ACKNOWLEDGEMENT

This thesis as well as the complete MBA study would not have been possible without support of many people:

I would like to open my acknowledgement with a word of gratitude to my supervisor, Dr. Klaus Solberg Söilen, first of all, for his suggestion of this very interesting thesis topic, as well as for his guidance, valuable advice and enthusiasm during the complete process of this thesis work. And of course, special thanks to the organizers of the MBA study at BTH for making all these possible.

My word of gratitude is also for my group leader at SARA Computing and Networking Services, Walter Lioen, who upon hearing about my search for collection of empirical data, immediately suggested his help to contact his friend at BI software company Crystalloids. Special thanks to Quintus-Filius Grensduring, managing partner of Crystalloids, for finding time to answer to my questionnaire.

I would like also to thank Tim Harbers, consultant at BI software company Sentient, who immediately expressed his willingness to help a student, e.g. me with completion of my thesis by giving an extensive feedback and answers to my emailed questionnaire.

I am very grateful as well to my thesis opponent and classmate, Maarit Hendriksson, who gave valuable and on-time critique of my thesis content that definitely added value to it.

Among my friends and colleagues at SARA I would like to thank those who were always interested in my progress and achievements during these studies.

Finally and most importantly, this complete MBA study would not have been possible without the faith, patients and support of two very dare to me people: I would like to express my enormous thanks to Jasper Kelder, for his endless encouragements, care, constant support and faith in me and also for his valuable comments on my thesis. And my very big thanks and hugs to my mother, Anna Axner, who was first shocked by finding out that immediately after PhD in computer science I decided to follow MBA study, but then, as always, supportive and enthusiastic and most patient...
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1. ABSTRACT

Nowadays, a large number of BI and/or CI software is available, and being developed worldwide. A simple search of the “Business Intelligence software” term in Google gives about 548,000 results. Most of these software are quite enhanced and well developed, however, only a few of them have a good analysis tool, and even fewer give a choice of analysis tools to their users.

In this research we have pursued two goals: First we have investigated what are the major obstacles for making a better analysis function in the Business Intelligence (BI) software and second we have examined how those obstacles can be solved. Thus we have approached both goals from two different perspectives: Competitive Intelligence (CI) from the managerial point of view and Business Intelligence (BI) from the more technical point of view.

Through an extensive literature overview we have examined the possible obstacles on the way of implementation of comprehensive analysis tool in BI software and categorized them in accordance with their nature. From the technical point of view we have identified two major obstacles: The large variety of intelligence tasks that needs to be addressed and the large variety of analysis that can be performed for different intelligence tasks. From the managerial point of view we found out that these obstacles are: The influence of managers’ entrepreneurial attitude on final decision making process and their lack of investment and understanding of the BI analysis tools in general.

Next, we have developed a method to solve the above mentioned obstacles by using the theory of graphs. With incorporation of weighted connectivity graphs and information tagging tactic we proposed to solve the problem of intelligence-analysis correlation, while with the help of hyper-graphs we proposed to generate the final advice to assist for decision making process. Also, using object oriented programming languages we proposed the actual implementation of the enhanced analysis tool. Finally we concentrated on advantages and disadvantages of the proposed method and collected empirical data to ensure the importance and essence of investigated problems.

The proposed technical solution is under construction in the BI software called Subsoft developed by Dr. Klaus Solberg Söilen. We have investigated to what extent conclusions here can be used to develop the software further. The managerial perspective of the solutions is explored in close collaboration with two other BI companies: Sentient and Crystalloids, both based in Amsterdam, The Netherlands.

**Keywords:** Business Intelligence (BI), analysis tool, Competitive Intelligence (CI)
2. INTRODUCTION

2.1 Background

Competitive Intelligence (CI) has been defined by many authors. These definitions do have certain differences but all of them have a main common feature: They put the accent on the analysis. The most precise definition is given by the Society for Competitive Intelligence Professionals (SCIP): “A systematic and ethical program for gathering, analyzing, and managing external information that can affect your company’s plans, decisions, and operations”.

Business Intelligence (BI) is much broader concept than CI. It has rather technical meaning while CI is more about managerial perspective of intelligence. BI includes activities such as data mining, market analysis, sales analysis, and analysis of customer and supplier records and behavior (Bouthillier et al., 2003). However, in some European countries, such as Sweden and Denmark, BI and CI have the similar meaning (Bouthillier et al., 2003). Either way, the main feature of both concepts is the ability to analyze data and information and to deduct intelligence out of them.

An extensive work has been done on BI software evaluation by Amara et al. (2009) to classify the top BI software vendors according to the extent of their analysis by using the SSAV (Solberg Söilen, Amara, Vriens) model. A number of analyses for Business Intelligence have been summed up also in Solberg Söilen (2005). The conclusion of both works was the same: BI software need robust analysis tools.

Most of the commercial and non-commercial BI software do not have a well defined analysis tool in disposition to help the users analyze the given data and extract intelligence out of it. Nowadays, the amount of data gathered by companies is enormous. Especially with the wide possibilities of Internet, data collection is extremely fast. In a matter of hours an overwhelming amount of data and information can be accessible to any analyst in a company. This means that in a matter of minutes BI software should be able to access, analyze and extract useful intelligence out of it. Thus it needs to be equipped with a sophisticated analysis tool that will first: Find relationships between data structures to convert them into information, and second: Filter, analyze, synthesize and enhance this information and convert it into intelligence. In general, analysis means to take apart, the opposite of synthesis, which means putting together again. The aim of analysis and synthesis is to create some additional useful information, some added value. Some of the BI software have good analysis tools but they mostly provide standard analyses such as mathematical and statistical analyses but they do not provide any BI business analytical from OLAP (Online Analytical Processing), box analyses, data mining, predictive or qualitative analysis, game theoretical approaches.

Due to the easily accessible information its reliability is extremely low and the possibility of gathering irrelevant information is quite high. Moreover, the life cycle of information is unpredictable and consumption of the information does not decrease its amount. As stated by Bouthillier et al. (2003) the information is not only expandable but also compressible, since it can be summarized or concentrated to facilitate its use. Thus sophisticated BI software analysis tool should not only just analyze the incoming information but should be able to distinguish between reliable and false information as
well as should be able to augment the usefulness of the information as the value of the information is only in its usefulness. In short it should be able to define the value of the information. For this reason, the first intuitive step would be to implement an analysis tool that is able to classify the intelligence immediately using methods such as Likert scale, Consensus Based Assessment (CBA) or Diamond of Opposites. 

Some of the BI software do provide a limited analysis tools to users. But almost none are sophisticated enough to comply with the combination of all main features that a comprehensive analysis tool should have. These basic features are to provide a variety of analytical techniques, to allow a choice of levels of analyses, to include noise reduction by synthesis of information and to offer a variety of possible actions (Bouthillier et al. (2003). Moreover, the analyses provided by BI software tool can be presented as different software or add-ons or just as integrated parts in one BI software tool.

For noise reduction purposes BI software needs to investigate the data. According to Calof and Lithwick (2001) there are four steps to investigate the data/information:

1. Data cell screen
2. Data clarification
3. Data overlapping
4. Data verification

Zanassi (1998) calls the combination all these steps data-mining for competitive intelligence. The data-mining technique is already known to the world in different areas such as database marketing, basket analysis etc. Zanassi (1998) applied it to CI. 

Most of the existing BI software provide analysis tools that offer one or two analytical techniques such as benchmarking and/or Devil’s advocate while they completely omit either the possibility of noise reduction and/or advice of future actions.

And last but not least, a BI software analysis tool should be user friendly. The subtracted information of BI software can be of interest not only to well-trained analysts, that are using it on daily bases, but also for managers and sometimes to CEOs who are most probably unfamiliar to the applicability of BI software. Thus, analysis tool should have several possibilities for easy adjustments. For example, it must give a possibility to generate different types of reports, such as text documents, figures, tables etc., it should allow the selection of reports only in the direction of interest, such as only customer and supplier reports or only competitor-specific reports, it and should supply with a user-configurable toolbar that can be used by both basic and advanced users.

### 2.2 Problem Formulation

A well defined, efficient, user-friendly and decision supporting analysis tool that will comply with the entire Competitive Intelligence cycle is a critical feature that nowadays BI software are lacking.

In general, to distinguish BI software from other types of software, there are three important selection criteria defined (Bouthillier et al. 2003):

1. It must perform more than two value-added processes
2. The value-added processes must satisfy the BI intelligence needs
3. The software must perform some level of analysis

While most of the existing BI software satisfies the first two criteria, they hardly ever comply with the third one. They mainly address the analysis process through categorizing information rather than extracting knowledge out of it. To satisfy the third criteria the BI software needs to overcome several obstacles that are of both logical and technical nature.

The logical obstacles are:

1. The large variety of intelligence tasks that needs to be addressed.
2. The large variety of analyses that can be performed for different intelligence tasks.

A way to solve these two problems is to categorize both intelligence tasks and possible analysis (Solberg Söilen, 2005).

The problems of technical nature are connected with the possibilities and choices the tool offers to the user. It should be enhanced enough to offer a flexible toolbox but it should also be simple enough to be useful for both basic and advance users. The tool must produce different types of reports, give a choice of analysis levels, include a noise reduction facility and be easy adjustable.

2.3 Thesis Focus

In this thesis we will discuss the following hypotheses:

- Some of the BI software have good analysis tools but their score is low as they do not provide any BI business analytical from OLAP (Online Analytical Processing), data mining, predictive or qualitative analysis.

- Most of the software do not comply with the entire Competitive Intelligence (CI) cycles as they have obstacles to create sophisticated tools such as data visualization interfaces to sort and view the collected information, data sorting by user-defined rules, extraction of relationship between people, places, dates, events etc., text-mining technology to locate and extract user-defined variables and many more.

- The obstacles preventing to create the analysis tool is both of a technical and logical managerial nature.

- The most effective way to implement an analytical tool from a technical perspective is to create a connectivity graph of possible analysis directions, together with explicit schemes and then integrate those ideas as separate modules or structures using Java, Visual C++ programming languages together with already developed tools such as excel sheets.

- The most effective way to implement an analysis tool from a managerial perspective is to present a menu of more or less standardized analyses to choose from, also giving the user a possibility to alter some features.
• It is effective to classify the different types of analyses into a certain number of groups; Box analysis (SWOT, Benchmarking, Game theoretical matrixes, Spreadsheets), Time-horizon analysis (game trees, scenario analysis), Ratio Analysis, Exploratory Analysis (Focus Groups, Questionnaires), or a combination of the above.

• It is useful and effective to provide different analysis components as an integrated part of one BI software, that can be stripped down in dependence of user preference rather than to provide them as separate BI software.

2.4 Disposition

The disposition of this thesis is given in the following manner:

1. Abstract: Outlines the general purpose of this thesis

2. Introduction: Focuses on the background, problem formulation, and hypothesis the research will concentrate upon.

3. Literature Overview: Gives a complete and comprehensive overview of the defined problems and evaluations of BI software identified by different authors up until now.

4. Method: Describes the possible solution of the given problem and discusses it from different point of views. Here we present the technical as well as managerial point of view of the proposed solution.

5. Conclusions: Discusses and derives conclusions how well is the conducted research touched upon the aforementioned hypothesis.
3. LITERATURE OVERVIEW

3.1 From Data through Information to Knowledge or Extracting Intelligence

The term “data” is defined as a collection of facts, measurements and statistics from which conclusions may be drawn. The term “knowledge” is defined as a psychological result of perception and learning and reasoning (http://wordnet.princeton.edu/). Information is the connector between data and knowledge: On one hand the organized data is information (Miller, 2000) on the other hand knowledge is the organized information that is internalized by its user and integrated in its behavior (Bouthillier et al., 2003; Jenster and Solberg Söilen, 2009). Intelligence is the informing knowledge, it is information that has been filtered, examined enhanced and analyzed (Taylor, 1986). The problem with knowledge as well as with intelligence is that they are difficult to document. To analyze information and to extract intelligence from it one needs knowledge, but the intelligence itself can generate new knowledge (Bouthillier et al., 2003). The correlation of these basic concepts can be clearly seen in Fig.1.

![Figure 1: Correlation between basic concepts](image)

3.2 Competitive Intelligence and the Value of Information

Competitive Intelligence (CI) has multiple definitions in literature. This is due to the fact that CI has many characteristics in common with different disciplines. Moreover, in different cultures the conceptual understanding of CI is different. For example Japanese approach to CI is the collection and synthesis of large amount of information about competitors. While in European countries the emphasis is on the analytical aspect of CI. For example in Sweden and Denmark the companies and government institutions are together gathering information about foreign competitors for goods of the national economy (Bouthillier et al., 2003).
Several factors have also influence on the conceptual definition of CI. One of these factors is the globalization. With the enlarged competitiveness of markets the importance of gathering intelligence about foreign competitors became even more important than the information about local competitors. Another factor is the new, rapidly developing technologies, as the access to the information became faster and extremely broad competitive market became even larger (Desouza, 2001; Langford, 2008; Chung et al., 2002; Chung et al., 2005). Already in 1990s Internet was one of the biggest data and information collection tools for CI (Pawar and Sharda, 1997).

The first definition of competitive advantage was given by Porter (Porter, 1980) which included four directions: future goals, current strategy, assumptions and capabilities. Later, when companies have adapted Porter’s definition to their needs, the term “competitive intelligence” appeared (Bouthillier et al., 2003; Solberg Söilen, 2005). Porter also was the first who introduced business models on competitor analysis (Solberg Söilen, 2005). Several authors have attempted to give a clear definition to CI (Kahaner, 1998; Miller, 2000). But the most precise definition is given by the Society for Competitive Intelligence Professionals (SCIP) which states that CI is “A systematic and ethical program for gathering, analyzing, and managing external information that can affect your company’s plans, decisions, and operations” (http://www.scip.org). Thus, in the concept of CI, augmenting information in a way that it will be useful for your company’s plans is the key value. Taylor (1986) was the first who stated that the value of information is in its usefulness.

Bouthillier et al. (2003) defines three basic approaches to measure the value of information:

1. The normative value approach – to measure what people are willing to pay for information, not what its value is in the decision-making process
2. The realistic value approach – to measure the impact of information by examining the effect of information on the outcomes of the decision making or on performance.
3. The perceived value approach – to examine how users perceive the value of information by identifying the perceived benefits of information by those using it.

But in order to obtain the value of information specific activities need to be realized by information services and systems. According to Taylor (1986) the value-added processes are the activities performed by information services and systems that offer the means both to signal the potential of information and to relate it to specific problems in specific environments. In order to choose the right information services and systems one needs to be directed by the following criteria: ease of use, noise reduction, quality, adaptability, time saving and cost saving.

*Ease of use* – incorporate different elements into the system, such as browsing formatting, selecting, sorting etc. to reduce its difficulty to use.
*Noise reduction* – exclude unwanted information and include the information that has a potential value and precision.
*Quality* – assure accuracy, comprehensiveness, reliability, validity and currency of the retrieved information.
*Adaptability* – assure responsiveness of the system to the user needs and problems. The system should be capable to manipulate the retrieved information.
Time saving and cost saving – implement processes that are less time consuming and less costly for users.

Solberg Söilen (2005) suggests that only the organization which clearly knows the differences between information and intelligence and is able to understand and implement an efficient intelligent system is going to be successful. It should have the ability of sorting information, knowing the relevance of it in order to implement a good strategy and gain a competitive advantage in the market (Jenster and Solberg Söilen, 2009). Golfarelli et al. (2004) even suggests that a new era is coming in BI which will propose a general architecture for business performance management and will lay premises for investigating the most challenging issues in this field.

But independent of all the above listed factors the main factor determining the usefulness of the system is the context in which it is used and whether the use of information is valued in a particular environment that it is dependent on, the information culture. If the use of information is profitable the information system will be used even if it does not satisfy most of the above mention criteria (Bouthillier et al., 2003). That is why Dugal (1998) differentiates between ten different types of intelligence and emphasizes each type is unique in sense of its life duration, audience and applicability direction. These types are:

1. Current intelligence
2. Basic intelligence
3. Technical intelligence
4. Early warning intelligence
5. Estimated intelligence
6. Work group intelligence
7. Targeted intelligence
8. Crisis intelligence
9. Foreign intelligence
10. Counterintelligence

In addition all these attributes the information system should also be an expert system. That is it should be able to transform into a decision making process. According to Bouthillier et al. (2003), somewhere between the information system and the expert information system is the CI system. CI software should both satisfy all the above mentioned attributes as an information system and it should also be an expert system in order to extract intelligence out of information and give advice, hypotheses and forecasts to help to the “decision making”. Moreover, the decision making support system should also help managers with the negotiation processes (Marin-Llanes et al., 2001). CI software should assist a user to become aware of different types of information to make the right decision (McGonagle et al., 2008; Vella et al., 2001). As the existing information can be large, highly unstable and rapidly changing, it is extremely difficult to create CI software that will incorporate all these features. In short, a CI system is the combination of several processes defined in the CI cycle by CIA (Central Intelligence Agency, 2001, https://www.cia.gov/) as shown in Fig. 2.
The most important difference between CI cycle and the information system cycle is the inclusion of the analysis and production function. According to CIA (2001), this step integrates data into a coherent whole, puts the evaluated information in context and produces finished intelligence that includes assessment of events and judgment about the implications of information.

**3.3 Business Intelligence, Competitive Intelligence and Market Intelligence**

Above we gave a clear definition of CI. But up until now we did not introduce the term Market Intelligence and Business Intelligence.

Market Intelligence (MI) incorporates the analysis of companies’ customers or potential customers, and sales patterns. It mostly shows analysis of short-term and operational goals (Bouthillier et al., 2003; Dishman and Calof, 2008). In order for the companies to achieve high profits they should gather MI and share it across their departments. Scanning for CI is the main action to obtain needed information for MI generation and market adaptation (Qiu, 2007; Jenster and Solberg Söilen, 2009).

Conway *et al.* (2001) have conducted a benchmarking study of 16 companies to determine how the market intelligence function is structured in these enterprises. They concluded that a company needs to lay the foundation, build the infrastructure, and leverage market intelligence on an ongoing basis to be successful in obtaining competitive advantage. A user orientation, total corporate commitment beginning with the CEO, and effective distribution channels are key elements to the success of any CI function.
Business intelligence (BI) is a broader concept than competitive intelligence or market intelligence. In fact it is the combination of these two as shown in the Fig. 3 (Bouthillier et al., 2003; Jenster and Solberg Söilen, 2009).

![Figure 3: The Scope of Business Intelligence](source)

Multiple authors have attempted to draw clear boundaries between CI and BI concepts. For some BI is the activity of monitoring the external firms for the information that will assist for decision making (Gilad and Gilad, 1988). For others it is the analysis of mergers and acquisitions, risk assessments (Choo, 2002). For some countries such as Sweden and Denmark both concepts are used interchangeably and have the same meaning (Bouthillier et al., 2003).

Further in the thesis we will use BI to emphasize the technical aspects and CI to refer to the competitive intelligence in general.

### 3.4 Private and Public Intelligence

Private and public intelligence is the English translation of the Swedish word ‘omvärldsanalys’ which has a broader meaning than BI and CI (here we consider the difference between BI and CI) but narrower than the word intelligence. It is a combination of economical, business and political studies (Solberg Söilen, 2005; Jenster and Solberg Söilen, 2009). Intelligence, in this context, is defined by Solberg Söilen (2005) as “actionable information” e.g. information that companies can use for their future actions or decisions. He states that intelligence function is performed by special teams called business intelligence team (BIT) that have three different customers:

1. Top management that seeks strategic intelligence
2. Middle management
3. Front line management that seeks operational management

A BIT consists of intelligence agents and intelligence officers whose task is to provide answers to all the questions of members from different levels of an organization (Solberg Söilen, 2005).

In different cultures private and public intelligence have different interpretations. For example Japan and Sweden have a well defined private and public system, but in Japan it is coordinated by their ministry of economy, trade and industry while in Sweden the system is less formal (Solberg Söilen, 2005). Pettersson (2001) has built a system for handling information concerning the financial administration system for Swedish National Financial Management Authority (ESV). He pinpoints that many Swedish organizations have systemized their BI activities already during 1990s and that the system he was constructing required two parallel processes: one in high-tech, IT solutions and one in high-touch, people solutions. The aim of the system was to produce:

a. The current outcome of the state budget
b. Forecasts for the state budget
c. Facts and figures for the annual central government report
d. Financial statistics

Solberg Söilen (2005) defines public intelligence as a gathering of information for the interest of regional and local government, while private intelligence, in opposite to the public one, is about information of business and non-profit organizations.

Private and public intelligence is focused on finding techniques and developing organizational processes for solving practical problems of information. Thus they are complementary to BI (Solberg Söilen 2005).

According to Solberg Söilen (2005), the aim of private and public intelligence is foreknowledge. On the other hand it is almost impossible to predict human and social behavior. The further is the future one wants to predict the greater are the chances of error. This means that the chances to do accurate predictions are greater if one looks into immediate future. BI is concentrated on what is happening in immediate future and at most what will happen in near future.

### 3.5 The Intelligence Cycle and the CI cycle

Above we have presented a typical scope of CI cycle proposed by CIA (2001). Solberg Söilen (2005) states that typical Intelligence cycle consists of four stages:

1. Direction – the determination of requirements and preparation of the plan for information gathering
2. Collation or Accumulation - the actual gathering and delivery of information to analysts.
3. Incubation or Elevation – the extracting of intelligence from information through analysis
4. Presentation or Dissemination – the delivery of intelligence to decision-makers.
Intelligence cycle as well as CI (BI) cycle are ongoing processes and always illustrated in a circle as in Fig. 4.

**Figure 4: The Intelligence Cycle**
Source: Solberg Söilen (2005)

As we can see, in general, both cycles have similar functionalities while the BI cycle seems to have a more detailed infrastructure.

### 3.6 Analysis of Information

According to Bouthillier et al. (2003) all CI models include an analysis stage as it is an integral part of the intelligence process. Analysis transforms the information into intelligence using variety of techniques. It is a process in itself, beginning with the synthesizing and grouping together of separate pieces of information. Only after this stage the user can add to it intelligence by adding a meaning to it and converting it into an advice for future actions. The complete analysis process is shown in Fig. 5.

**Figure 5: The Analysis Process**
Source: Bouthillier et al. (2003)

The main outcome of CI is a set of hypotheses based on a number of possible strategic actions that could be taken by an enterprise. Bouthillier et al. (2003) emphasizes that interference of analysis results to decision making process requires an expert system with a build-in knowledge base in which the inputs are the competitive conditions and an inference mechanism using the built-in knowledge base to make a decision about what
kind of solution should be chosen. These expert systems are very costly to produce as they require a large up-to-date knowledge base.

The analysis process is considered to be the most important step in the CI cycle. Already hundreds of analytical techniques are known to the world and new ones keep developing. Examples of these new techniques are SOLAP – Spatial OLAP (Rivest, 2005) and EBizPort (Marshall, 2004). These different techniques provide different information to users and satisfy different tasks. Therefore it is crucial that the analytical techniques being used is determined in the beginning of the CI process and is linked to the identification of the information needs process (Bouthillier et al., 2003). As there is no analytical technique that can satisfy all the needs of the user, one needs to consider the combination of using several of them in the CI process. The choice of the techniques depends on the competitive environment.

“The amount of value added in the analysis step is greater than that in any other step of the CI cycle. Because information in this step is manipulated, examined, considered, or expanded – to a large extend to add meaning and inference - it is transformed into intelligence. It has, after this process, a significantly higher use value for the company” (Bouthillier et al., 2003).

Analysis is also considered to be the most difficult part to automate as it requires human activity. Bouthillier et al. (2003) identifies four potential processes related to the task of analyzing:

1. Variety of CI analytical techniques – provide more than one technique for extracting meaning from information. This means to offer a choice of different analytical approaches which bring adaptability and value of closeness to the problem
2. Level of analysis – refers to the extent to which information is preceded. This ensures quality and comprehensiveness of extracted intelligence by helping the user to consider all the dimensions of the technique.
3. Synthesis of information – the ability to summarize an article or report and to reduce the potential for information overload. This will ensure a noise reduction and facilitate the value of intellectual access.
4. Recommendations for actions – analyzed information that leads to decision making and actions. This is the highest value-added information and the final outcome of the analysis. It adds quality and validity to the extracted intelligence.

3.7 Industry Analysis and Company Analysis

Industry analysis is a report that a company uses to describe an analysis outside of the company that BI is most concerned about. Company analysis is a report that describes what is going inside of the company (Solberg Söilen 2005; Jenster and Solberg Söilen, 2009).

Herring (1988) wrote that already in 1980s business environment in US became very complex and competitive. The corporations needed to be sure that they were receiving the right information on a variety of worldwide developments that were related to their long-term strategies as well as to their short-term decisions. The corporations needed to be sure that the information is relevant, timely and will promote an effective decision making.
As Solberg Söilen (2005) states, a strategic process starts from the industry analysis and goes on with company analysis. Both reports are essential for the companies’ strategic decisions and entrepreneurship. A good report is a prerequisite that will lead to the right decision. Both analyses should be made available to top management and to the board of directors at least twice a year (Solberg Söilen, 2005, Howson, 2008). Some of the companies order their reports from special external consultants. This on one hand saves time but on the other hand the information given by an external consultant can be known to other companies as well and thus just following this information may not bring competitive advantage to the company (Solberg Söilen, 2005; Jenster and Solberg Söilen, 2009).

Solberg Söilen (2005) points out that the most objective analyses can be obtained if the reports are conducted by two separate teams: company analysis team and industry analysis team. In this way the criteria of company analysis will not influence the ones of industry analysis. Moreover, on both analyses there can be an influence not only of non-human variables but also of human variables such as human characteristics and interests.

In general, the factor of human influence on public and private intelligence became a hot topic of recent years. The gathering of information through human sources and the description of relationships and personal characteristics is called personal and relational analysis (Solberg Söilen, 2005). In comparison to non-human factors, it is very difficult to conduct personal and relational analysis as the information is not easily accessible as it can be personal and sensitive or simply people may have no culture of communication (Solberg Söilen, 2005).

Solberg Söilen (2005) assures that both industry and company analysis cannot be complete and useful unless they consider also the personal and relational analysis. More about this topic we will discuss in subsection 3.10.

### 3.8 Analysis and Tasks

According to Solberg Söilen (2005) an important part of the intelligence function is to try to detect the unexpected before it becomes an uncertainty or a risk that was not considered for the companies’ future operations. He defines eight dimensions which constitute macro environment of any company: political, economic, judicial, social, infrastructural, demographic, technological and ecological. These eight categories are called indirect categories as they influence the business only indirectly. He also defines six dimensions: entry barrier, exit barrier, suppliers, customers, alternative suppliers and competitors as direct categories. These six categories have a direct influence on the competitive advantage of any company.

To solve the important part of the intelligence function Solberg Söilen (2005) proposes model which he calls the allegory of the submarine. Here the concept of the world is fitted into the concept of submarine as shown in Fig. 6.

The main tool of the submarine is the periscope. The periscope of the organization is the BI system. The captain of the submarine, e.g. CEO of the company looks into periscope to collect the information from the outside world that concerns the company. After that,
when the company gets the understanding of the function of BI system, it is the time to make the analysis model.

**Figure 6: The Submarine Allegory**
Source: Solberg Söilen (2005)

Solberg Söilen (2005) defines three environments that any company is faced with:

1. **Internal environment** – different departments and functions of company.
2. **Micro environment** – other companies that the current company deals with.
3. **Macro environment** – forces that the company has little or no influence over.

Using this model the company can start conducting analysis. But the most important analysis process to understand what analysis is and what it does and this is the factor that differentiates the good analyst from a mediocre one (Solberg Söilen, 2005).

An analysis is the procedure of taking the data apart (analysis), then putting them together in a new, different manner (synthesis) hoping that it will bring us additional information to see the problem clearer (Solberg Söilen, 2005). Thus, the Solberg Söilen (2005) formula of analysis is:

\[
\text{Analysis (A)} = \text{take apart (analysis)} + \text{put together (synthesis)} + \text{additional value}
\]

He emphasizes that in order to do a truly verifiable analysis one needs to first: Use even pieces of intelligence which has not been sorted into any boxes, and second: To keep opinions from influencing analytical process. Only in this case the analysis can be accurate, objective, timely, comprehensive and clear. To manage this complicated task one need to understand more about the nature of analysis (Solberg Söilen, 2005).

Solberg Söilen (2005) defines five steps of analysis process and five ways of understanding its nature. The five steps of analysis process are:

1. Choosing the right kind of boxes/analysis
2. Counting/evaluating the content of each box (more/less than next/last year, % increase, etc.)
3. Conclusion of counting/evaluating
4. Consequences of the conclusion
5. Implications – the most important step that shows us what we should do.

The five ways of understanding the nature of analysis are:

1. Consider that the analysis can be pre-active that is the actual result is the outcome of the process, or post-active when the idea of the result already exists before the process is realized.
2. Consider that the number of boxes/analysis should be 8-12 for practical reasons. Sometimes this number is left open. Consider the choice of right and optimal analysis that will fit the problem. That is there should not be any major category of problem left without its own box.
3. Define the threshold of adaptability of analysis to reality.
4. Place the analysis to time axis: some of the analysis are focusing on future, some of them on present.
5. Define the amount of confidence to put into analysis. Sometimes a redundancy in the method is advised to use.

Choosing and adapting the right analysis to the problem is the art of analysis, the rest is mostly form and procedure (Solberg Söilen, 2005). Table 1 shows how to choose the most appropriate analysis in micro and macro environment:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subject/Function</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Micro environment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customers</td>
<td>Marketing</td>
<td>Focus groups</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Questionnaires</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trend analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forecasting</td>
</tr>
<tr>
<td>Competitors</td>
<td>Marketing</td>
<td>Benchmarking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SWOT</td>
</tr>
<tr>
<td></td>
<td>Finance</td>
<td>Game theoretical approaches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simulations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ratio analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost analysis</td>
</tr>
<tr>
<td>Suppliers</td>
<td>Industrial management</td>
<td>Benchmarking</td>
</tr>
<tr>
<td></td>
<td>Finance</td>
<td>Game theoretical approaches</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>Cost analysis</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>Simulations</td>
</tr>
<tr>
<td>Suppliers</td>
<td>Finance</td>
<td>Spread sheets</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>Cost analysis</td>
</tr>
<tr>
<td>Entry barriers</td>
<td>Finance</td>
<td>Spread sheets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost analysis</td>
</tr>
<tr>
<td>Exit barriers</td>
<td>Finance</td>
<td>Spread sheets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost analysis</td>
</tr>
<tr>
<td>Substitutes to suppliers</td>
<td>Industrial management</td>
<td>Devil’s advocate</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>Spread sheets</td>
</tr>
<tr>
<td>Marketing</td>
<td>Simulations</td>
<td></td>
</tr>
<tr>
<td>Substitutes to customers</td>
<td>Marketing</td>
<td>Devil’s advocate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spread sheets</td>
</tr>
</tbody>
</table>
Macro environment:

<table>
<thead>
<tr>
<th>Economic</th>
<th>Economics, macro</th>
<th>Simulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political</td>
<td>Political science</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Sociology</td>
<td>PEST analysis</td>
</tr>
<tr>
<td>Technological</td>
<td>Technology-sociology</td>
<td></td>
</tr>
<tr>
<td>Infrastructural</td>
<td>Technology-sociology</td>
<td></td>
</tr>
<tr>
<td>Ecological</td>
<td>Ecology</td>
<td>State-of-art reporting</td>
</tr>
<tr>
<td>Legal</td>
<td>Law</td>
<td></td>
</tr>
<tr>
<td>Demographic</td>
<td>Political geography</td>
<td>Statistical analysis</td>
</tr>
</tbody>
</table>

Table 1: The relation of types of analysis and variables

Source: Solberg Söilen (2005)

3.8.1 The Types of Analysis

Here is the list of different types of analysis and their short descriptions given by Solberg Söilen (2005). Further in this thesis we will concentrate only on these types of analysis as according to the extensive literature overview they are the most common ones and the proposed method and solutions of this thesis can always be extended to include even wider list of analysis.

1. **Focus group** – it is form of organized discussion between groups of people and is mostly used in social research. It is different from group interviewing, where the participants answer to the analyst’s questions. Here the analyst can make observations of feelings, attitude and reactions.

2. **Questionnaires** – it is a simple list of questions that is answered by different people. It is important to remember that these questions can be biased and the answers may not be honest.

3. **Trend analysis** – it is the description of the whole picture of how the future may look like and what consequences this would have on consumer behavior. This analysis is used for social trends in political opinions, hobbies, choice of education or profession etc.

4. **Forecasting** – it is mostly carried out by financial or accounting departments and is focused on more quantitative rather than qualitative analysis.

5. **Benchmarking** – it is the collection of a number of key success factors for any given product or service, and their comparison between the company and the competitor(s). It is extensively used in technological industries.

6. **SWOT (Strengths, Weaknesses, Opportunities and Threats)** – it is the extended form of the old pro and con analysis. The real value of SWOT is the fact that through its opportunities and threats it allows conjecturing about the future.

7. **Game theoretical approaches** – they are the simple decision trees, or 2x2 decision matrixes.

8. **Simulations** - these are done by the computer software that is opening new opportunities for business simulations. In any given simulation we look in a future state of possibility and ask how to act in a series of occurrences.

9. **Ratio analysis** – it is the way to extract intelligence from combinations of comparable figures. They are used mostly in finance and managerial accounting. The only limitation is that the two values that are compared need to make the same sense.
10. **Cost analysis** – It is the investigation of costs in the accounting system of any company, extracting figures and/or ratios in order to make better business decisions.

11. **Spread sheets** – these are giving overview of data in an instant and can be strong predictive tools if the classifications of the dimensions and the categories are well chosen. Spread sheets are often used in connection with other analysis.

12. **Devil’s advocate** – it is the exercise of putting yourself in someone else’s place, or shoes, who is not your company or person. It may be a competitor, a customer or a supplier. This helps to learn how the other company would solve the same problem.

13. **PEST (Political, Economic, Socio-cultural and Technological analysis)** - it contains the most important macro factors which may affect the company. In the political analysis one looks into such variables as the political stability, the introduction of new laws and regulations that may affect the business. In economical analysis the factors such as interest rates, unemployment and gross domestic product (GDP) are interesting. In socio-cultural analysis composition of sexes, ethnic background, languages, religion, education and political conviction factors are analyzed. In technological analysis the attention is on the extent, distribution, and quality of the infrastructure, the general level of technology available for use in production at a certain location and the conditions for transportation and distribution of goods.

14. **Power analysis** – it is about the distribution of economic or political force between people and organizations.

15. **Statistical analysis** - it consists of number of techniques for counting, summarizing and finding relationships between data sets. The transformation of data to figures is the advantage of this analysis.

16. **Scenario analysis** – It is a typical qualitative method. It contains typically 2-3 possible scenarios or possible future events of possible future states of the world. The three scenarios are: one worst case, one best case and one in the middle. The question then is the consequences of each of these scenarios.

17. **Signal analysis** – it is the continuous skim of newspapers and articles to find the useful information thus it is an environmental scanning process. The value of the scanning depends on the goals one sets for the information gathering process.

18. **Early warning analysis** – this is the identification of signals from scanning of the information that can be weak for today but may become stronger signals in future.

The most important in all these analyses is to grasp the language of them rather than to memorize them (Solberg Söilen, 2005). To do so one needs to choose the types of task in accordance with the types of analyses. There are two different types of tasks: Continuous intelligence tasks and problem related intelligence tasks. Some of the analyses are used more for one type of tasks than for the other (Solberg Söilen, 2005). But some of the analyses are not possible to compare to each other and thus to avoid a wrong comparison Solberg Söilen (2005) proposes a classification of analyses by their business function:

- Strategic
- Product oriented
- Environment oriented
- Customer oriented
- Financial oriented
- Technology oriented
3.8.2 Some Technical Characteristics of Analysis

There are several techniques to present the results of analyses. Most of the business analyses are presented in the language of lines and circles. The economic analyses are usually presented in the language of equations and Cartesian curves (Solberg Söilen, 2005). This is because the figures are easier to interpret and understand than words. We all know that one figure cost 1000 words. Another way of presenting analyses is lists that can be sorted (Solberg Söilen, 2005).

As pointed out by Solberg Söilen (2005) the most important criteria of the choice of analyses presentation is to lead the reader straight to the point. There are multiple ways of presenting the written analyses but there is no one right way. That is why some standards have been developed and have been tested by psychologists.

Another important factor of analyses presentation is the classification of information by importance in order not to confuse the reader. For this purpose special templates can be used (Solberg Söilen, 2005).

Presented analyses can be also divided into three broad categories (Solberg Söilen, 2005):

1. Mathematic analysis
2. Linguistic analysis
3. Geometric analysis

Linguistic analysis is considered to be the most complicated one and that is why sometimes it is preferable to transfer linguistic data into mathematical numbers as they are easier to interpret (Solberg Söilen, 2005).

3.9 BI software Analysis Tools

As was presented in the Introduction of this thesis less than 10% of the BI software listed in the CI Resource Index could be considered complete and enhanced applications as most of them do not satisfy the complete CI cycle processes (Bouthillier et al., 2003). Most of the analysts are not satisfied with the quality of the existing “commercial off-the-shelf” (COTS) BI software. Although, the use of COTS software continues to raise due to the fact that first: They are much more cost-effective than the in-house developed software and second: As COTS are developed in the commercial marketplace they suppose to have more capability, reliability and functionality for the end-user than the custom-build BI software (Bouthillier et al., 2003).

According to Bouthillier et al. (2003) there are three criteria that the BI software needs to satisfy:

1. The software must perform more than two value-added processes similar to those outlined in CI cycle.
2. These value-added processes must include identifying intelligence needs that are tailored specifically to CI.
3. The software must perform some level of analysis.

Bouthillier *et al.* (2003) conducted evaluation of four software according to these three criteria. Here we will not cover the whole evaluation process and neither will we list the advantages or disadvantages of these four software in detail. But we rather will concentrate on the analysis tools evaluation criteria of the BI software evaluation process and the summery of the results only for this aspect. The following aspects of analysis tool were considered:

<table>
<thead>
<tr>
<th>Analysis of information</th>
<th>Evaluation questions:</th>
<th>Summary of results for 4 companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety of CI analytical techniques</td>
<td>Does the application offer a variety of CI analytical techniques? (e.g. three or more analytical techniques)</td>
<td>2 x Yes, 2 x No</td>
</tr>
<tr>
<td>Level of analyses</td>
<td>Does the application allow varying the level of analyses?</td>
<td>2 x Yes, 2 x No</td>
</tr>
<tr>
<td>Synthesis of information</td>
<td>Does the application synthesize (summarize) in any way?</td>
<td>4 x No</td>
</tr>
<tr>
<td>Recommendations for actions</td>
<td>Does the analysis result in recommendations for actions?</td>
<td>4 x No</td>
</tr>
</tbody>
</table>

**Table 2: Evaluation criteria and results for the analysis tool of four BI software**

Source: Bouthillier *et al.*, 2003

The highest level of analysis is considered when the recommendations for actions are presented by analysis tool. As we can see from presented results neither of the software are satisfying this criteria. This is not surprising as this last step require a lot of human intelligence. However special word processing and/or spreadsheet application or special templates can be used to fulfill these criteria (Bouthillier *et al.*, 2003).

**3.10 BI software Analyses Tools from Managerial Prospective**

As we have mentioned above, scanning for CI is the main action to find competitive advantage for the company. But only scanning is not enough, the members within the company need to construct competitive perception and make strategic decisions. The managerial CI scanning behavior has been the subject of discussion for many authors (Beal, 2000; Qiu 2007). The results of these studies suggest that managers mostly rely on personal and external sources for market information, and that the uncertainties push managers to scan for competitive advantage more frequently and in multiple markets (Qiu, 2007; Werther, 2001).

Qiu (2007) states that the questions why managers differ in their scanning behaviors and how managerial scanning for CI impacts their interpretation of companies’ competitive
advantage are still open. He touches these questions by showing the lack of knowledge in three main aspects:

1. In the influence of managers’ antecedent attitudes on the psychological scanning process.
2. In the influence of managers’ normative beliefs, embodied in the companies’ expectations and pressure, on the scanning process.
3. In the effect of scanning behaviors on managerial interpretation of companies’ competitive advantage.

Understanding all these aspects is essential for companies profit and performance as the managerial interpretation of scanning directly influences on decision making and strategic actions.

Managers at all levels of company’s organization conduct CI scanning to monitor market changes and to sustain their market position. Managers must be aware of all the changes of customer preferences, competitor strategies and technological developments. Qiu (2007) defines two important aspects of scanning for CI – the frequency and the scope. The scope is the number of different markets sectors that the manager scans and the frequency is how often the manager does the scanning. Market sector is the combination of competitor, customer and the technology. Frequency determines the timeliness, relevancy and the amount of CI the managers collect.

Qiu (2007) suggests that there are two main antecedents of managerial scanning behavior:

1. Entrepreneurial attitude orientation – manager’s attitude towards the processes, practices and decision making.
2. Market orientation

*Entrepreneurial attitude* orientation is connected with the following business motivations:

1. Need for achievement – desire to be successful
2. Locus of control – personal control of outcomes
3. Innovation – tendency to support creative ideas

According to Qiu (2007) different levels of entrepreneurial attitude orientation have a strong impact on the scanning process. Managers with high level of need for achievement, locus of control and innovation have a strong motivation to control the market. This motivation leads to their intensive search for competitive advantage. Their scope of scanning usually large and the frequency is high.

Market orientation is defined by Qiu (2007) as a reflection of the company’s standards and expectations for CI generation and dissemination. In market-oriented company there is a culture in which employees are expected to provide efforts to accommodate customer needs through information gathering and sharing across departments. In contrast to entrepreneurial attitude orientation, market orientation is acting more on the collective level rather than individual. It has a positive influence on business performance and the market-oriented members of company rigorously and frequently scanning for CI.

Traditionally it was considered that managers who are scanning for CI are well informed about tangible and independent entities in the market, and they are rationally identify
opportunities and threads there (Beal, 2000). However, the new perspective states that managerial representations of competitive advantage vary in the content and structure from person to person as managers have different ways of seeking and interpreting the information (Qiu, 2007). That is why the broader the scope of CI scanning and the more managers scan for CI the less bias will be the outcome of their scanning for competitive advantage.

In his work Qiu (2007) confirms the following six hypotheses about managerial perspective of CI:

1. Managers’ entrepreneurial attitude orientation has a positive relationship with their scope of CI scanning
2. Managers’ entrepreneurial attitude orientation has a positive relationship with their frequency of CI scanning
3. Market orientation has a positive relationship with the scope of CI scanning
4. Market orientation has a positive relationship with the frequency of CI scanning
5. The scope of CI scanning has a positive relationship with managerial representations of competitive advantage
6. The frequency of CI scanning has a positive relationship with managerial representations of competitive advantage

At the end of his study Qiu (2007) points out that there are many methods to identify the influence of managerial individual behavior on CI scanning but which method to use for which case and when is still under the question.

**3.11 Short Summary of the chapter**

In the previous chapter we have fulfilled the first goal of this thesis. According to our extensive literature review we have identified the following major characteristics that the BI software analysis tool must satisfy:

1. Due to the wide possibilities of modern technologies such as Internet the data collection is extremely fast and in a matter of hours an overwhelming amount of data and information must be processed and sorted into boxes/analyzed.

2. Due to the easily accessible information its reliability is extremely low and the possibility of gathering irrelevant information is quite high. The life cycle of information is unpredictable and thus analyses of the information should be done on time and precisely.

3. The BI software analysis tool must comply with the complete CI cycle. It must:
   a. Propose a variety of analysis types,
   b. Allow a choice of levels of analyses,
   c. Must include noise reduction (in compliance with point 2) by synthesis of information,
   d. Offer a variety of possible actions for the decision making process.

4. The analysis tool must give a possibility to generate different types of reports, such as text documents, figures, tables etc., should allow the selection of reports
only in the direction of interest, such as only customer and supplier reports or only competitor-specific reports and should supply with a user-configurable toolbar that can be used by both basic and advanced users. It must be user-friendly.

5. The analysis tool must be capable to prevent the influence of managers’ antecedent attitudes and normative beliefs on the psychological CI scanning process, and must be capable to neutralize the managerial interpretation of companies’ competitive advantage. Of course this factor is almost impossible to diminish completely especially only with the help of analysis tool.
4. METHOD

4.1 The Outline of Problem and Suggested Solutions

As was identified in the beginning of the thesis, we pursue two goals: First we investigate what are the major obstacles for making a better analysis function in the Business Intelligence (BI) software and second we examine how those obstacles can be solved both technically and from a managerial perspective. In this chapter we address the technical aspects of the solution.

In our solution we propose to use the idea of connectivity graph that is heavily weighted. Here the vertices will represent the types of analysis and the edges will show their correlation in accordance to their identified nature. To manage and to sort the data into appropriate boxes we propose to use the tagging mechanism of the input data. Later, the identification of the data tag will help to find out which analysis types are compatible for the given data.

The algorithm can be implemented using the object oriented programming language such as Java. The user interface can be generated by textual programming language Visual C++ or by Java itself or by the combination of the two.

To be able to implement the ability of the analysis tool to give an advice in the decision making process one can use the concept of semantic network. In this way relating several negative concepts to the negative outcome of the solution or several positive concepts to the positive future steps for the company one can implement the advisory attribute of the analysis tool.

Finally for the generated analyses reports we propose to use generic data output formats that can be viewed with the help of several different commercial and non-commercial software.

4.2 The Theoretical Approach

Here we introduce the main theoretical concepts and methods that we will use in future developments of our method and solutions.

4.2.1 The Connectivity Graph

Graph is an abstraction of relationships among objects. A "graph" is a collection of vertices or nodes and edges that connect pairs of vertices to each other. In mathematics and computer science, connectivity is one of the basic concepts of graph theory; it is an important measure of graph’s robustness as a network. A graph is called connected if every pair of distinct vertices in the graph can be connected through some path (Gibbons, 1985; Bollobás, 1998).

One can determine if two vertices of a graph are connected by using either a search algorithm, such as breadth-first search, or by using a disjoint-set data structure, or by counting the number of connected components. Here is an example of such an algorithm (Gibbons, 1985; Bollobás, 1998):

1. Begin at any arbitrary node of the graph
2. Proceed from that node using either depth-first or breadth-first search, counting all nodes reached.
3. At the end, if the number of nodes counted is equal to the number of nodes of the graph, then the graph is connected, otherwise it is disconnected.

4.2.2 The Weighted graph

A weighted graph means that every edge of the graph has a label (weight) that is usually a real number and may be restricted to rational number or integer. The weight of a path or the weight of a tree in a weighted graph is the sum of the weights of the selected edges (Gibbons, 1985; Bollobás, 1998).

When the edges of the graph have no weight graph is unweighted. In some articles on graph theory the term network is a synonym for a weighted graph. A network may be directed or undirected; it may contain special vertices (nodes), such as source or sink. The vertices of the graphs can also have weights. Examples of classical network problems are (Gibbons, 1985; Bollobás, 1998):

- Minimum cost spanning tree
- Shortest paths
- Maximal flow

A hyper-graph is a generalization of a graph, where edges can connect any number of vertices. It is also called a set system or a family of sets. While graph edges are pairs of nodes, hyper-edges are arbitrary sets of nodes, and can therefore contain an arbitrary number of nodes (Gibbons, 1985; Bollobás, 1998).

Here are some definitions of general terms in graph theory (Gibbons, 1985; Bollobás, 1998):

The route of the graph is a sequence of edges and nodes from one node to another. Any given edge or node might be used more than once.

The path of the graph is a route that does not pass any edge more than once. If the path does not pass any node more than once, it is a simple path.

The loop, cycle of graph is a path which ends at the node where it began. A graph tree is a connected graph with no loops.

4.2.3 Semantic Networks

A semantic network is a network which represents semantic relations between the concepts. Semantic networks are forms of knowledge representations. In the basics of it is a directed or undirected graph consisting of vertices, which represent concepts, and edges that make a connections between concepts (Collins and Quillian, 1969).

For example, WordNet is a semantic network, a lexical database of English. It combines English words into sets of synonyms called synsets, provides short, general definitions, and records the various semantic relations between these synonym sets. The commonly used semantic relations are (Collins and Quillian, 1969):
• meronymy - means if A is part of B, then B has A as a part of itself,
• holonomy – means if B is part of A, then A has B as a part of itself,
• hyponymy (or troponymy) – means if A is subordinate of B; A is kind of B,
• hypernymy - mean A is super-ordinate of B,
• synonymy - means A denotes the same as B,
• antonymy – means A denotes the opposite of B.

4.2.4 Java and Visual C++ Programming Languages

Here we give a small introduction to two programming languages we propose to use in order to implement the above described method. We identify some of the wide range features these two languages have.

Java is a programming language originally developed by James Gosling at Sun Microsystems and released in 1995 as a core component of Sun Microsystems' Java platform. Later, in 2006, Sun released Java as free and open source software and in 2007 Sun made all of Java's core code available as an open-source distribution (Liang, 2008). The language has most of the C and C++ programming languages’ features although it has less complicated object oriented structure. Java has a "Write Once, Run Anywhere" (WORA) attitude which allows run-times without costs on all platforms. It is secure and its security can be configured to specify network- and file-access restrictions (Liang, 2008).

Java applets are quite strong and popular tools and a lot of web browsers use the ability of Java to run Java applets. These are programs that are embedded in other applications Liang, (2008).

Java Servlet technology provides web developers with a simple, consistent mechanism for extending the functionality of a web server and for accessing existing business systems (Liang, 2008).

Java Swing is a graphical user interface library and it helps to specify different looks (Liang, 2008).

Java language has five main features

(http://java.sun.com/docs/white/langenv/Intro.doc2.html):

1. It is simple, object oriented and familiar.
2. It is robust and secure.
3. It has a neutral architecture and is portable.
4. It is a high performance language.
5. It can be interpreted, threaded and is dynamic.

Microsoft Visual C++ is a commercial integrated development environment (IDE) product created by Microsoft for the C, C++, and C++/CLI programming languages. It is a programming language which uses a graphical user interface builder to make programming decent interfaces easier (Björnander, 2008).

It has the following features (Björnander, 2008):
Has a design Windows Presentation Foundation (WPF) applications with built-in
designer support.
• Allows creating data-enabled applications with the lightweight SQL Server
Compact Edition or powerful client/server applications with SQL Server 2008
Express for use with databases.
• Allows to build applications using LINQ (Language Integrated Query) which adds
data querying capabilities for SQL Server, XML, and objects to Visual C#
• Has a support for the Entity Framework and designer tool to create user-friendly
interfaces.
• Allows to develop rich 2D and 3D games with The Game Creators GDK

Simple actions such as create a simple window, create a popup window, call a dialog
from a dialog, remove an occurrence in a string, implement radio buttons, create a
property sheet-based application, create a list view in a dialog, transfer data from one
dialog box to another, launch an application, display a context menu on a control, create a
border-less, title bar-less, maximized dialog box, store values in the registry etc. can be
easily implemented in Visual C++ (Björnander, 2008).

4.3 The Technical Implementation
Here we introduce the actual implementation of the proposed solution using above
described theoretical concepts and methods.

4.3.1 Classification of Analysis through Weighted Connectivity Graphs
In the section 3.8 we have listed the most frequently used analyses and then classified
them by different metrics:

1. According to the **micro** and **macro** environment
2. **Variables** they concern about: Customers, competitors, suppliers, entry and exit
   barriers, substitutes to suppliers, marketing, substituted to customers, economic,
   political, social, technological, infrastructural, ecological, legal and demographic.
3. According to their **business function**: strategic, product oriented, environment
   oriented, customer oriented, financial oriented, technology oriented and
   behavioral.
4. According to their **broad nature**: mathematic, linguistic and geometric analysis.

For example, suppose that we have several A, B, C etc. types of analysis implemented in
the BI software. Each of these analyses has its own business function. If we consider
these types of analyses are the vertices of a graph then each of the vertices can get a
weight in accordance to the business function of the analysis.
Suppose that all these analysis are of micro environment. For simplicity we consider that
the analyst needs only two categories of analyses: competitor and supplier. The A, B, C,
D and E are competitor analyses and the D, E, F, G and H are supplier analyses. This
scenario is depicted in Fig. 7. As we can see D and E analysis belong to both competitor
and supplier categories. This double correlation can be shown through the weights on the
edges between the vertices of the graph. Finally to classify the broad nature of the
analyses, the vertices can be combined into hyper-graphs. If the vertex is in more than
one hyper-graph then it has multiple broad natures. Such as vertex D is of both linguistic and mathematic analysis.

The final correlation of these classifications presented in Fig.7 is a weighted connectivity graph together with the hyper-graph. This is how we propose to implement the grouping of analysis types.

![Graph Representation of Analyses Classification](image)

The legend of the figure

- **Weights of vertices:**
  - 1 - strategic
  - 2 - product oriented
  - 3 - environment oriented
  - 4 - customer oriented
  - 5 - financial oriented
  - 6 - technology oriented
  - 7 - behavioral

- **Weights of edges:**
  - 1 - competitor related
  - 2 - supplier related

- **Hyper-graphs:**
  - --- - Mathematic
  - --- - Linguistic
  - --- - Geometric

**Figure 7: The graph representation of analyses classification**

Next, if the input data and information of the BI software is also tagged in accordance to these classifications then the correlation between data and information, and analysis types is easy to find for the BI software analysis tool.

This idea of tagging of the data and information we propose to implement in the following way: When the data/information arrive into the system the analyst needs to sort them into boxes according to their nature. To do so analyst needs to tag them. We define four categories of tags in accordance to our above mentioned classification of analysis.
types. As the incoming information can have intelligence of several orientations in one category it may get several tags accordingly. To show how we tag the incoming information let us again look into a typical scenario.

Suppose that the information arrived into the system has double intelligence in it: First it includes intelligence over supplier and second over competitor. And this intelligence includes both financial and product orientation. Thus the analyst will tag it as:

From environment metric point of view - one tag: micro
From variable metric point of view – two tags: supplier, competitor,
From business metric point of view – two tags: product and financial oriented,
From nature metric point of view – two tags: mathematic and linguistic.

Each of this tags will connected the information to the appropriate boxes. Note that the given information can be connected to several boxes as it may contain essential intelligence in several orientations. Thus the given information can appear as intelligence in many boxes which on the other hand can create confusion for the analyst as he can assume that these are different intelligence. In order to avoid this confusion next to the given intelligence the identification of tags will be visible and by clicking on the appropriate intelligence the tree of tag-connections will be visualized as shown in Fig. 8.

![Diagram of Tagging and Sorting of Information]

**Figure 8: Tagging and Sorting of Information**

### 4.3.2 Extraction of the Final Advice through Semantic Networks

The logic behind the extraction of final advice is hidden in the use of semantic networks, where the correlation of the output of the analyses to the conclusions can be made. Any output of the analyses from SWOT, Devil’s advocate etc. has its own specific standard layout and terminology. This terminology should be beforehand included and exist in the database of the semantic network of the program.
After the results of analyses are ready several conclusions can be subtracted to give an advice to the analyst as a support for decision making process. In order for the BI software to know in which directions the analyst needs the advice for, the analyst should specify beforehand the directions of interest by choosing appropriate identifiers from the given menu. Moreover, to help the software to understand the negative and positive correlations of the terminologies, analyst will have the possibility to define negative and positive, and/or minimum and maximum thresholds for the given identifiers. Semantic grids will then correlate the terminologies and values chosen by the analyst with the ones produced by the analyses and will derive the appropriate conclusion. These conclusions will then be presented to the analyst as an advice-support for the decision making.

For example, if the analyst is interested to find out whether the investment in the future product will be a good decision he/she should look into the cash flow, net income and expenses. Analyst then needs to choose these three identifiers form the given menu before the analyses are conducted and give maximum and minimum value thresholds to them in accordance to the expectations. After analyses are performed the program will compare these terms and values with the outcome of analyses and if the income is negative and expenses are high then in the semantic graph this two results will be connected to the vertex that will advice do not invest.

### 4.3.3 Choice of Analyses Types and Levels

As we have identified above the main drawbacks of existing BI software analysis tools are that they do not offer a variety of analytical techniques and do not allow a choice of levels of analyses to the user.

We propose to overcome this drawback by using the drop down menus. When the analyst is in one of the boxes and is at the point of analyzing the information to extract the intelligence out of it, after choosing the “Analyze” button from the menu, a list of possible analysis types will be offered. This list is a selection of analysis types that are applicable to the earlier chosen intelligence using connectivity graph. For example if the chosen intelligence has tags of finance and product orientation, and of competitor category then the following list of analysis types will be offered: Benchmarking, SWOT, Game theoretical approaches, Simulations, Ratio analysis, Cost analysis. Using keys such as ctrl from keyboard analyst will be able to select the techniques he/she prefers.

Level of analysis refers to the extent to which information is preceded. By choosing the appropriate level, analyst ensures the quality and comprehensiveness of extracted intelligence. Also different levels of the company may need intelligence of different levels of analyses. To ensure this we propose to preliminary define several levels of analysis in the analysis tools. Such as:

- **Level1** – A preliminary report of overall picture of the current situation in the company
- **Level2** – Intelligence of level1 and additional financial reports such as income statement, cash flow statement.
- **Level3** – Intelligence of level2 and additional profiling of the company etc.

Analyst, after choosing appropriate types of analysis will choose the levels of the performance and the outcomes of analyses will be in accordance with these choices.
4.3.4 Custom Toolboxes and sessions

According to the literature overview, usually each department of the company has its own frequently used list of analysis. For example, the analysts of the financial department will barely use PEST analysis or Power analysis. Considering this fact, it will be helpful for the users of analysis tools to have a possibility to save their first time choice of analysis types and levels and use it immediately every time they need it. To make it possible the program will have the opportunity to create and save sessions. That is, if the analyst wants to save all the steps he/she did to apply them on the next intelligence another time then he/she can save the session under any name as a separate file and next time just upload that file into the software. The loaded session will then have the same types and levels of analyses used previously but no any intelligence included, thus it can be applied to the new intelligence easily.

Another possibility is to offer a creation of user defined toolbox/toolmenu. This means that the analyst can choose custom functionalities of the analysis tool and create his/her own easy menu. This menu will also have a separate line showing the last time used functionalities.

4.3.5 Final Reports: Documents, Graphs and Charts

A BI software analyses tool should be user friendly. The subtracted information of BI software can be of interest not only for analysts but also for managers and sometimes to CEOs who are most probably unfamiliar to the applicability of BI software. In our aforementioned developments we have tried to keep the user interface as close to the well-known software’s interface standard as possible. But not only the tools, also final reports need to be user-friendly and easy understandable. For this reason, analysis tools must be equipped with a possibility to generate different types of reports, such as text documents, figures, tables etc., and also must allow the selection of reports only in the direction of interest, such as only customer and supplier reports or only competitor-specific reports.

The major point to consider in this step is whether to implement the report generation with the help of commercial software: such as excel, power point, adobe acrobat etc., or to generate own non-commercial tools. Another point is if the choice is to use the commercial software, then whether to integrate them into the BI software or whether to leave them on the customer’s consideration of obtaining them.

In case of the choice of commercial software for report generation purposes we suggest to integrate them into the BI software as first: the customer will not have the hassle to determine which software are needed and how to obtain them and second: the BI software will work much faster with its own components.

The best choice we consider is the generation of the generic formats of the reports. Considering that some of the BI software users will have Windows operating system other Unix/Linux or Mac the use of the commercial software may raise incompatibility issues, while generic formats may help to overstep these issues. For example, tables and graphs can be generated in CSV (Comma Separated Values) format files instead of excel sheets.
In CVS file format each associated item in a group is in association with others separated by the commas of its set and each line corresponds to a row in the table. These files are used to move tabular data between two different computer programs such as different spreadsheet programs. Thus, later analyst can extract them into either excel sheet, or any Open/(S) office sheet.

Similar formats exist also for generation of figures, plots etc. This solution will also help the customers of BI software to avoid extra costs associated with report generating commercial software.

Finally, the ready reports need to be circulated between members of the same department or between members of different departments as well as between members of different levels in the company. This can be done through intranet and/or email lists of the company. The addresses and email lists can be imported into BI software beforehand and the only thing the analyst will need to do is just to choose whether he/she want to use intranet or any appropriate email list or both to spread the generated reports.

### 4.3.6 A Case Study – Analysis tool for Subsoft BI software

Subsoft 1.0 is BI software developed by a leading academic in the field of private and public intelligence, Dr. Klaus Solberg Söilen of the Blekinge Institute of Technology, Sweden. The philosophy behind Subsoft is to create a good intelligence system, whether for use in private or public organizations. It functions like the periscope of a submarine; by employing it analyst should be able to make an immediate scan of your environment (www.subsoft.se).

The ideas in the software, which builds on the latest research, have been developed and tested on Swedish local companies and students for two years (www.subsoft.se). Fig. 9 shows the interface of the Subsoft as the user logs in.

![The user interface of Subsoft 1.0 BI software.](www.subsoft.se)

**Figure 9: The user interface of Subsoft 1.0 BI software.**

Source: www.subsoft.se
As soon as the user logs in the number of new intelligence is displayed and they are also distributed into appropriate boxes. In this way the user can easily track the incoming intelligence. The analyst has the possibility either to see all the intelligence as shown in Fig.10 or just by box.

**Figure 10:** The list of the new intelligence.

Source: www.subsoft.se

**Figure 11:** SWOT analysis in Subsoft.

Source: www.subsoft.se
Next, the analyst can decide to analyze the incoming information by choosing one of the given methods. In Fig. 11 an example window of SWOT analysis is shown.

The Subsoft is developed based on SSAV (Solberg Söilen, Amara, Vriens) BI Software evaluation model (Amara et al., 2009). The aim of SSAV is to evaluate BI Software effectiveness and efficiency as a tool and in addition to assess how each BI function supports a particular CI activity in the cycle (Amara et al., 2009). SSAV evaluation model is based on three classes of variables (Amara et al., 2009):

2. Product variables: - for evaluating the effectiveness and efficiency of artifacts, deliverables or documents that result from BI Software function.
3. Process variables: - for evaluating how a BI function supports a particular CI cycle activity.

In the current stage Subsoft is still in the development phase. The general ideas and tools are created, it is able to sort the incoming intelligence but the analysis phase, user interface, generated reports and final decision support advice are still under construction or not implemented. For example, in Subsoft all the possible analyses are proposed to the user, as shown in Fig. 11, independent of the metrics of the incoming intelligence. This can create confusion for the analyst to make the right choice. The next step in the development of Subsoft will be to integrate tools and solutions developed in this thesis.
5. EMPIRICAL DATA

To collect empirical data about BI software analysis tools its advantages and disadvantages, implementation obstacles and their state-of-the art we have constructed a questionnaire and sent it by email to six companies based in The Netherlands: Crystalloids, Sentient, Astragy, Kadeza, OneLine and Incore Solutions. The choice was made by simple search, without any specific profile preferences. From one of the companies, Kadeza, we have received a rejection with apologies stating that managing director decided in hindsight that he doesn't want to participate in this questionnaire. From the rest of the companies we didn’t receive any answer.

Immediate willingness to help and answers to the questions have been received only from two of them: Sentient and Crystalloids.

Here we summarize the opinion of these two BI software development companies about the ideas and statements in this thesis. The managerial point of view is also considered. A questionnaire is composed based on above mentioned aspects of managers’ entrepreneurial attitude orientation. We also investigate the profiles of the two BI software companies and discuss the current state of their BI software analysis tools in the scope of the above listed main criteria.

5.1 The Company Profile - Sentient

Sentient is an independent software company, based in Amsterdam, with a long track record in data mining and business intelligence. Since 1991, Sentient has enabled many organizations to discover patterns and trends in their data. This has provided more insight and an improved information position to make accurate forecasts and better decisions. Customers of Sentient include Delta Lloyd, KPN, De Telegraaf (Netherlands' largest newspaper), police forces, libraries and tax offices in the Netherlands and abroad (http://www.sentient.nl).

Sentient believes that data mining does not have to be difficult and that there should be an interaction between automatic techniques and the analytic skills of the user. Sentient's software therefore proves itself through user friendliness and options for interactive analysis. Sentient is the first company in The Netherlands to focus on data mining. Many of their consultants have more than 10 years of experience in data mining projects in various organizations (http://www.sentient.nl).

To identify their customers needs and potential in data mining Sentient has a tool called Quickscan. When customer orders a Quickscan, one of Sentient's experienced consultants schedules a meeting with customers to establish a profile of the data mining potential in their organization. The profile is then created based on the specific requirements, the operating market domain and the information management process that is used in given organization.

The results of the Quickscan are presented in a written report. With this service, Sentient offers an ideal chance to quickly explore the added value of data mining for any organization. The Quickscan is free of charge and obligations (http://www.sentient.nl).
Sentient offers also a tool called Recommender that dives deep into that personal taste by analyzing the customer's choices and recommending products that best fit their personal preferences. Recommender bases its insight in these personal preferences on a database that contains earlier choices by many other consumers. For instance, this database could be the complete lending records of a public library (http://www.sentient.nl).

The main software Sentient offers is the DataDetective. It is Sentient's data mining software product. DataDetective helps organizations become more effective by enabling them to run deep analyses on their complete data. Advanced analysis technologies make finding relationships, patterns and trends a quick and easy job. This gives users more insight and allows them to create better forecasts. The most important functionalities in DataDetective are: predicting, clustering, finding relationships, profiling, network analysis, fuzzy matching, creating graphs, creating maps, defining selections and creating cross tables (OLAP).

![Image of DataDetective interface]

**Figure 12: The interface of DataDetective**
Source: http://www.sentient.nl

- **Intelligent datamining:** DataDetective actively supports the user in applying the built-in data mining techniques, thereby replacing technology-oriented work by task-oriented work.
- **Return on investment:** Because of the ease-of-use and speed of DataDetective, every organization can start applying data mining technology with a minimal investment of time and effort.
- **Scalable and automatic:** DataDetective can handle a large variety of data sources, containing millions of records and thousands of variables.
- **Fuzzy matching:** DataDetective has an ability of fuzzy matching, to search intelligently, to find clusters, and to make forecasts based on a self-learning process. An important advantage of fuzzy matching is the lack of strict requirements on the data format: items may be missing from records. Complex
Data types, such as free text and data collections, can be included in the matching process.

Figure 13: An example snapshot of analysis tool of DataDetective
Source: http://www.sentient.nl

5.1.1 The Technical and Managerial Point of View - Sentient
According to the answers of our questionnaire Sentient believes that only few of the nowadays BI software sufficiently enhanced with analysis tools. The BI software in Sentient is one of these few as it is specifically designed for the analysis part of BI and provides different types of analysis. The main components of the BI software at Sentient are organizer (general data view), geographical analysis, clustering, model studio, profile analysis, decision trees, powerquery (selection). The correlations between incoming records are measured using the associative memory technique.

Sentient currently provides their BI software to about 30 customers. They collect the customer feedback via a devoted customer support telephone number. Also, Sentient has a central forum for developers where internal and customer feedback is collected and evaluated. Moreover, Sentient offers pilots to their customer before the purchase of their BI software. In these pilots they discuss the correlations of customers’ needs and offered solutions.

DataDetective, the BI software at Sentient is capable to produce different kind of reports, such as tables, all sorts of graphs, geographical reports, XML-reports, cluster visualization. Moreover, it is capable of producing the final reports both by using
commercial and non-commercial software. Sentient believes that integration of analysis results saves some time and makes interactive analysis possible (use analysis results immediately for the next analysis) but also user should have the option to export the results to standard formats such as MS Excel to share it with others.

According to Sentient data analysis is very important but it is as important in BI software as sharing and organizing of information in the right manner. The main characteristics that the analysis tool must have according to Sentient are good visualizations of results, analyzing in real-time, ease of use, good selection options. All these features are implemented in DataDetective.

In the implementation of the sophisticated BI software analysis tools Sentient encountered the following main obstacles: organizing the data, bringing different sources together and cleaning the data.

Sentient states that the ability of analysis tool to provide an advice for decision support process is important only if the outcome is not immediately obvious for the user. However, in most of the cases they believe that the outcomes of analysis are quite obvious already. Thus, this feature currently is not implemented in DataDetective. It also doesn’t comply with the complete CI cycle as it is concentrated on analysis tool, thus it cannot be considered an expert system yet.

BI software at Sentient does provide a possibility for users to choose between different types and levels of analysis: Different problems require different analyses, so the user should have multiple options to choose. DataDetective at Sentient can be of interests for different departments as well as for different levels of the company: it enables standardized reports for management teams as well as for real-time analysis and predictions.

To satisfy the user-friendly interface, the BI software at Sentient has organized menu structure, only popular functions directly available, results visualization in an intuitive and interactive way capabilities. The user-friendliness is one of the important features of DataDetective.

In general DataDetective is easy to use (visual interface, no expertise required, no coding), is adaptable (interactive analyses), is time and cost saving tool (DataDetective tries to automate its analysis as much as possible). DataDetective can analyze very large amounts of data from many different data sources at the same time. Sentient considers the analyses in the indirect category scope is theoretically possible but difficult.

As for the obstacles from managerial point of view, Sentient states two of them: Managers do not invest enough to get BI analyses right and they do not fully understand the benefit of BI software in general. Sentient agrees that the managers’ entrepreneurial attitude can have an influence on the final decision making as sometimes managers can overrule the BI analysis tool’s recommendations. In the current version of DataDetective it is not possible to overcome this consequence. As a possible solution Sentient suggests to perform “what if” analyses, to compare the impact of different decisions.
5.2 The Company Profile - Crystalloids

Crystalloids assists organizations that are moving towards predictive enterprise paradigm by supporting and training their people; by crystallizing, implementing and optimizing the relevant processes; and by selecting, implementing and controlling the required technologies. Crystalloids is a start-up consulting company situated on the Science Park Amsterdam, The Netherlands (http://www.crystalloids.com/).

Crystalloids focuses on the people and processes of Customer Intelligence and Risk Intelligence and technologies of SPSS (analytical solutions providing software by SPSS Inc.), SAS (Business analytics and BI software) and Netezza (BI analytics software) (http://www.crystalloids.com/).

The technologies of SPSS supported by Crystalloids are PredictiveMarketing, PredictiveCallCenter, PredictiveWeb and PredictiveClaims based on Clementine and the acquired software of DataDistilleries being Model Builder, Event Builder, Interaction Builder and Risk Control Builder (http://www.crystalloids.com/).

The technology of SAS supported by Crystalloids is SAS Customer Intelligence based on Enterprise Guide, Enterprise Miner, Customer Intelligence Studio, Digital Marketing, Marketing Optimization, Interaction Manager, Real Time Decision Manager and Web-report Studio (http://www.crystalloids.com/).

The technology of Netezza supported by Crystalloids is the Performance Server System.

Crystalloids supports customers in the Finance, Banking and Insurance industry and the Leisure industry. Their projects are focused on Marketing & Sales and Claim Handling (http://www.crystalloids.com/).

For example, they are supporting an Insurance Company in Belgium. Crystalloids restructured their Data Mining processes and assisted them in building their predictive models. Another example is for a Leisure Company in Germany Crystalloids implemented SPSS PredictiveMarketing, improved their Database Marketing department and advised them on cross-campaign optimization. For another Insurance Company in the south of the Netherlands they have implemented SPSS Predictive Marketing (http://www.crystalloids.com/).

5.2.1 The Technical and Managerial Point of View - Crystalloids

According to the answers of our questionnaire Crystalloids believes that nowadays BI software are sufficiently enhanced with analysis tools. In fact SAS and SAP business objects supported by Crystalloids have advanced data mining facilities. Cognos also supported by Crystalloids now partners with SPSS statistics. The main components of these BI software are ROLAP, Data Mining, Reporting and Dashboard.

Crystalloids currently provides these BI software to about 20 customers. Customer support and customer feedback collection are not directly implemented in Crystalloids. These are provided by their partners: SPSS, SAS and SAP. However, Crystalloids has usage tracing facilities to make sure that the provided BI software suits their customers’ needs.
Crystalloids believes that analysis tool is the essential part of BI software and with integration of more advance analysis methods the BI software becomes more powerful. The main characteristics that analysis tools must have are performance, security, data preparation, transformation, presentation and much more. According to Crystalloids SAS and SAP provide all these characteristics.

In the implementation of the sophisticated BI software analysis tools Crystalloids encountered two main obstacles: The data preparation and the user understanding of the technology. The analysis tools of BI software at Crystalloids can operate both in the scope of direct categorist and indirect categories, such as political, infrastructural, social etc., but only if the appropriate data is available.

Crystalloids did not find the ability of analysis tool to provide an advice for decision support process an important feature. According to them the analysis tool must provide information and the user must interpret it in accordance to the situation. Currently neither SAS nor SAP has this feature. As such these tools are not expert systems.

SAS and SAP do provide a possibility for users to choose between different types and levels of analysis: For simple people, simple analysis. These BI software supported by Crystalloids can be of interests for different departments as well as for different levels of the company: For central management department and for decentralize usage.

The understandability of the system must be considered in the implementation of user-friendly interface for the BI software. As for using commercial or non-commercial software for final reports Crystalloids proposes to use web-base of Portable Document Format (PDF) based reports.

According to Crystalloids there is always an influence of managers’ entrepreneurial attitude on the final decision making process and it is not possible to prevent this influence with the help of BI software.
6. CONCLUSIONS

In the beginning of this thesis we have outlined the two main goals we intended to pursue throughout this work: First was to investigate what are the major obstacles for making a better analysis function in the Business Intelligence (BI) software and second was to examined how those obstacles can be solved both from a technical and from a managerial perspective. We have also proposed to analyze these two goals in the scope of seven hypotheses. The first goal we have reached through an extensive literature overview. To solve the second one we have proposed a new method.

To conclude our findings, below we quote again each hypotheses accompanied by our results and discussions. Finally we suggest several directions for future work and developments.

**H1: Some of the BI software have good analysis tools but their score is low as they do not provide any BI business analyses from OLAP, data mining, predictive or qualitative analysis.**

In our extensive literature overview given in Section 3 we have presented the ideas and opinions of different researchers in BI area about this topic. It became clear that there are two major obstacles in the way of implementation of the sophisticated BI software analysis tools. These two major obstacles are:

1. The large variety of intelligence tasks that needs to be addressed.
2. The large variety of analyses that can be performed for different intelligence tasks.

Moreover, the enormous amount of data and information that is rapidly growing thanks to the modern technologies, the low reliability of them, the fast growing methods of data and information analysis are making the implementation of sophisticated BI software analysis tool even more difficult. By sophisticated we mean BI software that will be well defined, user-friendly and capable to serve as a decision support system.

Several authors have done benchmarking of multiple existing BI software. As was emphasized in the Section 3 and demonstrated in Table 2, according to these benchmarks most of the existing software have one or two analysis techniques and neither of them can serve as a decision support system and very few perform OLAP, data mining, predictive or qualitative analysis. This was not surprising, as especially the decision support process requires a large portion of human interference.

From to companies we have questioned Sentient agreed with this statement Crystalloids did not. The BI software in Sentient is one of the few that are specifically designed for the analysis part of BI and provides different types of analysis. The main components of the BI software at Sentient are organizer (general data view), geographical analysis, clustering, model studio, profile analysis, decision trees, powerquery (selection). The correlations between incoming records are measured using the associative memory technique. The BI Software supported by Crystalloids are SAS and SAP which have advanced data mining facilities.
The way we have proposed to solve the identified two major obstacles is to categorize both intelligence tasks and possible analysis and find a method to correlate these categories to each other.

To derive a conclusion as an advice of the decision support process we proposed to use the key-word correlations method between generated by analysis standard reports and included into the software number of standard advice.

**H2: Most of the software do not comply with the entire Competitive Intelligence (CI) cycles as they have obstacles to create sophisticated tools such as data visualization interfaces to sort and view the collected information, data sorting by user-defined rules, extraction of relationship between people, places, dates, events etc., text-mining technology to locate and extract user-defined variables and many more.**

As identified in Subsection 3.5, the entire CI cycle consists of four ongoing processes: direction, collation, incubation and dissemination. To satisfy all these stages the BI software analysis tool must satisfy the following four criteria defined in Subsection 3.6:

1. Variety of CI analytical techniques – provide more than one technique for extracting meaning from information. This means to offer a choice of different analytical approaches which will bring adaptability and the value of closeness to the problem
2. Level of analysis – refers to the extent to which information is preceded. This ensures quality and comprehensiveness of extracted intelligence by helping the user to consider all the dimensions of the technique.
3. Synthesis of information – the ability to summarize an article or report and to reduce the potential for information overload. This will ensure a noise reduction and facilitate the value of intellectual access.
4. Recommendations for actions – analyzed information that leads to decision making and actions. This is the highest value-added information and the final outcome of analysis. It will add quality and validity to the extracted intelligence.

However, according to the literature overview, most of the existing BI software offer one or two variety of CI analytical techniques and level of analysis, a limited synthesis of information and neither of them offer recommendations for future actions.

From our empirical data collection we realized that the BI software indeed do not comply with the complete CI cycle as: First, the developers do not consider the extraction of advice for decision support process important, and second some of the software are concentrated just on analysis tools.

Sentient states that the ability of analysis tool to provide an advice for decision support process is important only if the outcome is not immediately obvious for the user. However, in most of the cases they believe that the outcomes of analysis are quite obvious already. Thus, this feature currently is not implemented in DataDetective, the BI software at Sentient. It also doesn’t comply with the complete CI cycle as it is concentrated on analysis tool, thus it cannot be considered an expert system yet.

As for sophisticated tools, DataDetective is capable to produce different kind of reports, such as tables, all sorts of graphs, geographical reports, XML-reports, cluster visualization. Moreover, it is capable of producing the final reports both using
commercial and non-commercial software. Sentient believes that integration of analysis results saves some time and makes interactive analysis possible (use analysis results immediately for the next analysis) but also user should have the option to export the results to standard formats such as MS Excel to share it with others.

Crystalloids did not find the ability of analysis tool to provide an advice for decision support process an important feature. According to them the analysis tool must provide information and the user must interpret it in accordance to the situation. Currently neither SAS nor SAP has this feature. As such these tools are not expert systems either.

The understandability of the system must be considered in the implementation of user-friendly interface for the BI software. As for using commercial or non-commercial software for final reports Crystalloids proposes to use web-base or Portable Document Format (PDF) based reports.

**H3: The obstacles preventing to create the analysis tool is both of a technical and a logical managerial nature.**

Indeed, throughout the complete literature overview we have noticed that different obstacles on the way of implementing a comprehensive analysis tools have been highlighted by multiple authors. These obstacles are of both technical and managerial nature.

In Sections 3.8 and 3.9 we have concentrated on the technical obstacles. Those were:

1. The enormous amount of existing data and information that should be synthesized and sorted into appropriate boxes.
2. The multiple types of analyses that can be applied to different incoming information.
3. The difficulty to correlate multiple incoming information to appropriate types of analyses.
4. The choice between varieties of report generation methods: by incorporating either commercial or non-commercial software.
5. The difficulty of final advice generation for the decision support process.
6. The creation of user-friendly interface that will satisfy the needs of specific users in different areas of business.

The obstacles of managerial nature are highlighted in Section 3.10. Managers at all levels of company’s organization conduct CI scanning to monitor market changes and to sustain their market position. Analysis tools have a major role in this aspect. Managers must be aware of all the changes of customer preferences, competitor strategies and technological developments and analysis tools can help them to be always aware about state of the art. But unfortunately the manager’s antecedent attitudes and their normative beliefs can have great influence on two important aspects of scanning for CI – the frequency and the scope. Thus analysis tools must be also capable to minimize:

1. The influence of managers’ antecedent attitudes on the psychological scanning process.
2. The influence of managers’ normative beliefs, embodied in the companies’ expectations and pressure, on the scanning process.
3. The effect of scanning behaviors on managerial interpretation of companies’ competitive advantage.

This is a complicated task for the BI software as it has a large portion of human factor in it.

In the implementation of the sophisticated BI software analysis tools Crystalloids encountered two main obstacles: The data preparation and the user understanding of the technology. The analysis tools of BI software at Crystalloids can operate both in the scope of direct categorist and indirect categories, such as political, infrastructural, social etc., but only if the appropriate data is available.

According to Crystalloids there is always an influence of managers’ entrepreneurial attitude on the final decision making process and it is not possible to prevent this influence with the help of BI software.

In the implementation of the sophisticated BI software analysis tools Sentient encountered the following main obstacles: organizing the data, bringing different sources together and cleaning the data.

As for the obstacles from managerial point of view, Sentient states two of them: Managers do not invest enough to get BI analyses right and they do not fully understand the benefit of BI software in general. Sentient agrees that the managers’ entrepreneurial attitude can have an influence on the final decision making as sometimes managers can overrule the BI analysis tool’s recommendations. In the current version of DataDetective it is not possible to overcome this consequence. As a possible solution Sentient suggests to perform “what if” analyses, to compare the impact of different decisions.

**H4: The most effective way to implement an analytical tool from a technical perspective is to create a connectivity graph of possible analysis directions, together with explicit schemes and then integrate those ideas as separate modules or structures using Java, Visual C++ programming languages together with already developed tools such as excel sheets.**

In Section 4.3 we propose the weighted connectivity graph and intelligence tagging methods to find the correlations between information and analysis types and levels. We also propose to use semantic network for the generation of the final decision support advice.

In our solution we consider the types of analysis to be the vertices of a graph then each of the vertices gets a weight in accordance to its business function. If one of the analysis belongs to multiple categories then that can be shown by using the weights on the edges between the vertices of the graph. Finally to classify the broad nature of the analyses, the vertices can be combined into hyper-graphs. If the vertex is in more than one hyper-graph then it has multiple broad natures.

We also tag the input data and information in the BI software in accordance to their classifications. Next, the correlation between data and information, and the analysis types is easy to find for the BI software analysis tool. We define four categories of tags in accordance to the classification of analysis types. As the incoming information can have intelligence of several classifications it may get several tags accordingly. Each of these
tags connects the intelligence to the appropriate box. Note that the given intelligence can be connected to several boxes as it may contain essential intelligence in several orientations.

Any output of the standard analyses such as SWOT, Devil’s advocate etc. has its own specific standard layout and terminology. We propose to include this terminology beforehand into the BI software analysis tool.

After the results of the standard analyses are ready several conclusions can be subtracted to give an advice to the analyst as a support for decision making process. In order for the BI software to know in which directions the analyst needs the advice for, the analyst should specify beforehand the directions of interest by choosing appropriate identifiers from the given menu. Moreover, to help the software to understand the negative and positive correlations of the terminologies, analyst will have the possibility to define negative and positive, and/or minimum and maximum thresholds for the given identifiers. Semantic grids will then correlate the terminologies and values chosen by the analyst with the ones produced by the analyses and will derive the appropriate conclusion. These conclusions will then be presented to the analyst as an advice-support for the decision making.

All these solution we propose to implement using Java object oriented programming language (together with) Visual C++. Java is a sophisticated language to implement complicated algorithms and Visual C++ is an easy language to create user-friendly interface tools such as drop down menus, bars etc.

For the output reports we also propose to use generic data formats for any type of analysis outputs, e.g. tables, text reports or figures. One of these generic types of output is the CVS format that can be viewed using different commercial or non-commercial tools.

**H5: The most effective way to implement an analytical tool from a managerial perspective is to present a menu of more or less standardized analyses to choose from, also giving the user a possibility to alter some features.**

Indeed, the analysis range can be presented to the user through, for example, the drop down menus. When the analyst is in one of the analysis boxes and is at the point of analyzing the information to extract the intelligence out of it, after choosing the "Analyze" button from the menu, a list of possible analysis types will be offered in the drop down menu. This list is a selection of analysis types that are applicable to the earlier chosen intelligence using connectivity graph.

Also a menu of choice of analysis levels will be offered. These levels refer to the extent to which information will be preceded. By choosing the appropriate level, analyst ensures the quality and comprehensiveness of extracted intelligence. Also different levels of the company may need intelligence of different levels of analyses. To ensure this we propose to preliminary define several levels of analysis in the analysis tools. Such as:

Analyst, after choosing appropriate types of analysis will choose the levels of the performance and the outcomes of analyses will be in accordance with these choices.

According to the literature overview, usually each department of the company has its own frequently used list of analysis. To make it possible the program will have the opportunity
to create and save sessions. That is, if the analyst wants to save all the steps he/she did to apply them on the next intelligence another time then he/she can save the session under any name as a separate file and next time just upload that file into the software. The loaded session will then have the same types and levels of analyses used previously but no any intelligence included, thus it can be applied to the new intelligence easily.

Another possibility we propose is a creation of user defined toolbox/toolmenu. This means that the analyst can choose custom functionalities of the analysis tool and create his/her own easy menu. This menu will also have a separate line showing the last time used functionalities.

**H6: It is effective to classify the different types of analyses into a certain number of groups; Box analysis (SWOT, Benchmarking, Game theoretical matrixes, Spreadsheets), Time-horizon analysis (game trees, scenario analysis), Ratio Analysis, Exploratory Analysis (Focus Groups, Questionnaires), or a combination of the above.**

Indeed as was proposed by Solberg Söilen, (2005) and used in our above mentioned solution the types of analysis were classified according to four categories into groups:

1. According to the **micro** and **macro** environment
2. **Variables** they concern about: Customers, competitors, suppliers, entry and exit barriers, substitutes to suppliers, marketing, substituted to customers, economic, political, social, technological, infrastructural, ecological, legal and demographic.
3. According to their **business function**: strategic, product oriented, environment oriented, customer oriented, financial oriented, technology oriented and behavioral.
4. According to their **broad nature**: mathematic, linguistic and geometric analysis.

In this way the analysis are separated into groups/boxes and the incoming information can be then connected to the given box(es) to subtract the intelligence out of it. The incoming information is also tagged by the defined four categories of tags in accordance the given classification of analysis types.

**H7: It is useful and effective to provide different analysis components as a integrated part of one BI software, that can be stripped down in dependence of user preference rather than to provide them as separate BI software.**

Some of the BI software companies differentiate between different types of analysis components by implementing them as separate BI software. This means that for one industry or organization, in order to obtain two different analysis tools for two different departments, it should buy and pay for these two software separately as well as the conditions for user support of these two software can be different. Other BI software companies propose to their customers to buy different analysis tools in one software package as add-ons and pay extra for each add-on component. This is a better solution than to have it as separate software but on the other hand if the customer needs several analysis tools then the number of add-ons can become large and confusing for departments and for user-support.

We propose to have all the possible analysis tools in one software and adjustable to customer preferences. The adjustments can be done either by customer using the
aforementioned toolmenu or by BI software companies selling striped down versions of BI software analysis tools.

**Future work and developments**

Business Intelligence is a fast growing and extensively developing area. The presented literature overview is only a small fraction of what is going on in the BI world. As was already mentioned the new technologies are developing rapidly and offering large enhancement possibilities for BI analysis tools and software in general.

This work can be continued by keeping the hand on the pulse of these changes and applying them in the further developments of the proposed method. Moreover, a list of most successful BI software can be collected and examined to extract the useful features that can be integrated in our further enhancements of the analysis tool.

The method proposed in this thesis is the first attempt to overcome the highlighted major obstacles in the implementation of BI software analysis. But this method is in its early immature state, except being implemented, it needs to be extensively tested.

Due to the time constraints we did not manage to implement the proposed method at Subsoft. The next step would be its actual implementation and extensive evaluation of the qualitative and quantitative aspects of this analysis tool. The outcomes and drawbacks of this evaluation then need to be considered in the future developments and enhancements of the proposed method.

The usefulness and effectiveness of the analysis tool can only be obvious through a critical feedback of actual customers and everyday users. Even in its immature state the method needs to be tested by a group of users.

The next logical step would be a selection of a proper group of users and collection of their feedback on usefulness, applicability, user-friendliness of the analysis tool.

The proposed implementation of BI software analysis tool is limited to a certain number of analysis techniques (currently 18), the ones that are commonly used. But the more techniques are engaged into the tool, the wider would become the possibilities to analyze the incoming information and the higher would be the precision of extracted intelligence.

The expansion of the list of incorporated analysis techniques would be the next development step in the line of the actions for the proposed analysis tool.

The final feature of the proposed analysis tool is its ability to generate an advice for the decision support process. This feature, as was obvious from our empirical data collection, was not encouraged and was considered the least important one. However, we are convinced that it is one of the major features that an analysis tool must have in order to comply with the CI cycle.

An important future action to consider is the confirmation of importance of advice generation component in the BI analysis tool. This can be done by collecting user-feedback specifically about this last component and by estimating the success of the final decisions that have been made by companies with and without help of this decision support component.
REFERENCES


17. http://www.crystalloids.com/


### GLOSSARY

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BI</td>
<td>Business Intelligence</td>
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<tr>
<td>BIT</td>
<td>Business Intelligence Team</td>
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<tr>
<td>CI</td>
<td>Competitive Intelligence</td>
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<tr>
<td>CIA</td>
<td>Central Intelligence Agency</td>
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<tr>
<td>CBA</td>
<td>Consensus Based Assessment (CBA)</td>
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<tr>
<td>COTS</td>
<td>Commercial Off-The-Shelf software</td>
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<tr>
<td>Crystalloids</td>
<td>Software development and business consulting company</td>
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<tr>
<td>CSV</td>
<td>Comma Separated Values</td>
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<tr>
<td>DataDetective</td>
<td>Data mining software product</td>
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<td>Devil’s advocate</td>
<td>Analysis method</td>
</tr>
<tr>
<td>Diamond of Opposites</td>
<td>Sociometric scaling method</td>
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<td>EBizPort</td>
<td>BI software for business/IT community</td>
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<tr>
<td>ESV</td>
<td>Swedish National Financial Management Authority</td>
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<tr>
<td>IDE</td>
<td>Integrated Development Environment</td>
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<tr>
<td>Java</td>
<td>Programming language</td>
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<tr>
<td>Likert scale</td>
<td>Psychometric scale commonly used in questionnaires</td>
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<td>LINQ</td>
<td>Language Integrated Query</td>
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<tr>
<td>MI</td>
<td>Market Intelligence</td>
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<tr>
<td>Netezza</td>
<td>BI analytics software</td>
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<tr>
<td>OLAP</td>
<td>Online Analytical Processing</td>
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<tr>
<td>PDF</td>
<td>Portable Document Format</td>
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<tr>
<td>PEST</td>
<td>Political, Economic, Socio-cultural and Technological analysis</td>
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<tr>
<td>Quickscan</td>
<td>Tool to identify the potential of data mining in a company</td>
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<tr>
<td>SAS</td>
<td>Business analytics and BI software</td>
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<tr>
<td>SCIP</td>
<td>Society for Competitive Intelligence Professionals</td>
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<tr>
<td>Sentient</td>
<td>Software development and business consulting company</td>
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<tr>
<td>SOLAP</td>
<td>Spatial OLAP</td>
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<tr>
<td>SPSS</td>
<td>Analytical solutions providing software by SPSS Inc.</td>
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<tr>
<td>SSAV</td>
<td>Solberg Söilen, Amara, Vriens</td>
</tr>
<tr>
<td>Subsoft</td>
<td>BI software</td>
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<tr>
<td>SWOT</td>
<td>Strengths, Weaknesses, Opportunities and Threats analysis</td>
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<tr>
<td>Visual C++</td>
<td>Textual programming language</td>
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<tr>
<td>WORA</td>
<td>Write Once, Run Anywhere</td>
</tr>
<tr>
<td>WordNet</td>
<td>Is a semantic network</td>
</tr>
<tr>
<td>WPF</td>
<td>Windows Presentation Foundation</td>
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</table>
# APENDIX – Interview Questionnaire

The questionnaire for the two companies: Sentient and Crystalloids to explore their point of view on technical and managerial aspects of BI software analysis tools was constructed from the following 30 questions:

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you agree with the concept that most of the nowadays BI software are quite enhanced and well developed but only a few of them have a good analysis tool, and even fewer give a choice of analysis tools to their users? Why? What are the possibilities of the BI software developed or supported at your company?</td>
<td>Yes □ No □</td>
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<tr>
<td>2. Which main parts/tools are your BI software consist from?</td>
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<td>3. How the correlation of the incoming information to the analysis types is implemented in the BI software at your company?</td>
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<td>4. How many customers do you have since the company was established?</td>
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<td>5. How is the customer support system at your company implemented?</td>
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<td>6. What kind of reports, e.g. tables, figures, etc. is your BI software capable to produce?</td>
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<tr>
<td>7. Do you collect customer feedback to consider in the future developments and support system of BI software?</td>
<td>Yes □ No □</td>
<td></td>
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<tr>
<td>8. How do you test if the developed or supported BI software at your company satisfy the specific customer needs?</td>
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<td>9. Do you agree that the essential part of the BI software is the analysis tool? Why?</td>
<td>Yes □ No □</td>
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<td>Q.</td>
<td>Question</td>
<td>Comments</td>
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<tr>
<td>10</td>
<td>What are the major obstacles on the way of implementation of sophisticated analysis tools in the BI software from the technical point of view?</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Which of these obstacles have you encountered?</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>What are the major obstacles on the way of implementation of sophisticated analysis tools in the BI software from the managerial point of view?</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Which of these obstacles have you encountered?</td>
<td></td>
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<tr>
<td>14</td>
<td>Define the main characteristics that the analysis tool must have. Why?</td>
<td></td>
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<tr>
<td>15</td>
<td>Which of these characteristics does the analysis tool of the BI software at your company have?</td>
<td></td>
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<tr>
<td>16</td>
<td>Do you consider the ability of the BI software analysis tool to derive an advice for the decision support process of the user is important? Why?</td>
<td>Yes</td>
</tr>
<tr>
<td>17</td>
<td>Does the analysis tool of the BI software at your company have this ability?</td>
<td>Yes</td>
</tr>
<tr>
<td>18</td>
<td>Is it necessary for the analysis tool to give the user a possibility of choosing between types and levels of analyses? Why?</td>
<td>Yes</td>
</tr>
<tr>
<td>19</td>
<td>Does the analysis tool of the BI software at your company have this ability?</td>
<td>Yes</td>
</tr>
<tr>
<td>Comments:</td>
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</table>

20. **What are the main criteria of a user-friendly interface of the analysis tool in the BI software? Which of these criteria is implemented in your software analysis tool?**

21. **Do you agree that the managers’ entrepreneurial attitude can have an influence on the final decision making process independent of the outcome of the analysis tool? Why? (if yes, continue with the question 22, otherwise go to question 23)**

22. **How do you think is it possible to prevent this influence? Is the prevention considered in your BI software?**

23. **Do you agree that the managers’ entrepreneurial attitude has a positive influence on the Competitive Intelligence (CI) scanning (looking for competitive advantage) and the frequency of the CI scanning? Why?**

24. **Do you agree with the statement that the frequency and the scope of market scanning are higher for the managers with high level of need for achievement, locus of control and innovation? Why?**

25. **Does the BI software developed in your company comply with the complete CI cycle (the 4 known stages)? If yes, how and if not, why not?**

26. **Some of the BI software analysis tools require commercial software such as MS Excel sheets to display the produced reports. What is the best solution: to have them integrated into the software or to suggest customers to buy these software apart?**

27. **Which of the following criteria is satisfied by the BI software developed or supported at your company: Ease of use, noise reduction, quality, adaptability, tame saving and cost saving? How are they satisfied?**
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<tr>
<td><strong>28.</strong> Do you consider the BI software at your company an expert system, e.g. capable to support a decision making process in any environment? Why?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Comments:</td>
</tr>
<tr>
<td><strong>29.</strong> The outcomes of the BI software can be of interest for different departments as well as different levels such as top, middle and front line management of the company. Is the BI software developed or supported at your company capable to satisfy the need of all these departments and levels? If yes, how and if not, why not?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Comments:</td>
</tr>
<tr>
<td><strong>30.</strong> Is the BI software at your company capable to analyze information and extract intelligence not only in the scope of direct categories such as suppliers, customers, competitors but also in the scope of indirect categories such as political, infrastructural, social etc.? If yes, how and if not, why not?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Comments:</td>
</tr>
</tbody>
</table>