use it and make its own decisions in a very fast way. No communication is needed with other departments or IT-personnel. Whether you look from an operational perspective with internal processes or from a strategic perspective with external processes, OLAP can deal with it.

OLAP is very beneficial for organizations because it can be applied to various levels of an organization. ABC only refers to operational cost reduction. It can’t be used for setting company goals for example. BSC is only related to projects and how to steer them in the right direction. But OLAP is a very general software solution. OLAP is the fastest way for information retrieval and gives methodologies like ABC, BSC and CPM the right information. It makes these methodologies work. It is almost applicable to any process or methodology within the organization. OLAP is a facilitator. It makes certain processes possible. The first step in which business processes are translated into activities makes the company very transparent. It will make managers think about their business process and make them wonder if those processes are needed at all.

3.4 Benefits of DM

In this section I will try to isolate the benefits of DM, the (process of) analyzing and finding of patterns in large amounts of data.

Whereas query and even OLAP functions require human interaction to follow relationships through a data source, DM programs are able to derive many of these relationships automatically by analyzing and "learning" from the data values contained in files and databases [9].
For further information on DM I would like to refer to [8] where part of this paragraph is derived from.

3.4.1 Application areas

The idea of DM is to support (management) decision-making processes by discovering (hidden) patterns in large amounts of data. The patterns that are found in the data could provide information that cannot directly be deduced from the data itself, patterns and connections that are not straightforward.

These 'invisible' patterns might not always be logical and useful. For instance, for a supermarket chain that is based in several different countries, DM might show that the sales of yoghurt in America might be strongly correlated with the sales of bicycles in the UK. Naturally this is a coincidental connection. But if DM reveals that customers who buy Product X most of the time also purchase Products Y and Z, it is a very valuable tool for the management to help them in their strategic decision making. Products X, Y and Z could be in shelves that are located close to each other, or the management could chose to make special offers for these three products at the same time, to increase the sales in a short time.

Typical DM products are: Data Mining, Web Analytics, Text Mining and Data Visualization. In the next section I will zoom in on DM applied to the Web, but for now I will discuss the DM applications.

There are two types of DM: predictive DM and descriptive DM. Considering predictive DM one could think of forecasting the mail response and the behaviour of customers. Of course, other applications are thinkable. Descriptive DM concerns: *Discovery/Trend Identification*, *Credit Scoring and Control* (in the financial world), *Fraud Detection* (analysing transaction patterns and discover fraud in an early stage) and *Customer Profiling*. The latter means: categorizing customers on the basis of certain characteristics with the aim to have a specific, more effective approach to customers and prospects which will ultimately increase profits.

In the area of DM especially concepts like Customer Profiling will stay popular, because in the end it will always be rewarding to keep on knowing who your most profitable customers are.

3.4.2 Applying DM to the Internet – BI and e-commerce (Web Mining)

An area of growing importance for companies trying to sell their products is e-commerce. There is a lot of 'invisible' and 'not-straightforward' information in the pages of a website, that is most valuable to have when engaged in e-commerce activities. The idea behind Web Mining is that the information and knowledge that is "dug up" by DM in every-day databases can also be used to provide information about a web site and its visitors. Web sites, and especially commercial ones, generate gigabytes of data a day that describe every action made by every visitor to the site.

An article by [7] gives a short but interesting description of the different ways of applying DM to the Internet. The first is 'Mining the Web' itself. An example of this is improving (new) websites by collecting data from various sites and categorizing, analyzing and presenting them on (new) web pages for the benefit of the web visitor. Another example is a search engine on the Web: by searching for hits of a word, phrase or synonym, recording these hits, grouping them into categories and keeping up a history, the search engine could be made more powerful. The DM element in this is making predictions, trend analysis, categorizing and data reduction.

A second type of Web Mining is 'Web usage mining', also referred to as Clickstream Analysis. The goal of web usage mining is analyzing the site navigation. Typical questions answered by this type of Web Mining are:

- How do visitors "click" through the site?
- On which page of the web site do visitors enter / leave the site?
- How much time do visitors spend on which part (page) of the site?
- How many visitors fill their shopping cart but leave the site without making a purchase?

By combining all these data with the registered customer profiles it is possible to define those types of customers that are most likely to purchase using the internet. Also, these customer profiles in connection with their behaviour on the Web site can be used to see if the site should be designed differently.

Web Mining applications of a more advanced level are *Personalization* and *Multichannel-analysis*. Personalization happens when rules are activated in order to offer personalized content to the visitor. A danger in this application is that the information is not always fully reliable, in the sense that the visitor cannot be categorized correctly. When individual visitors make use of a large company network, for example, they will not be recognized as separate visitors. What Multichannel-analysis comes down to is anticipating the behavior, wishes and possibilities of the customer in the use of different communication channels.

3.4.3 Conclusions

DM aims to provide patterns in data, (extra) intelligence, in order to gain new insights and understanding of present and future scenarios of the organization and its environment with the aim to support decision making.

DM answers questions like:

- Can we use historic knowledge to create better and efficient policy?
- Can we predict future behaviour if we analyze stored data?
- What information can we find in the data we collected over the years?

Following is a short list of what one could do with DM:

- Forecasting mail response
- Predicting behaviour of customers. For example: define those types of customers that are most likely to purchase using the internet
- Discovery/Trend Identification
- Credit scoring and control (in the financial world)
- Fraud Detection
- Specific approach of customers and prospects. Offer personalized content to the visitor (Customer Profiling, Personalization)
- Anticipating the behaviour, wishes and possibilities of the customer in the use of different communication channels
- Improving websites

All these activities will ultimately lead to more satisfied customers, less costs and more profits.

3.5 Conclusions

The output of BI is actionable knowledge. With this knowledge in hand the management can make better decisions with (more) confidence leading to (more) profit.

BI links information from all sorts of departments and layers of an organization with the aim to provide an overall view. All types of end-users can use BI tools. End-users with different levels of expertise can apply BI applications to different levels of knowledge.

The boundaries that exist between the concepts within BI are vague. In this chapter I tried to isolate the BI applications and their benefits. Although the advantages are to numerous to mention, I will try to give an overview of what has been discussed in this chapter and summarise the business value of the BI applications separately as well as the business value of BI as a whole.

The business value of BI:

- *Analyses and reports* on virtually all thinkable aspects of the underlying business;
- Improved strategic, tactical and operational *decision-making* processes;
- Improved *business processes;*
- A more collaborative *work environment;*
- Extended *knowledge management* and *management of information systems.* Improved information dissemination, improved information access and propagation of knowledge about the organization;
- Improved short- and middle long term *planning;*
- Increased *revenues*. Total grip on *cash flow*. *Reduced costs*;
- Decreased *reaction time* which leads to *competitive advantage;*
- Instant view on which *products*, customers and markets are most profitable;
- A 360 degree *customer* view;
    - Identifying *customer profitability*;
    - Creating *risk profiles* of existing and new customers;
    - Total grip on *customer satisfaction*;
    - Predicting *behaviour of customers;*
- Improved *customer satisfaction.* Offer personalized products and services to the customer*;*
- Anticipating the behaviour, wishes and possibilities of the customer in the use of different communication channels. Improved *websites;*
- Monitoring the *external business environment* ;
- *Extremely fast monitoring;*
- Better insights in *markets, suppliers, competitors and technology;*
- Tracing *opportunities and threats;*
- *Complete end-to-end information* on the supplies and logistical data from the whole supply chain;
- Increased *reactive power* of the supply chain as a whole;
- A more *transparent and calm supply chain;*
- *Inventory reduction* on every point at the supply chain;
- Discovery/Trend Identification
- *Fraud Detection*

Chapter 4 Evaluating BI solutions

4.1 Introduction

In the previous chapter we took a look at the potential business value of BI. Quite a lot as we could see. In this chapter I would like to take a closer look at means to evaluate BI solutions. I will first briefly mention a way to evaluate any IT-investment, followed by the financial and non-financial considerations of BI projects. The focus will be on the benefits rather than the costs.

For now I would like to begin with the following statement from [20] because I think it is important to mention here. It is strongly linked to what has been discussed in the second chapter of this report:

> *The quantitative and qualitative benefits of a BI project need to be evaluated before the project is undertaken calculating the Return On Investment (ROI) on a BI project is one means of measuring the benefits to the organization. However, even more critical to the success of the BI project than the calculated costs, benefits, and ROI, is the extent of "buy-in" for the project from the executive leadership and the business operations of the organization. Having support for the BI project from senior management as well as user involvement in the configuration of the application(s) is essential to its success. Without the necessary support and involvement, the ROI calculation for the BI project is meaningless.*

4.2 How to evaluate any IT-investment?

IT-investments should be approached in a commercial manner/from a business perspective according to Alexander Rinnooy Kan[6] and many others. But how to do this? Well, at least the costs, the contribution to objectives as well as the risks should be regarded. One should keep in mind that the benefits of IT investments are not instantly visible. Results of the replacement of manual work by automation, for instance, do not show off until the replaced employees stop working for the company or have other profitable tasks. Furthermore, the advantages will not show until the end-users know how to work with the systems.

4.2.1 Business Case approach

In this section I briefly discuss one way to evaluate the profits of IT (investment) decisions, namely the business case. According to [21]

> *A business case is a document with within an explanatory note to a proposal to invest in IT.*

But, although the business case is meant to support the investment decision beforehand, it could also be used to explain why one has made a certain decision after the decision has been made. A business case can be regarded as the communication vehicle between business en IT and aims to align IT with the business. The business case leads to: better substantiation, better decision-making and control of (IT-) investments with which you can achieve your company objectives faster and cheaper. For a full discussion of the business case approach I would like to refer to [21]

[6] Alexander Rinnooy Kan, Member of the Board of Directors of ING

4.3 Quantitative analysis of BI solutions

As [6] teaches us, in order to know how you can put a value on information one has to keep in mind that it is

> *very easily, when a lack of access to it can cost your company millions of dollars.*

So, according to this, in order to know the value of a BI solution one has to look how much money it costs the company for not having the information/actionable knowledge BI produces.

It is important to specify the financial outcomes desired from an analytical initiative to help measure the success of a BI effort. Cost savings are recommended as specification of financial benefit rather than increased revenue (although this is a better value proposition), because it is much easier to specify in advance how these will be achieved.

"Calculating ROI for BI Projects" is a white paper by Jonathan Wu (2000). In this paper Wu addresses the calculation of ROI, including financial measures such as the Net Present Value (NPV), Internal Rate of Return (IRR) and payback period, as well as other non-financial considerations for BI projects. While each financial measure focuses on one specific analysis, the ROI calculation combines the features of NPV, IRR and payback period. In addition, ROI is the commonly accepted financial measure for evaluating the financial benefits of a BI project. The ROI calculation evaluates the NPV projected cash flows derived from the savings generated by the BI project divided by the initial investment. With this financial measure, one can assess the benefit of the project over the initial costs. If one would likes to read further on this subject, I would like to refer to [20]

4.4 Qualitative analysis of BI solutions

In the previous sections we discussed the financial advantages of BI. Yet, the business value of an IT investment is broader than straightforward financial advantages. BI can also contribute to better execution of the processes in an organization. Other non-financial considerations we've discussed in the previous chapter and are, among others: improved information dissemination, improved information access and propagation of knowledge about the organization through training and the use of the BI application.

[13] Offers a model for the information provision with which one can improve the insight on the benefits of the BI solution. The model consists of a matrix with on one axis the information requirements and on the other axis the information product.

4.5 Conclusions

In this chapter I gave a brief overview of articles on evaluation of BI initiatives. ROI is the commonly accepted financial measure for evaluating the financial benefits of a BI project, but as we could see, without the necessary support and involvement, the ROI calculation for the BI project is meaningless. In order to evaluate BI from different perspectives the business case approach will be appropriate.

Chapter 5 Summary and Conclusions

Industries that are known to benefit most from BI are data rich industries. Departments that are known to benefit most from BI are: (Database) Marketing, Sales, Finance, IT (especially the Web) and the, Higher Management.

The largest appreciation of BI lies in the integration of data from several sources. Before one rushes into developing and implementing a BI solution one has to make sure that the following requirements are met:

- high-quality (transaction) data should be in place
- there should be commitment of the (senior) executives

Other CSFs include:

- a clearly defined strategy
- alignment of the information requirements with the strategic and operational focus of the business.
- highly skilled employees with analytical capabilities
- the organization should have a data-oriented culture
- those who need to perform should have a clear reason for new behaviours
- ACTION!! Without it one can't gain advantage.

ROI is the commonly accepted financial measure for evaluating the financial benefits of a BI project, but as we could see, without the necessary support and involvement, the ROI calculation for the BI project is meaningless. In order to evaluate BI from different perspectives the business case approach will be appropriate.

Following is a short list of some advantages of BI:

- *Analyses and reports* on virtually all thinkable aspects of the underlying business;
- Improved strategic, tactical and operational *decision-making* processes;
- Improved *business processes;*
- A more collaborative *work environment;*
- Extended *knowledge management* and *management of information systems.* Improved information dissemination, improved information access and propagation of knowledge about the organization;
- Improved short- and middle long term *planning;*
- Increased *revenues*. Total grip on *cash flow*. *Reduced costs*;
- Instant view on which *products*, customers and markets are most profitable;
- A 360 degree *customer* view;
- Improved *customer satisfaction.*
- Anticipating the behaviour, wishes and possibilities of the customer in the use of different communication channels. Improved *websites;*
- Monitoring the *external business environment* ;
- *Extremely fast monitoring;*
- Better insights in *markets, suppliers, competitors and technology;*
- Tracing *opportunities and threats;*
- *Complete end-to-end information* on the supplies and logistical data from the whole supply chain;
- A more transparent and calm supply chain;
- Inventory reduction on every point at the supply chain;

In short, the business value of BI is: gaining *better insights* on a continuous basis in markets, customers, suppliers, competitors, technology, the internal as well as the external environment with

which – if one acts upon it – *will lead to increased profits, reduced costs, more satisfied customers, competitive advantages and a greater market share.*

I would really recommend data-intensive organizations to consider BI. As we saw it can have a great business value

Part II: Case Study

Chapter 6 BI at the *Vrije* Universiteit

6.1 Introduction

Throughout my study I've read of and experienced a lot of inefficiencies at companies, which could (easily) be solved with solid information retrieval and analysis.

One of the things that was most striking to me was the fact that within the VU and especially the Department of Computer Science of the Faculty of Sciences there is no question of implemented BI methods for neither student information, nor capacity of educational personnel, although there is a whole course on BI.

The reasons for this I do not know – it could be the high costs of a BI solution, it could be the fact that not everyone (especially the decision makers) is familiar with BI and its possible effects. In this case study I will discuss the advantages BI could have on the department. So, the core question I would like to address is:

What is the business value of BI for the Department of Computer Sciences at the VU?

6.2 Scope and approach

The focus of this case study is not on external report, but rather on the internal usage of information. For external report there are the so-called Indicators Academic Education[7] *(KUO: Kentallen Universitair Onderwijs).* This will not be addressed in this report. Another focus point is the analytical aspect of BI rather than operational aspects.

The information gathered within this research was gained through interviews I held with key employees of the faculty and specifically the Department of Computer Science.

6.3 Current situation

6.3.1 BI Tools

The department already has an OLAP license, but as far as I could determine, it is not adjusted to the information needs of the department. Furthermore, there is no DW available. The department should further investigate if a Data Ware House is necessary or if a query-server solution will be sufficient[8]. I would recommend applying as much as possible Commercial-of-the-Shelf (COTS) applications and interfaces.

6.3.2 Operational Systems: Student Tracking System

[7] For more information on this subject see the website of *VSNU (De Verenging van Universiteiten),*available at http://www.vsnu.nl/web/show/id=46873/langid=43

[8] See also *ETL-tool of Query Server? Dossier Semi ETL-tools* , Freek Kamst http://www.array.nl/dbm/art0301/ETL-Tools.pdf, Database Magazine (Nr 1), February 2003

Nowadays a Student Tracking System (*studentvolgsysteem*) called *ISIS* is used to track students and their performance. After enrolment[9] *(inschrijving)* some student information is entered into this system.

The Educational Office *(het Onderwijsbureau)* sends a teacher a list of students that follow the course the teacher provides. Then, the teacher offers the Educational Office sub results *(deelresultaten)* as well as the final results (explicitly!) of these students. The educational Office then registers the results in ISIS.

Twice a year the (average) results of students are reported to the study coaches *(studiebegeleiders)*.

Some operational disadvantages of ISIS:

- It is *long-winded (omslachtig)*. Only study advisors have direct access. So, in order for teachers for example to receive the information about the students they want, they have to either go to the educational Office or a study advisor which has direct access to ISIS.
- It is *time expensive*. It usually takes one to two weeks to get results from a information request. Sometimes it even takes up to one or two months to receive answer to ones question. This relies heavily on the (workload of the) personnel of the Educational Office.

The focus of this report is rather on the analytical aspect of BI. For this reason we take a look at the so-called disadvantages at an analytical level.

Some characteristics (of ISIS) which impede analysis:

- No credit points are registered
- No calculations are done
- There is limited statistical data available
- Because of the fact that only study advisors have direct access and thus the chairman of the board for example doesn't, means that the decision makers can't instantly do their analysis. Maybe this is a disadvantage at operational level rather than at an analytical level, because if the correct information could be available for the study advisor, the decision makers could access this information via this advisor, which is long-winded but only an operational problem.
- Student information can't be aggregated to a higher level, rather on individual or *cohort* level. For example: the pre-schooling is only known on an individual student level.

So, what we see is that ISIS can be regarded as a registration system, a big card-tray with for every student information such as: exam results, pre-schooling and *personalia*. This isn't what you call a solid basis for thorough analysis.

Considering the VU as a whole:

- There are only marks *(cijfers)* per study or per department available, so comparison between faculties is difficult.
- There is talk of *double registration*. The exam results of a student who follows a course at another faculty is registered at that faculty, sent to this faculty and then registered again in ISIS. There is no direct connection between the information systems of faculties.
- The exchange of information between faculties is not always what it should be. For example, the information exchange between the Faculty of Arts *(faculteit der Letteren)* and the Faculty of Computer Science should certainly be improved.

[9] In this year (2004) more than 17000 students are enrolled at the VU as a whole, more than 1250 students at the Faculty of Sciences and more than 550 students at the Department of Computer Science. Source: *Inschrijvingen 2004 – 2005: stand per 19 oktober 2004*, http://www.vu.nl/organisatie/index.cfm

6.3.3 Operational Systems: Allocation of Tasks Program

Since recently, the faculty has a model[10] with which one can calculate how much education the staff[11] is able to give, how much staff time *(staftijd)* a study takes and what could reasonably be asked for educational tasks from an individual teacher. This model is called the 'Educational Capacity Model' *(Onderwijscapaciteitsmodel)*. It consists of *two components*: the educational time available (dependent on the available money) and the required educational time

The computer application with which - based on the model described above - the necessary calculations can easily be made to obtain information about the available educational time and the time spent on education is called the 'Allocation of Tasks Program' *(Onderwijstaakverdelingsprogramma)*.

For further information on the subjects mentioned in 6.3.1 and 6.3.2 I would like to refer to the document: *"Een Onderwijscapaciteitsmodel en een Onderwijstaakverdelingsprogramma"* available at the Educational Office.

6.3.4 Financial Input

Just to get an idea of where the VU gets its financial means from, I will discuss it briefly in this part. The financial income from the VU depends on:

I. Education

- Students: tuition fee. This is equal to almost 10% of the costs of the VU.
- The state: subvention for the amount of degree certificates *(diplomafinanciering)*. So, the more students graduate (output) the more subventions the VU receives (financial input) one could think. Yet, this is not a linear relation. The annual total budget for all universities is proportionally distributed. It could be seen as a game (a "sero sum game" as some people call it) in which you have to prevent getting less. Off course this is not really a game, but serious business - survival.

II. Research

- European Commision
- Central government (Ministry of Economic Affairs)
- Netherlands Organization for Scientific Research *(NWO)*
- Industry companies

The more completed PhD theses, the more subventions. The VU does not receive compensation from placement companies *(stagebedrijven)*.

6.4 Advantages of BI

The advantages of BI reach further than the need of information *(informatiebehoefte)* the interviewees addressed. In this section I will discuss the benefits for this department which will contain the information need of the employees I spoke with.

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[10] Department of Computer Science, Vrije Universiteit:
Een Onderwijscapaciteitsmodel en een Onderwijstaakverdelingsprogramma

[11] The academic staff of the Department of Computer Science consists, among others, of almost 70 professors and university lecturers. Source: http://www.cs.vu.nl/peop/faculty-nl.html (Last Viewed: December 8th, 2004)

6.4.1 Information

The idea of BI is to use the information within a program such as the Allocation of Tasks Program as well as information about students (through a more sophisticated system than ISIS) and information from other information sources and link them in a clever way with the aim to produce answers to questions such as:

1. What is the image of the VU (and its department that is subject of this research) at a national level?
2. What is the origin of our students? Where do our students (physically) come from? In which *part of the country* do the live? And why do people choose for the VU? There are, for instance, few students from the Gooi and Kennemerland, although there is talk of favorable attainableness *(bereikbaarheid)*. These students usually attend the University of Leiden, which is further away from their home.
3. What is the educational background of the students? What kind of *pre-schooling (vooropleiding)* and degree do they have?
   a. HBO? University? Other? None?
   b. Master degree? Bachelor degree? Other? No degree at all?
   c. Which *school* did they attend? Where?
4. Which courses do students stumble at *(struikelvakken)*?
5. What are the average grades of students who attend a specific course compared to the grades of the last five years?
6. What are the success rates of courses of this year compared to the success rates of last year? What are the success rates for the past five years for a specific course?
7. What is the success rate of students of a certain course?
8. Which trend in success rates could be noticed?
9. What are the drop-out rates? What is the drop-out rate of BI-students compared to those of I-students?
10. What is an appropriate moment (what year) for study coaches to stop guiding students without loosing sight of/touch with these students?
11. What is the drop-out rate per study of students who are registered for more than one study at a time?
12. How much time do students spend on preparing exams (this info could be obtained through questionnaires)?
13. What is the relation between times spent on preparing exams and attending lectures and grades?

I could go on and on with this list…

6.4.2 Analysis

One could ask oneself: suppose we have all the answers to the questions displayed in the previous sections. What can we gain with this? The answer to this lies within the analysis of the information and the benefits that flows from this analysis. In this section I will try to give an overview of the possible benefits of actionable knowledge which is the output of BI.

I. Inflow *(instroom)*

Marketing: knowing why people choose to study at the VU and where your customers (students in the case of a university) come from and their educational background (what kind of pre-schooling they have) helps one to a) know what the net result of ones marketing activities in a certain year or in a certain place was (the success rate of recruitment activities) and thus b) better tune ones marketing activities, which will increase the inflow and thus the total tuition fee received per year. The idea is to gain more - reach more students that have a bigger chance of going to study at the VU - with more

efficient and effective promotional activities. *Where should we put (more) effort to attract what kind of students?*

II. Guidance *(voorlichting)* and Selection

1. The possibility of tracking the courses students stumble at, courses that are worrisome for those students, makes it possible to adjust the guidance. For example, if you can notice a trend in a category (categorized by pre-schooling) students' result you could.
2. Adjust the curriculum so that the gap between the prerequisites and their educational background is closed. The quality of the courses/curriculum should not decrease though.
3. The first year is for orientation (the student) and selection (the VU). The student looks if the study he has chosen is the right one for him/her and is he/she would like to proceed. The VU on the other hand picks the students she likes to keep. In order to do this she uses some selection criteria.

   Which students do (or even should) we like to keep? Which selection criteria should we use? What should the prerequisites be?

III. Flow (*doorstroming*)

1. Linking the information of students to their results could lead to significant actionable knowledge. The possibility of tracking the courses students stumble at, courses that are worrisome for those students, makes it possible to adjust the curriculum. For example, if you can notice a trend in a category (categorized by pre-schooling) students' result you could adjust the curriculum so that the gap between the prerequisites and their educational background is closed. The quality of the courses/curriculum should not decrease though.
2. Another possible advantage is that the Department can decide what percentage of which lectures students should be obliged to attend at a minimum in order to minimize the failure rate at exams. This helps improves the success rate.

Increasing the inflow has a financial impact as well as an improvement of the image of the university. Improving the flow will also have a positive influence on the output and thus the image of the VU.

IV. Educational capacity and allocation of tasks *(onderwijscapaciteit en taakverdeling)*

Linking the information of the educational staff to the students' information gives one the opportunity to analyze if and where there is an imbalance between the efforts and the results.
This is not to blame some teacher or something like that, but from here on one can begin analyzing if there are problems and what those problems are. It could be that students in a particular year aren't motivated enough. All kinds of scenarios could be thought of in order to obtain the information needed to know the causes for this. If the educational staff sees better results from its efforts it will be more satisfied eventually.

A benefit that is not directly derived from analytical but the operational aspect of BI is that there will be no need to go to the Educational Office to request information. In this way, the Educational Office can focus on other core tasks.

6.5 Efforts

In this paragraph I would like to add an educated guess, an estimate of what the efforts will be for the department in order to implement a successful BI solution. I will not discuss the steps in building a BI solution in detail, as this is out of the scope of this thesis. I rather focus on different roles in the BI project and the skills required from the key players, the cost components and estimated costs.

Things that should be done are, among others:

1. A DW has to be implemented,
2. The OLAP tool should be adjusted to the DW and information requirements of the users
3. End-users should be trained

6.5.1 Roles

The following list contains the roles involved in the activities of BI project[12,13]**:**

1. A BI Steering Committee
2. Project Management
3. Development Team
4. Extended Project Team

A BI Steering Committee should be installed for project sponsorship and governance and should contain the CIO as well as a business executive.

The tasks of a project management team include managing daily tasks, reporting status, and communicating to the extended project team, steering committee, and affected business users.
The project management team includes the following members:

1. A hands-on *IT manager* with a background in iterative development (a so-called project development manager) who must understand the changes caused by the BI approach and the impact on the business, project resources, schedule and the trade-offs.
2. A *business advisor* who serves as the business advocate on the project team and the project advocate within the business community.
3. A *business representative* must be involved in the entire planning process
4. A *BI/DW project advisor* to ensure that architecture, data models, databases, ETL code, and BI tools are all being used effectively and conform to best practices and standards.

The third role is that of the development team (the core team) which is divided into the following sub-teams:

- The *business requirements team* represents the business and their interests. It is responsible for gathering and prioritizing business needs and translating them into IT systems requirements
- The *BI architecture team* develops the overall BI architecture, selects the appropriate technology, creates the data models, maps the overall data workflow from source systems to BI analytics, and oversees the ETL and BI development teams from a technical perspective.
- The *ETL development team* defines what types of data transformations and data cleansing the BI application will require and develops the ETL code needed to gather data from the

[12] *Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications*, Larissa Moss, Addison Wesley Professional, **Feb 25, 2003 (Book)**

[13] *The Four Legs of a Successful Business Intelligence (BI) Project Team*, Rick Sherman, April 2003, http://www.athena-solutions.com/bi-brief/april03.html

appropriate source systems into the BI databases. Based on the condition of the source files and databases it will give ETL estimates to the project manager for the project plan.
- The *BI development team* creates the reports or analytics that the business users will interact with to do their jobs.

There are several functions required by the project team that can be accomplished through an "extended" team:
- *Players* - A sub-group of the academic staff and department management should be signed up to "play with" or test the BI analytics and reports as they are developed to provide feedback to the core development team.
- *Testers* who test the BI analytics, ETL processes, and do overall systems testing.
- *Operators* (database administration, systems administration, and networks) to ensure that the systems are developed and deployed within the infrastructure of the department.
- Help desk and training resources

6.5.2 Skills

Assembling a team with the right mix of hard and soft skills for your BI project is critical to its success. The greatest challenge in assembling any BI project team is identifying the necessary softer traits and skills which, most of them at least, tend to be non-technical in nature[14].

The following list contains some IT-, business- and personal skills required from members from the project and development team:

a. IT skills
   i. Everyone on the team should know at least the basics about databases.
   ii. An ETL team member with expertise in the source systems could be part of the team to provide knowledge of the data sources, customizations, and data quality.
   iii. Everyone on the team ought to have an understanding of data warehousing terms and concepts. This can be reached through this thesis as well as (die van Raymond en van Deborah)
   iv. The project management team needs extensive BI expertise and DW architecture background
   v. A fundamental understanding of how data is used at an operational level and how it's combined with other data to provide insight is very important.
   vi. The BI/DW project advisor should have enough expertise with architectures and technologies to guides the project team on their use
b. Business and Personal skills
   i. Knowing how the BI solution corresponds to corporate goals is vitally important
   ii. The project management team needs extensive business knowledge, and knowledge of people- and project management
   iii. Team members should be good team players
   iv. Great written and verbal communication skills are essential. Team members should not overwhelm business users with technical details.
   v. Solid requirements gathering skills. Each team member doesn't need to be a full-time business analyst, but everyone on the project will be involved in some way with gathering requirements.
   vi. The business requirements team may have business people who understand IT systems, or IT people who understand the business.

[14] *The Dream Team*, Patti Bunker, June 13 2002, http://www.iemagazine.com/020613/510feat2_1.jhtml?_requestid=272150

6.5.3 Costs

The total cost of implementing a BI project can be divided into 2 categories: initial and recurring. I will focus on the initial costs. According to Veldhuis these costs amount to a total a couple of ten thousands of euros[15].

According to Wu[16] costs can be classified into one of three categories:

1. Hardware - Information System devices such as:
    a. Network communication
    b. Server system(s)
    c. Client systems
2. Software – license fees for the
    a. BI application (OLAP)
    b. Database Management System
    c. Labor (See 6.5.1)

The training takes about a week.

The process in which the data from operational databases is extracted, cleansed, transformed and loaded into the DW, ETL (Extraction, Transformation, Loading), represents the most technically challenging part of any BI environment. Some industry experts estimate that 60 to 80 percent of a BI project's effort is spent on this process alone.

A rule of thumb for the costs of a BI project is that the costs for consultancy are twice as high as the software itself[17].

With these basic cost components in mind, *what will the total cost be of implementing a BI project at the department?*

The magazine *Smart Business Strategies* calculated that if there are 50 users, the license fees are maybe € 25.000 and the computer server costs € 5.000. Development by specialists will then cost near € 700 a day. The total costs with their calculations sum up to € 60.000.

With an academic staff of almost 70 and near 550 students, the department should not cost too much and certainly not more than €100.000,-. There is also already an OLAP tool available. If no more license fee is obliged for the end-users of the department, this will reduce the total costs for the BI solution.
I estimate the costs for a BI project for this department between the €20.000 and €40.000 if external consultants of big, well-known companies are involved.

6.6 Summary and conclusions

As we saw in this case study there is certainly need of BI within the Department of Computer Science at the VU. The advantages are too numerous to mention here. In this report I tried to list some of the advantages of and thus reasons why this Department should implement BI.

In short, BI could produce answers to questions with which the Department could reap the following benefits (and more):

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[15] *Kostenbesparing mbv BI in de praktijk*, http://www. Iseriesinfo.com, Fred Veldhuis
[16] Jonathan Wu, Calculating ROI for BI projects, datawarehouse.com 12/08/00
[17] *Hoeveel kost Business Intelligence?* William Visterin, Tijdnet, November 5th, 2004.
http://www.tijd.be/ondernemen/business_intelligence/artikel.asp?Id=1455193

1. More and better information (dissemination)
2. Culture change (performance measurement and monitoring)
3. Optimal time spending of employees
4. Improved image
5. Customers (students) who are more satisfied

Following is a rather more detailed list:

6. More and better information
    c. Consistent view (one single source of data)
    d. 360º view of the customer (student)
7. Culture change
    a. Mirror for the organization which improves measurable and measured performance
    b. Performance Indicators could eventually be produced, leading to benchmarks with which one could evaluate oneself more effectively and compare oneself to other departments, faculties or even universities
8. Optimal time spending of employees
    a. Less pressure on the Educational Office
    b. Greater satisfaction for employees over their work
9. Improvement of the image of the department, the faculty and the university as a whole;
10. Customers (students) who are more satisfied
    a. More effective PR policy and more effective and efficient marketing activities;
    b. Improving the filtering effect of the first study year and selection criteria of students
    c. Improving the quality of the product the VU offers (education and guidance) the students;
    d. Higher output and success rates of students. Lower drop-out rates

I could go on and on…

All these benefits are in one way or another linked to each other.

I would really recommend the department to seriously take a look at the possibility to implement BI considering the magnitude of advantages this will have for (the image of) the department (and the VU as a whole), the students and the employees.
The department itself has a good basis of (intellectual) capacity to assist in implementing a BI-solution: students could make a star schema, set up the DW if necessary and even the programming could be done by students, under guidance of professors and their assistants.

Further investigation should point out what the financial, operational and organizational impact will be whenever the VU decides to implement a BI solution and if it is feasible. The costs for the project I estimate at between €20.000 and €40.000 if external consultants and developers are involved. One thing that should be remembered is that BI doesn't only consist of techniques and technology: the human factor is also very important and should not be underestimated. As an Afrikan proverb tells us: "It takes a village to raise a child".

Appendix A Links to the World Wide Web[18]

People's home pages

Ralph Kimball:	http://www.rkimball.com
Bill Inmon:	http://www.billinmon.com

Company home pages

Brio Technology:	http://www.brio.com
BI Technologies:	http://www.businessintelligencetechnologies.com
Business Objects:	http://www.businessobjects.com
Cognos:	http://www.cognos.com
CorVu:	http://www.corvu.com
Crystal Decisions:	http://www.crystaldecisions.com
Gartner Group:	http://www.gartner.com
Hummingbird:	http://www.hummingbird.com
Hyperion:	http://www.hyperion.com
IBM:	http://www.ibm.com
Microsoft:	http://www.microsoft.com
MicroStrategy:	http://www.microstrategy.com
OLAP Council:	http://www.olapcouncil.org
OLAP Solutions:	http://www.olapsolutions.co.uk
Oracle:	http://www.oracle.com
SAS Institute:	http://www.sas.com

Pages for finding journals and magazines on BI

BI Quarterly:	http://www.biq.nl???
Database Magazine:	http://www.array.nl/dbm
Datawarehouse Infocenter:	http://www.dwinfocenter.org/periodi
Intelligent Enterprise:	http://www.intelligententerprise.com
KDnuggets:	http://www.kdnuggets.com/publications/index.html

Conference proceedings

KDD Conference Proceedings:	http://www.kdnuggets.com/publications/sigkdd.html

Papers and articles

The OLAP Report:	http://www.olapreport.com
Datawarehouse Infocenter:	http://www.dwinfocenter.org/whitepap
Hyperion White Papers:	http://www.hyperion.com/products/whitepapers/
IBM White Papers:	http://www.microstrategy.com/Publications/Whitepapers/
MicroStrategy White Papers:	http://www-3.ibm.com/software/data/pubs/papers/

[18] This list is based on a list taken from [14].

Other information sites

BI for Excel http://www.bixl.com

Decision Support Systems Resources: http://www.dssresources.com

Oracle9*i* Data Warehousing Guide: http://download west.oracle.com/otndoc/oracle9i/901_doc/server.901/a90237/title.htm

Competitive Intelligence

Leonard Fuld: http://www.fuld.com/whatCI.html

CI Academy: http://www.academyci.com

CI Solutions: http://www.competitive-intelligence.co.uk

Appendix B List of abbreviations[19]

ABC	Activity Based Costing
BI	Business Intelligence
BSC	Balanced Score Card
CIO	Chief Information Officer
CPM	Corporate Performance Measurement
DM	Data Mining
DSS	Decision Support System
DW	Data Warehouse
EIS	Enterprise Information System
ETL	Extraction, Transformation & Loading
FASMI	Fast Analysis of Shared Multidimensional Information
IPIT	Information Provision In Time
IRR	Internal Rate of Return
IT	Information & Communication Technology
KPI	Key Performance Indicator
KUO	Kentallen Universitair Onderwijs
MIS	Management Information System
NPV	Net Present Value
NWO	Netherlands Organization for Scientific Research
OLAP	OnLine Analytical Processing
QR	Queries & Reports
ROI	Return on Investment
SQL	Structured Query Language
VU	Vrije Universiteit

Table 2: List of abbreviations

[19] This list is based on a list taken from [14]

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ABI/INFORM Trade & Industry, page 18
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Database Magazine (DB/M), no. 6, p. 13

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OLAP at work, VU Amsterdam

[16] Shahim, Abbas (2003)
Logistics of Information flow: towards an architectural theory of managerial information provision, VU, Amsterdam

[17] Songini, Marc L. (March 31st, 2003)
Revenue Optimization Software, ABI/INFORM Global, Computerworld, p. 37
http://www.computerworld.com

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Why do so many Business Intelligence Initiatives fail, BI Report
http://www.dmreview.com

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http://www.whatis.com

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Database Magazine (DB/M), Database Systems, maart 2001, p. 61

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Data Warehousing and Business Intelligence for e-Commerce, Morgan Kaufmann, 2001

[Watson, Hugh J. et al.]
The Benefits of Data Warehousing: why some organizations realize exceptional payoffs,
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