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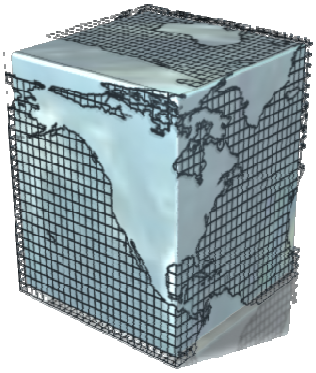

M.Sc. Thesis in Computer Engineering AV,
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Tools for Business Intelligence

A comparison between Cognos 8 BI, Microsoft BI and SAP BW/NetWeaver

Katarina Lundqvist

Abstract

The aim of the thesis was to conduct a general study of Business Intelligence and BI systems followed by a comparison of Cognos 8 BI, Microsoft BI and SAP BW/NetWeaver. The goal was to distinguish similarities and differences between the tools regarding technique, cost, usability and educational need and to provide a mapping for different customer situations. The method consisted of a theoretical study followed by a practical part including development, testing and interviews. The comparison showed that SAP and Microsoft both use the client/server model while Cognos is an integrated web-based system built on SOA. SQL Server can only be installed on Windows while BW and Cognos also support UNIX, Linux and IBM. SSRS report formats are HTML, PDF, CSV, XML, TIFF, Word and Excel. In BW, query results can be viewed as HTML, CSV and Excel. Cognos report formats are HTML, PDF, CSV, XML and Excel. The educational need for SQL Server and Cognos is low and may often be solved internally or through e-learning. In contrast, BW uses its own terminology and the enhanced star schema, so developers will most likely require additional training. The education for SQL Server will be the least costly option, followed by BW and Cognos. Microsoft received the highest score in all usability tests and appeared to be the best choice as long as Windows can be used and there are no SAP business systems. In this case, BW is a good alternative and can be combined with SSRS for reporting. Because of the high costs involved, Cognos is only recommended when it is not possible to use Windows and there are no SAP business systems.

Keywords: BI, ETL, OLAP, usability.

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Terminology

Acronyms

API	Application Programming Interface. Interface that enables interaction between software programs.
ALE	Application Link Enabling. Technology from SAP that supports processes across several SAP systems.
BAPI	Business API. Interface that enables access to SAP functions.
BI	Business Intelligence. A collection of processes and technologies used to support decision making.
BLOB	Binary Large Object. A collection of binary data stored as a single entity in a DBMS.
CGI	Common Gateway Interface. Protocol that defines how web content generation can be delegated from a web server to an application.
CSV	Comma-Separated Values. File format for digital storage of tabular data where a comma is used to separate values.
DBMS	Database Management System. A set of software programs that control data in a database.
DW	Data Warehouse. Data storage designed to facilitate reporting and analysis.
EDA	Event-Driven Architecture. Architectural model where actions are triggered by events.
ETL	Extract/Transform/Load. Database process for extracting data from outside sources, transforming it if needed and loading it to the target database.

HOLAP	Hybrid OLAP. A combination of ROLAP's data capacity and MOLAP's processing capability.
HTML	Hyper Text Markup Language. Markup language and standard for structuring Web content.
HTTP	Hyper Text Transfer Protocol. Application-level protocol for distributed, collaborative, hypermedia information systems.
ISAPI	Internet Server API. An N-tier API of Microsoft Internet Information Services.
ISO	International Organization for Standardization. A group of representatives from various national standards organizations.
JDBC	Java Database Connectivity. Java API that defines how a client may access a database.
KPI	Key Performance Indicator. A measure of performance to define and evaluate success.
LOB	Line Of Business. General term that refers to a set of related products which service a particular customer transaction or business need.
MDDB	Multidimensional Database. Database supporting multidimensional views of data.
MDX	MultiDimensional eXpression. Query language for OLAP databases.
MOLAP	Multidimensional OLAP. Performs analysis on data in multidimensional cubes.
ODBC	Open Database Connectivity. Standard API method for using DBMS's.

ODBO	OLE DB for OLAP. Standard API for exchanging metadata and data between an OLAP server and a client on a Windows platform.
ODS	Operational Data Store. Database designed to integrate data from multiple sources. Have a more limited history and more frequent updates than a data warehouse.
OLE DB	Object Linking and Embedding, Database. API designed by Microsoft for accessing different types of data stored in a uniform manner.
OLAP	On-Line Analytical Processing. An approach to quickly answer multidimensional analytical queries.
PDF	Portable Document Format. File format by Adobe Systems that represents documents in a manner independent of software, hardware and operating system.
PSA	Persistent Staging Area. Storage area for data from source systems.
RFC	Remote Function Call. Procedure for data inter-changes between a client and a server.
ROI	Return On Investment. The ratio of money gained or lost on an investment relative to the amount of money invested.
ROLAP	Relational OLAP. Performs multidimensional analysis on data in relational databases.
SOA	Service Oriented Architecture. Architectural model based on services.
SOAP	Protocol specification for exchanging information in the implementation of Web services in networks.

SQL	Structured Query Language. Language for managing data in relational DBMS´s.
SSAS	SQL Server Analysis Services. Provides OLAP and data mining capabilities in Microsoft SQL Server.
SSIS	SQL Server Integration Services. Platform for data integration and ETL operations in Microsoft SQL Server.
SSRS	SQL Server Reporting Services. Server-based report tool in Microsoft SQL Server.
TCO	Total Cost of Ownership. Financial estimate for direct and indirect costs of a product or system.
TIFF	Tagged Image File Format. File format from Adobe Systems for storing images.
WSDL	Web Services Definition Language. XML-based language for describing Web services.
XML	Extensive Markup Language. A set of rules for encoding documents electronically.
XMLA	XML for Analysis. Industry standard for data access in analytical systems, such as OLAP and data mining. Based on XML, SOAP and HTTP.

1 Introduction

Decisions are made on a daily basis in all companies and organizations, and these decisions present certain risks. In order for decision makers to be able to make good decisions and limit the risk they must have access to the correct information at the right time. This information can come from staff, databases, flat files etc.

In order to improve the flow of information and decision making, many companies have begun to implement Business Intelligence (BI) systems. Business Intelligence is not a novel idea as it has existed for some time but with the use of computers the task of information gathering and analysis can be made more rapidly.

1.1 Background and problem formulation

Whether a BI system is developed by a company´s own staff or external consultants are hired, a decision must be made as to which development tool should be used.

According to the American research company Gartner [1] [2]; more than 50 % of BI projects fail. One of the reasons for this is that no comparisons are made between tools from different vendors. Instead, companies tend to choose a tool from a major vendor or one that they are already familiar with – however ill suited this tool may be for their business. This is probably not based on time constraints, but rather due to the lack of an appropriate basis for comparison.

Sogeti in Sundsvall has several BI commissions and their expertise is primarily in the areas of SAP BW/NetWeaver, Microsoft BI, and Cognos. As shown in Figure 1, these three tools scored well in Gartner´s Magic Quadrant for Business Intelligence Platforms 2008. Since SAP bought Business Objects they too have a place among the leaders.

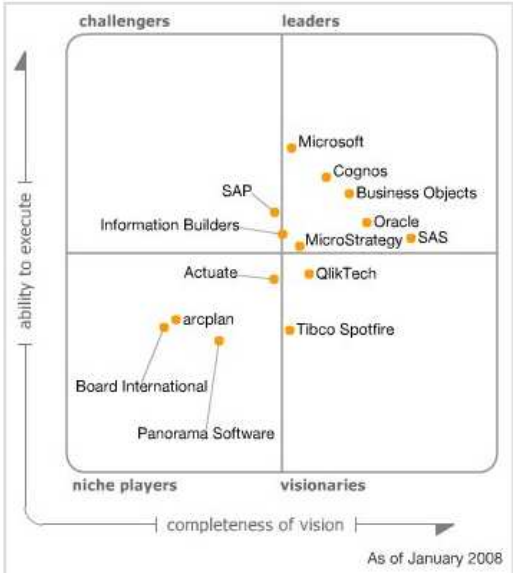

Figure 1: Magic Quadrant for Business Intelligence Platforms, 2008. [3]

For each new commission, Sogeti are faced with the question "which tool should be used?" The decision or proposal is now primarily being based on the customer's present technical and system environment, instead of what might actually produce the best solution in terms of cost, usability and technical solution.

For this reason, Sogeti wishes to have this matter further investigated so that they may be able to provide their customers with an even better service in the future.

1.1.1 Sogeti

The Sogeti group, based in Paris, has approximately 20 000 employees in 14 different countries and is present in over 200 locations worldwide. All companies in the group are fully owned subsidiaries of Cap Gemini S.A.

Sogeti Sverige AB delivers IT consulting services within the local market. At the company´s 21 offices there are approximately 1 000 consultants working with IT management, expert services, development and integration projects, testing, system management and right-shore services.

As a result of the local customer and market structure, the office in Sundsvall has become specialized in the areas of Applications Manage-

ment, integration with WebSphere, IT architecture, Microsoft, project management, IBM Rational, system and organizational development. Many of Sogeti´s customers are in the field of forest and paper, telecom, finance, manufacturing and public administration. [4]

Among the BI commissions, Sogeti has helped Mid Sweden University implement a Microsoft solution in order to coordinate their educational information, and for SCA Skog and SCA Timber they manage and develop their SAP based BI systems.

1.2 Overall aim and verifiable goals

The overall aim of the thesis is to conduct a general study of Business Intelligence and BI systems followed by a more thorough comparison of Cognos 8 BI, Microsoft BI and SAP BW/NetWeaver, three commonly used tools for development and management of BI systems. The comparison will look at similarities and differences regarding technique, cost, usability and educational needs. The work will consist of both theoretical and practical comparisons, as well as interviews with developers and end users.

The goal is to be able to distinguish similarities and differences between the tools and to provide a recommendation with regards to how to map them to different customer situations. More concretely, the thesis will result in the following:

- A theoretical study of Business Intelligence, BI systems and the three tools from Cognos, Microsoft and SAP.
- At least one cube/model and report developed for each of the tools. The cube is to be built from scratch with a fact table, dimensions and measures. Data is then to be loaded into the cubes using available techniques for ETL and staging. The report should contain some type of filter and/or calculated measure.
- A usability test that objectively evaluates the usability of each tool and a user test during which the developers are given a chance to offer their subjective views of the tool that they work with.

- A recommended mapping of development tool to customer situation and possibly how tools may be combined.

1.3 Restrictions

Since this thesis is based on a real commission from Sogeti, and their primary interest is in tools from Cognos, Microsoft and SAP, only Cognos 8 BI, SAP BW/NetWeaver and Microsoft BI will be considered, even though it is possible that other tools and versions might be available on the market.

Apart from the initial presentation of Business Intelligence, BI will be discussed from an IT perspective which in some cases can differ somewhat from, for example, a pure economic perspective.

The architecture of the tools will be fully described but the comparison will focus on the parts used for integration with other systems, development of cubes, analysis of data and report creation.

1.4 Outline

Chapter 2-5 provides an introduction to the area of Business Intelligence, BI-systems, SOA, usability and usability testing. Chapter 6 describes the method for the thesis and chapter 7-9 describes the three tools Microsoft BI, SAP BW/NetWeaver and Cognos 8 BI. Chapter 10-11 presents and discusses the result of the thesis.

2 Business Intelligence

In companies and organizations, decisions are made at different levels on a regular basis. These decisions must also be made as quickly as possible in order to maintain competitiveness and so as to make the correct decisions a solid base in terms of data, information and knowledge must be available. This base can come from the business press, conferences, customers, sales personnel and so on, and together they form a concept regarding the market and world around a given business. By analyzing the gathered information, each decision´s risk factor can be eliminated or reduced to an acceptable level and a strategy for the future can be developed. To conduct this work as quickly as possible, different types of computer support are often used. [5] [6] [7]

Figure 2 shows the structure of an intelligence system for competitive analysis, presented by Michael E. Porter [8] in his book Competitive strategy.

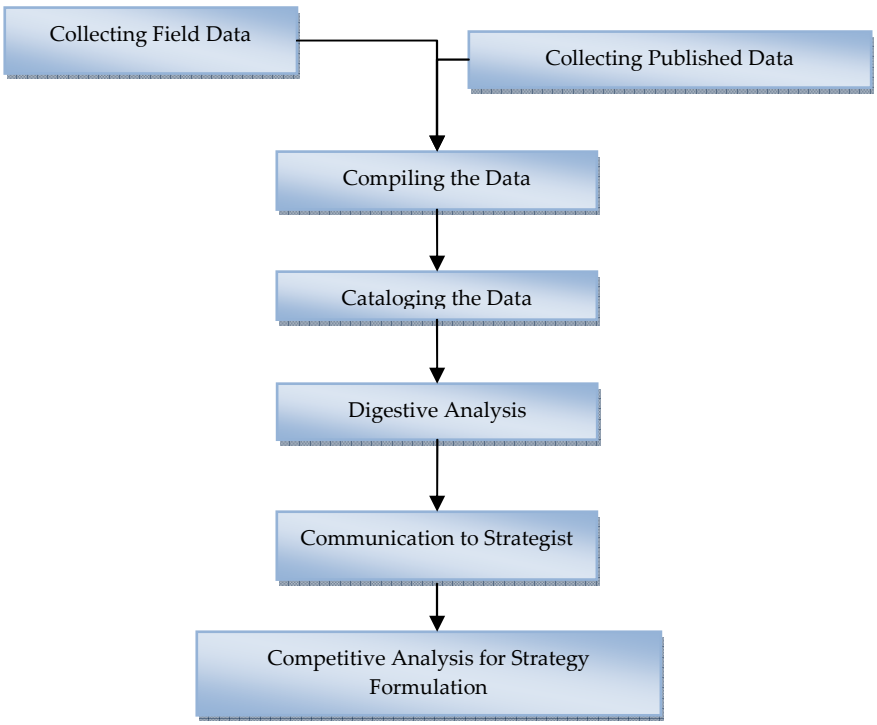

Figure 2: Functions of a Competitor Intelligence System. [8]

Porter´s system from 1980 is still valid today, even if the role of the strategist has become obsolete, and it provides a good description regarding how to obtain a good basis for decision making. This method can be used for all kinds of decisions, not only those focused on competitors. [8]

What separates Business Intelligence from traditional analysis is that it is a continuous work instead of on an ad hoc basis, when a specific problem arises. The BI processes are also improved regularly in terms of knowledge, methods and tools. This could, for example, be performed by using IT which will deliver information to decision makers more rapidly. [5]

2.1 Generic and Decision-Oriented BI

One could say that Business Intelligence is made up of two different areas. The generic branch is the continuous gathering of data that affects all parts of a business. It is not possible to ask specific questions from this collection of data without some kind of data selection and analysis, but it is a good knowledge base for future questions.

The decision-oriented branch, on the other hand, deals with specific questions. Data from the generic process, and additional data that may be required, can be used to investigate customer behavior, new markets and other aspects which may affect the business. It is also possible to create a prognosis for the future based on historic data. [5]

2.2 Profitability and Efficiency of BI

There are no specific measuring methods available for determining how much more effective decision making has become thanks to a BI investment. The reason for this is that it is impossible to know what decisions would have otherwise been made and the effect that they would have had on the business. [5]

In relation to the efficiency and profitability of an investment, then return on investment (ROI) and total cost of ownership (TCO) are often used, but it is difficult to say exactly how to calculate these for BI. This is due to the fact that it is difficult to put a price on what comes out of the BI system, since this is information and not products that can be sold.

Parts of the system may also already have been in use and the question then becomes whether the cost should be included or not. In general, the formulas for ROI and TCO are the following:

$$ROI = \frac{(Gain\ from\ Investment - Cost\ of\ Investment)}{Cost\ of\ Investment} \quad (1)$$

$$TCO = Purchase\ \Pr ice + Cost\ of\ Operation \quad (2)$$

If none of these formulas appear to be appropriate, another approach is to set up goals for the BI activities and after a period of time evaluate whether or not they have been achieved. If IT is used for the BI process, the cost can be measured against the speed of data collection, effective storage, ease of report creation etc. [5] [9] [10]

Figure 3 shows what 510 companies felt they had gained from their BI systems.

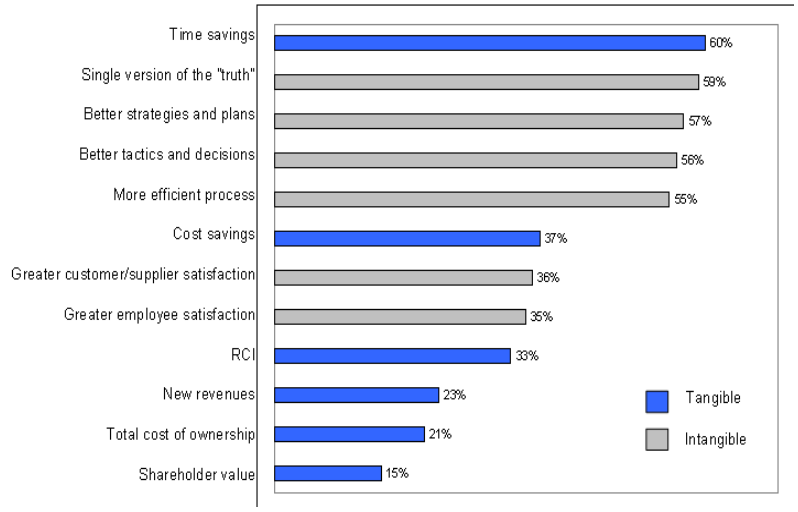

Figure 3: Benefits from BI. [7]

Results marked as "tangible" are those that are concrete and measurable. According to this investigation the benefits from BI are that companies save time and make better decisions. [7]

3 BI-systems

Companies are always interested in improving their businesses and BI is no exception to this rule. The task of collecting, sorting and analyzing data is very time consuming if only performed manually. Eventually, there will be an enormous amount of data to store and retrieving what is required will become increasingly difficult. Here, IT can provide solutions all the way to the decision makers. The aim is to lessen the gap between the company´s present position and the one they wish to reach. [7]

The usual starting point is to acquire a database in order to store data more efficiently. But how is the data retrieved from the database in a quicker and better manner in order to provide better analyses than was the case previously? This is where BI systems can be involved. They are designed to improve the entire flow, from data collection to the presentation of usable reports based on quality data. Having high quality data is crucial in this type of system and there are several techniques for cleansing, standardizing and validating data. Figure 4 shows an example of the appearance of a BI system, and the different parts will be described in this chapter. [7] [11]

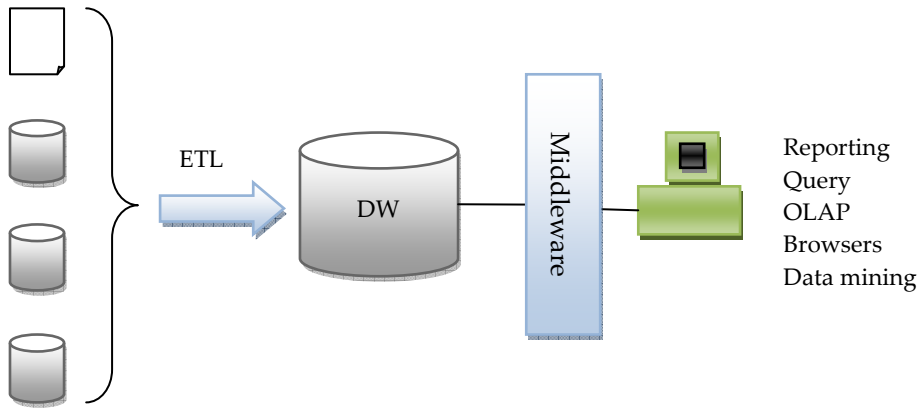

Figure 4: The parts of a BI system.

This is a common design of a BI system, but it is not the only design. Figure 5 shows different tools and techniques that could also be used.

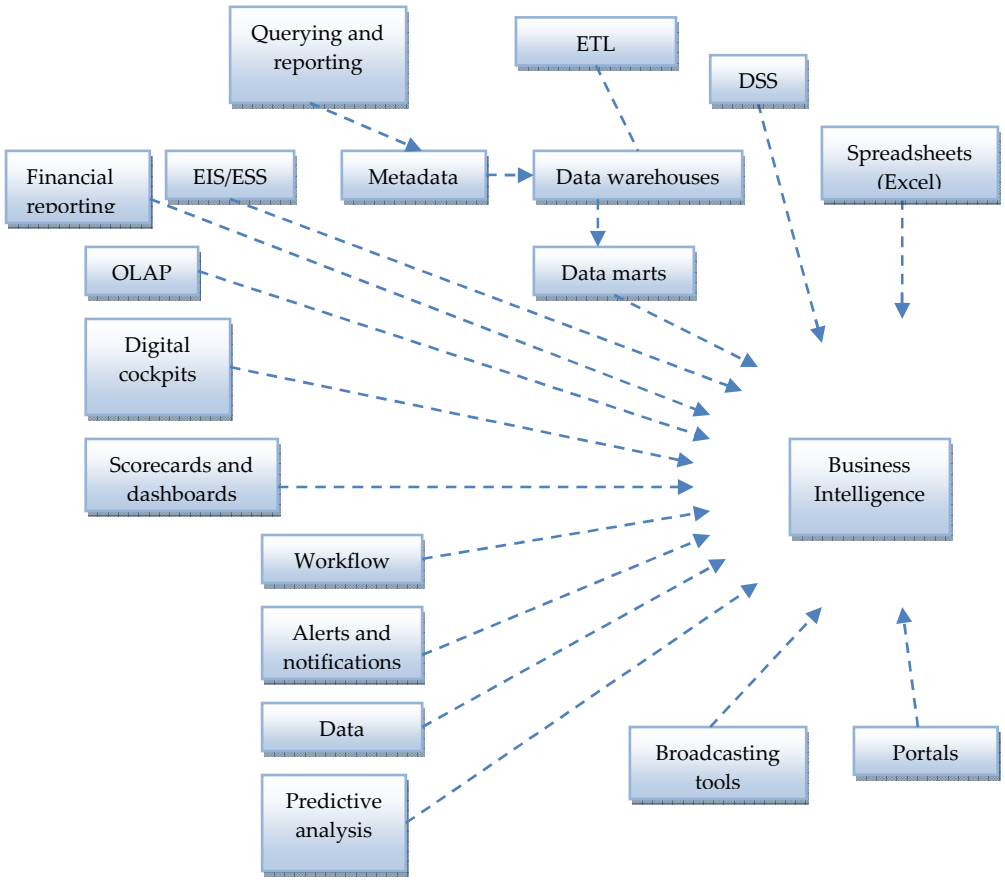

Figure 5: Possible elements of a BI system. [7]

3.1 Databases

Traditional operational databases are constructed to store large amounts of data over long periods of time. They are normalized in order to avoid redundancy and update anomalies, which are good qualities for efficient storage. Normalization, however, is not so good for reporting. In order to obtain data from several different tables, long JOINs must be used and extraction can become very time consuming.

For this reason, BI systems normally use a data warehouse that has a multidimensional design. Here, the focus is on the efficient data extraction instead of storage capacity.

Data from different databases and files are collected into the data warehouse and structured in such a way to support fast and effective queries, analysis and decision support.

Two popular multidimensional designs are the star schema and the snowflake schema. [7] [12] [13]

3.1.1 Star Schema

The star schema obtained its name from its appearance when it is drawn and the model is supposed to mirror business questions. The schema has a single object in the middle, called a fact table, and this is then linked to a number of objects called dimension tables, see Figure 6.

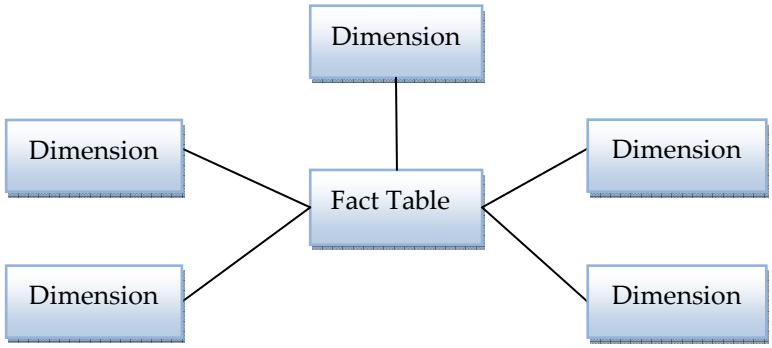

Figure 6: A star schema.

To show the relation between the fact table and the dimension tables, the primary key of the dimension table is used as a foreign key in the fact table. Together, the foreign keys make up the composite key of the fact table.

Dimension data and hierarchies are stored in a shared, non-normalized table. The benefit of this type of schema is that few JOIN operations are required. On the other hand, there could be an increased redundancy which could cause problems with insertions, updates and deletions.

The star schema is the most popular design schema for BI systems. This is because it provides the best performance for trend analysis, offers maximal flexibility for multidimensional analysis and is supported by most Database Management Systems (DBMSs). [12] [14]

3.1.2 Snowflake Schema

A snowflake schema is a variation of the star schema, in which the end points of the star (the dimension tables) are linked to additional points, see Figure 7. Data in the dimension tables are stored in the third normal form and every dimension´s hierarchy level is stored in a separate table.

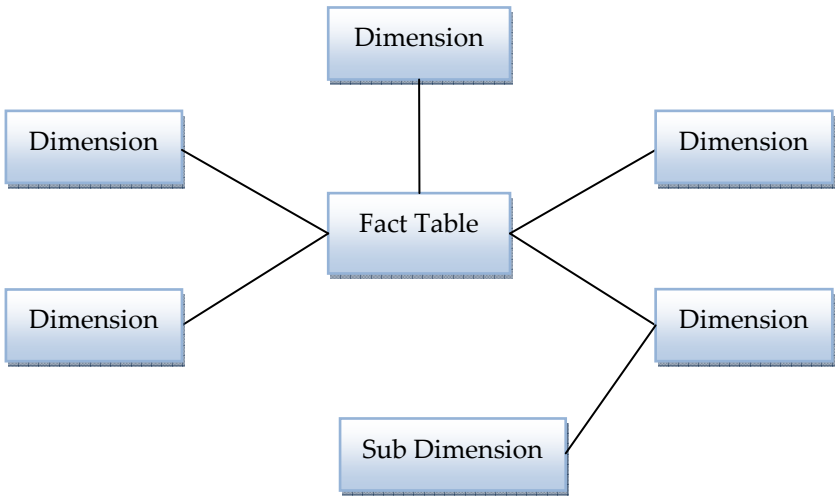

Figure 7: A snowflake schema.

As in the star schema, the foreign keys are used to show relations between the different tables.

The benefit of this model is that the sizes of the dimension tables are smaller and redundant data values are avoided. The negative side of the model is that the number of tables will increase, leading to an increase in the number of JOINs. This will eventually have a negative effect on the query performance. [12] [14]

3.2 ETL

One problem that may appear when collecting data to BI applications is that data can come from different platforms, and these platforms are controlled by different operating systems and applications. This may cause data to be inconsistent with the business, summarization and calculation rules that are used in the BI database.

To rectify the problem a process called Extract/Transform/Load (ETL) is used, in which data from different platforms are transformed and merged to a standard format for the BI database. [7] [12]

The ETL process starts with a preparation for the formatting, merging and cleansing of data. Dirty data, for example cities that have been spelled differently in different locations, discovered during the analysis is cleansed so that all data is consistent. In addition to transforming raw data that are not compatible in type, length, or in other ways erroneous, a significant part of the transformational logic is made up of precalculating data for multidimensional storage.

A common estimate is that 80 percent of the work during the ETL process is conducted in the transformation part, and in which extensive data integration and cleansing is required. Extraction and loading make up the remaining 20 percent.

The final step of the process is to perform the loading to the BI database. This can be performed by inserting new rows into tables or by using the bulk load provided by the DBMS. [12]

3.3 OLAP

On-Line Analytical Processing (OLAP) is a collection of technologies that have been designed for ad hoc data access in order to create and answer questions and to perform an analysis. OLAP has become synonymous with multidimensional views of data, and these multidimensional views are supported by multidimensional database techniques. [7] [13]

Most approaches to OLAP focus on transforming relational and file data to a multidimensional model that is optimized for analysis. This model is similar to a Rubik´s cube, where the data is stored in dimensions. The cube structure makes it possible to analyze data along different axes, see Figure 8. [7] [13] [14]

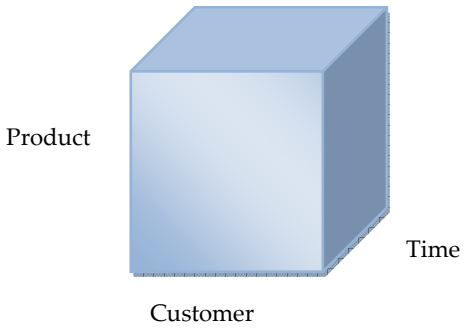

Figure 8: Data cube with dimensions product, customer and time.

Different questions can then be asked against the cube, for example the product that was mostly purchased by young people between 18 and 25 during July 2009. Selecting data in this manner is called rotation and slice and dice, which means that different filters are used to single out data of interest for the particular question. By using slice and dice, it is possible to look only at the product mobile phones, and it then becomes possible to determine the profit on phones for different customer segments over time. If the requirement is to investigate a specific group, the cube is rotated and then drilling down to the information.

There are three different designs for storing multidimensional structures in a database to choose from. These are called multidimensional OLAP (MOLAP), relational OLAP (ROLAP) and hybrid OLAP (HOLAP). [14]

3.3.1 Multidimensional OLAP

MOLAP systems use Multidimensional Database Systems (MDDBs) that offer an existing multidimensional memory structure. This direct mapping provides a very good query performance, but since this performance has to do with memory volume there is a risk of high costs. The memory structure also causes longer load times than ROLAP since the multidimensional structures are not filled until after the data warehouse has been loaded. Compression techniques are used to avoid empty cells, a problem in early MDDBs, and some overhead present in the transactional databases can be avoided. [14]

3.3.2 Relational OLAP

ROLAP systems use a virtual model to copy multidimensional structures to the corresponding relational structures. This transformation

provides the ROLAP systems with a considerably worse query performance than is the case for MOLAP, but on the other hand it requires less memory and offers better scalability because the cubes are virtual. Since less transformation is required in the loading process it is quicker than for MOLAP. [14]

3.3.3 Hybrid OLAP

HOLAP systems attempt to join the benefits of both MOLAP and ROLAP. The aggregation levels are normally stored in a multidimensional memory structure since this provides a remarkable improvement in query performance. Queries that are seldom run or that require significant system resources are calculated directly and data is stored in a relational structure.

HOLAP gives optimal scalability, query time and load processing but the administration becomes more extensive and requires special tools. [14]

3.4 Data Mining

Data mining is a collection of techniques that is used to analyze the enormous quantity of data that has been gathered during the generic process in order to discover important (previously unknown) information. The extraction process uses techniques and methods found in mathematics, statistics and artificial intelligence. Five commonly used techniques are

Association discovery	Identifies behavior for specific events or processes. It is based on rules of the form "if A is part of an event, then in x percent of the cases B is part of the same event".
Sequential discovery	Similar to association discovery but links associations over time and determines how things relate to each other.
Classification	Looks at behaviors and attributes for predefined groups. Historic data is analyzed and a model is created that can be used for prognoses.

Clustering	Discovers segments in data. The technique is similar to classification but no groups have been defined.
Forecast	Forecasts can be created by regression analysis or time series discovery. Regression analysis uses known data values to predict future values based on historic trends and statistics. Time series discovery only predicts time-dependent data values.

Data mining can provide answers to many questions and is often used for quality control, process management and fraud detection. [6] [7] [12]

4 Service Oriented Architecture

Marks and Bell [15] describe Service Oriented Architecture (SOA) as a conceptual architecture in which functionality or logic is made available to a user as shared and reusable services in a network. Figure 9 shows the components that collaborate in a SOA.

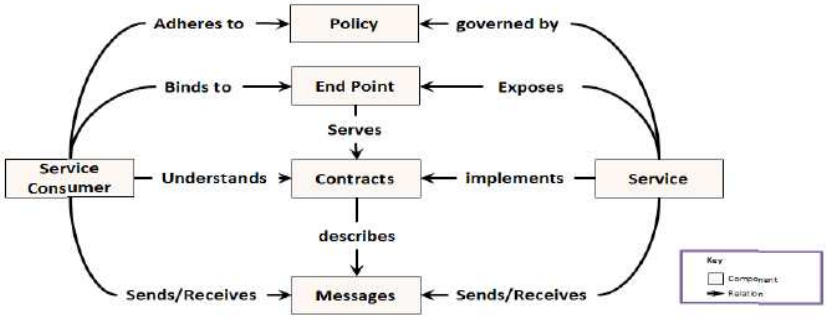

Figure 9: Components and relations in a SOA. [16]

Services are the foundation of a SOA. It often appears that SOA equals web services but although they are popular and often used, they are not the only type of service that can occur. All services that may exist in an organization can also be part of a SOA. [15]

Communication in the architecture is conducted by messages and all messages that are supported by a service constitute its contract. The service can be reached through a specific address, its end point, and a policy specifies the characteristics of the service, for example security rules.

All programs that communicate with a service through messages are called service consumers. [16]

One benefit that is often mentioned in connection with SOA is that companies and organizations that develop a well thought-out SOA service layer do not have to worry about costly and, sooner or later, outdated middleware and integration platforms. Unfortunately, it is not very easy to implement, manage and control a SOA.

It is not actually the technique that is the problem but the fact that a successful SOA demands changes within the whole organization. [15]

4.1 SOA for BI

Rotem-Gal-Oz [17] points out an obvious problem associated with the use of SOA for BI. In such a system, data is the key component and data is what is required to be collected, transformed, analyzed, modelled, discovered and reported. Data must in other words be easily accessible. When SOA is used, data will be scattered between services and hidden behind contracts. The vision here is that data should never be available outside the service, but it is exactly this data that BI wants, which creates a conflict of interest.

A first strategy that could be used to access data from the services is to use regular ETL operations for BI systems. This method, however, goes against all the reasons for choosing SOA in the first place since this creates a point-to-point connection and a dependency between the system and the service.

The second strategy is to use the existing contracts available for the services and regularly poll data. This presents two new issues. If the services are consumed regularly there will be large amounts of data transported over the network, which has a negative impact on the bandwidth. To resolve this, the interval between the polls could be extended, but then the risk is in missing important events during the waiting period. An alternative is to create specific BI contracts but this would result in the same situation as with ETL.

The third and last option is to combine SOA with event-driven architecture (EDA) and its ability to publish events. By adding publishing messages into the contracts, a service is able to publish its state on a regular basis. This approach solves the bandwidth problem to some extent since no polling is necessary. By creating an event stream in the network, the BI components can collect and wash data as required and then push it into the data warehouse. The streams could also be used for runtime analysis.

5 Usability

The term usability can be described in many different ways. International Organization for Standardization (ISO) gives the following definition: "Extent to which a product can be used by specified users to achieve specified goals in a specified context of use with effectiveness, efficiency, and satisfaction." [18]

Jakob Nielsen [19] [20] extends the definition of usability to the following five components:

Learnability	A system should be easy to learn so that the user can start to work with it rapidly.
Efficiency	A system should be efficient to use. As soon as it has been learned, it should give the user a high productivity.
Memorability	It should be easy to remember how a system works so that users who do not use it on a daily basis will not have to relearn it on every occasion.
Errors	A system should be designed so that users can make few errors and can easily correct those that do occur.
Satisfaction	The user´s subjective feeling about the system should be positive – they should like to use it.

Usability is in other words a term that puts the user first, not the product or system.

5.1 Usability Testing

Usability tests can be performed in many different ways depending on what should be tested and the means available. It may range from a simple inspection test to controlled experiments with test groups that represent the intended end users.

Section 5.1.1-5.1.2 will describe three different test methods - heuristic evaluations, interviews and surveys.

5.1.1 Heuristic Evaluation

Heuristic evaluation is the most popular way to conduct an inspection test. This is because the method is both cheap and effective.

In a heuristic evaluation, the product of interest is examined against a set of rules or principles to determine how well they have been met. Such a set of rules can be quite extensive, but in one way or another it is often connected to the ten rules given by Nielsen´s model:

Visible system status	A system should always keep the user informed of what is happening through appropriate feedback within reasonable time.
Conformity between system and environment	The system should use a natural language that is familiar to the user instead of system oriented terms. Information should be provided in a natural and logical order.
User control and freedom	Users often choose the wrong functions by mistake and need a clear way back. The system should support undo and redo.
Consistency and standard	The system should follow platform conventions so that user's do not have to wonder if words and concepts have the same meaning or not.
Error prevention	Instead of good error messages, a system should have a thought-through design that prevents errors from occurring in the first place.

Recognition instead of memorizing	Make objects, functions and choices visible. Users should not have to remember information between dialogs. Instructions on how to use the system should be visible or easily accessible.
Flexibility and efficiency at use	Accelerators can often speed up the interaction for expert users to the extent that a system can support both novice and expert users.
Easthetic and minimalistic design	Dialogs should not contain information that is irrelevant or that is seldom required. Such information takes the focus away from what is actually important.
Help users to discover, diagnose and repair faults.	Error messages should be presented in natural language, describe the problem and give constructive tips on how to correct them.
Help and documentation	Help and documentation should be easy to search, focus on user tasks, list concrete steps to take and not be too extensive. [19] [20]

5.1.2 Interviews and Surveys

One of the significant benefits of surveys is that a large number of users can be reached through small means. A survey could for example be sent by e-mail or made available through a web site.

The challenge of surveys are, according to Barnum [20], to formulate the questions so that they cannot be misinterpreted and so that the participants can give their answers in a similar manner. This will provide a better basis for evaluation and in the end a better result. Surveys could be constructed using yes/no alternatives, but this approach will force the respondents to choose one option and there is no way to determine how

much or little they agree with a certain statement. For this reason, a scale with 4-5 degrees is often used.

Interviews present a good alternative when more information than can be learned from a survey is required. Respondents are often more willing to expand their answers in an interview than if they have to write them down in a survey. Performing interviews, however, is more time consuming which often leads to higher costs and smaller user groups. It is also important to remember that questions must be asked in the same order to every respondent, and as neutrally as possible so that the respondents are not influenced in any way. [20]

6 Methodology

This thesis will investigate how to better evaluate tools for BI systems than by merely looking at a customer's present technical environment or choosing a well-known vendor. The aim is to create a basis that will assist consultants to better understand a customer´s requirement and to be able to suggest the right development tool. The starting point is from Michael E. Porters model for an information system and a theoretical study will be performed in the areas of Business Intelligence and BI systems in order to understand how these concepts can be related to Porters theory, how computer support can be used to simplify the task of gathering information and analysis, and what other techniques are available in those areas.

Figure 10 shows how the methodology described in this section will help achieve the goals specified in chapter 1.

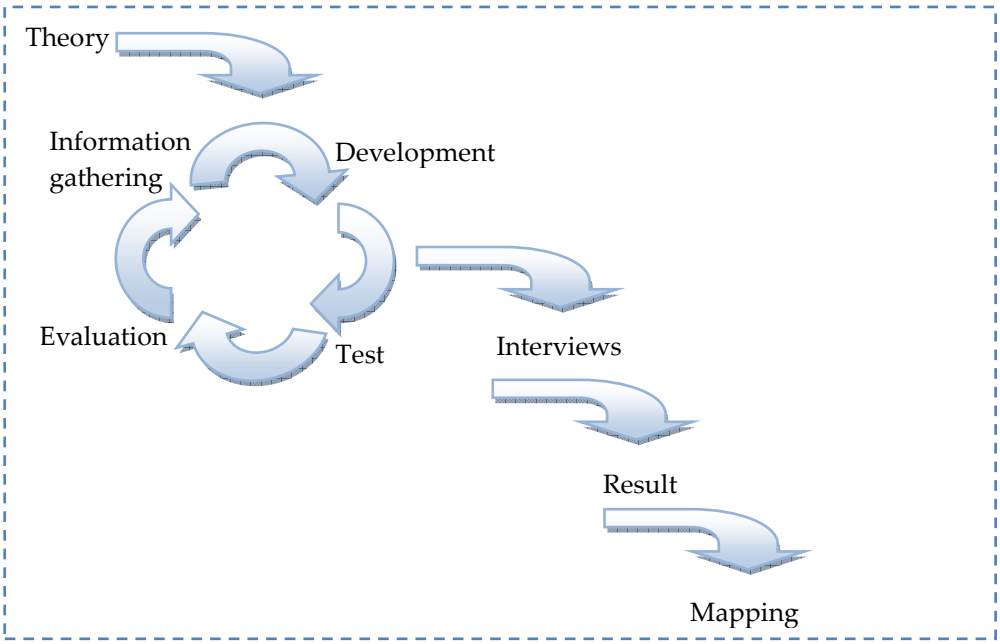

Figure 10: Method for achieving the goals of the thesis.

Since the work is based on a real assignment from Sogeti, three different tools for the development of BI systems from Cognos, Microsoft and SAP will be compared more closely. The functionality of the tools will

firstly be covered theoretically in terms of architecture, technical solution, compability and costs for licensing and education. This will then be followed by a practical development phase during which the author, by working with different cubes and reports, gains knowledge with regards as to how the tools are designed and how they differ when used. The purpose of this review is to find areas of interests for the following user tests and interviews.

In order to determine the usability, a usability test based on Nielsen's theories [19] [20] will be created and used on the tools. A user test will also be constructed to evaluate the user´s subjective feelings towards the tools. These two tests and the practical review will serve as a basis for the interviews that will be held with both developers and end users. The purpose of the interviews is to gather additional information about educational need, factors that determine the choice of tool today etc.

Finally, the results from the different parts will be summarized to show how the tools can be mapped to different customer situations.

7 Microsoft BI

Microsoft has had tools for databases, data warehouses, spreadsheets and information sharing for many years. As the interest for Business Intelligence started to increase it was not difficult for the company to develop a BI product. They simply took three popular solutions that companies already used or had knowledge of and, together, these formed Microsoft BI.

7.1 Architecture

Microsoft´s recommended BI solution has three tiers, as Figure 11 shows.

Figure 11: Tiers of Microsoft BI. [21]

The data infrastructure and platform is made up of SQL Server 2008 which contains Analysis services, Integration services, Reporting services and tools for data storage and data mining. The middle business tier is Office SharePoint Server 2007 that, besides an open, scalable architecture, offers Line of Business (LOB) data integration, content management, search functions, web based formulas, Excel services and dashboards. Finally, Office is used closest to the users in order to facilitate data exploration, predictive analysis and data visualization. [21]

7.2 SQL Server 2008

SQL Server 2008 is a continuation to SQL Server 2005 where the existing strengths have been retained and additional security functionality and BI support has been added.

On the BI side there is compression for data warehouses and backups, better performance for partitioned tables and queries, better scalability for Integration services, a new Report Designer and a deep integration with SharePoint Server. [22]

SQL Server 2008 can be installed on Microsoft´s own operating systems. Enterprise Edition can be installed on Windows Server 2003 and Windows Server 2008. Standard Edition comes with more options - Windows XP, Windows Vista, Windows 7, Windows Small Business Server, Windows Server 2003 and Windows Server 2008. The recommended web browser is Internet Explorer 6 SP1 or later versions. [23]

7.2.1 Integration Services

The core of SQL Server Integration Services (SSIS) is its transformation pipeline. It has a buffer oriented architecture that very rapidly manipulates table data which have been loaded into memory. All steps of the ETL process are made in one single operation without staging in order to achieve maximum performance. Copying to memory is also avoided, if possible.

SSIS converts all types of data to table format before data is loaded to the buffers. Thus, any operations that can be performed on regular table data can be performed during the entire trip through the pipeline.

Earlier versions of SSIS were optimized for Object Linking and Embedding, Database (OLE DB) or Open Database Connectivity (ODBC). The new version is optimized for ADO.NET in order to provide better system integration and third party support. SSIS can extract data from or load data to several different sources, for example SAP BW, by using adapters. These could be ADO.NET, OLE DB, ODBC, flat files, Excel and Extensive Markup Language (XML). Data can also be loaded directly into the cubes from the pipeline. [24]

7.2.2 Analysis Services

The cubes in SQL Server Analysis Services (SSAS) are multidimensional structures that offer users rapid access to large amounts of pre-aggregated data. The data is normally stored in MOLAP format, but SSAS also supports ROLAP and HOLAP. By using a technique called Block Computation, where only data that is not NULL is considered, the query performance can be greatly improved and it also allows a more granular analysis. SSAS also uses writeback, which means that cell values can be altered by users. Writeback data can be stored as MOLAP for better performance and proactive caching enables real time analysis. [25]

7.2.3 Reporting Services

SQL Server Reporting Services (SSRS) is a server based platform that supports different reporting needs, from ad hoc reporting to corporate reports and web-based reporting.

Since reports can be created by both developers and users there are report tools for both categories. The users are given a more intuitive environment separated from technical details in Report Builder and developers use the part of Business Intelligence Development Studio that is called Report Designer.

Thanks to the integration with SharePoint, all reports can be stored in one place and they could also be imbedded directly into SharePoint pages. The reports can be presented in several different formats depending on the requirement, for example Hyper Text Markup Language (HTML), Portable Document Format (PDF), Comma-separated Values (CSV), XML, Tagged Image File Format (TIFF), Word and Excel. [26]

An example report created in Report Designer can be found in Appendix D.

7.2.4 Business Intelligence Development Studio

SQL Server Business Intelligence Development Studio (BIDS) is a Visual Studio based development environment that is shared by SSIS, SSAS and SSRS. Apart from being a central place of development for BI applications, it could also be used for the development of other types of

Visual Studio projects. Along with SSIS Application Programming Interfaces (APIs), this makes it possible for developers to customize solutions in all languages supported under .NET or Visual C++. [22] [24] [26]

7.3 Cost

The major costs when implementing a new system, in addition to any hardware or consulting costs are licenses and education of staff. The license model and educations available for SQL Server 2008 will be described in section 7.3.1-7.3.2.

7.3.1 Licensing

Licensing for SQL Server 2008 can normally be conducted in three ways.

Processor license	A license is purchased for every physical or virtual processor used by an operating system environment running SQL Server software.
Server and client license	A server license is purchased for each operating system environment running an instance of the SQL Server software, and a client access license (CAL) for each client machine that communicates with a server running SQL Server.
Server and user license	A server license is purchased for each operating system environment running an instance of SQL Server software, and a user license for each user that communicates with a server running SQL Server.

The processor license is different to the other options since it, in addition to the installation rights for the server software, also allows an unlimited number of clients and users to use the software run by the processor, whether they reside inside or outside the organization. Microsoft only licenses full processors, no matter how many kernels they may contain.

Microsoft gives the following recommendation regarding how to choose the right license model.

Externly focused server applications	For Internet and extranet usage the processor license is recommended since it may be difficult to estimate the number of clients or users.
Mixed server usage	For servers used by both internal and external users/clients the processor license is recommended since the number of external connections may be difficult to predict.
Environments inside a firewall	If the client-to-server ratio is low and if there are several clients per user, the server and client licensing is recommended. This should be more cost efficient. If the ratio is high on the other hand, the processor license is the best option.

For SQL Server 2008 Microsoft provides the following license prices, given in Swedish currency.

	Processor	Server and CAL
Enterprise Edition	175 000 kr	60 000 kr for the server license and 1 100 kr per CAL
Standard Edition	41 000 kr	6 200 kr for the server license and 1 100 kr per CAL

The license price is paid once and then there is a choice of buying new licenses when a new version arrives or when purchasing Software Assurance, which for an annual fee will provide free support, training and upgrades to any new versions of the software. This cost will depend on the chosen edition and volume license program.

Figure 12 shows the relationship between the processor license cost and the cost of the server and client/user license in Enterprise Edition for one processor and one server.

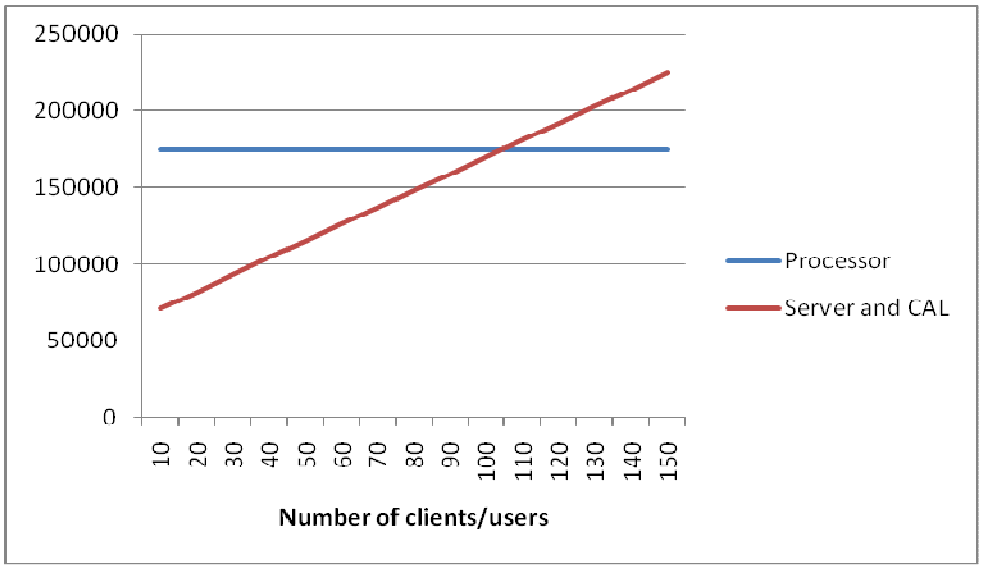

Figure 12: Cost in Enterprise Edition in regard to the number of users or clients.

A processor license is more cost efficient when the number of clients and/or users exceeds 100 or when the number is difficult to predict. If the number is less, it is better to choose a server license and then to add licenses for users or clients.

The relationship for Standard Edition is shown in Figure 13. Here the breaking point will occur earlier, at about 32 users or clients.

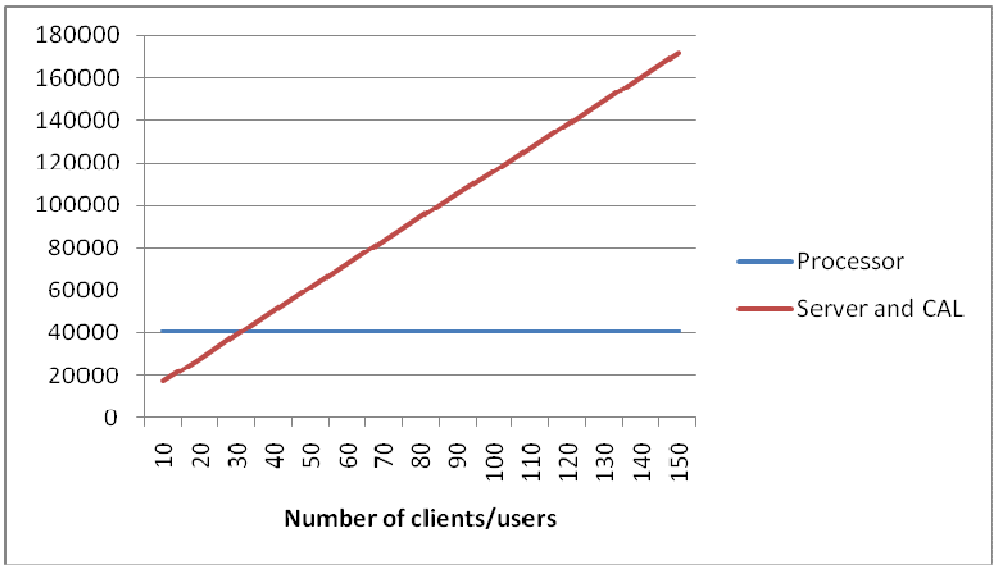

Figure 13: Cost in Standard Edition in regard to the number of users or clients.

If a company or organization will require more than five licenses, Microsoft recommend joining a volume license program. This means signing a contract for 2-3 years and during that time to have easy access to new licenses at discount prices. For small and mid sized businesses or organizations the Open programs are recommended. They consist of Microsoft Open Value and Microsoft Open License. The price depends on which products are licensed and how many licenses are required. For customers who transform their qualified long term licenses to subscription based (Open Value subscription) an actuality discount of 50 % is offered during the first year. For larger companies, organizations and corporations there are four different volume agreements: Select, Select Plus, Enterprise Agreement and Enterprise Subscription Agreement. [27] [28]

7.3.2 Education

Microsoft, at present, mainly offers education as e-learning so that staff can train when and where they wish instead of having to leave the workplace for several days at a time. This also means a reasonable price for the companies that buy the service. One of Microsoft´s partners, Microworld, offers a 12-month subscription on material for SQL Server 2005/2008 for about 10 000 kr. This package includes all official e-learning courses covering 19 different areas and it contains all information necessary for five different certifications. [29] [30]

There are also a number of education centers, many of whom are partners, which offer classroom courses for SQL Server. One could choose to take separate courses for SSAS, SSIS and SSRS, or a course focused on BI that covers all three areas. Price example:

SQL Server 2008 Analysis Services	3 days	18 950 kr
SQL Server 2008 Integration Services	4 days	21 950 kr
SQL Server 2008 Reporting Services	3 days	18 950 kr
Designing BI Solutions	5 days	23 950 kr

[31] [32] [33]

7.4 Usability

The constructed heuristic evaluation, see Appendix A, was used on Report Builder, Report Designer and SSAS (BIDS) to evaluate their respective usability. The survey, see Appendix B, covered the whole of Microsoft BI. The results are presented in section 7.4.1-7.4.2.

7.4.1 Heuristic Evaluation

Report Builder

For Report Builder the result was six negative marks and a usability measure of 92 %. For a complete table showing the marks per category, see Appendix C.

Three of the negative marks involved fields and this involved erroneous ones not being marked, the field length not being shown and it is not obvious which ones are obligatory and which are not. Furthermore, information is not available on different levels for expert and novice users, sound is not used to signal errors and error messages do not suggest appropriate help sections. It is however possible to use dynamic help which will provide a similar function.

Report Designer

For Report Designer the result was six negative marks and a usability measure of 92 %. The negative markings were the same as previously described for Report Builder. For a complete table showing the marks per category, see Appendix C.

SSAS

For SSAS the result was four negative marks and a usability measure of 94, 7 %. For a complete table showing the marks per category, see Appendix C.

The aspects not considered to be satisfactory during the evaluation were that erroneous objects or fields are not always marked or shown and there is no information about the maximum field length. Some icons for example process and refresh, appeared very similar which could result

in unnecessary errors. Finally, sound is not used to signal errors which sometimes could alert the user more quickly.

7.4.2 Survey

All of the developers think that SQL Server is easy to learn since there are plenty of wizards, guides and literature available for the tool. Once the tool has been learned, they feel that it gives them a good productivity and it is quite easy to remember how to do things in it. There are however a few things in Management Studio that can be troublesome in the beginning. Furthermore, the tool is designed so that few errors occur and those that do are for the greater part easy to repair. Overall, their subjective feeling about the tool is positive and they find it usable.

The developers who took part in this survey had 6 months to 10 years experience working with the tool and all had learned it by themselves and/or from each other.

All respondents say that they had, on occasions, felt anger or annoyance when working with the tool. They have also experienced that the tool has stopped working for no apparent reason. On the positive side, they do not feel that any kind of functionality is missing in the tool.

All respondents like the design and layout used in the tool and are content with the help and documentation available in it. They also feel that SQL Server´s reputation is correct.

When asked to state what they felt to be particularly good with SQL Server, the answers were flexibility, usability, performance, the ability to connect cubes to other tools such as Excel and SharePoint and that they always have a good view of the work in BIDS.

7.5 Educational Need

The educational need in SQL Server 2008 is quite low, especially on the user side. First of all, many users have already used Windows and Office which will make the environment feel familiar and comfortable. Secondly, there are wizards, tutorials and guides for just about everything one might want to do in the tool. As long as developers have had some database experience, learning BIDS and SQL Server Management

Studio will be quite easy. The only aspect which might involve some additional effort is MultiDimensional eXpressions (MDX), which is used to create selection statements etc. Microsoft BI uses MDX far more extensively than other tools and although it looks similar to Structured Query Language (SQL), they are two different languages.

8 SAP BW/NetWeaver

SAP is short for Systems Applications and Products, a German company that was founded in 1972 and which is one of the large vendors on the business system market. In order to offer customers who have invested in any of these systems, for example SAP R/3, a BI solution SAP has a package they call SAP BW/NetWeaver. [34] [35]

8.1 Architecture

The core of SAPs BI solution is the SAP Business Information Warehouse (SAP BW). As shown in Figure 14, the main components of SAP BW are the data warehouse, Administrator Workbench and Business Explorer.

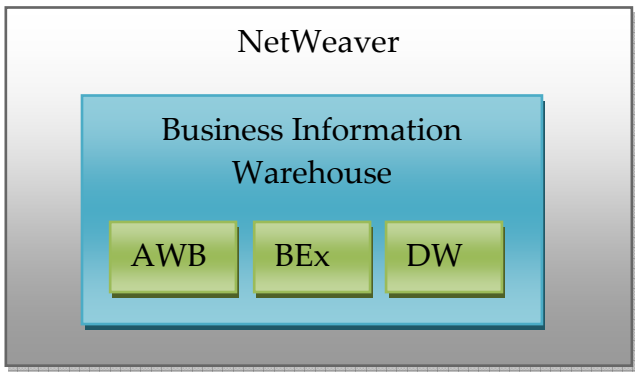

Figure 14: Architecture of SAP BW/NetWeaver.

NetWeaver is a scalable web-based integration and application platform that facilitates SOA. [14] [36]

8.2 SAP BW

SAP BW is an integrated data warehouse environment run on its own client/server installation. Figure 15 shows how this environment is constructed. Version 3.5 can be installed on IBM i5/OS, Sun Solaris 10, Windows 2000, Windows 2003, Windows XP, HP UX IA64, HP UX RISC and AIX 5.x. The recommended web browser is Internet Explorer but there is also support for Netscape. [37] [38]

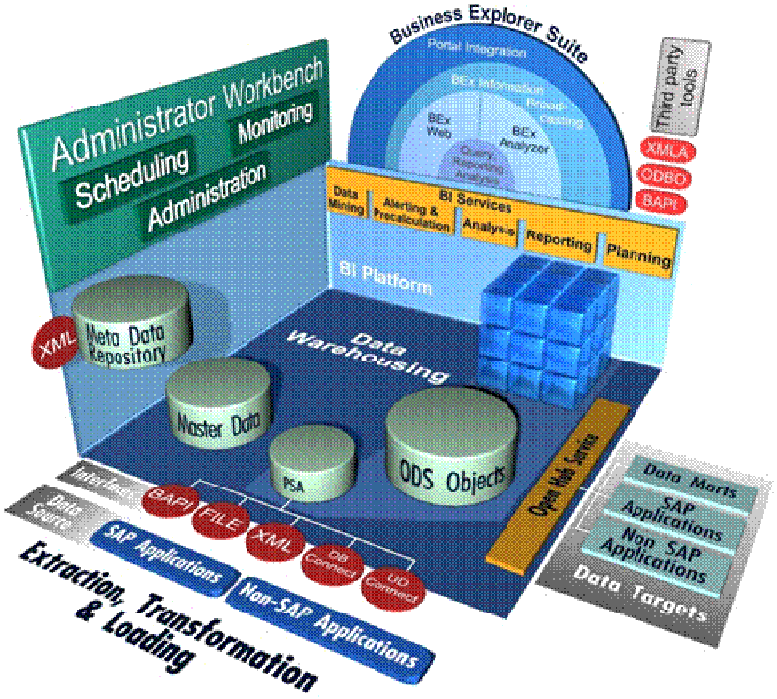

Figure 15: The architecture of SAP BW. [14]

BW consists of six different layers: ETL service layer, storage service layer, analysis and access layer, presentation and service layer, administration services and metadata services.

To be able to communicate with other SAP systems and third party systems, BW uses Application Link Enabling (ALE), Remote Function Call (RFC), XML, OLE DB for OLAP (ODBO), XML for Analysis (XMLA) or Business API (BAPI). [14]

8.2.1 Administrator Workbench

The administration services in SAP BW can be found under Administration Workbench (AWB). AWB is a central place where development, administration and maintenance can be performed. The main components of AWB are a metadata modeling component, the scheduler and the monitor.

SAP uses a terminology that is somewhat different to that used by Microsoft and Cognos. The foundation of BWs data model is its InfoObjects which can be divided into key figures and characteristics.

InfoObjects are gathered in InfoObjectCatalogs and these make up different InfoAreas. Objects containing data and views are called InfoProviders. The data objects can be InfoCubes, Operational Data Store (ODS) objects and InfoObjects containing master data. [14]

Enhanced Star Schema

When an InfoCube is to be modeled in AWB, SAP uses what they call an enhanced star schema, see Figure 16. This schema has two components – the cube´s star schema and master data with attributes, text and hierarchies. [14]

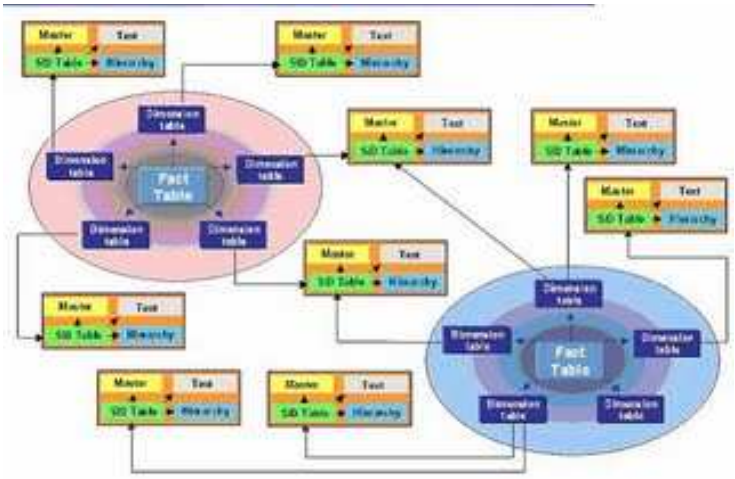

Figure 16: Extended Star Schema in SAP BW. [39]

The idea behind this model is to improve the star schema by moving the attributes from the dimension tables to master data tables that can be shared by several cubes. This, however, is not something that is done automatically. The developers must decide whether the attributes are to be stored in the dimensions, master data table or both. [39]

Data gathering

BW can collect data from a number of different sources, for example other SAP systems, flat files and XML. DB Connect is used to obtain data from database systems, for example Oracle, DB2, SQL Server or Informix, and UD Connect can be used to obtain data from practically all types of relational and multidimensional data sources, for example SQL Server.

Transfer rules and update rules decide how and when data is to be moved to the data warehouse. During the collection process necessary ETL operations are applied and data can also be staged in the Persistent Staging Area (PSA) to ensure that no errors are present before the cubes are loaded. [14] [38]

8.2.2 Business Explorer

The different tools provided for analysis and reporting in BW can be found in SAP Business Explorer (SAP BEx). These are

Query Designer	Tool for identifying queries against InfoProviders.
Web Application Designer	Tool for creating web reporting applications.
Web Applications	The environment that is used to run reports and analyses in a web browser.
Analyzer	The environment that is used to run queries in Excel.
Information Broadcasting	Makes it possible to make objects with BI content available to groups of users.

Apart from these tools there are also other functions for integrating web applications with a SAP Enterprise Portal and a Reporting Agent that can be used to print queries, create bookmarks or handle exceptional events. [14]

Query Designer

Query Designer is an icon based tool that is used to create queries. Here it is possible to choose the information that is to be shown in rows and columns, and different variables and filters can be used to refine the query. If the query is to be run more than once it can be saved as a template.

If several different users will run the query free characteristics can be added, which will allow them to twist and turn data with the parameters of choice.

When all parameters are set, the query can be run directly from Query Designer and the result is shown in a browser window. In addition to HTML, results can be exported to CSV or Excel. [14]

An example query created in Query Designer can be found in Appendix D.

8.3 Cost

The significant costs when implementing a new system, in addition to any hardware or consulting costs are licenses and education of staff. The license model and educations available for SAP BW will be described in sections 8.3.1-8.3.2.

8.3.1 Licensing

The license model for SAPs software consists of two parts – a software license and a maintenance and support service.

The software license is not for a specific version or time period. The licensed functionality can be used without restrictions but in order to upgrade to future versions a maintenance contract must exist or be entered into. The license is priced according to one of the business´s KPIs, for example the number of processed orders, plus the number of named users. Such a user license is in turn priced after the role of the user. The different roles available in SAP are

Developer	For users who take part in development tasks beyond pure system administration.
Business expert	For advanced users who use the software to manage the business and perform daily business transactions.
Professional	For primary users who use the software to perform daily business transactions.

Limited professional	For temporary users who use the software for limited business transactions.
Business information user	For temporary users who use the software for limited tasks such as reviewing reports.
Employee	For temporary users who only need to perform tasks in connection with their employment, for example expense reports.
Employee self-service	For employees who only need to update their own information, for example time reports.

In some cases the software license may be priced based on technical aspects, for example the number of processors in a server environment. If a processor has several kernels, the first one is counted as a full processor and every additional kernel as a half.

The maintenance and support service is offered against a recurrent fee and includes access to SAPs support infrastructure, error correction for the software and new versions of the licensed software. [40]

SAP has not been forthcoming about the price of licenses and support. There is no information on the web site and when asked they simply replied that this information was not available for students, but according to Wiklund [41] it is possible for larger groups who use a business system such as the R3 to be relieved of the pricing according to KPIs and only pay for user licenses and support. The cost is then about 4 000 kr per user and year. The users can then access both R3 and BW.

8.3.2 Education

SAP offers both classroom courses and e-learning for BI. There are several different courses available that can be combined according to the requirements. A recommended package for basic training is shown in Figure 17.

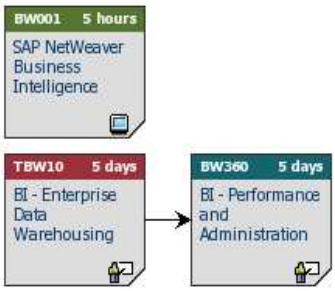

Figure 17: Technology Consultant Basic Training. [42]

The course BW001 is five hours long, given over the Internet and costs 5 500 kr. BW360 and TBW10 are both classroom courses and cost 31 500 kr each. The total cost for this package is 68 500 kr. [42]

8.4 Usability

The constructed heuristic evaluation, see Appendix A, was used on Query Designer and AWB to evaluate their respective usability. The survey, see Appendix B, covered the whole of SAP BW/NetWeaver. The results are presented in section 8.4.1-8.4.2.

8.4.1 Heuristic Evaluation

Query Designer

For Query Designer the test resulted in nine negative marks and a usability measure of 87 %. For a complete table showing the marks according to category, see Appendix C.

In Query Designer there are no menus and it does not support un-do/redo. It is completely icon based which no doubt is for simplicity, but this does not suit all users. In order to redo something the entire query must be aborted or one has to redo manually. This is negative for usability and makes the work tedious. Strong and close colors have not been avoided in the tool. A relatively strong green color is used together with a similar light green color. This is particularly bad for color blind people who often have a problem with or are unable to see red and green. What saves the tool in this aspect is the fact that color is combined with forms or pictures. Furthermore, the tool does not show the maximum length of fields and it is not obvious which fields are obligatory

and which not, which could cause unnecessary errors. Query Designer does not have any wizards or different information levels. It is assumed that users are professionals and/or educated. Finally, the tool does not suggest the help section when errors occur.

AWB

For AWB the result was seven negative marks and a usability measure of 90, 7 %, a somewhat better result than for Query Designer. For a complete table showing the marks according to categories, see Appendix C.

The test showed that it is very difficult, and sometimes impossible, to abort ongoing activities in AWB, and those performed cannot be revoked. If something goes wrong it must be redone correctly. As in Query Designer, similar green colors are used which poses a risk for the color blind and there is no guidance on the length of fields or which ones are obligatory and which not. AWB does not really support drag and drop to any extent which makes development tasks time consuming. Finally, the information in the help section or dialogs is not given at different levels.

8.4.2 Survey

The majority of developers do not think that BW is easy to learn. It is difficult to find and learn how to use transactions and cube development involves many steps without providing a good overview of the work. Once the tool has been learned, they feel that it provides them with satisfactory productivity and it is easy to remember how to do things. Furthermore, the tool is designed so that few errors occur and the ones that do are easy to repair. Overall, their subjective feeling about the tool is positive and apart from being difficult to learn they find it usable.

The developers who took part in this survey had 9 months to 2, 5 years experience in the tool and all had received external training. A few participants also mentioned studies on their own and/or seminars and webinars.

All respondents state that they sometimes experience anger or annoyance when working with the tool. One person also said that the tool had stopped working for no obvious reason.

When asked if they were missing something in the tool the answers were drag & drop (in AWB) and a better reporting tool. The drag & drop functionality will however appear in the next version of the tool so they don´t see this as being a problem for long.

The majority of respondents do not like the design and layout used in the tool but are content with the help and documentation available in it. The majority also felt that BW´s reputation is correct.

One of the developers has also used Cognos but thinks that BW is better.

Features that they find to be particularly good in BW include standard flows and reports that can be installed and used to set up reports for SAP Enterprise Resource Planning Central Component (ECC) and the fact that master data for objects can be shared between cubes.

8.5 Educational Need

Many users and developers will not have had any previous experience from SAP systems which makes BW a completely new environment. This is not necessarily negative, but the learning period will probably be longer than if the environment was familiar from the start. BW also uses a different terminology to other BI tools which may be confusing for developers who have used other tools before learning BW. Since AWB does not provide a good overview of tables and relationships and uses complex naming of objects, developers are likely to require some training before becoming really effective in their work. On the positive side, Query Designer is very simple to use for ad hoc analysis so users will not have to spend a great deal of time learning this functionality.

9 Cognos 8 BI

Cognos 8 BI is a web-based BI tool with integrated event management, analysis, reporting and spreadsheets. Cognos has recently been bought up by IBM and is now part of their software catalog.

9.1 Architecture

The web-based architecture of Cognos has been developed in order to offer scalability, availability and openness. By using platform independent techniques such as XML, SOAP and Web Services Definition Language (WSDL) Cognos can be integrated with a company´s existing infrastructure on several different platforms. Cognos 8 BI can be installed on IBM AIX 5.2-6.1, HP UX 11i, Windows Server 2003-2008, Windows 2000, Windows XP, Windows Vista, Windows 2000 Datacenter Server, Novell SUSE Linux Enterprise 10, Red Hat Enterprise Linux 4.6-5.2 and Sun Solaris 9-10. [43] [44] [45]

Cognos has a three tiered architecture, as shown in Figure 18. The three tiers are the web server tier, application tier and data tier. Normally they are separated by firewalls and the communication between the tiers is conducted using the Hyper Text Transfer Protocol (HTTP) and SOAP. Closest to the users are the user interfaces that are both web-based and windows-based. [43]

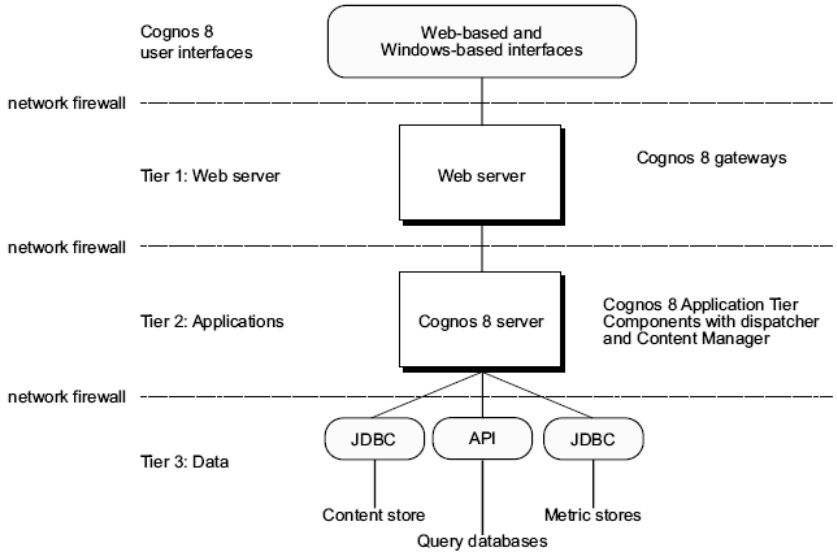

Figure 18: The architecture of Cognos 8 BI. [43]

9.2 User interfaces

Both web-based and windows-based user interfaces are used in Cognos 8 BI. These will be described more closely in section 9.2.1-9.2.2.

9.2.1 Web Based Interfaces

There are a number of different web-based interfaces, but depending on the user rights, different combinations will be available for the users.

Cognos Connection	Web portal that is the starting point when working with Cognos 8 BI. From here the user interfaces can be reached and other BI applications and links to applications can be integrated.
Cognos Office Connection	Can be used to show report content in workbooks and presentations in Microsoft Office.
Query Studio	Simple report tool for novice users.

Report Studio	Report tool for advanced users and developers where they can create, alter and distribute reports and templates.
Analysis Studio	Analysis tool for data sources.
Event Studio	Tool for creating agents that can monitor data and perform activities when specific events occur.
Metric Studio	Tool to create tailored spreadsheets where users can monitor, analyze and report on time-critical information [38].

For Cognos Connection, Query Studio and Metric Studio both Internet Explorer and Mozilla Firefox can be used, but in order to work with Report Studio, Analysis Studio or Event Studio, Internet Explorer must be used. [45]

Query Studio and Report Studio

Reports can be created using two different tools depending on the user´s knowledge and experience. The reports can be presented as HTML, PDF, CSV, XML or Excel. [43] [46]

Query Studio is the simpler report tool that has full support for drag and drop. The idea is that users should be able to create ad hoc reports and graphics easily instead of working with spreadsheets. When a report is finished it can be run directly and the results are shown in real time. The reports can also be saved and used as templates for more advanced reports in Report Studio.

Report Studio is a more advanced tool than that of Query Studio where reports can be designed in a similar manner to that of a web site. Different objects and tables can rapidly be placed where they belong by the drag and drop functionality. Links can be created to other reports or spreadsheets and as for the web, graphical objects can be used for hot spots, roll over and animation. This functionality makes it possible to tailor attractive reports with data at different levels. Report Studio can be used in either Professional authoring mode or Express authoring

mode. The professional mode provides full access to all functionality in Report Studio while express mode is a scaled down version with fewer report objects. [47] [48]

An example report created in Report Studio can be found in Appendix D.

Analysis Studio

Analysis Studio provides access to dimensional, OLAP and relational data sources. This makes it possible to explore, analyze and compare data, and the analyses created here can then be opened in Report Studio to be presented in report form. [43]

The analysis in Cognos 8 BI is based on the OLAP and analysis software Cognos PowerPlay. PowerPlay can handle large amounts of data and offers quick and predictable response times as well as multidimensional functions, such as drill down, slice and dice, filtering and sorting.

In addition to Cognos PowerCubes, third party cubes from Microsoft SSAS, SAP BW, Hyperion Essbase and IBM OLAP for DB2 can be analyzed without any modification. [44]

9.2.2 Window Based Interfaces

The windows-based interfaces of Cognos 8 BI are those that are used for modeling and integration.

Framework Manager	Tool for the creation and management of business-related metadata.
Metric designer	Tool for creating the extracts used by spreadsheet applications.
Transformer	Tool for modeling cubes.
Map Manager	Tool to import maps and update labels for maps in Report Studio.

Data Manager	Tool for data integration, data warehouse and ETL operations. [43]

Framework Manager

In Framework Manager business-related metadata can be created and managed. The metadata model can represent both dimensional and relational data and can be used for ad hoc reporting, advanced analysis, spreadsheets and dashboards. Such a model can use several different sources, for example ODS and data warehouses from IBM DB2, Oracle, SQL Server, SAP R/3, Siebel and Hyperion Essbase.

It is also possible to create dimensional models (cubes) from relational data. These cubes are modeled with the minimum amount of information that is required to access the cube. Dimensions, hierarchies and levels are loaded at runtime. [43] [49]

Transformer

Transformer is the tool used to model Cognos´ own cubes which are stored in MOLAP format. Data can come from many different sources and is transformed to Cognos PowerCubes. These cubes can be used with both version 7 and 8.

Transformer allows developers to visually design dimensions, levels, measures, rules, calculations and other multidimensional structures. PowerCubes can be constructed using a star or snowflake schema and it also discovers and suggests hierarchies automatically. [43] [44]

Data Manager

Data Manager is the tool that is used for extraction, transformation, loading and merging of data for data warehouses. Data can also be moved to Cognos without using Data Manager, but then there are no ETL operations available and all data must be consistent before it is imported. [50]

9.3 Web Server Tier

In the web server tier there are one or more Cognos 8 gateways present. When such a gateway receives a request, passwords are encrypted, information that is required in order to send the request to the server is retrieved, environmental variables for the server and a default namespace are added and finally the request is sent on to a dispatcher for processing. Several types of gateways are supported, for example Common Gateway Interface (CGI), apache_mod, Internet Server API (ISAPI) and servlet. [43]

9.4 Application Tier

In the application tier, one or more Cognos 8 BI servers and their respective services can be found, for example Dispatcher and Content Manager.

Since the server processes and summarizes data in the application tier and only returns summarized results, bandwidth is saved and the network performance is optimized. The results of the queries are stored in the server's cache and are retrieved from here if possible. This is beneficial for the query time and makes it possible to run more queries in a shorter time. [43] [44]

9.4.1 Dispatcher

The Dispatcher starts all Cognos services that have been configured and made available on a computer and it also directs requests. It is a multi-thread application that uses one or more threads per request and for security the Dispatcher also contains Cognos Application Firewall.

When the Dispatcher starts up it registers itself with Content Manager. This makes each dispatcher aware of all others that are active. [43]

9.4.2 Content Manager

Content Manager is the Cognos service that handles the storage of customer application data, for example report specifications, models, configuration data and security settings. The service is required in order to be able to publish models, open or save report specifications and report content.

Content Manager stores the information in a content store database that usually resides in the third tier. To communicate with the content store and metric store the Content Manager uses a Java Database Connectivity (JDBC) API. Cognos 8 BI comes with JDBC drivers for SQL Server on both Windows and UNIX platforms. In order to use databases from Oracle, IBM or Sybase drivers must be downloaded from the vendors. [43]

9.5 Data warehouse

The data warehouse in Cognos 8 BI has three main components: content store, metric store and data sources.

Content store is a relational database that contains report specifications, packets of published models, connection information for the data sources, scheduling information and namespace information etc - everything that the tool requires in order to function. Large amounts of information found in the database are stored as Binary Large Object (BLOB) fields and this is also where compression of report results is conducted.

Data sources are physical storage locations, for example dimensional cubes, flat files and relational databases that can be accessed by Cognos.

Metric store is a relational database that contains settings for Metric Studio. It could be user settings and metric packages. Several databases can be created for different types of applications. [43]

9.6 Cost

The significant costs when implementing a new system, in addition to any hardware or consulting costs are licenses and education of staff. The license model and educations available for Cognos 8 BI will be described in section 9.6.1-9.6.2.

9.6.1 Licensing

Cognos uses a license model called Per User. Table 1 shows the interfaces available for the most common user roles.

Table 1: User roles in Cognos 8.

	Remote Recipient	Recipient	Consumer	Business Author	Business Analyst	Business Manager	Professional Author	BI Professional	BI Administrator
Cognos Connection		x	x	x	x	x	x	x	x
Query Studio				x			x	x	x
Report Studio							x	x	x
Event Studio								x	x
Metric Studio						x		x	x
Analysis Studio					x			x	x

[48]

These roles are shown below with their respective license price. In addition to these roles there are numerous others for Cognos 8 Go! Mobile, migration licenses for customer who are using Cognos 7 etc. Support and upgrades are also available for an annual fee (25 % of the license cost).

Development, modeling and administration	Cognos 8 BI Administrator	70 000 kr
Roles	Cognos 8 BI Professional	16 800 kr
	Cognos 8 BI Professional Author	16 800 kr
	Cognos 8 BI Business Analyst	7 300 kr
	Cognos 8 BI Business Author	7 300 kr
	Cognos 8 BI Business Manager	7 300 kr

Consumer roles	Cognos 8 BI Consumer	4 500 kr
	Cognos 8 BI Recipient	1 700 kr [51]

Figure 19 shows IBM´s own estimate of how the user roles are distributed in a BI system.

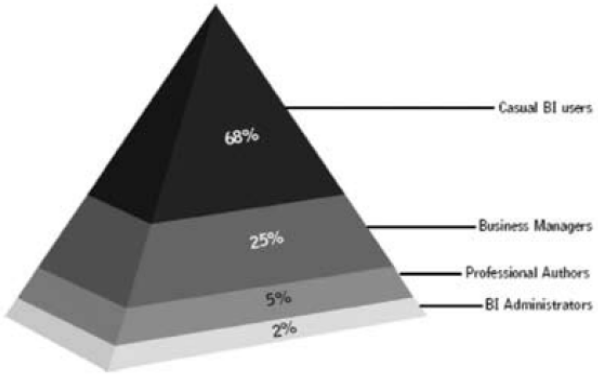

Figure 19: Distribution of roles in Cognos 8 BI. [52]

9.6.2 Education

IBM offers both e-learning and classroom courses for Cognos 8 BI. There are a number of different courses for the different BI parts, for example

Framework Manager	5 days	27 500 kr
Analysis Studio	1 day	5 500 kr
Report Studio	3 days	16 500 kr
Data Manager	5 days	27 500 kr

If a basic course that covers the entire work flow is of interest, there is a course called Essentials for IBM Cognos 8 BI. It is a tutored course during a five day period plus four days of e-learning. This option costs about 37 000 kr. [53]

9.7 Usability

The constructed heuristic evaluation, see Appendix A, was used on Query Studio, Report Studio and Analysis Studio to evaluate their respective usability. The survey, see Appendix B, covered the whole of Cognos 8 BI. The results are presented in section 9.7.1-9.7.2.

9.7.1 Heuristic Evaluation

Query Studio

The result for Query Studio was 10 negative marks and a usability measure of 87 %. For a complete table showing the marks according to categories, see Appendix C.

Erroneous fields and objects are not marked and there is no information about the maximum field length or which fields are obligatory and which not. In a similar manner to Query Designer, Query Studio is mostly icon based even though there are a few menu links. When choices are to be made the pointing device must be used and except for F1 for help there are no commands. When performing searches the system is not case insensitive. It is for example not possible to write sca or germany and obtain a hit. When an error occurs no sound signal is used and depending on where the error occurs different error messages can be shown. The error messages do not suggest the help section and the information is not given at different levels. Apart from the test itself, another error was encountered. The help could not be accessed by the icon – F1 had to be used.

Report Studio

The result for Report Studio was eight negative marks and a usability measure of 89 %. For a complete table showing the marks according to categories, see Appendix C.

As in Query Studio, there is no marking of erroneous fields and objects, the field length is not shown and it is not obvious which fields are obligatory and which not. The system is not case insensitive and only F1 works as a command.

Sound is not used to signal errors, error messages do not suggest the help section and the help can only be opened by pressing F1.

Analysis Studio

The result for Analysis Studio was eight negative marks and a usability measure of 89 %. For a complete table showing the marks according to categories, see Appendix C.

The negative markings were the same as previously described for Report Studio.

9.7.2 Survey

All developers think that Cognos is easy to learn. Once the tool has been learned, it was felt that it provided good productivity and it is quite easy to remember how to do things in it. There are however a few more advanced functions that might take some time to learn properly. Furthermore, the tool is designed so that few errors occur and those that do are easy to repair. Overall, their subjective feeling about the tool is positive and once learned they find it usable.

The developers who took part in this survey had 2 months to 1, 5 years experience in the tool and all had received some internal training to learn the basic functionality and after that they had been practicing on their own.

A majority of the respondents stated that they sometimes felt anger or annoyance when working with the tool. It has also stopped working for no obvious reason. On the positive side, they do not feel that they are missing any functionality in the tool.

All respondents like the design and layout used in the tool but all are not content with the help and documentation available in it. One respondent says that it sometimes can be difficult to find the right information. They all feel that the reputation of Cognos is correct.

One of the developers has also used BW but thinks that Cognos is better since it has a much better reporting functionality.

BW´s enhanced star schema and terminology was also difficult to understand when being used to the traditional terminology and star schema.

When asked what aspects were felt to be particularly good in Cognos the answers were that it is easy to create advanced reports in a short amount of time and that it is compatible with many operating systems, databases and cubes.

9.8 Educational Need

Since the majority of developers and users today are experienced in the use of the Internet and web browsers, the web-based part of Cognos will feel familiar and quite easy to use. Some of the more advanced reporting objects may require a little training and not many books are available on the market. There is however an interactive training called Cognos Tours available which covers the basic steps of working with the tools. The windows-based interfaces used for modeling is not covered in the Cognos Tours and requires some training before developers can work efficiently.

End users will probably not need any courses in order to use the reporting and analysis tool. Internal training or Cognos Tours will most likely be sufficient for this group.

10 Results

In section 10 the results of the investigation will be presented.

10.1 Architecture

SAP BW and SQL Server both use the traditional client/server model with windows-based user interfaces. These tools can then be combined with the integration platforms NetWeaver and SharePoint to achieve scalability and SOA. Cognos 8 on the other hand is a completely integrated web-based system built on SOA. Cognos mostly uses web-based user interfaces but there are a few windows-based ones for modeling tasks too.

10.2 Compability

SQL Server Enterprise Edition can be installed on either Windows Server 2003 or Windows Server 2008. For the Standard Edition the choices are between Windows XP/Vista/7, Windows Small Business Server 2008 and Windows Server 2003/2008. The recommended web browser is Internet Explorer 6 SP1 or later versions.

SAP BW can be installed on SUSE Linux Enterprise Server 8-10, Windows Server 2003, Sun Solaris 10, HP UX 11i and IBMs i5/OS. The recommended web browser is Internet Explorer but BW also has support for Netscape.

Cognos 8 can be installed on IBM AIX 5.2-6.1, HP UX 11i, Windows Server 2003/2008, Windows 2000/ XP/ Vista, Windows 2000 Datacenter Server, Novell SUSE Linux Enterprise 10, Red Hat Enterprise Linux 4.6-5.2 and Sun Solaris 9-10. Cognos Connection, Query Studio and Metric Studio can be used with both Internet Explorer 6 SP1 (and later versions) and Mozilla Firefox. Report Studio, Analysis Studio and Event Studio require Internet Explorer 6 or later.

10.2.1 Third-party cubes

SQL Server and Cognos both know how to handle SAP BWs InfoCubes, Cognos and SAP BW both know how to handle SQL Server cubes but neither SQL Server nor SAP BW can use Cognos cubes. Cognos can also make use of cubes from Hyperion Essbase and IBM OLAP for DB2.

10.3 Data warehousing

SAP BW uses the enhanced star schema while SQL Server and Cognos normally use the regular star schema. The star schema is the most popular design schema for BI systems since it provides the best performance for trend analysis, gives maximal flexibility for multidimensional analysis and is supported by most DBMSs. What is said to be the advantage of the enhanced schema is that attributes can be shared between cubes, but the developers must also be careful when deciding where to store the attributes so that there is not much duplicate data where it is not necessary.

10.3.1 OLAP formats

All three tools normally store data as MOLAP which is the best alternative for achieving good query performance. In SQL Server and SAP BW it is also possible to store data as ROLAP or HOLAP while Cognos only supports ROLAP.

10.3.2 Integration and ETL

SAP BW has a built-in ETL tool and data can be collected to the data warehouse directly or through the PSA. SSIS collects data without staging and loading and ETL operations are performed in one step. Copying to memory is also avoided, if possible. Cognos Data Manager is used for data integration and staging and ETL operations can be performed if required.

10.4 Modeling and analysis

In SAP BW there is a restriction of 16 dimensions for a cube while SQL Server and Cognos can have cubes with an unlimited number of dimensions. SQL Server and Cognos both provide a graphical view of cubes, models and relations while BW does not. They also fully support drag and drop, which is not currently the case in BW.

10.5 Reporting

SQL Server offers two different reporting tools – Report Builder and Report Designer. The available report formats are HTML, PDF, CSV, XML, TIFF, Word and Excel.

SAP BW does not really offer a pure reporting tool. Queries are created in Query Designer and the result is shown as HTML and it can also be exported to CSV and Excel. Templates can be opened in Web Application Designer where additional functionality can be added. These functions, however, cannot be exported to any other format.

Cognos has two reporting tools – Query Studio and Report Studio, where the latter can be used in Professional authoring mode or Express authoring mode. The report formats available are HTML, PDF, CSV, XML and Excel.

10.6 Licensing

In large companies where many employees will be using the BI system the initial cost for Cognos will be very high compared to SQL Server and BW. Table 2 shows an example with 50 users based on the distribution for Cognos that was described in chapter 8.

Table 2: Initial license costs in the different tools.

Tool	License option	Price	Sum
Cognos 8 BI	1 BI Administrator	70 000 kr	
	3 Professional Author	50 400 kr	
	12 Business Manager	87 600 kr	
	34 Consumer	153 000 kr	361 000 kr
SQL Server Standard Edition	1 server	6 200 kr	
	50 Client Access License	55 000 kr	61 200 kr
	1 processor	41 000 kr	41 000 kr
SQL Server Enterprise Edition	1 server	60 000 kr	
	50 Client Access License	55 000 kr	115 000 kr
	1 processor	175 000 kr	175 000 kr
SAP BW	50 Professional	200 000 kr	200 000 kr

This shows that there is plenty of room for additional users or clients in both server license options for SQL Server before the cost of Cognos is met. More exactly it would be possible to add 272 users or clients in Standard Edition or 223 users or clients in Enterprise Edition. For the processor option the number of users or clients is unlimited. For BW the number of extra users would be approximately 40. It should be noted however, that this estimate is only valid for large groups who also use some SAP business system.

10.7 Education

There are good educational opportunities for all tools and they all offer a choice between classroom courses and e-learning.

Table 3 shows an estimated price list with separate courses for the parts involved in reporting, modeling and integration. To perform a direct comparison in this area is not totally fair since the content of the courses are so different, but the prices might be of interest when considering the total cost of the investment.

Table 3: Educational cost for the different tools.

Tool	Part	Price	Sum
Cognos 8 BI	Framework Manager	27 500 kr	
	Analysis Studio	5 500 kr	
	Report Studio	16 500 kr	
	Data Manager	27 500 kr	77 000 kr
SQL Server 2008	SSAS	18 950 kr	
	SSRS	18 950 kr	
	SSIS	21 950 kr	59 850 kr
SAP BW/NetWeaver	NetWeaver BI	5 500 kr	
	BI-Performance and administration	31 500 kr	
	Enterprise Data Warehousing	31 500 kr	68 500 kr

The education for SQL Server will be the least costly one, followed by SAP BW/NetWeaver and Cognos 8 BI.

10.7.1 Educational need

Since many companies already use Windows and Office, the environment in SQL Server will feel familiar to the users. There are also wizards and tutorials available for almost every possible action in SQL Server which will help novices create cubes, conduct analyses and design reports. This makes the educational requirements low and they may often be solved internally or through e-learning. MDX for specifying selections and some functionality in Management Studio might require some additional studies.

In contrast to what has just been stated for Microsoft, many users and developers may never have had any experience of SAP systems before

using BW. This tool also uses its own terminology and the enhanced star schema, so developers will probably require some training before being able to start. Conducting analyses and templates in Query Designer is, however, easy and does not require more than a quick introduction.

Cognos web-based user interfaces will feel familiar and quite intuitive to both developers and users. There are a few more advanced reporting actions that might require some training, but for the most part reporting and analysis can be learnt quickly for example by Cognos Tours. The modeling interfaces used by developers are not covered by Tours and must to be studied before they can be used efficiently.

10.8 Usability

In section 10.8.1 the results of the tests that were conducted on the reporting, analysis and modeling tools will be presented.

10.8.1 Heuristic Evaluation

Figure 20 shows the usability for the different reporting tools based on the heuristic evaluation. From this figure it is clear that all the tools meet an acceptable usability level since they all scored over 85 %. Both of Microsoft´s reporting tools received the highest score of 92 % followed by Cognos Report Studio at 89,5 %, BW Query Designer at 88 % and Cognos Query Studio at 86,5 %.

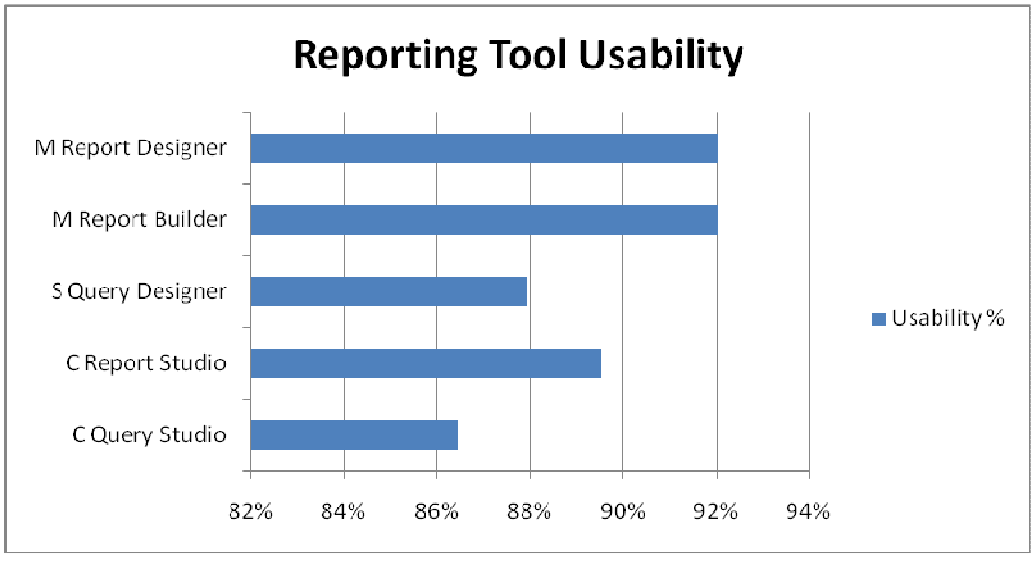

Figure 20: Usability for reporting tools.

Figure 21 shows the usability for the different analysis and modeling tools based on the heuristic evaluation. All tools in this category scored around 90 % or better, which is a positive result from the users´ point of view. Microsoft´s SSAS received the highest score of 94, 7 %.

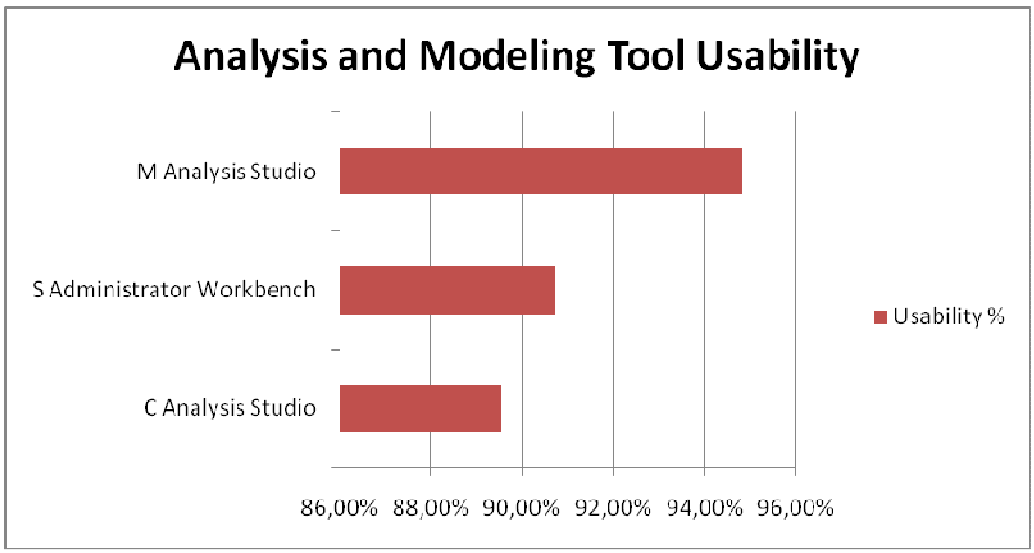

Figure 21: Usability for the analysis and modeling tools.

10.8.2 Survey

Figure 22 shows how developers feel about the usability in their respective tool.

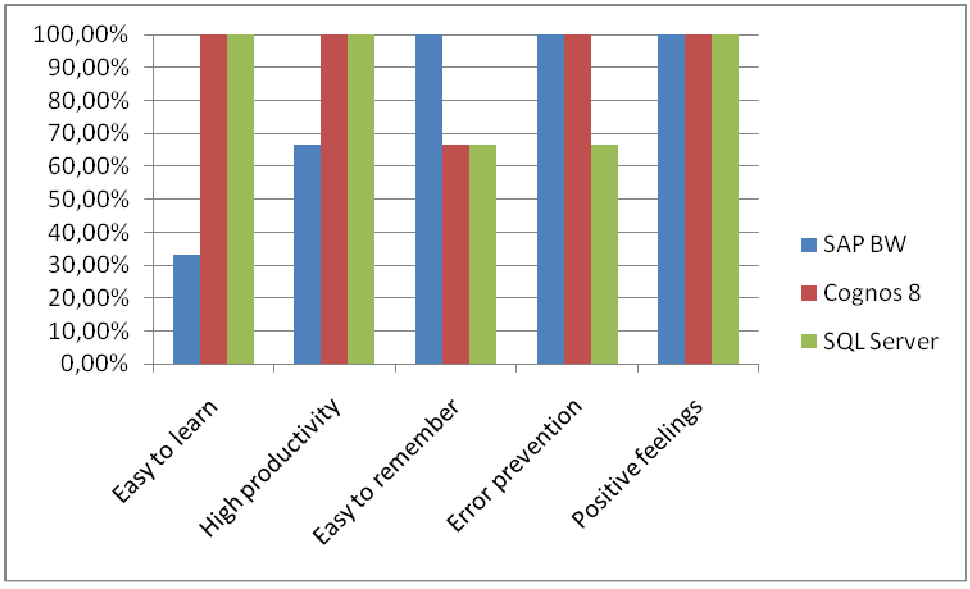

Figure 22: Usability according to developers.

From the figure it is clear that the developers like their respective tools since all three scored 100 % at this question. Overall, Cognos developers are pleased with the tool with the exception of some advanced functions being difficult to remember. BW developers do not find the tool very easy to learn and it could provide them with a higher productivity. It is however easy to remember how the tool works and to correct errors. Microsoft developers find the tool easy to learn and they feel that it offers them a high productivity. There are however some functions that are difficult to remember and some errors that are difficult to correct quickly.

11 Discussion

In section 11 the results will be discussed and a mapping will be provided for choosing the right tool depending on the customer situation.

11.1 Architecture, compability and integration

There are many and separate opinions regarding whether SOA should be used for BI or not. Based on the information found during this thesis it appears to be better to collect data to and from a data warehouse and only use SOA as an integration platform. Then the usual ETL tools can be used without compromising the encapsulation of services. During the development phase in Cognos some of the performance issues that might arise in BI systems that use SOA were noted. Running a report in Cognos took much longer than in the other tools and especially in Query Studio where data is handled in real time. Even simple reports soon become tiresome to work with since data is retrieved for each added object.

Cognos is, on the other hand, ahead when it comes to supported operating systems. The tool can be installed on most operating systems, something that cannot be said for Microsoft. It is clearly a limitation to only support Microsoft´s own operating systems and this has probably hindered some prospective buyers from choosing the tool. BW also receives credit for supporting Windows, UNIX, Linux and IBM, but it would be desirable to have more versions than are presently supported.

BW and Cognos both support the staging of data while SSIS loads data directly into the cubes. The SSIS method will be quicker but staging provides security in case something goes wrong during the load. Staging or no staging is probably a matter of taste and this choice will probably be of minor importance.

11.2 Modeling, analysis and reporting

Modeling cubes in SQL Server is fairly easy since there are both wizards and guides available. It is also helpful to always have a graphical view of the fact and dimension tables and the relations in order to understand

what information the cube can provide. Another plus is that everything can be performed in one place – BIDS. Modeling in Cognos is the opposite. If a relational or dimensional model is required then Framework Manager has to be used and to make Cognos cubes Transformer must be used. Even if the modeling itself is easy in Cognos it does not appear to be necessary to have two different interfaces. Modeling in AWB is quite different from SQL Server and Cognos. There is no view of the tables so developers must have a good understanding of the underlying data. Secondly, there is not much support for drag and drop so making selections from lists and clicking arrows and radio buttons takes time.

Analyzing data in BW is on the other hand very easy. There are short response times and the ability to add free characteristics is very good. Analyzing data in Cognos and BIDS is also straightforward and the tools do not differ much in the way they are used. There is however a risk of long response times in Cognos which is not satisfactory.

The fact that BW is lacking a proper reporting tool must be considered a major drawback. It is possible for analysis results to be viewed in HTML and to be exported to Excel and CSV, but none of these options provide a nice layout. Hopefully, this will appear in later versions now that SAP also has access to Business Objects. Cognos Report Studio and SSRS on the other hand are very good reporting tools with many available report formats. Reports created in these tools can be provided with a nice layout using images, maps, links etc. Cognos Report Studio would have been a particularly good front-end for BI systems had it not been for the license costs.

11.3 Usability, education and cost

SQL Server obtained the highest scores in all three heuristic evaluations and the developers also mentioned its usability in the survey. Obviously Microsoft has tried to make a usable tool and apart from a few minor details they have succeeded. BW and Cognos did not score as well but the developers are still in favor of their respective tool. The results of this thesis suggest that the SQL Server is the most complete tool of the three.

Cognos has good reporting, BW has good modeling and analysis but SQL Server is good in all areas as can be seen from the tests and surveys.

Comparing educations is difficult as they do not have the same content and all developers will not have the same requirements. SQL Server appears to be the cheapest but there is not a significant difference between the tools in this aspect.

End users will probably be able to achieve fairly advanced reports and analyses in all of the tools after only a short introduction while modeling and integration requires more knowledge. The number of wizards and guides in SQL Server will greatly assist developers and there is also an extensive user guide for Cognos. BW does not provide the same support and with its special terminology and enhanced star schema, it will be the tool that requires the most initial training. It is always a good idea to offer developers education - regardless of which tool they are working with - in order for them to perform their work in the most appropriate manner, but from the survey it is clear that BW is considered hardest to learn and developers are sent on courses while developers in Cognos and SQL Server have learned the tool themselves or from other developers. Although it might be easy to have an easy start to using these tools there is a great deal “under the hood” which should not be forgotten.

A decision in relation to the price for using the tools clearly shows that SQL Server is a very good choice. A processor license will allow an unlimited number of users and the server license is an alternative when there are few users. Cognos will be quite expensive when there are many users and system administrators will probably have to restrict the number of users and terminate inactive ones. BW is available for a reasonable price for large groups who use business systems such as R3, but it reasonable to believe that it will be much more expensive for smaller companies and those that do not have a business system from SAP.

11.4 Mapping

Figure 23 shows a perceptual mapping of the tools according to overall usability and cost. The usability dimension includes all usability test performed and the cost dimension includes the educational cost and initial license cost presented in the result chapter.

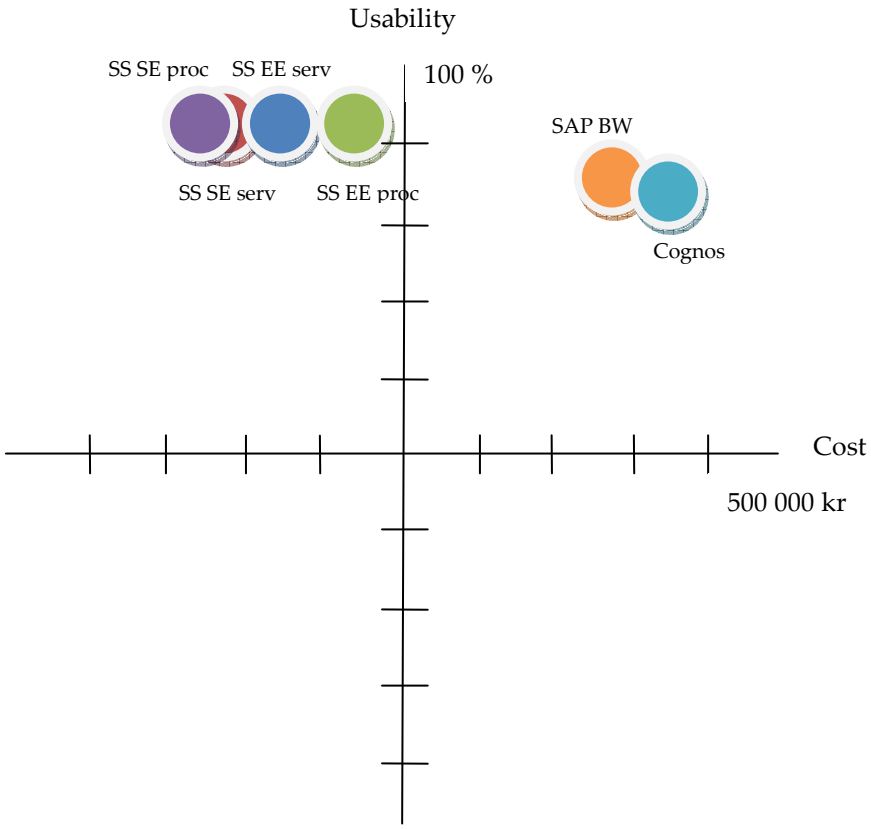

Figure 23: Perceptual mapping of usability versus cost for the tools.

From this mapping it is clear that SQL Server will provide a high usability at a low cost. However, other aspects might also need to be considered when choosing a BI tool. Figure 24 shows a flowchart that could be used as a guide for choosing between the tools based on the results presented previously.

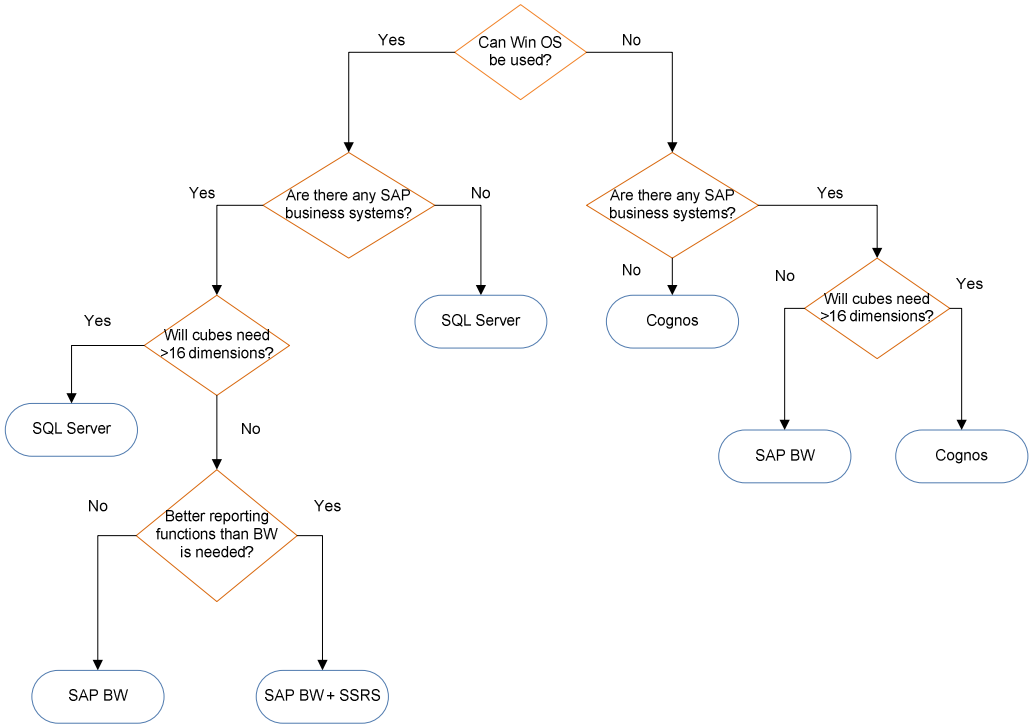

Figure 24: Flowchart for choosing BI-tool.

The first step is to consider whether or not Windows operating systems can be used. If so, are there any business systems from SAP that are going to be connected to the BI-system? If not, SQL Server will always be the best choice. If there are business systems, SAP BW should be considered since it comes with ready connections and there is a good chance for acceptable license costs. The question is then if more than 16 dimensions are required in the cubes and whether it is possible to make do with the limited reporting functionality in BW or whether better reports are required. The required cube size may not always be known beforehand but it is still an important aspect to consider. Previous experiences may guide developers in the right direction here. If 16 dimensions are sufficient and extra reporting functionality is not required then BW is the correct choice. If more than 16 dimensions are necessary then SQL Server should be chosen instead. For extra reporting functionality, Reporting Services could be used as a front-end for BW.

If, on the other hand, Windows will not or cannot be used as operating system, then SQL Server should not be considered. If there are business systems and 16 dimensions is sufficient then the choice should be towards BW. In this case it is not really possible to use Cognos as a

front-end since the costs would be too high, but other tools might be worth considering for reporting purposes. If business systems do not require to be considered and more than 16 dimensions in cubes are required or there is no real requirement for a good reporting tool, then the choice should be Cognos.

11.5 Reflection on the result

Since Cognos has been working with this type of systems exclusively over a long period of time, the expectation was that it should perform better than it did – and it was expected to prove to be the best tool of the three. The reporting tool is good but not sufficiently so to justify the additional cost. On the other hand it was felt that as Microsoft was relatively new in the BI market, some important functionality would be missing. This was also incorrect since SQL Server appeared to be both usable and worthy of its price. The development of SQL Server appears to have been a good decision instead of making a new BI tool. SQL Server provides both stability and a low learning threshold on the development side. BW is a reasonable choice if some SAP business system is already in use and will be connected to the BI system. It will provide the basic functionality required but it is also somewhat difficult to work with and lacking in refinement. The fact that SAP refuses to answer any questions about license costs could be interpreted as them not being competitive in that area.

11.6 Future work

One aspect not conducted during this investigation but could be of interest in the future is to set up three systems with the same data and cubes and then to compare query response times and storage size. These results could further assist in making a choice between these tools.

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Appendix A: Heuristic evaluation

The choice of a heuristic evaluation was a natural one. For this investigation it was not possible to conduct any controlled experiments with test groups and there was no budget. In this situation, the heuristic evaluation was the best alternative.

The heuristic evaluation was developed from Jakob Nielsen´s ten points for inspection of systems. For each point 5-10 questions were asked and the total number of questions was 75.

System …….

Synlig systemstatus		Ja	Nej	NA	Kommentar
1	Ges visuell återkoppling för aktiva fönster och fält?				
2	Vid väntan, visas timglas, klocka eller annat visuellt stöd för användaren?				
3	Ges visuell återkoppling när en ikon väljs eller flyttas?				
4	Kan användaren se vilka ikoner som är aktiva/inaktiva?				
5	Kan användaren se vilka menyval som är aktiva/inaktiva?				
6	Visar systemet var pekaren befinner sig?				
7	Markeras felande fält/objekt?				

Överensstämmelse mellan system och omvärld		Ja	Nej	NA	Kommentar
8	Används färger på ett sätt som förväntas av användaren?				
9	Används logiska namn för operationer (öppna/stäng)?				
10	Föreslår ikonernas grafik vad de används till?				
11	Används en terminologi som är bekant för användaren?				
12	Utförs de operationer användaren förväntar sig när ikon- eller menyval görs?				
13	Följer menyerna en logisk uppbyggnad?				

Användarkontroll och frihet		Ja	Nej	NA	Kommentar
14	Kan pågående aktiviteter avbrytas?				
15	Är det lätt att navigera mellan olika fönster?				
16	Kan användaren ångra tidigare åtgärder?				
17	Är det lätt att navigera i menyer och fält?				
18	Styrs aktiviteter av användaren och inte systemet?				
19	Finns stöd för ”dra och släpp” eller ”klipp och klistra”?				
20	Kan användaren välja mellan kortkommandon, menyval och ikoner?				

Konsistens och standard		Ja	Nej	NA	Kommentar
21	Används samma terminologi i hela systemet?				
22	Har starka och närliggande färgtoner undvikits?				
23	Är text vänsterjusterad och siffror höger- och/eller decimaljusterade?				
24	Har ikoner försetts med etiketter?				
25	Finns rullningslister både horisontellt och vertikalt?				
26	Presenteras menyer vertikalt?				
27	Dyker dialogrutor upp på samma ställe i varje fönster?				
28	Har varje fönster eller dialogruta ett namn?				
29	Visas direktioner ovanför eller till vänster om inmatningsfält?				
30	Har standard följts vid namngivning av menyval?				

Förebyggande av fel		Ja	Nej	NA	Kommentar
31	Har man tagit i beaktning att användare kan vara färgblinda?				
32	Är inmatning okänslig för små och stora bokstäver när så är möjligt?				
33	Varnar systemet för åtgärder med destruktiva följder?				
34	Indikerar systemet min/max inmatningslängd i fält?				
35	Har liknande menyvalsnamn undvikits?				
36	Har ikoner distinkt utseende?				
37	Föreslår systemet lämpliga åtgärder (pilar/defaultvärde)?				
38	Anges förvalda värden där så är lämpligt?				

Igenkänning istället för memorering		Ja	Nej	NA	Kommentar
39	Används samma färgkodning i hela systemet?				
40	Används färg tillsammans med form, text eller grafik?				
41	Behöver användaren komma ihåg information mellan operationer, fält eller fönster?				
42	Framgår det vilka fält som måste fyllas i och vilka som är frivilliga?				
43	Används samma varnings- och felsignaler i hela systemet?				
44	Innehåller fönster och dialogrutor all för användaren nödvändig information?				
45	Har text formaterats för ökad läsbarhet?				
46	Används färg, understrykning, fetstil eller textstorlek för att fånga användarens uppmärksamhet?				

Flexibilitet och effektivitet vid användning		Ja	Nej	NA	Kommentar
47	Finns guider/wizards för oerfarna användare?				
48	Finns olika nivåer av information för erfarna och oerfarna användare?				
49	Kan menyval göras bade genom musklick och kortkommandon?				
50	Finns kortkommandon för vanliga operationer som kopiera, klipp ut och klistra in?				
51	Har användaren hela tiden en god överblick over arbetet?				
52	Är det lätt för användare att förstå inom vilken menykategori visa val återfinns?				

Estetisk och minimalistisk design		Ja	Nej	NA	Kommentar
53	Har varje fönster en beskrivande titel?				
54	Är ikoner lätta att urskilja?				
55	Grupperas objekt som hör ihop?				
56	Har irrelevant information undvikits i dialoger?				
57	Används bakgrunds- och textfärg på ett sätt som ger en hög läsbarhet?				
58	Används en god kontrast mellan bilder och bakgrund?				

Hjälpa användare att upptäcka, diagnostisera och reparera fel		Ja	Nej	NA	Kommentar
59	Används ljud för att signalera fel?				
60	Används färg för att signalera fel?				
61	Föreslår felmeddelanden vad som orsakat felet?				
62	Föreslår felmeddelanden hur felet kan rättas till?				
63	Har utropstecken undvikits i felmeddelanden?				
64	Har kritik av användaren undvikits i felmeddelanden?				
65	Beskrivs fel snarare i ord än kod?				
66	Har alla felmeddelanden i systemet en liknande utformning till form och språk?				

Hjälp och dokumentation		Ja	Nej	NA	Kommentar
67	Finns en egen hjälpmeny eller ikon som alltid är synlig?				
68	Är det lätt att navigera i hjälpavsnittet?				
69	Finns någon form av sökfunktion i hjälpavsnittet?				
70	Går det att hoppa mellan arbete och hjälpavsnitt?				
71	Följer guider och instruktioner den faktiska arbetsgången?				
72	Täcker hjälp och instruktioner systemets funktionalitet?				
73	Föreslår systemet lämpligt hjälpavsnitt vid fel?				
74	Används ett lättförståeligt språk i hjälp och instruktioner?				
75	Är hjälpen målorienterad, beskrivande, tolkande och navigerande (vad/hur/varför/var)?				

Appendix B: Survey for BI-tools

The survey was developed from Jakob Nielsen´s five points for usability. These points were given as statements in the first five questions during which the respondents were asked to determine whether they felt that the tool matched the statement or not. If they did not agree they were asked to provide a reason why. Fifteen complementary questions followed in order to discover more about the developers experience, education and subjective feelings about the tool.

Since the number of developers who were going to answer the questions was low, no investigation was conducted in respect to gender or age. The number of respondents would have been too few for this to give any reliable results of interest.

The majority of the questions were given yes/no alternatives, often followed by space for reasons. Normally, a graded scale would have been better, but in this case the primary motive with the test was to find interesting areas for the following interview where more extensive questions were going to be asked.

Utvärdering av BI-verktyg

Verktyg som utvärderas: ……

Följande fem frågor grundar sig på Jakob Nielsens definition av användbarhet.

1. Ett system ska vara lätt att lära sig så att användaren snabbt kan börja använda det. Tycker du att verktyget lever upp till detta påstående?

   Ja ☐ Nej ☐

   Om nej, varför inte? ……
   ……
   ……..
   ……...

2. Så snart man lärt sig att använda systemet så ska det ge användaren en hög produktivitet. Tycker du att verktyget lever upp till detta påstående?

   Ja ☐ Nej ☐

   Om nej, varför inte? ……
   ……
   ……
   ……

3. Det ska vara lätt att komma ihåg hur ett system fungerar så att användare som inte använder det dagligen slipper lära om sig varje gång. Tycker du att verktyget lever upp till detta påstående?

   Ja ☐ Nej ☐

Om nej, varför inte? ……
……
……
……

4. Systemet ska vara utformat så att användarna gör få fel och lätt kan reparera de som trots allt uppstår. Tycker du att verktyget lever upp till detta påstående?

   Ja ☐ Nej ☐

   Om nej, varför inte? ……
   ……
   ……
   ……

5. Användarnas subjektiva känsla av systemet ska vara positiv – de ska tycka o matt använda det. Tycker du att verktyget lever upp till detta påstående?

   Ja ☐ Nej ☐

   Om nej, varför inte? ……
   ……
   ……
   ……

Följande femton frågor är av kompletterande karaktär.

6. Hur länge har du arbetat med det här verktyget? ……
   ……
   ……

7. Vilken typ av utbildning har du fått för verktyget? Har den varit i form av kurser, internutbildning eller liknande?
   ……
   ……

8. Hur lång utbildning skulle du uppskatta att du fått, i timmar eller dagar? ……
   ……
   ……

9. Har du använt något av de andra BI-verktygen (Microsoft BI/Cognos 8 BI/SAP BW/NetWeaver)? Om ja, ange vilket och fortsätt med fråga 10. Om nej, hoppa till fråga 11.
   ……
   ……
   ……

10. Hur står sig det här verktyget mot det/de du i fråga 9 angav att du använt?

    Bättre ☐ Likvärdigt ☐ Sämre ☐

11. Har det här verktyget gjort dig irriterad eller arg någon gång?

    Ja ☐ Nej ☐

12. Har verktyget någon gång slutat fungera utan uppenbar anledning?

    Ja ☐ Nej ☐

13. Saknar du någon funktionalitet i det här verktyget?

    Ja ☐ Nej ☐

    Om ja, vilken? …….
    ……
    ……
    ……

14. Tycker du att den design och layout som används i verktyget är genomtänkt och tilltalande?

    Ja ☐ Nej ☐

15. Tycker du att den hjälp och documentation som finns för verktyget är tillräcklig?

    Ja ☐ Nej ☐

16. Har du vid något tillfälle varit i kontakt med tillverkarens support för det här verktyget? Om ja, fortsätt till fråga 17. Om nej, hoppa till fråga 18.

    Ja ☐ Nej ☐

17. Motsvarade den här kontakten dina förväntningar i fråga om bemötande, kunskap och avhjälpande av fel?

    Ja ☐ Nej ☐

    Om nej, vad var du missnöjd med? ……...
    ……..
    ……..

18. Skulle du rekommendera andra att använda det här verktyget?

    Ja ☐ Nej ☐

19. Finns det något du tycker är speciellt bra med det här verktyget?

    Ja ☐ Nej ☐

    Om ja, vad? ……..
    ……
    ……

20. Tycker du att verktyget har förtjänat sitt rykte?

För dåligt rykte ☐ Korrekt ☐ För bra rykte ☐

Appendix C: Test results

Tables 4-11 show the results of the heuristic evaluation.

Table 4: Test result for Report Builder.

Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	6	1	0
Överensstämmelse mellan system och omvärld	6	0	0
Användarkontroll och frihet	7	0	0
Konsistens och standard	10	0	0
Förebyggande av fel	7	1	0
Igenkänning iställer för memorering	6	2	0
Flexibilitet och effektivitet vid användning	5	1	0
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	7	1	0
Hjälp och dokumentation	8	1	0
	69	**5**	**0**

Table 5: Test result for Report Designer.

Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	6	1	0
Överensstämmelse mellan system och omvärld	6	0	0
Användarkontroll och frihet	6	0	1
Konsistens och standard	10	0	0
Förebyggande av fel	7	1	0
Igenkänning iställer för memorering	6	2	0
Flexibilitet och effektivitet vid användning	5	1	0
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	7	1	0
Hjälp och dokumentation	8	1	0
	68	**6**	**1**

Table 6: Test result for SSAS.

Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	6	1	0
Överensstämmelse mellan system och omvärld	6	0	0
Användarkontroll och frihet	7	0	0
Konsistens och standard	10	0	0
Förebyggande av fel	6	2	0
Igenkänning iställer för memorering	7	1	0
Flexibilitet och effektivitet vid användning	6	0	0
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	7	1	0
Hjälp och dokumentation	9	0	0
	70	**5**	**0**

Table 7: Test result for Query Designer.

Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	6	0	1
Överensstämmelse mellan system och omvärld	5	0	1
Användarkontroll och frihet	5	2	0
Konsistens och standard	7	1	2
Förebyggande av fel	5	2	1
Igenkänning iställer för memorering	6	2	0
Flexibilitet och effektivitet vid användning	2	2	2
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	8	0	0
Hjälp och dokumentation	8	1	0
	59	**10**	**6**

Table 8: Test result for Administrator Workbench.

Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	7	0	0
Överensstämmelse mellan system och omvärld	6	0	0
Användarkontroll och frihet	5	2	0
Konsistens och standard	9	1	0
Förebyggande av fel	6	2	0
Igenkänning iställer för memorering	6	2	0
Flexibilitet och effektivitet vid användning	5	1	0
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	8	0	0
Hjälp och dokumentation	9	0	0
	67	**8**	**0**

Table 9: Test result for Query Designer.

Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	6	1	0
Överensstämmelse mellan system och omvärld	6	0	0
Användarkontroll och frihet	6	1	0
Konsistens och standard	9	1	0
Förebyggande av fel	6	2	0
Igenkänning iställer för memorering	6	2	0
Flexibilitet och effektivitet vid användning	4	2	0
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	6	2	0
Hjälp och dokumentation	8	1	0
	63	**12**	**0**

Table 10: Test result for Report Studio.

Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	6	1	0
Överensstämmelse mellan system och omvärld	6	0	0
Användarkontroll och frihet	7	0	0
Konsistens och standard	10	0	0
Förebyggande av fel	6	2	0
Igenkänning iställer för memorering	6	2	0
Flexibilitet och effektivitet vid användning	5	1	0
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	6	2	0
Hjälp och dokumentation	8	1	0
	66	**9**	**0**

Table 11: Test result for Analysis Studio.

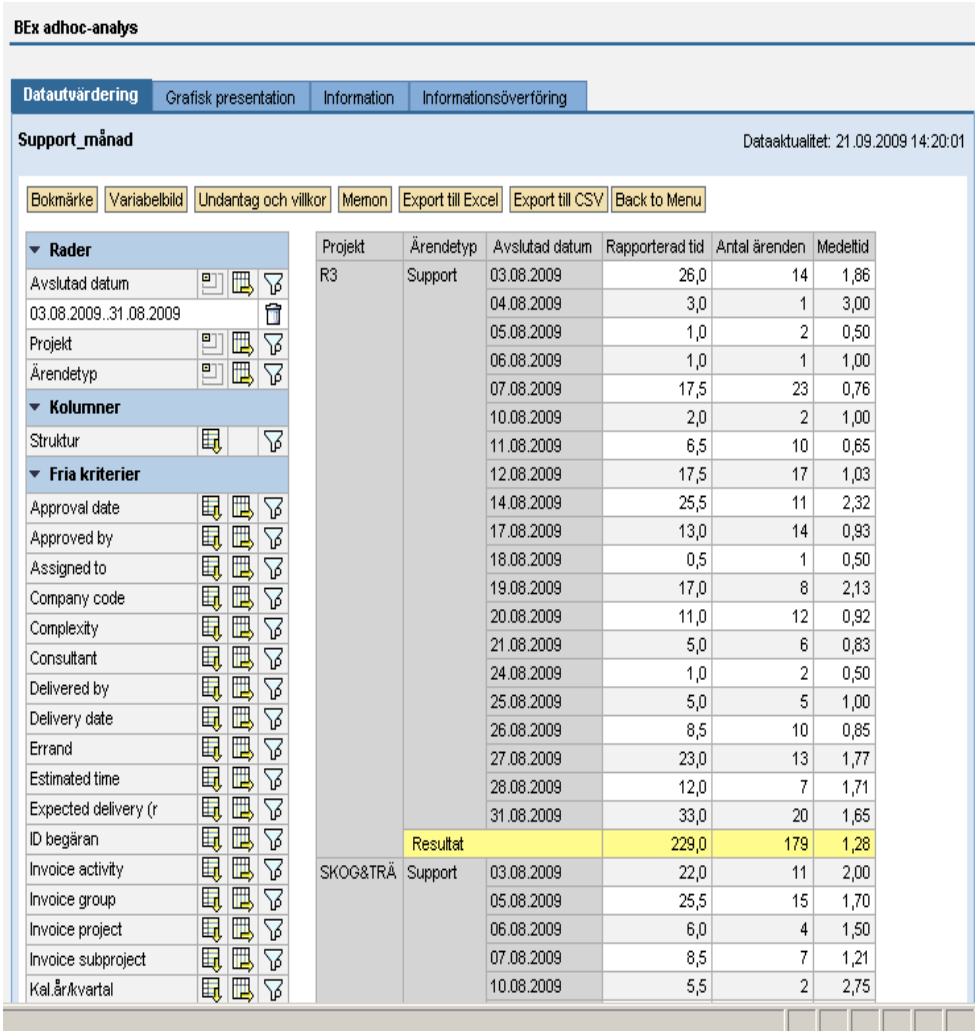
Utvärderingskategori	Ja	Nej	NA
Synlig systemstatus	6	1	0
Överensstämmelse mellan system och omvärld	6	0	0
Användarkontroll och frihet	7	0	0
Konsistens och standard	10	0	0
Förebyggande av fel	6	2	0
Igenkänning iställer för memorering	6	2	0
Flexibilitet och effektivitet vid användning	5	1	0
Estetisk och minimalistisk design	6	0	0
Hjälpa användare att upptäcka, diagnostisera och reparera fel	6	2	0
Hjälp och dokumentation	8	1	0
	66	**9**	**0**

Appendix D: Reports

Figures 25-27 show the runtime results of the reports created in Query Designer, Microsoft Report Studio and Cognos Report Studio.

Final report in SAP BW Query Studio

Figure 25 shows the report that was designed in SAP BW Query Designer. The report shows the number of support errands during a specific period of time, in this case August of 2009, divided on projects. From the reported time, an average time per errand was calculated. Additional data was provided as free characteristics.



Projekt	Ärendetyp	Avslutad datum	Rapporterad tid	Antal ärenden	Medeltid
R3	Support	03.08.2009	26,0	14	1,86
		04.08.2009	3,0	1	3,00
		05.08.2009	1,0	2	0,50
		06.08.2009	1,0	1	1,00
		07.08.2009	17,5	23	0,76
		10.08.2009	2,0	2	1,00
		11.08.2009	6,5	10	0,65
		12.08.2009	17,5	17	1,03
		14.08.2009	25,5	11	2,32
		17.08.2009	13,0	14	0,93
		18.08.2009	0,5	1	0,50
		19.08.2009	17,0	8	2,13
		20.08.2009	11,0	12	0,92
		21.08.2009	5,0	6	0,83
		24.08.2009	1,0	2	0,50
		25.08.2009	5,0	5	1,00
		26.08.2009	8,5	10	0,85
		27.08.2009	23,0	13	1,77
		28.08.2009	12,0	7	1,71
		31.08.2009	33,0	20	1,65
	Resultat		229,0	179	1,28
SKOG&TRÄ	Support	03.08.2009	22,0	11	2,00
		05.08.2009	25,5	15	1,70
		06.08.2009	6,0	4	1,50
		07.08.2009	8,5	7	1,21
		10.08.2009	5,5	2	2,75

Figure 25: Report for support errands.

Final report in Microsoft Report Builder

Figure 26 shows the report that was designed in Microsoft Report Designer. The report shows all sales orders during a specified period of time, in this case January 1, 2002. Each order has its own total sum and quantity and we can also see the daily and grand total.

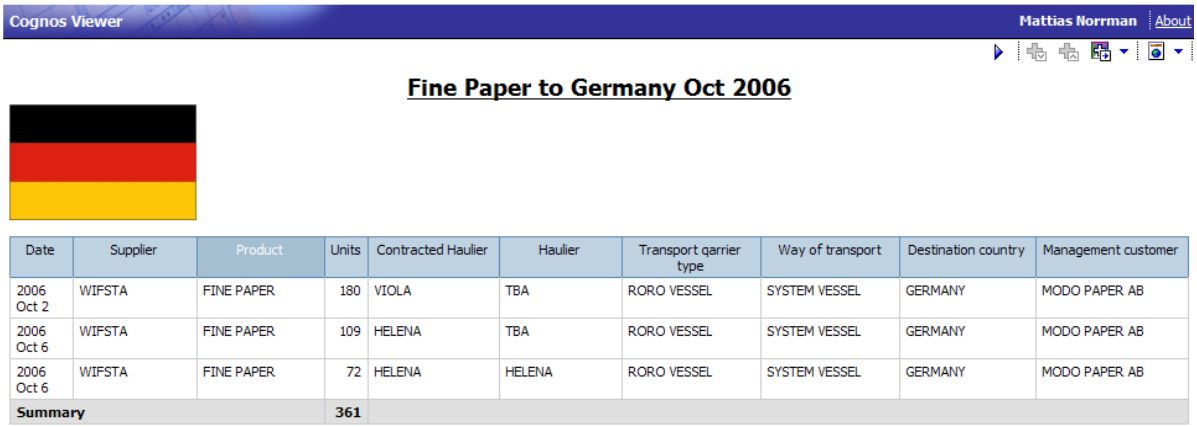
Adventureworks

Date	Order	Product	Qty	Line Total
2002-01-01	SO45038	AWC Logo Cap	3	15,56kr
		Long-Sleeve Logo Jersey, L	4	115,36kr
		Long-Sleeve Logo Jersey, M	1	28,84kr
		Mountain Bike Socks, M	2	11,40kr
		Order Total	10	171,16kr
	SO45042	Mountain Bike Socks, M	5	28,50kr
		Order Total	5	28,50kr
	SO45043	AWC Logo Cap	1	5,19kr
		Long-Sleeve Logo Jersey, L	1	28,84kr
		Mountain Bike Socks, M	4	22,80kr
		Order Total	6	56,83kr
	SO45045	Mountain Bike Socks, M	2	11,40kr
		Order Total	2	11,40kr
	SO45047	Long-Sleeve Logo Jersey, L	1	28,84kr
		Long-Sleeve Logo Jersey, M	2	57,68kr
		Long-Sleeve Logo Jersey, XL	2	57,68kr
		Order Total	5	144,20kr
	SO45048	Mountain Bike Socks, M	4	22,80kr
		Order Total	4	22,80kr
	Daily Total		32	434,89kr
Grand Total			32	434,89kr

Figure 26: Report for sales orders.

Final report in Cognos Report Studio

Figure 27 shows the report that was designed in Cognos Report Studio. The report shows the quantity of fine paper delivered to Germany and how it was transported.



Date	Supplier	Product	Units	Contracted Haulier	Haulier	Transport qarrier type	Way of transport	Destination country	Management customer
2006 Oct 2	WIFSTA	FINE PAPER	180	VIOLA	TBA	RORO VESSEL	SYSTEM VESSEL	GERMANY	MODO PAPER AB
2006 Oct 6	WIFSTA	FINE PAPER	109	HELENA	TBA	RORO VESSEL	SYSTEM VESSEL	GERMANY	MODO PAPER AB
2006 Oct 6	WIFSTA	FINE PAPER	72	HELENA	HELENA	RORO VESSEL	SYSTEM VESSEL	GERMANY	MODO PAPER AB
Summary			**361**						

Figure 27: Report for fine paper delivery.