Evaluation of Information Quality in Business Intelligence as a key success factor for using Decision Support System

Yin-tsu Lin & Abidalsajad K. Mehdi Hadi

Thesis for the Degree of Master in Computer and Systems Sciences

Department of Informatics and Media

Uppsala University

Uppsala

Sweden

14 November 2011
“It is the quality of our work which will please God and not the quantity.”

Mahatma Gandhi
ABSTRACT

Title: Evaluation of Information Quality in Business Intelligence as a key success factor for using Decision Support System

Authors: Yin-tsu Lin & Abidalsajad K. Mehdi Hadi

Date: 14 November 2011

Tutor: Anneli Edman

Abstract: Information Technology (IT) has a main role in supporting the organizations to store and retrieve their information. The problem is how to get relevant information with an acceptable quality to achieve the daily tasks efficiently. Business Intelligence (BI), as one of the main tools in the IT field, contributes for in-depth analysis of information to get relevant information that leads to make better decisions. This research investigates the key success factors in BI implementations and the importance on Information Quality (IQ) in BI systems. After selecting common important factors in BI and framework of evaluation IQ dimensions from the literature, the authors conduct interviews with four companies. The results show that BI is an important tool and the user involvement influences greatly to get correct information for BI developers. Also, since IQ factor is not a necessity according to the interviewees’ perspectives, the importance of IQ depends on the tasks at hand. Moreover, accessibility is the main IQ dimension to retrieve the information easily and quickly. In addition, in order to reach acceptable Information Quality, the companies have no specific framework to assess this quality; rather, they use different mechanisms depending on the tasks at hand. The conclusions of this research could be generalized or partially generalized since most of the respondents’ perspectives to far extent are consonant with each other’s.

Keywords: Business Intelligence, Information Quality, Decision Support Systems, Decision-making process, key success factors
Acknowledgements

We would like to thank those who made this thesis possible. First of all, we are heartily thankful to our supervisor, Anneli Edman. This thesis would not have been possible without her encouragement, guidance, and continuous support from the initial to the final level.

We are deeply indebted to Jennie Rassool, Sverker Björling, Mats Olsson, and Peter Skoglund for participating in the interviews through which we got invaluable information for our empirical findings. Special thanks to our classmate, Petter Fogelqvist, for his constructive notes and recommendations. We would like to show our gratitude to all our teachers, our classmates, and the librarians at the Department of Informatics and Media for their help and support. It is a pleasure to extend our thanks and gratitude to our families, Dlovan Kassab, Kenneth von Zeipel and Haider Kamil who gave us the needed support for our thesis.

Finally, we fully offer our regards and blessings to all of those who helped us complete this research.
List of Tables

Table 1: The key success factors in Business Intelligence according literature Page 16
Table 2: Assessment class, IQ criterion, and Assessment method in IQ framework by Naumann and Rolker (2000) Page 22
Table 3: PSP/IQ model in IQ framework by Kahn et al. (2002) Page 24
Table 4: The results of the five IQ dimensions developed by Klein (2002) Page 25
Table 5: The definitions IQ dimensions by Kahn et al. (2002) Page 28
Table 6: Summary of IQ dimensions considered by the mentioned authors Page 29
Table 7: The summary of the analysis depending on literature and empirical findings Page 50

List of Figures

Figure 1: Information quality characteristics and sub-characteristics in IQ framework by Leung (2001) Page 23
Figure 2: The presented approach by Pipino et al. (2002) to assess if a data quality is high for a specific dimension Page 24
Figure 3: The relations between IQ dimensions in IQ framework by Bovee et al. (2003) Page 26
Figure 4: Framework for assessment IQ dimensions by Eppler (2006) Page 27
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ</td>
<td>Information Quality</td>
</tr>
<tr>
<td>BI</td>
<td>Business Intelligence</td>
</tr>
<tr>
<td>DSS</td>
<td>Decision Support System</td>
</tr>
<tr>
<td>MIS</td>
<td>Management Information System</td>
</tr>
<tr>
<td>DQ</td>
<td>Data Quality</td>
</tr>
<tr>
<td>DW</td>
<td>Data Warehouse</td>
</tr>
<tr>
<td>PSP/IQ</td>
<td>Product and Service Performance model for Information Quality</td>
</tr>
<tr>
<td>AIMQ</td>
<td>Methodology for Information Quality Assessment</td>
</tr>
</tbody>
</table>
# Table of Contents

1. Introduction .................................................................................................................. 1
   1.1 Background .............................................................................................................. 1
   1.2 Problem Discussion ............................................................................................... 2
   1.3 Problem .................................................................................................................... 3
   1.4 Purpose ..................................................................................................................... 3
   1.5 Interested stakeholders ........................................................................................... 4
   1.6 Delimitation .............................................................................................................. 4
   1.7 Thesis outline ......................................................................................................... 5
2. Research Method .......................................................................................................... 6
   2.1 Deductive and Inductive Approaches .................................................................... 6
   2.2 Qualitative and Quantitative Methodologies ......................................................... 7
   2.3 Data Collection ...................................................................................................... 7
      2.3.1 Literature Reviews ........................................................................................... 8
      2.3.2 Interviews ......................................................................................................... 8
   2.4 Selection of respondents ......................................................................................... 10
   2.5 Transcription of the interviews .............................................................................. 10
   2.6 Reliability and validity of the research ................................................................... 11
3. Literature Reviewing of Business Intelligence and related areas ................... 12
   3.1 Emergence of Business Intelligence (BI) ............................................................... 12
      3.1.1 What is Business? .......................................................................................... 12
      3.1.2 What is Intelligence? ...................................................................................... 13
      3.1.3 What is Business Intelligence? ...................................................................... 13
   3.2 Decision Support Systems (DSS) ........................................................................... 14
   3.3 The Key Success Factors in BI .............................................................................. 14
      3.3.1 Top management support ............................................................................. 17
      3.3.2 Planning and vision ......................................................................................... 17
      3.3.3 User involvement ............................................................................................ 18
      3.3.4 Development tools ......................................................................................... 18
      3.3.5 Data quality ..................................................................................................... 18
   3.4 Definition of Data, Information, Data Quality and Information Quality .......... 19
      3.4.1 Data .................................................................................................................. 19
      3.4.2 Data Quality (DQ) .......................................................................................... 19
      3.4.3 Information ....................................................................................................... 19
3.4.4 Information Quality ................................................................. 19
3.5 Relationship between DQ and IQ ............................................... 20

4. Literature Reviewing of Information Quality Frameworks .............. 21

4.1 Analysis of Information Quality Evaluation Frameworks ............... 21
  4.1.1 IQ framework by Naumann and Rolker (2000) ......................... 21
  4.1.2 IQ framework by Zhu & Gauch (2000) ...................................... 22
  4.1.3 IQ Framework by Leung (2001) .............................................. 22
  4.1.4 IQ framework by Kahn et al. (2002) ....................................... 23
  4.1.5 IQ framework by Pipino et al. (2002) .................................... 24
  4.1.6 IQ framework by Klein (2002) ............................................. 25
  4.1.7 IQ framework by Lee et al. (2002) ........................................ 25
  4.1.8 IQ framework by Bovee et al. (2003) ..................................... 26
  4.1.9 IQ framework by Liu & Huang (2005) .................................... 27
  4.1.10 IQ framework by Eppler (2006) .......................................... 27

4.2 Result of literature reviewing for IQ frameworks ....................... 27

5. Empirical Findings .................................................................. 31

5.1 About the companies ............................................................... 31
5.2 The usage of BI systems .......................................................... 32
5.3 Examples regarding the benefits of using BI systems ................... 34
5.4 The impact of implementing BI system on the decision-making process ......................................................... 36
5.5 The key success factors that considered as most important or crucial when developing BI systems .................. 36
5.6 The importance of IQ as a key success factor ............................. 38
5.7 The important factors/dimensions regarding information quality ...................... 39
5.8 Dimensions from the PSP/IQ framework .................................. 40
5.9 The information quality framework employed in the organizations ............................................................. 42
5.10 How the organizations make sure an accepted level of IQ is achieved ............................................................. 43

6. Analysis and Discussion ......................................................... 44

6.1 The benefits of using Business Intelligence (BI) systems ............ 44
6.2 The Impact of using BI systems on a decision-making process ....... 45
6.3 The key success factors during the development of BI systems ...... 46
6.4 The importance of Information Quality (IQ) as a key success factor in BI systems ..................................................... 47
6.5 The important dimensions that will affect the quality of the information .......................................................... 48
6.6 The IQ framework used in the organizations ............................. 48
6.7 Summary of the analysis ................................................................. 49

7. Conclusions ..................................................................................... 51

7.1. General Conclusions ................................................................. 51

7.1.1 Answers for research questions ............................................. 51

7.1.2 Reflections ............................................................................. 52

7.2. Suggestions for future works ..................................................... 53

References ...................................................................................... 54

Appendix 1- Interview Duide ............................................................. 59

Appendix 2- Details of Interviews ...................................................... 61

Interview 1: Releye AB ..................................................................... 61
Interview 2: Nobina AB ..................................................................... 66
Interview 3: Planning Division at Uppsala University ....................... 75
Interview 4: EdgeGuide Business Solutions AB .............................. 78
1. Introduction

This chapter demonstrates the background of Information Technology (IT) evolution, and highlights the main terms in IT that are focused in this thesis, such as Decision Support System (DSS) and Business Intelligence (BI). Afterwards, it presents the problem discussion, research questions, purpose, interested stockholders, delimitation, and disposition.

1.1 Background

In the past, it was easy for humans to keep all the necessary information in their memory in order to achieve their desires and interests. Later, the world started with new horizons of knowledge. In the last century, after the emergence of computers, what we can call "flood of information", came into being with its innumerable amount of information. Therefore, humans sought to collect, store, sort, process, and extract data according to the actual needs (Fang, 1997). In fact, one of the most important characteristics of this era is that there is such a huge amount of information that it is very difficult to control the flow of this information. This was a result of the technological progress, which leads to this era called “the information age". (Kluver, 2000)

Information as a product has become an industry with a large market, which does not differ from other well-known markets. Furthermore, money spent on the production of information is more than what is spent on a lot of strategic goods in the world (Fang, 1997)

More importantly, the term Information Technology (IT) came to surface. IT includes all types of hardware and software used in the processing, storage and retrieval of information (Kluver, 2000; Fan & Wu, 2010). The effective use of Information Technology leads to the modern Information Systems (IS), by using the programs and databases for collecting and processing information in companies. Decision Support System (DSS) and Management Information Systems (MIS) are considered the main types of information systems (Laudon & Laudon, 1988). MIS emerged in the 1960s, and was followed by the emergence of (DSS) during the 1980s. After that, economy has been greatly affected by the information revolution (Gorry & Scott Morton, 1989). This effect includes all sectors and economic aspects starting from the financial sector and banks, to the sectors of industry and food, as well as transportation and mining, etc.

In general, many problems in the modern societies are due to the lack of information, or the inability to retrieve the required information in a timely manner. Nowadays, the competition between organizations in the market is very high and it is not easy to maintain an acceptable level of revenue growth. This high degree of competition makes these companies realize the importance of both information management and the accurate analysis of this information (Gorry & Scott Morton, 1989). Accordingly, many organizations have become aware of the importance of information collection from trusted sources. And it is greatly considered one of the essential tasks to analyze this information in order to maintain the success of any organization (Fielding, 2006). In addition, because of the vast amount of information that is obtained from many sources, it became necessary, in recent years, for the organizations to use multiple techniques to perform their tasks. The purpose of these techniques is to help organizations process and analyze the received information in order to extract the useful part of it, which, in turn, will contribute in the possibility of taking important decisions that serve the organizations’ goals. (Turban et al., 2011)
One of the most important techniques used in the present time is what is known as “Business Intelligence”. Business Intelligence systems are used for in-depth analysis of data and transform it into organized information; so that it can be easily accessible for choosing the relevant information needed for a better decision-making process (Fielding, 2006).

Accordingly, it is possible to say that Business Intelligence technology is used to get the appropriate information in an appropriate time so that appropriate decisions can be made (Bogza & Zaharie, 2008). Business Intelligence (BI) simply means the intelligence in understanding your business, where you can understand your business through analysis of the operations and data included in the work (Pirnau & Botezatu, 2010).

The adoption of the Business Intelligence concept is not long-standing: it is a recent discipline, which has evolved from Decision Support Systems (DSS) (Watson, 2009). The need for Business Intelligence practices has evolved as a result of the weakness in the monitoring of the markets, the high costs of IT systems, poor performance of the management part in the organizations, etc. (Turban et al., 2011)

Hence, Business Intelligence aims to make the best decision through the use of information management systems, and technological applications in order to collect, store, analyze, and provide the data (Watson, 2009). That is, Business Intelligence leads to better decision-making through the use of accurate information with the value of an acceptable quality in a timely manner. Furthermore, Business Intelligence enables organizations to predict market trends in the future and possible changes that arise on the market that affect these organizations (Turban et al., 2011). Hence, by using Business Intelligence, these organizations can respond rapidly regarding these changes by updating their processes and make these changes serve the organizations’ goals. (Fielding, 2006; Bogza & Zaharie, 2008)

Therefore, the importance of Business Intelligence systems lies in the effective contribution to organizing the information of the organizations and reducing the costs as well as the steadily increasing the profits. (Turban et al., 2011)

1.2 Problem Discussion

In a world where data and working conditions change very quickly and this is coupled with a highly competitive market, the companies continuously face challenges in their business. This situation necessitates the companies to find more alternatives that can help them in taking crucial decisions, in order to realize their goals and strategies. (Williams & Williams, 2007)

It is not a secret that the use of modern technology, especially in the field of Information technology (IT) and Information Systems (IS), provides us the appropriate tools to read, analyze, and access information (Williams & Williams, 2007). The data can be interpreted in various ways, meaning that it is important that Business Intelligence (BI) makes these interpretations. In other words, with Business Intelligence, business can be managed, and through understanding problems, in-depth analysis of data and clear interpretation, organizations can obtain the best ways for taking appropriate decisions at an appropriate time (Yeoh et al., 2008). Moreover, Business Intelligence provides the ability for the development and improvement of the decision-making processes (Turban et al., 2011).

The great importance of the Business Intelligence concept comes from its ability of giving a comprehensive picture of the status quo of the market (which is characterized by being highly
competitive and has become more complicated due to its fast changes). Furthermore, Business Intelligence might be give the possibility to anticipate the market direction in the future, identifying opportunities that can be invested - or risks that should be avoided - in the endeavor of improving organizations’ business performance. (Williams & Williams, 2007)

In spite of the fact that Business Intelligence has become a top priority strategy at the management level in organizations, it is still not sufficiently and effectively implemented and exploited for supporting decision makers to reach the desired goals (Turban et al., 2011). Besides, the available information sources that represent real assets in the organizations are not exploited in Business Intelligence practice in a proper or full form (Watson, 2009). Starting from this essential point, in order to address these mentioned problems, we believe that the important factors that affect the efficiency of Business Intelligence practice should be taken into account, to help these organizations make appropriate decisions in order to improve their business performance and to be more competitive. (Yeoh et al., 2006)

Accordingly, many factors have impact on Business Intelligence to make this technology more effective and efficient (DeLone & McLean, 1992; Watson, 2007; Yeoh et al., 2008). To name a few, these factors might include information quality, system quality, user involvement and satisfaction, individual impact, management support, clear business vision and others (DeLone & McLean, 1992; Watson, 2007; Yeoh et al., 2008). However, in this thesis, we will focus on Information Quality, since it is a key success factor in Business Intelligence.

The question is: why Information Quality? The answer is: nowadays, the problem is not a lack of information, since the information is available in a huge amount from too many resources; rather, the problem lies in the ability of getting relevant, consistent, and reliable information. In other words, what is important is not the information itself; rather, it is the quality of this information and whether it can be accessed and used rapidly and timely for the purpose of taking a proper decision. Furthermore, companies that have information with high quality will get more competitive advantages than companies that based their decisions on poor quality information. (Turban et al., 2011)

Even though it is not possible to draw a clear line between information and data, we will try to focus only on the information quality rather than data quality. We will make a more detailed definition later (section 3.4. page - 19).

1.3 Problem

As mentioned above, successful organizations continuously try to build an efficient decision support system, so that they will be able to make tactical and strategic business decisions. Reliability of the decision support system process is based greatly on the effectiveness of Business Intelligence practice in the organizations, and their understanding of the importance of Business Intelligence in reaching and realizing their goals (Watson, 2009). In other words, organizations should take into account the key success factors that play an important role in applying and using Business Intelligence process in an efficient way to support decision makers. (Yeoh et al., 2006)
Accordingly, this thesis will focus on the following research questions:

1. Which factors or variables are important to deal with to get acceptable quality of information in BI systems and how to assess them?
2. Is Information Quality considered as a key success factor in BI for organizations’ decision makers and how to assess it?
3. Does Information Quality have an impact on the decision-making process in such a way that it leads to an improved use of Decision Support Systems (DSS)?

1.4 Purpose

This thesis will highlight and analyze the important factors affecting Business Intelligence. Then, it is concentrated on the evaluation of Information Quality as a basic foundation for attaining trusted and reliable information that leads to making the right decisions in the organizations. As a result, the main purpose of this thesis is an attempt to draw companies’ attention and helping them to understand the great importance of the quality of the derived information to enable them to be competitive and successful, and be far from the threat of bankruptcy, for instance.

1.5 Interested stakeholders

The decision-making process involves different levels in any company; therefore, this thesis is addressed to the implementers of Business Intelligence technology in all levels within various companies and sectors, not just the companies’ management. Thus, this thesis is trying to help these BI implementers at different levels to assess and select information with an acceptable quality as a contribution of making an important decision. In addition, this thesis can benefit other researchers and students who are interested in the field of Business Intelligence research.

1.6 Delimitation

The evaluation we aim to take into account is limited to only Information Quality factor in Business Intelligence, and how the right understanding of the role of this factor in BI will lead to better usage and benefit of Decision Support Systems (DSS). Besides, our thesis will not deal with design or improve a specific Decision Support System, neither to develop a new Information Quality framework; rather, it only focus on the analysis of importance of Information Quality to reach an appropriate decision. Also, in this thesis, we will focus only on information quality but not data quality when it is possible to make the difference (section 3.4. page - 19).
1.7 Thesis outline

The thesis is structured as follows:

**Chapter one** is about the background regarding the main terms used in this thesis, such as Decision Support System, Business Intelligence, and Information Quality. Besides, it involves problem discussion, research questions, purpose, interested stakeholders, and delimitation.

**Chapter two** highlights the research methods adopted for doing this thesis.

**Chapter three** demonstrates the literature reviewing of the importance of Business Intelligence, and presents the important key success factors for the implementation of Business Intelligence. In addition, it clarifies why Information Quality is considered an important success factor in Business Intelligence, and the relationship between Data Quality and Information Quality.

**Chapter four** discusses and analyzes the frameworks that evaluate the quality of information, and gives the selected Information Quality framework in this thesis.

**Chapter five** is about the qualitative findings that were collected through personal interviews with BI experts.

**Chapter six** will demonstrate the analysis and discussion regarding the empirical findings in order to clarify the differences, similarities, and common points with the theoretical findings in our thesis.

**Chapter seven** gives the conclusions by answering the research’s questions, and suggestions for future research.
2. Research Method

This chapter highlights the different methods used for research, and explains the reasons for selecting the suitable methods for this thesis. In addition, it discusses data collection process by reviewing literature and conducting interviews, and selecting the respondents. Furthermore, it presents the analysis of the empirical data and their credibility.

The process of any research is mainly based on a comprehensive plan for the activities required to get the new knowledge (Goldkuhl G., 1998). Having this in the mind, the researcher should begin with definition of the problem, going through the theoretical background of it, in order to build a suitable research design for reaching the new knowledge. Thereafter, data collection will be the next stage, which is followed by an in-depth analysis for these data in order to make an extent of credibility for the derived results in the research. In this thesis, we go through this procedure to keep an organized process. In the following sections, it will be clarified what methodologies are taken into consideration, which of them are adopted into our thesis, and the reason for our selection.

2.1 Deductive and Inductive Approaches

In principle, the first key point in any research is that the researcher specifies the appropriate approach to realizing the goals of the research. This point will pave the road for the clear procedure of any research. There are two reasoning approaches for doing research: Deductive and Inductive Approaches (Holme & Solvang, 1997; Trochim & Donnelly, 2006).

The deductive approach is a top-down method. In other words, the researcher begins with general things and then ends with something specific. In this approach, the researcher tries to start from the general theory in order to convert it into hypotheses or use it in building hypotheses or more specific ideas (Trochim & Donnelly, 2006). Depending on the data collected, these hypotheses or ideas are tested and analyzed in order to prove if they are true or not. On the other hand, the inductive approach is a bottom-up method. Here, the starting will be with something specific to produce a general thing. The researcher gets specific observations concerning a specific subject through surveys or experiments, through which he can reach a generalized conclusion or construct a general theory. (Trochim & Donnelly, 2006).

In this thesis, the deductive approach is employed in conducting the research and getting the answers for our research questions. First of all, we begin with studying the related literature regarding Business Intelligence concept in-depth in order to have a comprehensive understanding for the meaning and importance of Business Intelligence technology. Secondly, both Decision Support Systems and decision-making processes are studied by reading related literature in order to get an understanding of their importance in organizations. Thirdly, to clarify the impact of implementing Business Intelligence practice in a decision-making process, we study the literature about the key success factors in Business Intelligence systems. Thereafter, we select and analyze the common key factors that are considered success factors to enable decision makers to make crucial decisions. Our research then focuses only on Information Quality factor among these key success factors. Fourthly, a number of Information Quality frameworks are analyzed, and one of them is chosen as the suitable one for our thesis context. Fifthly, we interview Business Intelligence experts in different companies. We analyze the empirical data to evaluate the selected IQ framework and to understand how the organizations deal with Information Quality in their decision-making process. This analysis, in turn, will help us to answer our research questions.
According to the description above, the suitable approach for our research is the deductive approach. This is because our thesis is starting with general theory, going through collecting empirical data, and analyzing the findings to demonstrate the conclusions concerning a specific context.

2.2 Qualitative and Quantitative Methodologies

In general, one of the fundamental objectives for any research is trying to get new information and knowledge that help the researcher to understand and explain different phenomena. In order to collect this new information, the researchers usually use two types of methodologies: Qualitative and Quantitative Approaches (Creswell, J. W., 2009).

According to Denzin & Lincoln (2000), qualitative research stresses the relationship between the researcher, the subject and the context of the subject. A qualitative research method asks the “how” and “why” questions, i.e., the cause or the process of a phenomenon. Here, the researcher collects data in terms of words, pictures, observations, etc. Contrary to qualitative research, quantitative research methods focus on measuring aspects of the subject, trying to study the relationship between the variables under the controlled experiment but not the process. In this approach, the questions are in terms of how many? How much? How often? In other words, the purpose of quantitative approach is to give a numerical representation (tables, graphs, etc.) as the explanation of a problem. (Denzin & Lincoln, 2000)

Regarding our thesis, using the qualitative approach is advantageous for the objectives of the research. By following the qualitative approach, we will choose a small sample that consists of a number of Business Intelligence experts. Then, the intention is to interview these experts who are able to provide us with important and trustworthy information. Thereafter, an analysis of these interviews will be presented, followed by our comments on how they reach specific results.

2.3 Data Collection

There is no doubt that, in order to reach the goal of any research, and getting the answers to the research questions, the researcher should collect the required data for the research. Thereby, the researcher will be able to verify the hypotheses, or to answer the questions that are presented in the research. This is done by analyzing the data collected, to give credibility to the findings of the research.

More importantly, to ensure that there is a solid ground for the research, the researchers should define which kind of data is needed, from where the data could be collected, and what is the suitable plans or methods for collecting these data. Various data collection techniques are commonly used by the researchers, e.g. literature reviews, observations, interviews, questionnaires, surveys, and others. These techniques are used to gather the required information in order to achieve the objectives of the research (Marshall & Rossman, 1999). The data collection part in our thesis depends on literature reviews and interviews. Literature reviews are chosen to provide us a base for investigating and analyzing what others have done related to Information Quality in Business Intelligence. Then, an appropriate framework is chosen from the studied literature for evaluating the quality of information. Also, since we need to evaluate Information Quality in an application area, empirical data is collected through interviews with Business Intelligence implementers.
2.3.1 Literature Reviews

Literature reviewing is deemed as a basic way for researchers to get information regarding what it has done by others about a specific field or subject. It includes searching for and examining related literature such as articles, books, journals, encyclopedias, etc.

Learning from the previous studies in a particular topic provides us the in-depth knowledge from different views in solving and addressing the problems related to that topic. Also, if it is required to address a specific problem that has been addressed previously, through literature reviewing, it could be examined from a different angle. In other words, a different starting point to address the same problem might lead to different results.

In this thesis, the importance of studying and reviewing the previous literatures lies in the following points:
1. To be aware of the efforts and studies that have been done by others concerning the selected topic;
2. To get a comprehensive view and in-depth understanding of the topic in the research;
3. To pose new research questions that are not investigated previously;
4. To provide us with the important information that is necessary to answer the suggested questions.

To study the related literature, the sources of our research are the books, articles, journals, and other materials. At first, our focus is to have a good understanding of the meaning of the main terms: Business Intelligence (BI), Information Quality (IQ), and Decision Support Systems (DSS). By looking for the important references related to these terms, we can build our research questions and the way of doing the research.

The following points demonstrate our process during the searching and studying of the previous literature concerning the main terms (BI, IQ, and DSS) in the thesis:
1. Specifying the keywords in the research;
2. Searching for articles in the internet to get the knowledge and understanding of these key words;
3. Narrowing the searching to focus only on the references that could help us to answer our research questions;
4. Evaluating the references and sort them according to their benefits for our thesis;

2.3.2 Interviews

Quoting Rubin & Rubin (2005), “Rather than stripping away context, needlessly reducing people’s experiences to numbers, responsive interviewing approaches a problem in its natural setting, explores related and contradictory themes and concepts, and points out the missing and the subtle, as well as the explicit and the obvious”. Thus, in this thesis, we choose to use interviewing as a method to gather experts’ opinion regarding the chosen framework.

There are many different ways to conduct an interview. It can be conducted either in person, by phone, or maybe by a social network. It is worth mentioning that a plan should be prepared before doing an interview. Besides, it is very useful to determine which type of interview is more suitable in the context to get as much valuable information as possible.
There are many different types of interviews; here we will just list some commonly used ones. The most commonly used interview types are structured interviews, unstructured or semi-structured interviews and group interviews. In a structured interview, all the questions are prepared beforehand. A structured interview will follow the predefined script strictly. It is commonly conducted in a survey format and doesn’t need the researcher to conduct it in person. On the other hand, an unstructured (open) interview gives the interviewer more freedom to have a normal conversation with the respondent in order to cover the interviewer’s points of interest. A semi-structured interview consists of a predefined script, but the script doesn’t need to be followed strictly. In addition, the respondent’s answers may affect the next questions posed by the interviewer. And the person conducting it is usually the researcher. A group interview means that a group of interviewees are interviewed at the same time. It can be either structured or unstructured. (Myers & Newman 2007)

Since we realize that interviews are the key sources for us to get the needed empirical data in the research, our plan includes:

1. Select a number of companies that use Business Intelligence systems to perform their tasks;
2. Think about who can provide us with necessary and useful information related to our research topic;
3. Contact these companies to make appointments for the interviews;
4. Study some specific articles concerning how to organize the questions and how to deal with personal interviews;
5. Prepare the script for the interview and prioritize our questions, thus start with most important ones and then posing other questions.

The script of our interview consists of a brief agenda and a list of questions. The questions will be categorized into a few different categories based on the nature of the questions. These categories are: the importance of using Business Intelligence technology, the impact of Business Intelligence on a decision-making process, the importance of Information Quality in Business Intelligence to reach a good decision, and Information Quality dimensions used to evaluate the adopted IQ framework in our thesis. Then the questions will be prioritized within that category. And each category will be given a certain amount of time during the interview. With this design, we can make sure that all the different categories will be covered in our interview and we can also be sure that all the important questions will be asked in the interview (Appendix – 1 Interview Guide, page – 60).

In our research design, we choose to use semi-structured interviews. The reason is that we believe that with semi-structured interview, comparing to a structured interview or a survey, we will be able to elicit more detailed information from Business Intelligence experts. Also the flexibility of semi-structured interviews will give us the chance to investigate interesting opinions in depth.

Also, in the interview, we will follow the guidelines suggested by Myers & Newman (2007). These guidelines are listed and explained briefly here.

1. **Situating the researcher as actor.** This means the researchers should present the information about themselves to the readers, so that the readers will be able to assess the credibility of the research.
2. **Minimize social dissonance.** This means it is important to make the interviewee feel comfortable. Thus the interviewee can feel comfortable to disclose the details or present his or her opinion.

3. **Represent various voices.** The interview should include different roles in the organizations. Therefore it is possible to avoid bias. In this thesis, however, since our focus is on the applicability of the given framework, we will only interview experts to gather their opinion.

4. **Everyone is an interpreter.** The interview should be flexible and adapt to the ideas created during the interview.

5. **Use mirroring in questions and answers.** The interviewer should try to adapt to the interviewee’s language and use open questions rather than closed questions.

6. **Flexibility.** The interviewer should be flexible and follow the interesting line of research during the interview.

7. **Confidentiality of disclosure.** It is important to make the interviewee feel comfortable about the material.

### 2.4 Selection of respondents

The purpose of adopting the qualitative approach is to make it possible to get a deep understanding of the context in our thesis. In addition, it provides as sufficient information as possible in order to reach this understanding. Hence, the selected interviewees in this thesis should have enough experience and knowledge related to the Business Intelligence practice. Moreover, their organizations have already applied and used Business Intelligence technology in performing their tasks. To fulfill these conditions in our interviewees, the answers of our questions will make a solid base in order to know different perspectives regarding the importance of Business Intelligence itself and the impact of specific factors when applying this technology.

There are four conducted interviews in this thesis with the following interviews:

**Relaye:** Jennie Rassool (Manager of BI department, 2011.05.09)

**Nobina:** Sverker Björling (System owner of BI systems, and service delivery manager in IT department, 2011.05.10)

**Planning Division in UU:** Mats Olsson (Analyst, 2011.05.30)

**EdgeGuide:** Peter Skoglund (BI consultant, 2011.06.13)

### 2.5 Transcription of the interviews

Firstly, to make the interviews as efficient as possible, our plan is to send each interviewee in advance a list of the main subjects that it will be discussed during the interview. This could be useful for the interviewee for the preparation, and to use the time efficiently since there is a limited time for doing the interview. After having gotten permission from the interviewee, we record the whole interview. Moreover, other important notes are written down during the interview in order to create new questions that were not already prepared since the plan is to do a semi-structured interview.

In order to analyze the answers, we listen to the interview and write down the answers in details. Afterwards, there is a refinement of these answers by reformulating them in a way to make them clearer and easier to understand. We also remove all the information that is not related to the context of the thesis. We don’t present the interviews in this thesis by writing
the questions followed by the answers; rather, we present them through mentioning the interviewees’ perspective regarding the discussed subject. We believe that this way is more suitable for the reader, and makes it easier to focus on the main subjects that are discussed during the interview. However, the details of all the questions and the answers are quoted in the appendixes. Since we need to be sure that the interpretations of our interviews are correct, we send the presentation of the interview to the interviewee to check it, correct it, and add information if necessary. We believe that this will make both sides to be satisfied.

2.6 Reliability and validity of the research

The qualitative researchers should consider the reliability and validity factors regarding research method, analysis of the results, and evaluation of the quality of the research (Patton, 2002). In order to achieve reliability in our research, the preparation for doing the interviews is done as properly as possible by focusing on the relevant and important subjects while preparing the questions. Furthermore, we study literature related to the concepts Business Intelligence, Decision Support Systems, and Information Quality. This is done in order to understand the relationship between these terms, and to make them clearer when using them in the context of the thesis.

On the other hand, the validity of the information is dependent on the respondents who participate in the interviews. In order to reach as valid information as possible, we do personal interviews with Business Intelligence experts, ask the same questions to the interviewees, and discuss the key issues that related to the research during the interview. This is useful, and enables us to get different perspectives concerning the factors that impact implementation of the Business Intelligence systems in the organizations.
3. Literature Reviewing of Business Intelligence and related areas

This chapter presents how the Business Intelligence (BI) emerged in the IT world, the definitions of BI and DSS, and the relationship between these two terms. It also introduces the key success factors in BI practice, and clarifies why the Information Quality (IQ) is an important factor in BI. Finally, there is a description about the relationship between Information Quality and Data Quality.

3.1 Emergence of Business Intelligence (BI)

The main idea of Business Intelligence emerged from “The art of War” by Sun Tzu who said that “if you know your enemies and know yourself, you can win a hundred battles without a single loss.” (Albats & Fitzpatrick, 1994; Flanglin, 2005). Thus, any company should be aware of knowing itself first, and then its customers and competitors. The company can establish stable and effective strategies for making successful business decisions, by having an accurate data (both externally and internally).

In principle, the valuable information is very important to the companies to the extent that it could be deemed as a base, since it is like a wealth for these companies to specify their strategies and developments of both their marketing plans and decision-making process (Turban et al., 2011). The objective of Business Intelligence (BI) is to support the decision-making process. Hence, BI emerged from Decision Support System (DSS). During the 1960s and 1970s, the development of a variety of Decision Support Systems began, and continued throughout 1980s by researchers in order to extend the applications of such systems (Power, 2007). DSS is considered an umbrella term that covers many applications that enable analysis of data in order to support decision-making processes. This meaning was drawn to the term Business Intelligence (BI) which was first introduced by Howard Dressner in 1989, later an analyst at Gartner Group. BI is introduced as an umbrella term to describe concepts and methods to improve business decision making. (Power, 2007; Negash & Gray, 2008)

In order to provide a clear and understandable clarification of the term “Business Intelligence”, it is preferable to separate these two words Business and Intelligence from each other, and define them clearly in terms of their relationship with business’s understanding and implementation.

3.1.1 What is Business?

The notion of Business could be defined as “a collection of activities carried on for whatever purpose, be it science, technology, commerce, industry, law, government, defense, et cetera” (Luhn, 1958). Another definition of Business is “an organization designed to provide goods, services, or both to consumers” (Steven, 2007).

In general, there are specific goals for each individual, group, or even company, and there is an effort to achieve these goals. Therefore, if we can understand the required business better, it is more possible that we can reach and achieve these goals. (Steven, 2007)
3.1.2 What is Intelligence?

Generally, the meaning of Intelligence is different depending on the environment or the field. For instance, in school, the smart, or intelligent, student is the one who is superior in its study and sum up the best results in exams; while in the business sector, the intelligent one is the person who knows how and when to exploit business and marketing opportunities.

The notion of Intelligence is defined as “the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal.” (Luhn, 1958)

Thus, the general meaning of the intelligence is the tool that enables individuals (and groups) to cope better with the circumstances by taking advantage of what is available to reach a solution for a specific problem. (Gardner, 1993)

In the information world, Intelligence could be the ability to analyze information and understanding it in order to have a successful and useful decision-making process. More specifically, Intelligence is “a compilation and analysis of data and information provided by any and every source, human or otherwise, that has foresight and can render an insightful picture of intentions, capabilities, or activities, as well as their possible implications and consequences” (Shaker & Gembicki, 1998).

3.1.3 What is Business Intelligence?

Indeed, previous researches have presented many definitions of the term Business Intelligence (BI). BI can refer to “skills, processes, technologies, applications and practices used to support decision making” (Power, 2007). Another definition from Flanglin (2005) is that Business Intelligence is not a single product, a technology, or a methodology. It combines products, technology, and methods to organize key information that management needs to improve profit and performance. More broadly, BI is “business information and business analyses within the context of key business processes that lead to decisions and actions” (Flanglin, 2005). Moreover, “Business intelligence (BI) is a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions” (Watson, 2009).

Subsequently, the main objective of Business Intelligence is to enable the company to analyze information accurately for the purpose of making appropriate decisions during their daily business. This information can be divided into internal and external information. Internal information might include internal reports and documents in the company, as well as the database and knowledge base of the company. The external information, on the other hand, might include the information regarding stakeholders and the market trends used to find out all the necessary requirements to reach the desired goals. (Williams & Williams, 2007; Turban et al., 2011)

Furthermore, most of the business data is available in a data warehouse (DW) which is considered as a primary source of Business Intelligence information. The Data warehouse is a large database with an integrated collection of data that is extracted and transformed to meaningful information for support decision. The process of data extraction and transformation is a challenge of BI practice. This is because of many reasons, such as time consumption, high costs, and a poor data quality in the source systems. (Wixom & Watson, 2001; Negash & Gray, 2008)
3.2 Decision Support Systems (DSS)

Decision Support Systems (DSS) emerged as a result of the evolution of Information Technology (IT) during the 1970s, and was further developed in the 1980s (Watson, 2009). It simply emphasizes on providing an appropriate support to improve decisions’ quality, which, in turn, is based on the quality of the available information, and whether the used tools are suitable to analyze the problem at hand, etc. These requirements will be achieved by DSS by integrating data, tools, and software in an effective decision-making process (Watson, 2009). Since a decision-making operation is a big challenge for any company, as well as the tremendous development in information systems and technologies, DSS become vital for companies to make fast and useful decisions (Turban et al., 2011). Also, Decision Support Systems become more significant to be a necessity for maintaining the competitiveness in business world than to be just a tool in a company. Besides, the name of Decision Support Systems has changed to the widely used term Business Intelligence. (Watson, 2009)

On the one hand, both Decision Support System and Business Intelligence support users and decision makers to make better and easier business decisions. Moreover, DSS and BI depend on data analysis to reach such decisions (Kopackova & Skrobackova, 2006). On the other hand, Turban et al. (2011) present the differences between DSS and BI. These differences are related to the way the decision-making process is supported, the tools used for data analysis, and if data warehouse is necessary. Also, BI utilizes Data Warehouse practice while DSS don’t. (Turban et al., 2011)

3.3 The Key Success Factors in BI

The adoption and implementation of Business Intelligence (BI) systems do not rely solely on the possession of software and hardware within a company (Yeoh & Koronios, 2010). It cannot be considered as a process similar to the implementation of any other IT project, or just a process of gathering information on other competitors or the market trends (Yeoh & Koronios, 2010). Rather, the implementation of BI systems should be viewed from the perspective of being a complex and multifaceted task. It requires an infrastructure and considerable resources, reliable and valuable information, as well as understanding and use of appropriate tools in a timely manner. As a result, the application of BI systems will be fruitful for supporting individuals in various levels within the company to improve their capabilities in decision-making. (Yeoh et al., 2006)

Accordingly, organizations are always seeking to obtain an optimal implementation of Business Intelligence (BI) systems so that the results will be fruitful and profitable for both short and long term (Hwang et al., 2004). There are key success factors that the organizations should take into consideration, understand and be aware of, in order to ensure a practical implementation, and getting the desired results (Eckerson, 2005; Yeoh et al., 2006; Yeoh & Koronios, 2010). Nonetheless, these factors may vary, according to some studies (Hwang, 2004), depending on the nature of the tasks within a company and the size of these tasks, for instance.

Previous studies in the IS field suggests various critical factors in the implementation of an information system (Yeoh et al., 2006). Some of these factors are common in IS literature and have crucial roles during the implementation of BI systems. Also, there are other factors that are deemed important according to some authors, but not so critical according to other authors. Table-1 shows the critical success factors according to each author (Wixom &
Watson, 2001; Lee et al., 2001; Little & Gibson, 2003; Hwang et al., 2004; Eckerson, 2005; Yeoh et al., 2006; Yeoh & Koronios, 2010).
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Team skills</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Clear vision and planning</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>User involvement</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Presence of champion</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Development tools</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Quality</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Building a pilot system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modeling meta data</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate user training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business need for creating BI</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount of data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business driven-methodology</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mapping user requirements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robust framework</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Data representation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>External support</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right resources</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding external environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Size of organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Organization culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 1: The key success factors in Business Intelligence according literature
It is worth mentioning that the success of the implementation of BI systems is not necessarily dependent on the presence of all these key success factors to be required. But, it can be argued that a failure to take these factors into consideration will greatly impede the reaching of the desired goals and the success. (Yeoh et al., 2006)

In general, the literature is somewhat limited regarding the factors that affect the successful implementation of BI systems (Yeoh & Koronios, 2010). Nevertheless, we found that the researchers were able to identify these factors by obtaining empirical data to discover and specify to which extent these factors are significant regarding decision outcomes. In addition, while searching for the most important ones among these factors, we found that there is almost consensus among the researchers in respect of the existence a certain number of key success factors that cannot be excluded or indispensable to ensure the success of the BI practice.

However, from Table-1, which is based on previous studies (Wixom & Watson, 2001; Lee et al., 2001; Little & Gibson, 2003; Hwang et al., 2004; Eckerson, 2005; Yeoh et al., 2006; Yeoh & Koronios, 2010), we believe that there are common key success factors that possibly need to be focused on when implementing BI systems. Hence, we will only present the key success factors that have a crucial role when applying Business Intelligence practice and have impact on the decision outcomes.

3.3.1 Top management support

The implementation of BI systems cannot succeed without the support of the senior management. The managers need to be convinced about the importance of BI, and what benefits the BI practice can bring to the company (Lee et al., 2001). The role of the management is important when it comes to providing the necessary resources in each phase of the implementation. Therefore, senior management will greatly contribute in ensuring the successful implementation of BI systems through providing the required support, such as financial support, qualified human resources, the required technologies in the application process, and others (Eckerson, 2005). As a result, the availability of necessary resources for the BI implementers will help them accomplish their tasks in a timely manner and reduces the probability of failure.

When BI implementers seek the necessary support from senior managers, they need to make sure that the senior managers are fully aware of the benefits this BI practice can bring the company (Wixom & Watson, 2001). More importantly, top management support will overcome the resistance that may be emerged during implementation of BI technology within the organization (Little & Gibson, 2003). Thus, if the senior management can support with high commitment, it will be easier to overcome the difficulties and resistances that may occur during adoption of BI technology. (Eckerson, 2005)

3.3.2 Planning and vision

The planning process is very important to the success of any project. So, first of all, the organization should have a clear and complete vision about the goals and purposes they want to achieve with the implementation of Business Intelligence systems (Yeoh & Koronios, 2010). Also, it is suitable to establish short-and long-term strategies in respect of implementing BI practice. Moreover, during implementation process, the initial focus will be on what is most important, and then do other things that are considered less important, to manage the time in a proper way. (Lee et al., 2001)
Clear and complete strategic vision for meeting business goals and requirements regarding the adoption of BI systems is critical to make the outcomes of BI systems successful and gain customer satisfaction (Yeoh et al., 2006). Otherwise there is a possibility to fail when there is no alignment between the main objectives of BI systems and the strategic vision adopted by the company in order to meet their goals.

### 3.3.3 User involvement

One of the most important success factors is the user participation to ensure the success of implementing BI practice (Eckerson, 2005). User participation is necessary in all phases, including the preparation of a strategic plan, implementation, and monitoring. The importance of user participation in the stages of the implementation of BI systems will contribute in several aspects (Lee et al., 2001); including ease of achieving the strategic goals of all parties efficiently, and clarifying all user requirements, which in turn will ease the implementation process of BI practice. Also, this participation helps BI implementers during the development process, and also helps to reach a degree of satisfaction and acceptance by all parties when BI practice is implemented. (Wixom & Watson, 2001)

In general, user participation is necessary in the case where user requirements are not well defined or unclear, or even when it is necessary to refine and change some requirements (Eckerson, 2005; Yeoh et al., 2006). Then, user should be involved to make sure the desired needs to be understandable for BI implementers. So, previous researches indicate that user involvement affects positively on the adoption and implementation of BI systems. (Hwang et al., 2004)

### 3.3.4 Development tools

One of the main challenges of the implementation of BI systems is to achieve all or most of the user requirements. To do this efficiently, effective tools are needed in order to help BI implementers to achieve this goal on time (Wixom & Watson, 2001; Lee et al., 2001; Eckerson, 2005; Yeoh et al., 2006). Furthermore, the availability of such technologies and development tools will facilitate the implementation of BI practice and realize the desired goals. Development tools include the hardware, software, and methods that could be used to reach these goals. Actually, BI implementers need appropriate tools that help them to be more productive and effective in order to meet the requirements (Yeoh et al., 2006). Also, BI implementers should be able to understand and utilize these tools in such a way that these tools are fitting their technical skills and task requirements.

### 3.3.5 Data quality

The factors mentioned above are necessary and important, and contribute to the successful implementation of BI systems in any company. But, the quality of the information is a crucial factor, and it is also considered as the cornerstone that is indispensable to achieve this success (Yeoh et al., 2006). The higher quality of the information, the more effective decisions can be made, and thus promoting the success of the BI practice (Yeoh & Koronios, 2010). However, it is not the purpose here to emphasize that the quality of information is the most important factor among the key success factors in the implementation of BI systems; rather, it could be argued that if the quality of information is poor, the other factors will not be so vital regarding the success of implementing of BI systems (Yeoh & Koronios, 2010). More importantly, in our thesis, the focus will be on the importance of the factor Information Quality in Business Intelligence systems.
Raghunathan’s research (Raghunathan, 1999) concludes that information quality has positive impact on decision making when the decision-maker is familiar with the problem domain. Slone (2006) also stated in his research that information quality and organizational outcome are positively related in most cases. Therefore, we believe that poor quality of information is not acceptable by the users who need reliable data. Moreover, the more reliable the data sources, the stronger the decisions can be (Wixom & Watson, 2001; Lee et al., 2001; Yeoh & Koronios, 2010). Hence, the lack of high quality information will dramatically affect decision-making process (Yeoh et al., 2006).

3.4 Definition of Data, Information, Data Quality and Information Quality

Before continuing further discussion, we need to define data, information, data quality and information quality.

3.4.1 Data

Data is the raw material, the input to a Business Intelligence (BI) system; it is the description of objects in the real world. According to Redman (2001), it is a representation or model of the real world.

3.4.2 Data Quality (DQ)

Data Quality can be defined as the measure of the agreement between the data views presented by an information system and that same data in the real world. (Wang et al., 2008) Although there is no commonly accepted method to measure DQ, it is suggested that DQ is a multi-dimensional concept comprising accuracy, completeness, consistency, and timeliness (Wand & Wang, 1996). Therefore, the real concern with DQ is to ensure that the DQ system is accurate enough, timely enough, and consistent enough for the organization to survive and make reasonable decisions. (Wang et al., 2008)

3.4.3 Information

Information can be defined as the processed data. It can also be understood as the output of the BI system. In other words, information is when data is processed and presented with context. Context can be used to distinguish data and information. For example, data can exist without context, while information should exist with a context. Data processing is the procedure that trying to extract meaning from the data. (Liew, 2007)

3.4.4 Information Quality

According to Kahn and Strong (1998), Information Quality (IQ) is defined as its conformation to the specification. Juran (1999) suggests that the quality is “fitness for use”, which means whether the final product (information) serves its intended use.Lots of researches also accept “fitness for use” as a definition for IQ from the perspective of the information consumer. Another definition from information economics’ perspective, focus on the use of information. In other words, this definition focuses on how the user reacts after receiving the information. Therefore, the value of the information relies on the outcome (Wand & Wang, 1996). In the
context of this thesis, this can be interpreted in such a way; the IQ of a given BI system is the same as the quality of the decision the user can make with the help of this system.

Wand et al. (1996) pointed out an important aspect of IQ and DQ definitions. The definition of good DQ and IQ should be based on the context; good DQ and IQ in one context might not be applicable in another context. For example, the auditing firm or financial analysis firm might require different data precision regarding the data; the same data might be adequate to one case but not to the other. In conclusion, the criterion of IQ is not a universal standard. It should be based on the context and also on what the user needs.

3.5 Relationship between DQ and IQ

Since information is defined as processed data; IQ will inevitably be influenced by DQ. Therefore, by improving data collection, data recognition, data standardization, data cleaning and data aggregation, DQ will be improved and also improve IQ indirectly. However, the literature emphasizes that so far there are no specific standards to distinguish between data quality and information quality. Richard Y. Wang points out that data and information have the same sense, and data quality is the same as information quality (Wang, 1998). In addition, Tsinghua researchers, such as Su Qiang, confirm that the data quality is the basis of the information quality, where after doing data processing and transformation, these data will affect directly or indirectly the information quality. (Chen et al., 2009)

In this thesis, we will use data or information respectively when it is obvious and easy to distinguish them based on the definition we presented above. However, when it is not so distinguishable, we will use the term information to refer to both concepts.
4. Literature Reviewing of Information Quality Frameworks

This chapter explains and analyses the properties of a number of Information Quality evaluation frameworks in order to choose the most suitable one in the context of this thesis.

4.1 Analysis of Information Quality Evaluation Frameworks

Many frameworks have been created or developed for evaluating information quality (IQ). These frameworks aim at helping information consumers to make better decisions (Parker et al., 2006). In our thesis, we will focus on the frameworks that have developed during the last ten years (during the 2000s) and analyse them. The reason for this selection is that we believe that fewer studies have focused on these frameworks. Furthermore, we try to analyse recent frameworks that are developed in the context of information systems (Naumann & Rolker, 2000; Zhu & Gauch, 2000; Leung, 2001; Pipino et al., 2002; Kahn et al., 2002; Klein, 2002; Lee et al., 2002; Bovee et al., 2003; Liu & Huang, 2005; Eppler, 2006; Ge, 2009; Bertilsson et al., 2009). The aim is to choose a comprehensive framework, but also generic enough, so that it will be suitable to apply it in the context of organizational decision-making.

The IQ evaluation frameworks that will be analysed are as follows (listed by their authors):

3. Leung (2001)
5. Pipino et al. (2002)
7. Lee et al. (2002)

4.1.1 IQ framework by Naumann and Rolker (2000)

Naumann and Rolker (2000) first point out the difficulty regarding IQ assessment. Then, they present a framework dealing with the assessment methods. This framework focuses on the categorization of the IQ dimensions and then suggests suitable assessment methods regarding each dimension. It also puts much focus on which dimensions are suitable for automated assessment. Naumann and Rolker (2000) define three main factors, including the perception of the use, the information itself and the process to access the information. Respectively, these three factors can be mapped into three categories; these categories are subject-criteria, object-criteria and process-criteria. Then the dimensions are divided into these categories. Naumann and Rolker (2000) also suggest some assessment methods and point out which methods are suitable to assess each of the dimension (Naumann & Rolker, 2000). Table-2 provides more details.
Table 2: Assessment class, IQ criterion, and Assessment method in IQ framework by Naumann and Rolker (2000)

<table>
<thead>
<tr>
<th>Assessment Class</th>
<th>IQ Criterion</th>
<th>Assessment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject Criteria</td>
<td>Believability</td>
<td>User experience</td>
</tr>
<tr>
<td></td>
<td>Concise representation</td>
<td>User sampling</td>
</tr>
<tr>
<td></td>
<td>Interpretability</td>
<td>User sampling</td>
</tr>
<tr>
<td></td>
<td>Relevancy</td>
<td>Continuous user assessment</td>
</tr>
<tr>
<td></td>
<td>Reputation</td>
<td>User experience</td>
</tr>
<tr>
<td></td>
<td>Understandability</td>
<td>User sampling</td>
</tr>
<tr>
<td></td>
<td>Value-Added</td>
<td>Continuous user assessment</td>
</tr>
<tr>
<td>Object Criteria</td>
<td>Completeness</td>
<td>Parsing, sampling</td>
</tr>
<tr>
<td></td>
<td>Customer Support</td>
<td>Parsing, contract</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td>Parsing</td>
</tr>
<tr>
<td></td>
<td>Objectivity</td>
<td>Expert input</td>
</tr>
<tr>
<td></td>
<td>Price</td>
<td>Contract</td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td>Parsing</td>
</tr>
<tr>
<td></td>
<td>Timeliness</td>
<td>Parsing</td>
</tr>
<tr>
<td></td>
<td>Verifiability</td>
<td>Expert input</td>
</tr>
<tr>
<td>Process Criteria</td>
<td>Accuracy</td>
<td>Sampling, cleansing techniques</td>
</tr>
<tr>
<td></td>
<td>Amount of data</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td></td>
<td>Availability</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td></td>
<td>Consistent representation</td>
<td>Parsing</td>
</tr>
<tr>
<td></td>
<td>Latency</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td></td>
<td>Response time</td>
<td>Continuous assessment</td>
</tr>
</tbody>
</table>

4.1.2 IQ framework by Zhu & Gauch (2000)

Zhu & Gauch (2000) present an approach to evaluate the quality of information retrieved from web pages. The approach is based on six quality metrics that are: *Currency, Availability, Information-to-noise ratio, Authority, Popularity, and Cohesiveness* (Zhu & Gauch, 2000). According to Zhu & Gauch (2000), these quality metrics when incorporated (except for Currency and Authority) have a significant effect on improvement of search effectiveness.

4.1.3 IQ Framework by Leung (2001)

Leung (2001) introduces his work about identifying practical software quality metrics for intranet applications. It is based on the Extended ISO model to classify information quality metrics into the key quality characteristic and their sub-characteristics. Leung (2001) demonstrates these information quality characteristics and sub-characteristics as shown in Figure-1.
4.1.4 IQ framework by Kahn et al. (2002)

Kahn et al. (2002) present a model for describing and measuring information quality. The model is called PSP/IQ, which stands for Product and Service Performance model for Information Quality. According to Kahn et al. (2002), PSP/IQ is a two-by-two conceptual model. The main idea of PSP/IQ is the assessment of how organizations can develop useful information as “products” and deliver usable information as “services” to the information consumers (i.e., people who use the information). This is achieved by measuring the IQ dimensions and determining if they belong to product quality or service quality. (Kahn et al., 2002)

The two columns of PSP/IQ are “conforming to specifications” (i.e. to meet the specifications, they should be assigned and defined to ensure that products and services are free of deficiencies), and “meeting or exceeding consumer expectations” (i.e. the product and service meet or exceed consumer expectations). The two rows of PSP/IQ are “product quality” and “service quality”. Product quality is related to the process for putting and maintaining data in databases. On the other hand, service quality is related to the process of using the information after it is stored in databases. (Kahn et al., 2002)

IQ dimensions that are considered by Kahn et al. (2002) when developing PSP/IQ model are as follows:

“Accessibility, appropriate amount of information, believability, completeness, concise representation, consistent representation, ease of manipulation, free-of-error, interpretability, objectivity, relevancy, reputation, security, timeliness, understandability, and value-added”.

Kahn et al. (2002) have distributed IQ dimensions into the four quadrants (sound, dependable, useful, and usable information) of PSP/IQ model by doing a survey to determine which IQ
dimensions belong to each quadrant of PSP/IQ model. Table-3 demonstrates these four quadrants with their names and meanings. (Kahn et al., 2002)

<table>
<thead>
<tr>
<th>Product Quality</th>
<th>Conforms to Specifications</th>
<th>Meets or Exceeds Consumer Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound Information</td>
<td>The characteristics of the information supplied meet IQ standards.</td>
<td>Useful Information</td>
</tr>
<tr>
<td>Dependable Information</td>
<td>The process of converting data into information meets standards.</td>
<td>Usable Information</td>
</tr>
</tbody>
</table>

Table 3: PSP/IQ model in IQ framework by Kahn et al. (2002)

4.1.5 IQ framework by Pipino et al. (2002)

Pipino et al. (2002) introduce a data quality metrics. By using the key IQ dimensions mentioned in the Kahn et al. article presented earlier (see section 4.1.4.), Pipino et al. (2002) present an approach of the subjective and objective assessments for data quality. According to Pipino et al. (2002), the subjective assessments represent the needs and experiences of the stakeholders. The objective assessments either represent a specific application context or not. Furthermore, to develop the data quality metrics in practice, Pipino et al. (2002) list three functional forms (simple ratio, min or max operators, and weighted average).

The presented approach by Pipino et al. (2002) is demonstrated by four quadrants, as shown in Figure-2, to assess if a data quality is high for a specific dimension. Otherwise, it should be investigated by the organization to know the reason and do the corrective action.

Figure 2: The presented approach by Pipino et al. (2002) to assess if a data quality is high for a specific dimension.
4.1.6 IQ framework by Klein (2002)

Klein (2002) develops a theoretical model for detection information quality problems found on the web. The framework adopts five IQ dimensions: Accuracy, Completeness, Relevance, Timeliness, and Amount of data. Klein (2002) identifies the results of adopting these five IQ dimensions in Table 4. (Klein, 2002)

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Completeness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrepancy</td>
<td>Lack of Depth</td>
</tr>
<tr>
<td>Timeliness</td>
<td>Technical Problems</td>
</tr>
<tr>
<td>Source/Author</td>
<td>Missing Desired Information</td>
</tr>
<tr>
<td>Bias/Intentionally False Information</td>
<td>Incomplete When Compared with Other Sites</td>
</tr>
<tr>
<td></td>
<td>Lack of Breadth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relevance</th>
<th>Timeliness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrelevant Hits When Searching</td>
<td>Information is Not Current</td>
</tr>
<tr>
<td>Bias</td>
<td>Technical Problems</td>
</tr>
<tr>
<td>Too Broad</td>
<td>Publication Date is Unknown</td>
</tr>
<tr>
<td>Purpose of Web Site</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount of Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Too Much Information</td>
<td></td>
</tr>
<tr>
<td>Too Little Information</td>
<td></td>
</tr>
<tr>
<td>Information Unavailable</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: The results of the five IQ dimensions developed by Klein (2002)

4.1.7 IQ framework by Lee et al. (2002)

A methodology is developed by Lee et al. (2002). This methodology is called AIMQ quality (AIMQ) as a basis for IQ assessment. It is developed based on the IQ framework by Kahn et al. (2002), which is mentioned above (see section 4.1.4.). According to Lee et al. (2002), AIMQ is a model that considers the important IQ aspects for information consumers by assessing the key IQ dimensions. This AIMQ methodology evolves from the PSP/IQ model that was created by Kahn et al. (2002). AIMQ consists of three components:

1. PSP/IQ model is mentioned above in details (see section 4.1.4.). The purpose is to determine IQ aspects that are important for IQ improvement decisions;
2. IQA instrument is to measure IQ for each of the IQ dimensions, and then to form measures for the four quadrants in PSP/IQ;
3. IQ gap Analysis techniques are to assess of an organization’s IQ for each of these four quadrants. The purpose is to focus IQ improvement efforts. (Lee et al., 2002)

More importantly, Lee et al. (2002) clarify that the first step in their methodology is to determine what IQ means for information consumers and managers. This is achieved by using the PSP/IQ four quadrants to check if the information is considered a product or a service, and whether the assessment of IQ improvements will be related to the prerequisite specifications or customer expectations. The second step in AIMQ methodology is done by conducting a questionnaire to analyse which of the IQ dimensions is significant for information consumers and managers. The purpose here is to evaluate IQ within the organization. Thirdly, according to Lee et al. (2002), two analysis techniques are used for assessing the required IQ improvements according to the results of the questionnaire in step two. One of these
techniques measures the IQ improvements efforts compared with other organizations; while the other one measures these required efforts within the organization itself. (Lee et al., 2002)

4.1.8 IQ framework by Bovee et al. (2003)

This framework focuses on the methods to assess IQ. Bovee et al. (2003) first examine a few frameworks from other studies and formulate their own framework to overcome the disadvantage or problems they point out in other frameworks. Their framework consists of four categories; these categories are accessibility, interpretability, relevance and integrity. Then Bovee et al. (2003) argue that it is not realistic to simply evaluate a particular IQ dimension as fulfilled or not since it is almost impossible to be fully confident to make this judgement just based on the evidence gathered. Therefore, Bovee et al. (2003) propose to deal with the dimensions with the use of associated uncertainty. Details of this framework and the relation between the dimensions are briefly presented in Figure-3. Next, Bovee et al. (2003) present two algorithms incorporated with belief-function framework to calculate the overall score of IQ.

![Diagram of IQ framework by Bovee et al. (2003)](image)

Figure 3: The relations between IQ dimensions in IQ framework by Bovee et al. (2003)
4.1.9 IQ framework by Liu & Huang (2005)

The objective of this framework is to evaluate the quality of information on the web. Liu & Huang (2005) focus on some key IQ dimensions that are: Reputation, Consistent representation, Information Source, Format of the document, and Accuracy.

4.1.10 IQ framework by Eppler (2006)

Eppler (2006) presents a framework under the context of knowledge-intensive processes. This framework consists of 16 dimensions that are divided into 4 different levels. These levels are community level, product level, process level and infrastructure level. Also, in the other axis, the dimensions are divided into 4 phases, namely identification, evaluation, allocation and application, as shown in Figure-4. This framework focuses on the how to manage IQ; therefore, Eppler (2006) does not only present the criteria, but also provides advices on how to analyse and solve IQ problems. (Eppler, 2006)

![Figure 4: Framework for assessment IQ dimensions by Eppler (2006)](image)

4.2 Result of literature reviewing for IQ frameworks

From the previous analysing of various IQ frameworks, there are common IQ dimensions used in these frameworks for evaluating the quality of information. The definitions of these common IQ dimensions are listed in Table-5 (Kahn et al., 2002), to clarify the meaning of each one of them.
<table>
<thead>
<tr>
<th>IQ dimensions</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>The extent to which information is available, or easily and quickly retrievable</td>
</tr>
<tr>
<td>Accuracy</td>
<td>The extent to which information is certified error-free, accurate, correct, reliable, and errors can be easily identified</td>
</tr>
<tr>
<td>Access security</td>
<td>The extent to which access to information is restricted appropriately to maintain its security</td>
</tr>
<tr>
<td>Appropriateness</td>
<td>The extent to which the volume of information is appropriate for the task at hand</td>
</tr>
<tr>
<td>Believability</td>
<td>The extent to which information is regarded as true and credible</td>
</tr>
<tr>
<td>Completeness</td>
<td>The extent to which information is not missing and is of sufficient breadth and depth for the task at hand</td>
</tr>
<tr>
<td>Consistent</td>
<td>The extent to which information is presented in the same format</td>
</tr>
<tr>
<td>representation</td>
<td>Ease of manipulation</td>
</tr>
<tr>
<td>Free-of-error</td>
<td>The extent to which information is correct and reliable</td>
</tr>
<tr>
<td>Interpretability</td>
<td>The extent to which data is in appropriate languages, symbols, and units, and the definitions are clear</td>
</tr>
<tr>
<td>Objectivity</td>
<td>The extent to which information is unbiased, unprejudiced, and impartial</td>
</tr>
<tr>
<td>Relevant</td>
<td>The extent to which information is applicable and helpful for the task at hand</td>
</tr>
<tr>
<td>Reputation</td>
<td>The extent to which information is highly regarded in terms of its source or content</td>
</tr>
<tr>
<td>Timeliness</td>
<td>The extent to which information is sufficiently up-to-date for the task at hand</td>
</tr>
<tr>
<td>Understandability</td>
<td>The extent to which information is easily comprehended</td>
</tr>
<tr>
<td>Value-added</td>
<td>The extent to which information is beneficial and provides advantages from its use</td>
</tr>
</tbody>
</table>

Table 5: The definitions IQ dimensions by Kahn et al. (2002)

More importantly, Table-6 lists and summarizes the information quality dimensions that are considered by the authors listed above in their IQ evaluation frameworks. Although both context application and the approach of doing the evaluation are different, these frameworks have common dimensions regarding the evaluation of information quality.
Table 6: Summary of IQ dimensions considered by the mentioned authors

First of all, it is worth mentioning that the main context of IQ frameworks by Zhu & Gauch (2000), Leung (2000), Klein et al. (2002), and Liu & Huang (2005) are to assess the quality of information retrieved from World Wide Web. Even though this type of IQ assessment is important, it is not very related to the context of our thesis. Hence, our analysis will be focused on the other six IQ frameworks that are more generic and more related to our thesis context.
In fact, the suggested methods in IQ framework by Naumann and Rolker (2000) could be used as a guideline if the implementer wants to development an IQ assessment process and wants to automate part of the process when applicable. However, even when the automation is not considered, this article can still be considered as a valuable reference regarding the techniques for assessing each criterion.

Additionally, the IQ framework by Pipino et al. (2002) presents an important point that a data quality metrics could be established across industries. This is done by developing and analyzing measures of the data assessment in long term. (Pipino et al., 2002)

Also, the IQ framework by Bovee et al. (2003) has some advantages. First, this is a generic framework; it is possible to apply this framework to different domains. Second, they deal with uncertainty; every attribute is represented with a level of certainty of how confident one can say an attribute is met. However, more empirical evaluation is needed to further validate this framework.

In addition, there is one interesting point presented in IQ framework by Eppler (2006) that the author also tries to clearly define the relation between different dimensions. For example, the potential conflict between different dimensions. This can be helpful for implementers to understand the framework better and thus make it easier to manage and improve the IQ.

It is important to say that the IQ framework by Lee et al. (2002) is very interesting for organizations and has advantageous to evaluate and identify IQ problems. Also, with this framework, it is possible for an organization to compare the IQ deficiencies with other organizations. But, the complicated procedure and the many steps included in this framework make it more difficult to apply it.

Eventually, according to the properties found in the IQ framework by Kahn et al. (2002), we believe that this framework serves our thesis objective. Our reasons for the selection are:

1. The framework deems both parties (information producers and information consumers) when assessing IQ in an organization;
2. The framework provides an opportunity to compare IQ within the organization and to determine what is required efforts for IQ improvement;
3. The model used in the framework is easy to apply and comprehensive which cover the important IQ dimensions;
4. The framework is generic and not restricted for a specified context;
5. The authors have developed this framework based on their previous one which more important for later relative IQ literature. Furthermore, this framework is a result of their experience from previous framework to develop this new useful one.
6. The framework takes into account most of the key IQ dimensions.
5. Empirical Findings

This chapter is about the qualitative findings that were collected by doing personal interviews with the BI experts.

In this part, we will present the interviews that we had conducted, and analyze it. All these data are collected by conducting interviews with four Swedish companies; Nobina AB, Releye AB, Planning division at Uppsala University, and EdgeGuide Business Solutions AB. The main point here is to see how these companies apply and use the Business Intelligence (BI) systems, and the impact of using these systems on the decision-making process in these companies. In addition, we also focus on how these companies evaluate the quality of their information, and whether the Information Quality (IQ) is a crucial factor in their BI systems or not.

5.1 About the companies

- Nobina AB

<table>
<thead>
<tr>
<th>The interviewee</th>
<th>Sverker Björling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>System owner of BI systems, and service delivery manager in IT department</td>
</tr>
<tr>
<td>Place and date</td>
<td>Solna, 2011.05.10</td>
</tr>
</tbody>
</table>

Nobina is a company working in the transportation business. Nobina serves local communities throughout the Nordic Region with over 7,600 employees who transport the passengers to and from their destinations. Nobina is a group consisting of four companies in Sweden, Denmark, Norway, and Finland. There are around 280 million passengers per year within Nobina’s two business units: regional traffic and interregional traffic. In Nobina, all IT development activities and services are centralized, and the entire IT solutions are developed in the parent company Nobina in Sweden. The tasks of the IT department are to develop the IT systems to serve the goals of the company. One of the tasks is to develop BI systems and Decision Support Systems.

- Releye AB

<table>
<thead>
<tr>
<th>The interviewee</th>
<th>Jennie Rassool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Manager of BI department</td>
</tr>
<tr>
<td>Place and date</td>
<td>Stockholm, 2011.05.09</td>
</tr>
</tbody>
</table>

Releye is an IT consultant company with about 50 employees. Releye provide their clients with IT solutions regarding BI, CRM (Customer Relation Management) with the focus mainly in the customer service, marketing and sales fields. Sometimes, the employees also help their clients with business process improvement.

- Planning Division at Uppsala University

<table>
<thead>
<tr>
<th>The interviewee</th>
<th>Mats Olsson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Analyst</td>
</tr>
<tr>
<td>Place and date</td>
<td>Uppsala, 2011.05.30</td>
</tr>
</tbody>
</table>
The planning division at Uppsala University is mainly responsible for making plans to prioritize and distribute the resources according to the forecast, which decides, for example, which department or faculty should grow and so on.

- **EdgeGuide Business Solutions AB**

<table>
<thead>
<tr>
<th>The interviewee</th>
<th>Peter Skoglund</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>BI consultant</td>
</tr>
<tr>
<td>Place and date</td>
<td>Uppsala, 2011.06.13</td>
</tr>
</tbody>
</table>

EdgeGuide is an IT- consultancy company, which has two branches in Uppsala and Stockholm. Their services focus on the entire IT support by supplying mentors, business developers, project managers, system developers and technicians for implementations. Also, the company helps to develop solutions for decision support and Business Intelligence by using the software QlikView. EdgeGuide currently has 25 employees and continues to grow in 2011, and is expected to pass 30 employees during this year.

In the following section, we will divide the interview into a few headings. Following each heading, we will have a short description explaining the intension of the questions and then follows the details of the answers from the interviewees. Also, we will refer to the interviewees by mentioning the organization that they represent.

**Nobina:** Sverker Björling (System owner of BI systems, and service delivery manager in IT department)

**Releye:** Jennie Rassool (Manager of BI department)

**Planning Devision at UU:** Mats Olsson (Analyst)

**EdgeGuide:** Peter Skoglund (BI consultant)

### 5.2 The usage of BI systems

*In this section, we want to understand how the companies make use of the BI systems. We also want to find out the relations between the different stakeholders and the BI systems. For example, who develops the system? Who are the intended users? Who is responsible for checking the information?*

**Nobina:**

Nobina is a process-oriented company that has a lot of business processes. The goal is to have an identical process to deliver what Nobina call delivery traffic production in all countries where the company operates (Sweden, Denmark, Norway, and Finland). Nobina’s BI systems can be categorized into a few categories based on its relation with each process. The BI system for supporting production is associated with a production process. Another BI system is associated with marketing sales process. Also, the BI system for supporting management decision is associated with the management process (a management process dealing with how the decisions are made in the company). Hence, each BI system is associated with a particular business process. In addition, for each BI system, there is an information owner who is responsible for checking that BI system. For example, there is a system for analyzing the fuel consumptions of each bus, and an information owner from the operation part will be
responsible for that particular system. Also, the company has another BI system called salary cube. It is a mixture of people’s monthly salary, overtime payments, etc. There is a specific analysis tool for this salary system, and an information owner who is responsible for checking the information. For example, if there is a change in the tool, the figures shown in the system will look different, and the question will arise whether these figures are correct or not. Then, the information owner, who is the expert for salary analysis tool, can look into that salary cube to check if it is correct or not. Accordingly, for every BI system there is an information owner in the operational part in order to examine the information.

Releye:
Releye is an IT consulting company specialized in IT solutions regarding BI, which mainly includes CRM (Customer Relation Management), sales performance management, and performance indicator. For Releye, the BI systems are developed for their clients. Thus, it is not possible to put a simple classification for the systems being developed. Therefore, the BI systems mentioned here are just a few examples to illustrate some of the typical usages. One example of a BI system the company has developed is a system to help their client to analyze the customer segments they have. The system keeps track of how many resources are used for that particular customer segment and how much revenue it generates. Therefore, it can provide the management team with the information regarding which segment might be more profitable. The second example is a sales performance management system. This system helps the client analyze a salesperson’s performance by measuring, for example, how many customer visits are conducted, the quality of the visits, the number of deals the salesperson closed, the amount of the profit generated, etc. Regarding the examination of the system, it is usually done through constant user involvement. For example, when people from Releye are developing the system, they will visit the client’s office and try to understand how the client conducts their business by observing and interviewing the users. Also, after the system is developed, the users from the client side will be responsible for judging whether the information delivered is correct or not.

Planning Division at UU:
The system that Uppsala University is using is a commercial software product. There are maybe about 10 universities in Sweden that are using the same product. The BI system consists of a few subsystems. Each subsystem is responsible for certain functionality. The main system retrieves the data from its subsystems and presents it to the users. Therefore, the main system can be viewed as a centralized place to access the information. So, the users can get all the information they need from just one place. For example, the main system gets the information regarding student application from the national centralized system, and gets the financial data from another system. Therefore, both types of information can be found in the main system too. The user won't need to go to different systems to get this information.

In the interviewee's opinion, the way the BI system is used in the university is somehow different from how it is used in private sectors. In the university, it is more used as a tool to analyze and report current situation. For private sectors, the decision can be heavily-influenced by the system. For example, a company might look at some reports and make their strategy based on it. The university does make plans based on the reports from the systems but might not be as deeply influenced by it.
**EdgeGuide:**

EdgeGuide employs QlikView software and agile methods in developing Business Intelligence (BI) systems. By using this software, the company has the ability to deliver a quick approach for data analysis. This is done by digging into all the data and makes it available to the users quickly. The company chooses to adopt QlikView software instead of using the conventional BI solution because the conventional BI solutions need very long development cycle. Also, the company focuses on developing BI systems within financial field and the company has many employees with financial background to perform different kinds of BI consultancy. As an example of using a BI system, EdgeGuide helped a client to build, develop, and implement a BI system to manage the process of hiring temporary employees for some specific duties. This system is used to keep track of the financial information, i.e., how much consultancy the client hires? Is there any issue with too many employees getting sick, and so on.

5.3 Examples regarding the benefits of using BI systems

In this section, we asked the interviewees to give us some concrete examples regarding the benefits of using BI systems in their experience.

**Nobina:**

Firstly, we will start with a BI system called salary analysis cube. To illustrate how this system works, we will use the bus drivers’ salary as an example, some of them might be paid with monthly salary, others might be paid on hourly basis, also there might be overtime payment, etc... So, if the salary expenses get too high for a particular month, this BI salary analysis cube system can be used to help analyze the data and find out the reason. This system collects all the salary data from the salary systems. It enables the local management team to look at that analysis from different aspects, e.g., how many hourly employees there were during that month, how many weekdays, how many holidays, how much overtime did the company pay for, etc… Then, this BI system can hopefully provide the information regarding why the salary costs were high. One of the benefits of using BI for Nobina is to analyze these complex different materials of salary.

Secondly, contracts are central to Nobina. The company keeps track of the profitability for each contract. For example, if the contract in Malmö is extremely unprofitable. This BI system can help provide the necessary information for the management team to know if it is because the salaries were too high or damages were too many or due to other reasons. The third example is regarding the workshop BI system. This system can help workshop managers to study the characteristics of each bus. For example, one of the buses might have high fuel consumption, another one might have high maintenance cost, the other one has to change the tires every second month, etc. So, with the help of this BI system, the workshop managers can look into the information and make a decision about it. Altogether, the company has about 20 different BI systems dealing with, e.g., the buses, contracts, legal units, and salaries. These BI systems are very useful in analysis and making proper decisions for different cases.
Releye:
In this section, we will present two examples. The first example is the same system we mentioned in the previous section, i.e., the sales performance management system. Before this system was implemented, the salesperson wasn’t able to see how he or she was performing before the data was collected, analyzed and then put into a report. This is usually conducted just before the meeting with his or her manager. Therefore, it is common that the salespersons are not able to see the report until they are having a performance review with their managers. But with the help of this system, the salespersons can easily see how they are performing at any time. For the salespersons, they will be able to know how they are performing and thus become more motivated; for the manager, it is easier to coach the team members and to provide the help when it is necessary. The second example is from the interviewee’s experience of working in another organization earlier. The organization she used to work with once helped a dairy farm to develop a BI system for milk production. This farm had 1500 cows. It was important for the farm to be able to distinguish the milk quality produced by different cows, since the value of the milk is determined by its quality. In this BI system, they identify each cow by using RFID. This system measures, collects and reports three items; volume, conductivity (it is an indication of quality) and the temperature of the milk produced. Based on the quality of milk produced by each cow, they control which gate the cow should walk through and thereby feed them differently. Employing such a system help the farmer to produce milk with better quality and keep the feeding cost low.

Planning Division at UU:
The main benefit of using BI systems is the possibility to share the information to anyone who needs the information. For example, it is possible to see the number of researches published by different departments, or the number of students in each department. It is also possible to view the information in different ways. For example, the university can compare the actual number of students to the forecasted number; compare the number of accepted students or the number of applicants this year to the number of previous years. Another example of the benefit is the ability to analyze the information quickly. On the day of the interview, the news reported that the university received more applications this year than last year. But if one digs more deeply into the data, it can be found that the number of qualified applicants is actually lower comparing to last year. This means that the university spent more effort to process the applications, but got less qualified applicants in the end. This analysis might not be so easily done without the BI system. With the help of the BI system, it is easier to check and analyze the data from different perspectives and provide more meaningful information for decision support.

EdgeGuide:
The largest benefit of using BI systems is the ability to make people aware of the data and to know what kind of information is needed regarding the customers. Before using a BI tool, the analysis and the result is mainly available only to the management and the users usually don’t have access to the information. But, with the help of BI systems, everyone can see the information when they need to. Another benefit is the possibility to get access to the valid data with help of BI technology. Moreover, by using the BI system, it enables the company to make timely decisions. Also, there is a better understanding of what is actually happening in the business process after using BI systems.
5.4 The impact of implementing BI system on the decision-making process

In this section, we want to understand the impact of BI systems on the decision making process, i.e., how is the decision process changed after employing the BI systems.

**Nobina:**
In principle, there are considerable changes in the company after implementing BI systems that enable the managers to make better decisions. But these developments require high costs. It is expensive to develop BI systems and expensive to maintain them. However, as it is mentioned above in the examples regarding using BI systems, they have immediately impact in the management decision-making processes.

**Releye:**
We will use the performance management system mentioned earlier as an example here. After employing the system, it makes the decision making easier for the higher management team since the data is constantly available. Before the system was employed, the management team needed to ask for the data through the excel data sheet. This means they might need to wait for a few days to receive the report. With the help of the new BI system, the management team can check the latest report whenever they want to and can get the result immediately.

**Planning Division at UU:**
Before the BI system is employed, it was important to have an expert for every different type of report. That means it was necessary to have an expert for each type of report since the expert is usually the only person who knows how to collect and process the data. Therefore, the whole process can take quite some time and is not easily accessible to everyone. But with the help of BI systems, it is easier to generate the report when needed. It also makes it easier to access historical information and figures and perform analysis, which also make it easier for making decisions.

**EdgeGuide:**
After using the BI systems, there is a big difference in the management performance. The reason is that when using the BI systems, it is possible to get the necessary information on time to make their decisions. Also, the management can follow the information throughout the month. This is considered important because before using BI, the management had to wait until all the analyses, reports, and consultations of the information were done. Then, the management received the reports in the end of the month. Hence, with implementation of BI systems, the management has ability to access the most up-to-date information and focus more on the decisions rather than gathering the information.

5.5 The key success factors that considered as most important or crucial when developing BI systems

In this section, we want to know what factors are important in order to successfully develop a BI system from the interviewees' experience. Example factors can include but are not limited
to the following factors: senior management support, user involvement, development tools, planning and clear vision of the project and Information Quality.

Nobina:
The most crucial factor is the involvement of the users. In Nobina, the users are from the operational part of the organization. The operational part need to be very involved since the IT department has to get a very clear idea about the requirements from them.

The other key factor is the information quality. In Nobina, there is a portfolio of the source systems; production system, sales system, HR system, etc. Then, the data is fetched from those systems and stored into the data warehouse. Afterwards, utilizing the data warehouse, the BI systems will process these data. During this process, sometimes they found that some of the data are of very poor quality. This happens because nobody has really looked into that data. Take the fuel data as an example, when a bus is fueled, it is registered manually. The data recorded can include how many kilometers this bus had run and how many liters of fuel it had consumed. It is possible to make mistakes due to the manual input. So, the figures based on these data might not be correct, and the data need to be checked again. Accordingly, the information quality is extremely important in order to get a good result and thus can gain the users’ trust. But it is very difficult to reach high quality of information.

The third key factor is the access method. In many cases, the access method used to be excel sheets. During the process of building a BI system, the data is stored in a database, and then filtered in different ways to analyze the information by using an excel sheet. Using excel sheets could create a few problems. First, it is difficult to control these excel sheets, there could be many different versions of excel sheets being used by the users, and the outdated ones might deliver incorrect information. Secondly, the excel sheets could be modified by anyone. Thus, it is very difficult for the IT department to control these excel sheets. Furthermore, some users might not trust the BI systems because of these faulty excel sheets out there. Hence, the access method is an important factor since the credibility of the information is affected. In addition to these three factors, it is interesting to know that there are different types of users. For instance, top managers who don’t know how to modify an excel sheet will not manipulate anything. They just look on a table, which means that they are viewers, just look at the BI systems and use the information. On the other hand, there is another type of users who are the explorers who like to dig down into the data and do all the analysis and build all charts. So, it is the same BI system but the skills of the users could be very different. This is also crucial when developing a BI system. It should be taken into consideration for whom this system is intended. Is it for regular users, users with IT skills, business controllers, or is it for managers?

Releye:
In the interviewee’s experience, the importance of each factor depends a lot on the context of each case, such as the size of the project, the maturity of the client, or what the clients are delivering to their customers. But if one factor has to be chosen, top management support is important. The second factor will be user involvement. Higher level of user involvement can bring advantages. First, the users will understand how to use it correctly. Secondly, it can also help to close the gap between executives’ strategy and the operational process. This is because the user can understand the strategy more by understanding why the system is developed in this way.
Planning Division at UU:
The interviewee thinks all the factors we found in the literature are quite important. These factors are senior management support, user involvement, development tools, information quality, planning and clear vision of the project. But from his experience, the most important factors should be clear understanding of user requirements and the usability of the system. For example, if the system is not what the users really need, it is meaningless to develop a system even when all other factors are fulfilled. And for the usability factor, it is important that the system is easy to use, therefore the users will use it more and thus it can provide more help for the users.

EdgeGuide:
The involvement from both the senior management and the users is very helpful to be able to know how they react about the information at hand. This includes if the information is meaningful and correct or not. On the other hand, the development tools are not considered as a very important factor since most of the tools nowadays are similar. But, sometimes it depends on the organization’s culture and the cost of the project. Clear vision of the project is also an important factor. It is important in the sense that the projects should be feasible and doesn’t try to solve all the problems at once in the beginning of the project. Regarding Information Quality factors, it is important to work with information with good quality. But it is also important to deal with the data that is not accurate to correct and update it. It is also important to get access to the data, get the data out to the users, and see if the data is relevant to the task at hand. Then, it will be a start to build a good construction. This will make the company, with the help of BI application, able to employ approaches within shorter time and get the desirable results. Also, there is another factor which is the business process knowledge. It is important because the BI system will support the business process and the decisions surrounding the business process.

5.6 The importance of IQ as a key success factor

None of the interviewees think that IQ is the most important key success factor. In this section, we want to understand the reason why they didn’t think IQ is the most important factor.

Nobina:
In order to have a good BI system, the information quality plays a very central role. The reason is, if there is a lack in IQ, the whole BI system will be useless. It is important to have management support and the involvement from the users, but if a certain level of IQ is not achieved, the whole system will fail. So, IQ is a fundamental requirement for a BI system to succeed. Another interesting point is that, sometimes, the level of IQ is regarding how it is perceived, but not necessarily by some other objective measurements. This means maybe it is not the real quality of the system that is important, but it is the perceived quality from users’ perspective that is important. In other words, it is absolutely crucial that the users perceive the system as having a high level of information quality. Otherwise the users won’t believe the information delivered by system, and then the system will be useless. On the other hand, the other factors are important as well; if there is no management support, and no user involvement, the company will not succeed either. But, without IQ it will definitely fail. It is a must, but it is not enough since other factors are crucial as well.
Relevy:
Information quality might not be the most important in some cases. For example, when the purpose of the performance management system is to drive behavior changes, the importance of the performance is being measured. Even if the data is not exactly accurate, it won’t become a fatal problem. The importance of IQ is related to how the result from the system will be used. For example, if the information delivered by the system will affect how the salary is calculated, then the information quality will be very important. Information quality is not the only key success factor, as you cannot have a system with just IQ but nothing else. But the system will need a certain level of IQ; otherwise the system will be useless since it won’t be able to deliver information that is accurate enough. In other words, IQ is fundamental but not the only or most important key success factor in most of the cases the company has worked with.

Planning Division at UU:
Information quality is very important for the university. For example, the university needs to report some data such as the number of students to the authority; and the university will get paid based on the number reported. The data have to be correct, since it is financially related. Therefore, IQ is considered very important especially when it comes to this report. The authority also sends some people to examine the IQ periodically to make sure the quality is good.

EdgeGuide:
If BI is deemed as a management tool in the long run, the Information Quality is very important, and is probably one of the most important factors. Also, Information Quality is important since the decisions are depending on the quality of the information, and the required information should be correct. But, in the short term and in the beginning of the project, other factors might be prioritized higher than Information Quality. For short term, the key success factors are the time to get the information to the users, and the involvement from the organization. Again, it is very important to have correct information, and to get high Information Quality, but it is not an easy task.

5.7 The important factors/dimensions regarding information quality

In this section, we want to know the interviewees’ opinion regarding the important dimensions that will affect the quality of the information. The interviewees can add other dimensions that they think are important; it is not limited to the dimensions from the PSP/IQ framework.

Nobina:
The first important factor is the interpretability. One has to be very precise about the data that is being shown. An example is the table in a monthly report that shows different components from the operational part in the company. One component from that table is the number of damages per month. But there is another daily report about the same components. The problem is that sometimes the bus drivers don’t register the damages that happened in the buses right away. This will lead to the problem that the daily report and the monthly report don’t add up. Therefore, it is very tricky to present the information to the users without
causing some confusion. Otherwise, they will look at the report and say it is not clear and the information is not correct. So, the interpretability is important when the goal is to get high quality information. Another example is also from the operational part in the company. There was a change in the definition of Uppsala when it became new Uppsala (Uppsala plus Tierp). There are some BI systems showing the old Uppsala, but others showing new Uppsala instead. So, the figures and charts from different BI systems will have different definitions of Uppsala, this makes the user distrust the system because this information will be considered being of poor quality. This will affect the users’ perception, and make them doubt the figures. Therefore, the information being presented has to be very precise; otherwise it will be perceived as lack of quality in the information.

Relvey:
The most important factor is the understanding of the importance of IQ. The information quality will be lower when the client lacks the understanding regarding the importance of IQ. In the interviewee’s experience, when a company needs to put the information outward, they will start to care about IQ. For example, when a company is going to sell the information as a product, they tend to care more about IQ.

Planning Division at UU:
It is not possible to pick specific dimensions since the interviewee thinks the availability of high quality information is necessary in general.

EdgeGuide:
The accessibility is important. If it is not possible to access the business information, then it is difficult to have a control on the Information Quality. The company deals with the accessibility by retrieving the information and then simply presents it to the users. Then, the company will start discussions with their clients regarding whether the information is understandable for the users. Is there a need for more explanation? Is there a need to involve the software suppliers? Is there a need to hire an expert in some specific area? And so on. This is the common approach that the company usually uses to assess the accessibility of the information. Hence, first of all, the company tries to deliver the information to the users and let the users check what kind of information the system can provide. Then, the company starts building a model in a way that comforts with that organization and the business that it is working for at that moment.

5.8 Dimensions from the PSP/IQ framework

In this section, we ask the interviewees to choose a few dimensions from the PSP/IQ framework that is important in their opinion.

Nobina:
Interpretability: It is important according to the examples mentioned earlier.
Accessibility: It is extremely important, and sometimes it is very tricky for the users to know how to access the information they want.
Believability: This is about the expectations and the perceptions from the users more than what it is in the reality.

Consistent Representation: It is very important to be very clear about what is being shown in the reports; otherwise the users will misunderstand them and think that the system has poor quality.

Reputation: A poor quality reputation makes the users very skeptic about BI systems. This might happen if there is misunderstood by the users or something wrong with the charts. As a result, it will build a lot of incredibility in the organization. Accordingly, the reputation is extremely important. Further, it takes a long time to build credibility, and to make the users believe the BI systems.

Releve:
For different cases, the importance will be different. For example, ease of manipulation is not important or will even be a bad idea when the purpose of the system is to provide the users with a report only. But if the purpose is for forecasting, ease of manipulation is important. If the universal ones have to be picked, it will be accessibility, relevant, value-added and timeliness.

Accessibility: It is different in different cases. As an example, for one particular customer, the report has to be just one click away. So they have to make the information easy to access and to make it readily available is also important. But for another client, different ways of accessing the information is necessary; he or she wants to be able to choose which information should be reported. Mobility, i.e., the ability to access the information anywhere when needed, is also considered to be important.

Relevancy: To achieve this, the company needs to understand what the clients need and how they operate. It could be done by conducting interviews or by visiting the client’s office to see how they do their job. Also, the company usually starts with the following questions: What does the client need the system to do? How many users will be using this system? How often will they be using the system? And it is also mentioned during our interview that BI system requirements are more likely to be constantly changing.

Timeliness: If the information is not available or take too long to get, the company might miss the important market shift. Or they will not be able to change their strategy quick enough.

Value-added: An example of value-added information is the need to add emotional value to the product. For example, it can be some small gadgets on the system that can provide the clients with some simple but useful information. This can help the client create emotional bond with their customer.

Planning Division at UU:
It is not possible to pick specific dimensions since the interviewee thinks the availability of high quality information is necessary in general.

EdgeGuide:
Accessibility: As it is mentioned above, the accessibility is an important dimension. As soon as the accessibility is provided, it will be possible to solve the Information Quality problems. However, it depends on what it is going to present. It means that if the Information Quality is
necessary to make a good decision; in that case it might be needed to have consistent error free and correct data. But, if it is just in the beginning of implementing BI systems in an organization, then the accessibility is the first important thing as soon as the work is with Information Quality.

**Understandability:** It is the same concept as the accessibility; because if the data is not understandable, then it is not accessible.

As soon as these two above dimensions are fulfilled, then it is possible to solve the problems associated with the rest of the dimensions.

5.9 The information quality framework employed in the organizations

*In this section, we ask the interviewees if there is any specific Information Quality framework employed to assess the quality of information delivered by their BI systems*

**Nobina:**
There is no specific IQ framework or a metric system used in the company. Rather, as mentioned above, the users (the information owners in Nobina) are asked to validate the information. In Nobina, the developers in the IT department develop a system to clean the data, and in some way the company does manipulations in order to increase the quality of information. But the company don’t use any automated tools to check the quality of the information.

**Releye:**
There is no specific IQ framework or a metric system used in the company. Rather, as mentioned above, the users from Releye’s clients are asked to validate the information. In Releye, the company usually uses some data cleansing tools. But it is only on the data quality level. The company never had the need to use a more systematic method to deal with information quality. One possible reason can be that many of the clients usually buy the information from other companies, so the company expects the information is already of high quality.

**Planning Division at UU:**
The department doesn't have any systematic way to check and improve IQ. It is usually only dealt with when some problems occur. For example, if one of the subsystems updates the format with which the data is presented, it might cause some problems in the main system. Then, it will be checked for what happened and fixes it.

**EdgeGuide:**
The company doesn’t have a specific IQ framework. There are no specific tools, but the company uses some ways to secure Information Quality. But, it is hard to find a common way to assess since all the business processes are different.
5.10 How the organizations make sure an accepted level of IQ is achieved

In this section, we want to know how the companies judge whether the current IQ level is acceptable. For example, do the companies compare it with the result gathered before? Do the companies compare it with the result from other organizations? Or do the companies compare it to a predefined criterion?

**Nobina:**
The company usually maintains historical data. So, in the analysis, the new report is typically compared with the previous versions to see the differences, and remove faulty data and so on; in the hope that the quality will be higher afterwards.

**Releye:**
The company doesn’t use any systematical ways to monitor the IQ. It is mainly done through constant user-involvement. And usually it is from the user’s perspective to judge whether the information is correct or not.

**Planning Division at UU:**
Usually, each department is responsible for the quality of the information that they put into the BI system. The department needs to check the information they provide, because it is only the department that is able to know whether the information is correct or not. The planning division does run some analysis, but it is not done in a systematic way. However, when it comes to the report regarding the number of students enrolled in the university, this is treated with special care because it is sent to the authority to get the payment. For this particular report, it is very important to make sure the quality is good. Therefore, the way to process the data is very clearly defined or regulated, which includes what the report should contain, how the report should look and how the report should be produced. The planning division also checks if the report from the university is consistent with the report from another system called Uppdok. This is the way to check if the information quality is good enough or not.

**EdgeGuide:**
As soon as there is a weakness in the data, the company tries to include some kind of monitoring of the current information faults in the BI application. For instance, there is a dashboard to show that the duplication of some kind of information is not allowed. So, the company uses an approach to first show the data as it is, then gives the users the possibility for using or digging down in the information. It means that the company uses the monitoring features within the BI application to monitor known information problems. Furthermore, the feedback from the users is used as a way to make sure that the information is acceptable. Also, the user has the ability to check if there is an information problem.
6. Analysis and Discussion

This chapter will analyze and discuss the empirical findings in order to clarify the differences, similarities, and common points with the theoretical findings in our thesis.

The analysis depends on the results gathered by conducting both the literature review and the interviews with Business Intelligence experts. The purpose is to give a clear vision concerning the key points that are focused on throughout the research. Moreover, we intend to analyze and discuss how the interviewed companies consider the implementation of Business Intelligence technology when they are doing their tasks. Also, it is important for the research to explain how these companies treat the Information Quality factor and other factors in Business Intelligence. This will be done by comparing the interviews’ findings with the literature to see the impact of these terms in the organizations.

The following points are taken into account during the analysis process:

1. The benefits of using Business Intelligence (BI) systems
2. The impact of using BI systems on a decision-making process
3. The key success factors during the development of BI systems
4. The importance of Information Quality (IQ) as a key success factor in BI systems
5. The important dimensions that will affect the quality of the information
6. The IQ framework used in the organizations to achieve acceptable IQ

6.1 The benefits of using Business Intelligence (BI) systems

Flanglin (2005) defines the Business Intelligence as not only a single product, a technology, or a methodology. BI combines products, technologies, and methods to organize the key information that management needs in order to improve the profit and performance.

Business Intelligence enables for organizations to predict the market trends and possible changes in the market that might affect these organizations (Turban et al., 2011). Hence, by using Business Intelligence, these organizations can respond rapidly toward these changes by updating their processes and make these changes serve the goals of the organizations. (Fielding, 2006; Bogza & Zaharie, 2008). Therefore, the importance of Business Intelligence systems lies in the effective contribution to make the organizations organize and reduce the costs as well as to increase the profits steadily. (Turban et al., 2011)

It is clear that the interviewed companies get many benefits from implementing BI systems. Nobina uses many BI systems for different kinds of processes, for example salary analysis, track of the profitability for each contract, workshop systems and 20 other BI systems. Applying BI practice in Nobina gives them the possibility to analyze the complex materials of salary, and enables the local management to look in that analysis from many different aspects. Also, by using BI practice, the workshop managers can study the characteristics of each bus and make decisions about it. Nobina consider that these BI systems are very useful in analysis to make proper decisions for different cases.
Releye develops many BI systems for their clients, such as the salesperson performance system. By using this system, the salespersons can easily see how they are performing at any time, and thus become more motivated. Also, the managers can easily coach the team members and can provide the help when it is necessary.

For the Planning division at Uppsala University, BI systems give them the possibility to check and analyze their data efficiently from different perspectives, and provide meaningful information. For example, it is easy to get the required information when doing the analysis, investigation, or comparison regarding the number of applicants for applying to study in the university or the number of admitted students.

EdgeGuide thinks that BI systems make people aware of the data; can easily access the needed information at any time, and get access to the valid data within the organization. Also, these systems enable the company to make quick decisions on time, and give a better understanding of the business process.

As a result, the abundance of information necessitates the organizations to seek new methods or technologies for analyzing the retrieved information. The literature explains that the Business Intelligence contributes obviously in solving this issue by helping decision makers to make right decisions. Also, according to our interviewees, Business Intelligence enables these companies to do quick analysis and improve the performance of their decision makers. It means that there is a correspondence between the literature and the interviewees regarding the benefits of using BI applications. Moreover, since the interviewees assure that they are aware of the importance of BI applications, we think that they get more meaningful and understandable information. Eventually, it is also obvious that with the right application of the possible BI systems, the more benefits can be the result for both the companies and the customers.

6.2 The Impact of using BI systems on a decision-making process

The literature indicates that Business Intelligence systems are used to analyze the data in-depth and transform it into organized information. This makes the relevant information easily accessible for the users, thus helping the users to make better decisions (Fielding, 2006). It is possible to say that the use of Business Intelligence technology is to get the appropriate information in an appropriate time in order to make an appropriate decision (Bogza & Zaharie, 2008). Hence, Business Intelligence aims on helping the users to make the best decisions through the use of information management systems, and technological applications in order to collect, store, analyze, and provide the data (Watson, 2009). That is, Business Intelligence leads to better decision-making through the use of accurate information with the value of an acceptable quality in a timely manner.

All the interviewed companies agreed that there is a big impact of BI systems on the decision-making process. This impact affects positively on the performance of the management. The interviewee from Nobina assures that BI practice enables the managers to make better decisions. For Releye, BI practice makes the decision making easier for the higher management team since the data is constantly available. Also, the Planning division at UU states that BI systems are important when it comes to accessing the historical information,
makes analysis, and facilitate decision making. The interviewee from EdgeGuide says that it makes a big difference in the management performance after using BI systems. The management can get the necessary information on time to make their decisions.

Actually, both the literature and the interviewees highlight that the main focus of using BI systems is to support the decision-making process. By applying such a tool, the interviewees from the interviewed companies also agreed that decision makers are affected positively. We argue that the management is the main part in the companies that can get benefits and are more affected from BI implementations. This is because the improvement in the management’s decision-making process will lead to the success and thus meet the needs of the market. This can improve the companies’ performance significantly since the management will get the relevant information in the right time to make crucial decisions.

6.3 The key success factors during the development of BI systems

An optimal implementation of BI systems leads to fruitful and profitable results for both short term and long term (Hwang et al., 2004). In order to reach these results, the organizations should take some key success factors into their account when applying BI systems (Eckerson, 2005; Yeoh et al., 2006; Yeoh & Koronios, 2010). Previous studies in the IS field suggests various critical factors in the implementation of an information system (Yeoh et al., 2006). However, these factors might be different depending on, for instance, the nature and the size of the tasks (Hwang, 2004). Some of these key success factors are considered important in using BI systems such as senior management support, user involvement, development tools, planning and clear vision of the project. Information Quality (IQ) and others (Wixom & Watson, 2001; Lee et al., 2001; Little & Gibson, 2003; Hwang et al., 2004; Eckerson, 2005; Yeoh et al., 2006; Yeoh & Koronios, 2010)

The experience from using and developing BI systems helps greatly to specify the important factors that positively impact the BI implementation. Nobina considers the involvement of the users is the most crucial factors since it is the users who can correct and update the information to the IT department. In addition, Information Quality is a key factor for Nobina in order to get a good result and can gain the users’ trust. Also, the access method is an important factor when making the information more credible for the users. The fourth key success factor is that it should be taken into account for whom the BI system is intended and developed since the users have different IT skills. Releye means that the importance of each factor depends on e.g. the size of the project and the maturity of the client. Nonetheless, Releye deems that top management support and user involvement are the most crucial factors in BI implementation. Planning division at UU considers the important factors are senior management support, user involvement, development tools, Information Quality, and clear vision of the project. Moreover, the clear understanding of user requirements and ease of use are also very important. EdgeGuide states that the involvement from both the senior management and the users and the clear vision of the project are very important. Also, Information Quality is a key factor to get correct and relevant data. For EdgeGuide, the business process knowledge is also crucial in BI to support the decisions around the business process. On the other hand, EdgeGuide doesn’t think that the development tools are crucial since most of the used IT tools are similar.

We argue that in order to reach a successful BI application in a company, it should be existed some factors that support this application. In the literature, many of the factors are mentioned that could have a positive effect when implementing BI systems. But these factors are
different in their importance for each company depending on the size of the company, the experience of using BI systems, the context of the tasks at hand, the intended users who will apply BI tools, and others. However, most of the interviewees state that the user involvement is most important since the users are the main source for the information in these companies. Based on the interviews, we mean that the support from senior managers is very important to be able to apply BI implementation successfully.

6.4 The importance of Information Quality (IQ) as a key success factor in BI systems

Raghunathan’s research (Raghunathan, 1999) concludes that information quality has positive impact on decision making when the decision-maker is familiar with the problem domain. Slone (2006) also stated in his research that information quality and organizational outcome are positively related in most cases. Moreover, the more reliable the data sources, the stronger the decisions can be (Wixom & Watson, 2001; Lee et al., 2001; Yeoh & Koronios, 2010). Hence, the lack of high quality data will affect dramatically decision-making process (Yeoh et al., 2006). Thus, the higher quality of the information, the more effective decisions can be made, and thus promoting the success of the BI practices (Yeoh & Koronios, 2010).

According to Nobina, Information Quality (IQ) is a fundamental requirement for a BI system to succeed. It is a necessity, but it is not enough since the other factors have a central role as well. From Releye’s perspective, the importance of IQ depends on the tasks at hand. This means that IQ is crucial, but not the most important success factor; rather, there are other fundamental factors to get a successful BI implementation. For the Planning division at UU, the IQ factor is very important especially when the tasks are financially related. EdgeGuide thinks that, in the long term, the IQ factor is most important for the management to get right decisions. But, in the short term and in the starting of the project, it might be other factors that have higher importance than IQ factor.

The Information Quality is not the most important key success factor in a BI implementation according to the literature. But, low quality information affects negatively the results of the decisions that are based on that information. All the interviewed companies mention and repeat many times that getting high quality information is crucial to make BI implementation successful. This is why we can say that they assured implicitly that Information Quality (IQ) is an essential key success factor since there is no trustworthy information if there is a lack in its quality. Furthermore, although the importance of IQ depends on the tasks at hand according to our interviewees, how they could make crucial decisions with the lack of high quality information. Also, we state that the users’ perception of the IQ has an important role when succeeding with a BI implementation. In other words, based on the results of the interviews, we argue that IQ is a fundamental factor since it is important that the system will be able to deliver the information with a certain level of IQ. But as long as the quality is within an accepted range, it won’t be a major problem in most of the cases. Therefore, IQ is considered to be a fundamental factor but not the one with highest priority or highest importance. As a result, although both the interviewees and literature consider that IQ is not the most important, some of the interviewees state that IQ might be very important depending on the tasks at hand.
6.5 The important dimensions that will affect the quality of the information

Previous studies mentioned many essential dimensions that should be found to provide high quality of information. These Information Quality (IQ) dimensions are different depending on the context of the study. Nonetheless, there are some dimensions that might be important to deliver high quality information such as accessibility, accuracy, completeness, relevant, and timeliness (Naumann & Rolker, 2000; Zhu & Gauch, 2000; Leung, 2001; Pipino et al., 2002; Kahn et al., 2002; Klein, 2002; Lee et al., 2002; Bovee et al., 2003; Liu & Huang, 2005; Eppler, 2006; Ge, 2009; Bertilsson et al., 2009). Kahn et al. (2002) consider the following dimensions that are the base for many other researches regarding Information quality assessment:

“Accessibility, appropriate amount of information, believability, completeness, concise representation, consistent representation, ease of manipulation, free-of-error, interpretability, objectivity, relevancy, reputation, security, timeliness, understandability, and value-added”.

There are different perspectives from the interviewed companies about the essential IQ dimensions. Nobina takes into their consideration interpretability, accessibility, believability, consistent representation, and reputation as prioritized dimension to get high quality information. According to Nobina, the reason for this selection is that the information being presented has to be very precise to overcome the lack of quality in the information. For Releye, the understanding of the importance of IQ is crucial. This importance will be different in different cases. According to Releye, some IQ dimensions are not important in some cases, whereas the same dimensions might be crucial in other cases. However, Releye deems accessibility, relevant, value-added, and timeliness are important to be able to provide information with high quality. In the opinion of the Planning division at UU, it should be presented high quality information in general. So, there are no specific IQ dimensions that are considered more important. EdgeGuide thinks that accessibility and understandability are most important. According to EdgeGuide, as soon as these two dimensions are fulfilled, then it is possible to solve the rest of the dimensions.

In the studied frameworks, the dimensions that should exist to assess high quality of information are presented. According to the perspectives of the authors who developed these frameworks, the dimensions are different based on the context of providing the Information Quality (IQ). However, there are common IQ dimensions that are important to reach desired Information quality. We argue that the IQ dimensions in the framework by Kahn et al. (2002) include most of the important ones. Also, this framework provides understandable definitions for these dimensions in a way which explains why they are vital to reach information quality. Our interviewees present their IQ dimensions and three of them have the accessibility as a common dimension. We think that accessibility is important for these companies since the information should be available, and easily and quickly retrievable for the users according to Kahn et al. (2002). However, the other dimensions that are revealed by the interviewees are based on the types of their tasks and their users.

6.6 The IQ framework used in the organizations

It is difficult to get relevant and quality information since the lack of standards may lead to information quality problems (Parker et al., 2006). Accordingly, a number of Information
Quality (IQ) frameworks are developed to evaluate the quality of information. The aim of these IQ frameworks is to provide as applicable strategy as possible to assess the quality of the retrieved information. In addition, IQ frameworks will help the information consumers to make better decisions (Parker et al., 2006). Section 4.1 presents some of the IQ frameworks that have been developed after the year 2000. They are different depending on the context of the study and the purpose for using the information.

None of the interviewed companies has specific IQ framework or a metric system to evaluate the quality of information delivered by their Business Intelligence (BI) systems. Nobina depends on the information owners of BI systems to validate the information. Besides, Nobina maintains historical data, and compare the created new report with previous versions to see the difference and remove faulty data to make the quality higher. Releye usually asks their clients to validate the information, and the company uses some data cleansing tools as well. So, the quality of information is mainly done through constant user-involvement. For Planning division at UU, each department is responsible to check if the information they provide is correct or not. In the case of EdgeGuide, the company tries to include some kinds of monitoring of the known information faults in BI systems. Also, the feedback from the users is utilized to make sure that the information has an acceptable quality.

The literature presents many Information Quality (IQ) frameworks to assess the quality of information. These frameworks are developed in different contexts and present different ways for IQ evaluation. We can say that these frameworks provide a real opportunity for the organizations about how they will be aware of the factor IQ. On the other hand, none of our interviewees have or use a specific framework to evaluate their information. Rather, they have different ways to validate and monitor the quality of their information. We state that this is because the interviewees think that the Information Quality is important, but it is not must that they should take care about. Also, it is difficult to find a common way to assess the quality of information according to EdgeGuide’s perspective, for instance.

6.7 Summary of the analysis

After the above analysis and discussion of both theoretical and empirical findings, we will summarize the main points of this analysis in the following table. This table demonstrates the differences and similarities between literature review and our interviewees’ perspectives regarding the terms that are discussed in the previous sections.
<table>
<thead>
<tr>
<th>Item</th>
<th>Literature</th>
<th>Nobina</th>
<th>Releye</th>
<th>Planning division at UU</th>
<th>EdgeGuide</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI importance</td>
<td>• Fast analysis and organizing of key information</td>
<td>• Analyze complex material to be easy and understandable</td>
<td>• Easily track the salespersons’ performance</td>
<td>• Check and analyze the data efficiently</td>
<td>• Get access to the valid data</td>
</tr>
<tr>
<td></td>
<td>• Improve management performance</td>
<td>• Make proper decisions for different cases</td>
<td>• Managers easily coach team members</td>
<td>• Easily get the required information</td>
<td>• Make quick decisions in correct time</td>
</tr>
<tr>
<td></td>
<td>• Increase the profits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reduce the costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BI effect on decision</td>
<td>Reach better decision-making process</td>
<td>Enables managers to make better decisions</td>
<td>BI makes decision making easier</td>
<td>Make it easier for decision making</td>
<td>Getting efficient decision making</td>
</tr>
<tr>
<td>making process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BI key success factors</td>
<td>• Senior management support</td>
<td>• User involvement</td>
<td>• Top management support</td>
<td>• Senior management support</td>
<td>• User involvement</td>
</tr>
<tr>
<td></td>
<td>• User involvement</td>
<td>• Information quality</td>
<td>• User involvement</td>
<td>• User involvement</td>
<td>• Management support</td>
</tr>
<tr>
<td></td>
<td>• Development tools</td>
<td>• Access method</td>
<td></td>
<td>• Development tools</td>
<td>• Clear vision of the project</td>
</tr>
<tr>
<td></td>
<td>• Planning and clear vision of the project</td>
<td>• For whom BI system is developed</td>
<td></td>
<td>• Planning and clear vision of the project</td>
<td>• Information quality</td>
</tr>
<tr>
<td></td>
<td>• Information quality</td>
<td></td>
<td></td>
<td>• Information quality</td>
<td>• Business process knowledge</td>
</tr>
<tr>
<td>IQ importance</td>
<td>Lack of high quality information affects dramatically decision-making process</td>
<td>IQ is a must, but other factors have central role as well</td>
<td>IQ is crucial, but not the most important success factor</td>
<td>IQ is very important especially in financial issues</td>
<td></td>
</tr>
<tr>
<td>Important dimensions IQ</td>
<td>Accessibility, appropriate amount of information, believability, completeness, concise representation, consistent representation, ease of manipulation, free-of-error, interpretability, objectivity, relevancy, reputation, security, timeliness, understandability, and value-added.</td>
<td>Interpretability, accessibility, believability, consistent representation, and reputation</td>
<td>Accessibility, relevant, value-added, and timeliness</td>
<td>No specific dimension.</td>
<td>Accessibility and understandability</td>
</tr>
<tr>
<td>The used framework IQ</td>
<td>Many IQ frameworks are developed to evaluate quality of information</td>
<td>• No specific IQ framework is used</td>
<td>• No specific IQ framework is used</td>
<td>• No specific IQ framework is used</td>
<td>• No specific IQ framework is used</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Information owners of BI systems to validate the information</td>
<td>• Asking the clients to validate the information, and using some data cleansing tools</td>
<td>• Each department is responsible to check its information</td>
<td>• Monitoring the known information faults in BI systems, and using feedback from the users</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do comparison with previous reports to remove faulty data</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: The summary of the analysis depending on literature and empirical findings
7. Conclusions

In this chapter, our conclusions focus on the answers of the research questions, and our suggestions for future studies.

The challenge regarding the quality of information is somehow pervasive in the organizations’ work when implementing Business Intelligence technology. Below, we will conclude regarding the research questions that focus on the role of Information Quality factor in Business Intelligence systems.

7.1. General Conclusions

7.1.1 Answers for research questions

The aim of our research questions is to know how the organizations deem the importance of BI systems, and the factors surrounding the implementation of BI technology. Also, how they assess the quality of their information, and whether IQ is a crucial factor to reach high quality information. We have three research questions with the answers in the following:

**Which factors or variables are important to deal with to get acceptable quality of information in BI systems and how to assess them?**

In general, while some factors are important in BI systems for one organization, they are not for others. This emerges from to which extent these factors affect the desired results. In other words, there are no specific factors that determine the success of BI implementations. Rather, it depends on how an organization could use and apply a specific factor efficiently to reach its goals. The more experience of using BI systems, the more clearness of assessment which factor is crucial in these systems. However, many key factors when using BI systems are mentioned in the literature. But the interviewees state that the involvement of the users enables them to get the acceptable information quality. Also, the user involvement helps them to give their information more credibility.

**Is information quality considered as a key success factor in BI for organizations’ decision makers and how to assess it?**

The right decisions are mainly dependent on the quality of information. The reason is that the lack of information quality in BI systems has a negative impact on the decision making process. Besides, the users don’t trust BI systems with poor quality information. But, it is very hard and expensive to reach high quality information according to our interviewees.
Moreover, this factor is not the most important one since its importance depends on the tasks at hand.

In order to evaluate Information Quality (IQ), we adopted PSP/IQ framework which compasses a number of dimensions that help to do this evaluation. But, the interviewees don’t use any framework to evaluate their information quality. It means that, as we mentioned above, the interviewees don’t consider IQ a necessity, and they have other ways for information assessment. Also, it might be difficult to get a common way to assess the quality of information. However, there are some IQ dimensions that are important to have high quality information such as the accessibility and understandability. The available of these IQ dimensions provide trustworthy information to the users, and make them trust the BI systems.

**Does Information Quality have an impact on the decision-making process in such a way that it leads to improved use of Decision Support Systems (DSS)?**

The empirical findings in our thesis give a clear vision that if the right information with high quality is available, this has direct impact on the decision makers’ performance. It means that as soon as the management gets access to high quality information on right time, there is a strong possibility to make important and correct decisions in an organization. Also, the interviewees point out that they try to increase the information quality by filtering their information in different ways to get acceptable quality. We argue that an inaccurate and poor information quality will lead to ineffective decision support systems. Hence, the organizations should be more focused on this issue to present trustworthy information to the consumers.

### 7.1.2 Reflections

In relation to the purpose of our thesis, we conclude that there are important factors that impact the BI implementation. Also, reliable quality of information enables decision makers to make crucial decisions for their organizations to be more competitive and successful. More importantly, our conclusions from the empirical findings indicate that they are consonant with the literature regarding the importance of BI, the BI impact on decision-making process, and IQ is not the most important factor among other factors in BI implementation. The use of specific framework to evaluate the quality of information, on contrary, is not consonant with the literature that presents many IQ evaluation frameworks to be applicable in real world.

In order to provide a rich and depth understanding of the context in the thesis, the qualitative research approach is adopted (Polit et al., 2010). This enables the authors to make intensive study to reach the goals of the research by examining particular cases that are using BI systems in doing their tasks. After analyzing both the literature and the empirical results from this sample of companies, we argue that our conclusions could be generalized or partially generalized in similar populations. The point is that the results of conducting small qualitative studies can potentially contribute valuable knowledge to the community and provide an accurate understanding of the phenomenon (Myers, 2000). In addition, the generalizability of our conclusions lies in the fact that the same process of analysis has followed for all the
respondents in our sample of BI experts. Depending on the analytic generalization model by Firestone (1993), we try to generalize our conclusions from particulars to broader populations (Polit et al., 2010). In more details, our respondents are asked the same questions in order to recognize clearly the similarities and differences in their answers. Similar perspectives are gained regarding the importance of the use of BI, the considerable change of decision-making process after using BI practice, the IQ factor is not a necessity, and there is no specific framework used to assess the quality of information. A bit different perspectives, however, are considered in relation to the key success factors in BI implementations, and the important dimensions of evaluating IQ. Accordingly, we argue that the generalizability or partial generalization of our conclusions is possible as long as the context is with similar populations. This conclusion lies in the fact that depth analysis is done accurately to emphasize that the collected data indicate that most of the respondents’ perspectives to far extent are consonant with each other’s.

7.2. Suggestions for future works

By studying and analyzing the literature and conducting the interviews, our thesis focus on the importance of Information Quality (IQ) and how to assess it in the Business Intelligence systems. Since none of our interviewees utilize a specific framework to assess the quality of information, it could be an interesting suggestion to investigate this point deeply. For instance, to study why the organizations have this lack in the assessment of IQ, and to analyze whether it is difficult to apply a specific IQ framework, the cost are very high to implement IQ framework, or it is not so crucial for the organizations to apply such IQ framework.

Another interesting future work is to analyze different sizes of BI beneficiaries concerning the way to handle IQ problems; do they have their own BI maintenance team that take care of this kind of problem, or it is responsibility of their BI providers? Another point is to analyze the difference between big and small companies regarding this point when dealing with IQ problems.
References


Ge, M., 2009. Information Quality Assessment and Effects on Inventory Decision-Making, Ph.D. School of Computing, Dublin City University


Yeoh, W., Koronios, A. & Gao, J., 2006. Critical success factors for the implementation of business intelligence system in engineering asset management organizations, *Proceedings of the 1st World Congress on Engineering Asset Management (WCEAM)*


Appendix 1- Interview Guide

Information about the interviewee

What is your name?
What are your title or position, and the name of department you work in?
Could you describe the work that the organization does?
Could you describe the tasks of the department that you work in?
What are your role in the department, and the tasks you usually do?
How long have you been working in this organization?

The interviewee’s work in IT and IS

How long have you been working in the IT field?

The interviewee’s work in BI

How long have you been working in BI field?
What benefits do you see of using BI in the organization?
Does the organization use a specific type of BI systems?
Why do you use this type of BI systems?
Is there a specific department or people who are responsible for BI system’s maintenance and development?
Is the BI system effective enough, or need it to be further developed?

The effect of BI in decision-making process

Is there any considerable change in the decision-making process after implementing BI system in the organization? If yes, what is the change?
Regarding the implementation and the benefits of BI systems in the organization is it only for decision-making process, or could it be used for other tasks or issues?
Do you think it is necessary to implement BI system for getting support for making crucial decisions?

The key success factors in implementing BI system

In your experience, do you think that there are specific factors that make the implementation of a BI system successful and more effective during a decision-making process?
What is your comment about the importance of the following factors:

• Senior management support:
• User involvement:
• Development tools:
- Planning and clear vision of the project
- Information quality

In your experience, which factor is considered most important in BI practice for getting an appropriate and crucial decision in the organization? Why?

_The importance of information quality_

Is information quality a very important factor in BI system for getting suitable decisions in your organization? Can you explain the reason?
In your experience, which factors are important for distinguishing high from low quality information (not limited to the dimensions in the PSP/IQ framework)?
Do you think that there is a difference between data quality and information quality?

_IQ dimensions: the importance and meaning of each of them in BI and decision-making process_

There are 16 dimensions in the framework that we had chosen to focus on in the thesis. We would like to ask you to pick a number of dimensions that you think they are more important to reach high quality of information?

_Regarding frameworks_

Framework: (according to our thesis) is a structural plan containing a number of dimensions to assess the quality of information in Business Intelligence systems used in the organizations.

_General questions regarding frameworks used in the expert’s organization:_
Does your organization use any IQ framework? Can you tell us which framework it is and the reason?
Could you give us some examples about the IQ improvement effort in your organization?

If the answer is yes, following questions will be asked:
  How do you judge whether the IQ level is accepted? (Do you compare it with the result gathered before? Do you compare it with the result from other organizations? Or do you compare to a predefined criteria? And how was the criteria defined?)
  Do you use all the dimensions from the framework or just pick those that fit your organization’s need?

_Questions regarding PSP/IQ (it should be introduced first)_

Do you think any dimension that is important for your organization but is missing from PSP/IQ?
Among the dimensions listed above, which one do you think is difficult to measure?
What is your opinion regarding the number of dimensions in the framework? (Is it too many, too less or it is enough?)
Appendix 2 - Details of Interviews

Interview 1: Releye AB

Q: What is your name?
A: Jennie Rassool

-----------------

Q: Could you describe the work that the organization does?

A: The company name is Releye, an IT consultant company with about 50 employees. This company provides their clients with IT solutions regarding BI, CRM (Customer Relation Management).
   They also help the clients with process improvement process sometimes.

-----------------

Q: Could you describe the tasks of the department that you work in?

A: They help their clients with IT solutions regarding customer service, marketing and sales fields.
   Provides the clients with solutions related to CRM, sales performance management, performance indicator, report and analysis.
   Example of the IT solutions provided to the clients:
   What customer segmentation the client has, which one is more profitable.
   Help the clients analyze salesperson’s performance.
   Measure performance by, for example, how many customer visits, quality of the visits, how many deals they closed, how much profit generated.
   Experience with business consulting: The clients are mainly banks, financial industry, and insurance industry.
   They don’t tell the clients what has to be done, but provides recommendations regarding what should be measured if they want to develop a system.

-----------------

Q: How long have you been working in this organization?
A: 6 years.

-------------------
**Q**: What was your previous work before you came to this organization?

**A**: She had worked with balanced score card in Australia post for a few years and before that a farming company.

-------------------

**Q**: How long have you been working in BI field?

**A**: Worked with BI for about 10 years.

-------------------

**Q**: What the benefits of using BI in the organization?

**A**: A farming industry example: The farm has 1500 cows. It is important for the farm to be able to distinguish the milk quality produced between the cows. They identify each cow by using RFID. And base on the quality of milk produced by each cow, they control which gate the cow should walk through and feed them differently. The system measure, collect and report three items. These items are volume, conductivity (used as an indication of quality), temperature of milk produced. The main benefit of employing the system is to get milk with better quality and keep the feeding cost low.

-------------------

**Q**: Does the organization use a specific type of BI systems?

**A**: Microsoft DB, integration tool, BI front end, mysql, asp.

-------------------

**Q**: Is there any considerable change in the decision-making process after implementing BI system in the organization? If yes, what is the change?

**A**: The first example is regarding business analysis. Before the systems were employed, they collect much data but didn’t have enough time to process it. After the system was employed, they can focus on what they really should do. Performance management system: In this system, they divide the salesperson into 4 groups based on their performance and try to improve it. They focus on improving the performance of the bottom performers; in the end, they increase the performance by 100%. Before the system was used, the salesperson won’t be able to see how they are performing before data was collected, analyzed and then put into a report. So they usually see the
report only when they are having a review with their managers. But with the new system, they can easily see how they are performing at any time. It means that they can see the score card whenever they want to. For a salesperson, they will be able to know how they are performing and thus become more motivated; for the manager, it is easier to coach the team members and to provide the help when it is necessary. Also this makes the decision making easier for higher management since the data is constantly available. Before the system was employed, they need to go around and ask for the data through the excel data sheet. Now it is constantly available.

---------------------

**Q:** In your experience, which factor is considered most important in BI practice for getting an appropriate and crucial decision in the organization? Why?

**A:** The importance of each factor depends a lot on the context of each case, such as the size of the project, the maturity of the client and what the clients are delivering. But if one factor has to be chosen, top management support is important. The second factor will be user involvement. With more user involvement, the users will understand how to use it correctly. User involvement can also help to close the gap between executives’ strategy and performance matrix and the operational process.

As for information quality, it is not the only key success factor, as you cannot have a system with just IQ but nothing else. But the system will need IQ; otherwise it will break the system. In other words, IQ is fundamental but the only or most important key success factor in most of the cases they worked with.

---------------------

**Q:** Is information quality a very important factor in BI system for getting suitable decisions in your organization? Can you explain the reason?

**A:** Information quality might not be the most important in some case. For example, when the purpose of the performance management system is to drive behavior changes, the importance is the performance is being measured. Even if the data is not exactly accurate, it won’t become a fatal problem. The important factor is regarding how the result from the system will be used. For example, if it is related to how the salary is calculated, then the information quality will be very important. Although information quality is important in the sense of reputation of the system, it is important but might not be the first priority considered when developing a system in most cases.

---------------------
Q: In your experience, which factors are important for distinguishing high from low quality information (not limited to the dimensions in the PSP/IQ framework)?

A: The most important factor will be the understanding of the importance of IQ. The information quality will be lower when the client lacks the understanding regarding the importance of IQ. In her experience, when a company needs to put the information outward, they will start to care about IQ. For example, when a company is going to sell the information as a product, they tend to care more about IQ. What they are going to expose and how.

Q: Do you think that there is a difference between data quality and information quality?

A: In general, the difference is not made, it is often used interchangeably. But it can be done if it has to be distinguished.

In her opinion, in a simple example, DQ is whether you get correct decimal point or if the calculation is done correctly. IQ is regarding whether you deliver relevant information to the decision maker.

Q: IQ dimensions: the importance and meaning of each of them in BI and decision-making process

A: The importance:

For different cases, the importance will be different. For example, ease of manipulation is not important or will even be a bad idea when the purpose of the system is to provide the users with a report only. But if the purpose is for forecasting, ease of manipulation is important.

If the universal ones have to be picked, it will be accessibility, relevant, value-added and timeliness.

Now, we will ask you questions about the dimensions that affect the quality of information according to our research.

Q: How do you deal with the accessibility in your organization?

A: It is different in different cases. As an example, for one particular customer, the report has to be just one click away. So they have to make the information easy to access and make it readily available is important. But for another client, different ways of accessing the information is necessary; they will need to be able to choose which information should be reported. The mobility is also considered to be important. The ability to access the information anywhere when needed is important.
Q: To get relevant information is important to perform some tasks for a BI user. How does the organization do in order to give BI users relevant information?

A: This is done by trying to understand what the clients need and how they operate. It could be achieved by conducting interviews or by visiting the client’s office to see how they do their job. Also, they usually start with the following questions. What does the client need the system to do? How many users will be using this system? How often will they be using the system? And it is also mentioned during our interview that BI system requirement is more likely to be constantly changing.

-------------

Q: What is the importance of getting information on time (timeliness) in relation to decision-making process?

A: If the information is not available or take too long to get, the company might miss the important market shift. Or they will not be able to change their strategy quick enough.

-------------

Q: What can we do to make information be more beneficial and valuable (value-added)?

A: An example of value-added information: the need to add emotional value to the product. For example, some small gadget on the system can provide the client with some simple but useful information. This can help the client create emotional bond with their customer.

-------------

Q: Does your organization use any IQ framework? Can you tell us which framework it is and the why it is chosen?

A: This answer is both yes and no. In the CRM systems, they usually use some data cleansing tools. But it is usually only on the data quality level. They never had the need to use a more systematic method to deal with information quality. One possible reason can be that many of the clients usually buy the information from other companies, so they expect the information is already high quality.

-------------

Q: Could you give us some examples about the IQ improvement effort in your organization?

A: Regarding information quality improvement, there might be some tools used in the system from time to time to deal with the situations such duplicated data, but it is usually not done systematically.

One of the examples regarding the IQ improvement effort was once when they were working with a client. They found that the report generated from the system is not correct
since the calculated revenue is higher than the real result. And the overly optimistic data was reported to the higher management.
So they tried to fix this data quality problem. What they did in the end to prevent this from happening again was avoiding manual operations and always tries to go back to the source and fix it at the source when an error is presented. Also, user training is found to be very important in this case. Classical mistake is that a customer data is put into the system twice, this is difficult to fix by the system, as user training is needed.

-------------------

**Q:** How do you judge whether the IQ level is acceptable? (Do you compare it with the result gathered before? Do you compare it with the result from other organizations? Or do you compare to a predefined criteria? And how was the criteria defined?)

**A:** They don’t use any systematical ways to do monitor the IQ. It is mainly done through constant user-involvement. And usually it is from the user’s perspective to judge whether the information is correct or not.

-------------------

**Q:** Do you think that is there any important dimension for your organization missing from PSP/IQ?

**A:** It is not obvious what might be missing from the framework immediately. But if it has to be added, it would be intuitive. The information has to be easy for the users to understand and therefore possible for them to use the information. Or maybe ease-of-use in other words.

-------------------

**Interview 2: Nobina AB**

**Q:** What is your name?

**A:** My name is Sverker Björling

-------------------
Q: What are the name of department you work in, and the tasks of that department?

A: The name of the organization is NOBINA which is a group of about 1200-1300 professionals and about 7000 bus drivers.
I’m working in the IT department. All IT development operations and services are centralized. The entire IT is in the parent company NOBINA AB which is the top company of the group. So, we are delivery organization of the entire group. Our task is to receive the requirements from the organization and try to develop that.

-------------------

Q: What are your roles in the organization?

A: Within the organization, I have different roles; first I’m service delivery manager, which means that I’m responsible of delivery of the services to the organization. We don’t sell any hardware, work stations, or systems, but we only rent the services to other organizations. So, they subscribe to the systems, or they hire work stations from us. The only thing we sell is the services in different shapes to the organizations. So, Service delivery is our main activity. In addition, I’m a system owner of BI systems and Decision Support Systems. To describe this role, I can say that in order to develop the requirements in decision support systems, you have to be knowledgeable about the operations that are outside. In other words, you have to be expert about for instance how to run buses around Stockholm, or serve buses or whatever else, it means you have to be very close to these operations. But, as a central person like myself, I’ll never be expert about how we run the buses to Denmark or how we serve buses in Finland, for instance. Being centralized person or system owner of BI systems, I’m still not are expert about the output. And in order to be sure about the quality of the output, you need to be deep in the organization and the daily operation in order to understand the output. Hence, I’m a system owner but not expert about the actual output in these BI systems. And I think this case has to be in every organization, it means, in order to be expert you have to do the operation yourself. I mean the IT group is only as facilitators.

-------------------

Q: If the case that when you develop a system, so you need to co-work with the operations a lot, and they will be the one who judge if everything is good, is that right?

A: Absolutely. We have a developed structure. Actually, NOBINA is a process-oriented company that has a lot of process work. The goal is to have an identical process in all countries where we operate (we operate in four countries). In all these countries, we try to deliver what we call delivery traffic production that is the main core process, and we try to do that identical in Finland, Denmark, Norway and Sweden. So, we have one process for all these four countries.
We have split BI systems on each process; a system for supporting production is associate with a production process, another system have is associated with marketing sales process, and finally a system for supporting management decision is associated with the
management process (a management process is about how we take decisions in the company). So, we associate all these different BI systems with the different processes. In addition, for every system we have an information owner who is a person to deliver a report about that BI system. For example, there is one person identified in the operation and being information owner of that system. We have one system to follow up the fuel consumptions in the buses which is essential profitability, and there is one individual in the operation part who is responsible for that system. Moreover, we have another system which is called a salary cube because the salary is very complex in our company. It is a mixture of people’s monthly salary, bus drivers with overtime, extra time, etc... So, we have a specific analysis tool for that, and there is an information owner for that tool who can help us. If there is a change in that tool, the figures will look different, and the questions arise if these figures are correct or not. So, the information owner, who is the expert for salary analysis, can look to that salary cube to answer if it is right or not. So, for every BI system there is an information owner in the operational organization who can evaluate the information.

Q: How long have you been working in BI field?
A: Maybe a little more than one year in this facility role.

Q: What benefits do you see of using BI in the organization? And could you give us an example?
A: I will give you some examples about the benefits of using BI systems in the organization. Firstly, we have a system called salary analysis. For instance, if you are running 250 buses in Helsinki which means you have 500 bus drivers. Some of them have monthly salary, some of them work overtime, others are hourly employees, etc... And there are different strange complex versions in this case. So, here the salary expenses are too high, and why they are too high, that is a very tricky question to answer. We have this BI cube which is collecting all the salary data from the salary systems, and then enabling the local management to look in that from different aspects, e.g. how many hourly employees we have in this month, how many weekdays where there, how many holidays where there, how much overtime did we pay this month, etc... Then, we can go through this complex salary information in different aspects, and hopefully answer why salary costs were being so extremely high. I think that is one of the uses of BI to analyze these complex different materials of salary.

Another example, we have this parent company and we have other operational companies in Sweden, Norway, Denmark and Finland. In addition, we have one company which is running long distance traffic. However, the way we operate is that we win contracts. The contract is the central to us. For instance, nowadays there is a contract which is coming up in the northern part of Stockholm (SL Stockholm Lokal Trafikk). They were asking for proposals to run the northern of Stockholm traffic for 8 years. If we win that contract, then
we have another contract. Afterwards, we want to track the profitability of that contract. Now, the Swedish legal company is running from 40 or 50 contracts, altogether in Sweden. So, we need to distribute the legal company’s costs onto these 50 contracts. So, it is very complex issue. We have one legal report about what happen last year or in April for instance, and we split that into these 50 contracts. So, we will see in each contract, e.g. the contract in Malmö is extremely unprofitable, why is that? Well, salaries were too high or damages were too many or other reasons. So, that is another use of BI, that we can transfer the legal structure to the contract structure. And the contract structure is more important to us because we win the contract, we lose the contract, we close the contract, or we open the contract. The whole businesses are in the contracts.

Let us take a third example of using BI; it is more about the workshop. It is very interesting to look at buses. The workshop systems are used for the workshop manager to study the characteristics of these buses; e.g. this one has high fuel consumption, this one has a high maintenance bill, this one has to change the tires for the second month, etc... So, it is another tool we use for the workshop manager to be able to look in these bus individuals, and take decision that, for instance, these 5 buses have so many problems, and we have to sell them and buy new ones. Hence, that is another use of BI for the workshop manager to study the bus individuals.

Altogether, I think we have almost 20 different BI systems working on buses, working on contracts, working on legal units, working on salaries, etc...

-------------

**Q:** Is there any considerable change in the decision-making process after implementing BI system in the organization? If yes, what is the change?

**A:** I think it changes a lot. In principle, it always enables us to get better decisions. But, there are some “buts” here, first is the cost. For instance, when we talked about the workshop manager; sure he can make a better decision about buses individuals especially when he get information of different buses and compare it from different aspects. But it is not cheap. It is very expensive to develop BI systems and very expensive to maintain them. So, you will make better decisions, but you will raise your cost levels. And I will show you an example which quite recent. It is very simple BI system that describes some data issues from what was happened in our companies in all four countries. (The description here is about a chart or table which demonstrates some data about cancelled tours, damages, no. of sick employees. Etc...).

So, from this table, for example, here NOBINA Finland cancelled 0.2 percent of the scheduled tours, whereas NOBINA Sweden is 0.08 percent. And here people who were sick in Norway were 11 percent of the employees. So, this harmless information matrix was just received data from yesterday and will be placed on the managers’ desks every day. This information has already taken an effect. Here for example, you can look on the last week, these damages in the buses; immediately, people start doing conclusions from a very simple chart. But, nevertheless, here we can say if you have serviced the buses on time, you will have high figure. And here we have always high figure in Sweden, whereas
in Denmark they have very high average of debt, you can say this is service debt, or maintenance debt, e.g. these buses should have been to the services long time ago. So, this is another example of the using of BI systems. Again, I can say that it immediately has an impact when you display a management decision data. So, yes it has impact; if it is well done it has an impact. It changes the way the people taking decisions but it has a high cost connected to it; both developing and maintaining of the BI systems needs high costs.

-------------

**Q:** In your experience, which of the following factors (or maybe other factors that are not mentioned here) is considered most important or crucial in BI practice for getting an appropriate and crucial decision in your organization? Why?

- Senior management support;
- User involvement;
- Development tools;
- Planning and clear vision of the project;
- Information quality.

**A:** The more crucial factor is the involvement of the operational part. I would say that in the very beginning that the IT department which took some initiatives and took some data together and produce the report. And the operational side never really understood with what it is for. So, you need the operational part to be very involved. They must have very clear idea with what they want to achieve because it could never be invented by IT department. So, that is one, the other one I would say the information quality. We have portfolio of the source systems; production system, sell system, HR system, etc… Then, we re-feed data from those systems to the data warehouse, and base on that data warehouse we do these BI systems. So, we fetch all the data, and of course that we realize that some of the data that we re-fetch have very poor quality. This happens due to nobody has really looked into that data. Let we say, fuel data, when buses are fueled, this activity is registered manually, e.g. how many kilometers and how many liters, etc... It is sure poor quality data. So, some realize that the figures based on these data are ridicules and we have to check it back. So, the information quality is extremely important when you want to get a good result, and it is very difficult to reach high quality of information.

If I want to mention a third factor, I can say the access method. In many cases the access method is an excel sheet. So, we build a BI system; let us take fuel data as an example, we put fuel data in a data base. Then, it is filtered in different ways, where we have the information with very powerful cube of data which circle around fuel consumption. On the other hand, let somebody built an excel sheet and fetch data from this cube, took it into the excel sheet and then he started looking around to see where are the problems. But we have no control on those excel sheets because excel sheets can be programmed by anyone. So, it
means if they do errors in the excel programming so it is meaningless. So, the cube of data maybe excellent, but the excel sheet that used to re-track the data and look on it maybe it is faulty. Now, there is a question: is that within the control of IT? No, and that is really a problem. In those BI systems, the excel is used to retrieve the data and look on it, but we lose the control on it. Moreover, if the user is incompetent, it is just waste. Hence, the access method is important. So, I would say that my third crucial factor is the access method for the users.

-------------

Q: Can we say that the access method is important because the credibility of the information could be effective?

A: Yes, and we have exactly those problems; we have users who don’t trust the BI systems. They can’t trust on it because the problem is the excel sheet out there that are not correct. But it is very difficult for the centralized IT or for any developer of these BI systems control these excel sheets. Further, I think also it is interesting to say that there are different types of users. For instance, this chart or table is for top managers who don’t know about excel and they will not manipulate anything. They just look on that table and say it is interesting, which means that they are viewers, just look onto the BI systems and use the information. Also, there is another type of users who are the explorers. They extremely dig down into the data and do all the analysis and build all charts. So, I mean it is the same BI systems but the skills of the explorers are so different from what I called them viewers. So, this also crucial when you develop BI system you have to be careful and know for whom this system is done; for explorers, business controllers, or it is for top management.

-------------

Q: In your experience, which factors are important for distinguishing high from low quality information (not limited to the dimensions in the PSP/IQ framework)?

A: One important factor is interpretability. One has to be very precise on what the data is being show; it is easy to be unfair about what you looking at. I can give an example, here in this table there are different numbers about different components, and I will take the damages for instance. The problem is typically that we look on the damages that happen on monthly bases; we take all these damages that happened over one month divided by all driving kilometers and calculate the number of damages per 100000 kilometers. But this figure here is a daily report. So, if the bus driver didn’t register any damages yesterday because this is a manual operation, and he was sick. On the other hand, there are all the damages were reported over one month. But this is the day before, where there wasn’t reported any damage it is zero. So, this is not the same report as in the monthly charge, and there is a difference here. Hence, this difference between the daily KBI and Monthly KBI will make a big problem. That is, it is very tricky to be very precise here, but you have to gain the users’ trust because they will look on that and say it is not clear and not right information in the report. So, you have to precise about what you show.
We have another mismatch that makes the people say that this is not correct. I will try to describe this. I think Uppsala is a good example; we run traffic in Uppsala, and later somebody said Tierp should be a part from Uppsala. So, we changed the definition of Uppsala from old Uppsala, and Uppsala and Tierp (new Uppsala). We have some of these systems show the old Uppsala, and some of the systems show new Uppsala. So, there are different figures and different charts, so the trust goes down, and this bad quality of information you can’t trust in it. But the problem is that the operational part (people out there) has changed the definition of Uppsala, and they didn’t tell us in order to be implemented in our system. Typically, the fuel system which we use has this old Uppsala, while the financial system has the new Uppsala, so there is a mismatch. This is all in the users’ perception, and they don’t trust the figures, and they don’t know that Uppsala has different definitions. So, again you have to be very precise about what you present, otherwise you will create a perceptual lack of quality of information.

I can give you one more example which is very tricky. When we do this monthly report, we have a lot of financial results, e.g. the costs of operating results. In addition to this financial data, we present statistics like number of damages, fuel consumption, or number of workshop visits. So, e.g. in the end of April, we have to close the costs of monthly financial data of April (literally close the books). Now, for instance, today is 10th May; it is not possible to register costs in April because April books were closed. But, on the other hand, what about the production system, where we run the buses, employees, and the workshops; is it possible to be closed as financial systems? No, we typically don’t do that for any type of process support systems, we don’t close the books. So, the point is that when we look on the figures after March for instance, the cost of damages was 5(number of damages divided by financial costs and it is 5). But somebody reported the damages from December because this is under the production system, and also the damages in February were forgotten. So, when we reach next monthly report, the figures are changed; but not in the financial system because the books there are closed, but the change is in the production system. The management will say that it must be something wrong in the system. But there is no wrong in the system because the financial system is closed while the typical production process system is not closed. And again what happens are people perceived poor quality; again you have to be very precise about what you looking at.

Q: Can we say that the last factor you talked about could be timeliness, which is the information should be up-to-date for the task at hand?

A: It is very tricky in the system because we don’t know how to master it. We realize that everybody has the same problem, unless you do close books, and it takes a lot of efforts. I mean in the financial world you have to do that every month, you will spend a lot of time on matching the accounts and closing the books. But you don’t do that in the production systems. So, I think the issue here again is to be very clear about what the data you look at and what it is. In reality, this is the damages as they looked at after March compared to the damages as they looked at on April, so it is not the same figure; there is nothing wrong.
when they are not matched. So, you have to be very clear about what you display, otherwise it will be a misunderstanding which make the others perceived your data as poor quality but they are not.

Q: There are 16 dimensions in the framework that we had chosen to focus on in the thesis. We would like to ask you to pick a number of dimensions that you think they are more important to reach high quality of information?

A: Interpretability: as I said in the beginning;
   Accessibility: I think it is extremely important, and sometimes it is too tricky for people to know how to reach the information;
   Believability: it is a lot about the expectations and the perceptions from the users more than what it is in the reality;
   Consistent Representation: it is very important; it takes time for the people to get use these types of systems. It is always tricky; if you introduce your system, it takes a long time before they can get use it. So, this what I mean that you have to be very clear about what you show, otherwise the people will misunderstand that and perceive that as poor quality;
   Reputation: It is very important. I mean it is so easily; if you do a good job and these things don’t really be understood by the people, or something wrong with the charts, or these figures are not correct. So, this will create a poor reputation and people will be very skeptic, as the last example I told you about closing books before we realize what the problems are. It built a lot of incredibility in the organization, and people criticized about the difference in the numbers. So, the reputation is extremely important. And it takes a long time to build credibility, and to make people believe you.
   So, these dimensions will be my favorites I can say.

Q: It is about the believability that you said it is important, how do you judge if the information you got is truly credible?

A: In our case, we have to ask people in the operations to validate the figures because the developers can never validate that and they are not competent to do that. We have exactly this problem; e.g. it took long time and long discussion with a person from the operational part to find the fault in the figure which shows that there were too high costs in the maintenance. It was fault figure, and then we corrected the figure. So, again he was a person from the operations who could say that the figure is wrong. And I think this is the only way that you have to ask the operations to know if this is correct.
Q: Could we say that the users who see the chart of the operations, so if something is wrong they will back to you and tell you about that?

A: Yes, we have formalized that, and we have specific individuals about that because we can’t ask everybody. So, we ask them to look at the figure really hard to tell us if they are correct or not. So, that is our method, and I think as you analyze the operations, somebody from the operations can judge. I guess you can do it in different ways but that is our method.

------------------

Q: From the literature we choose IQ framework (Framework: (according to our thesis) is a structural plan containing a number of dimensions to assess the quality of information in Business Intelligence systems used in the organizations). The question is: does your organization use a specific IQ framework or a metric system to make sure or distinguish high from poor quality of information?

A: No, I don’t think so. As I said before, our way is to ask these specific individuals to evaluate the data. And obviously the developing people take their care about reading and writing the data in the data base, washing the data, and in some way they do manipulations in order to raise the quality of information. But in the end if we need to know if the data is correct, we have to ask the operations people. We don’t use automated tools to qualify the data.

------------------

Q: Could we say that you use the feedback to measure if the data is correct?

A: Yes, we use feedback from people who are very competent of operations and can judge if the data is correct or not.

------------------

Q: How do you judge whether the IQ level is accepted? (Do you compare it with the result gathered before? Do you compare it with the result from other organizations? Or do you compare to a predefined criteria?)

A: We usually use historical data systematically and maintain the generations of data by getting monthly outcomes. So, in our analysis to settle our data, we typically compare with the previous versions of data to see; yes that is the method we use it hopefully the quality will be higher, remove faulty and so on. Also, you can easily see that the maturity process when you start doing BI because people are used to look directly on the raw data with all errors and mistakes in it and they can’t filter the data and they first think that this is fault. Actually, it takes years until you realize the difference and appreciate the BI system. So, it is very maturity process to going in the BI systems. We started maybe 3-3.5 years old, and we had major problems in the beginning.
Q: Regarding the key success factors in BI (like senior management support, user involvement, Information Quality, etc...), we think that all other factors depend on IQ factor since it is very important. According to your experience, are we right in this perspective or all the factors have the same level of importance?

A: I think in order to have a good BI system; I can say that the information quality has a very central role because if you lack IQ, then all will fail. I understood that it is happened in several organizations that they are going in BI and they have invested in extremely expensive Microsoft products. But they have never gained the credibility in their organizations because these systems have never been used, and then they are removed. So, it is important to have management support, have involvement from the users, but if you don’t reach IQ they all will be failing. So, it is a fundamental requirement if you are going to succeed that you can reach IQ. Now, this IQ is to be perceived, maybe it is not real quality but it is perceived as IQ, then you may succeed. It is absolutely crucial that the users perceived this as quality of information, otherwise you will fail. So, is IQ important as other factors? Yes. I mean if you don’t have management support, and if you don’t get user involvement, you will not succeed either. But, without IQ I think you will definitely lose. It is must but it is not enough. I know maybe this is typical, but gaining users’ trust is crucial.

Interview 3: Planning Division at Uppsala University

Q: What is your name?

A: Mats Olsson

Q: What are your title or position, and the name of department you work in?

A: Planning office at Uppsala University

Q: Could you describe the work that the organization does?

A: University.
Q: Could you describe the tasks of the department that you work in?

A: The tasks are depends on what the university needs. The planning is for the development of the university. For example, prioritize and distribute the resource according to the forecast, which decides which department or faculty should grow and so on.

Q: How long have you been working in BI field?

A: Work for almost ten 10 years in the planning office of Uppsala University. Almost, I always work with BI system the whole time, although it was not called BI at that time.

Q: What the benefits of using BI in the organization?

A: Sharing the information to anyone who needs to access the information. For example, you can see the number of researches published by different departments, number of students in each department. It is also possible to view the information in different ways. For example, you can compare the actual number of students to the forecasted number. Or compare the number of accepted students, number of applicants or number of full-time students of this year to the number of previous year.

The use of BI in the university is somehow different from the private sectors. In the university, it is more used as a tool to analyze and report current situation. For private sectors, the decision can be influenced more by the system. For example, a company might look at some reports and make their strategy base on it. The university do make plan based on the reports from the systems but might not be as deeply influenced by it.

Q: Does the organization use a specific type of BI systems?

A: The system is a commercial software product. There are maybe about 10 universities in Sweden are using the same product. The BI system consists of a few subsystems. Each subsystem is responsible for certain functionality. The main system retrieves the data from its subsystems and presents it to the users. It is the centralized place to access the information, so users can get all the information they need from just one place. For example, the main system gets the information regarding student application from the national centralized system and get financial data from another system. Therefore, both information can be found in the main system too. So the user won't need to go to different systems to get this information.
Q: Is there any considerable change in the decision-making process after implementing BI system in the organization? If yes, what is the change?

A: Before the system is employed, you need an expert for every different type of report. That means it is necessary to have an expert to process the data for each type of report. With the help of the BI system, it is easier to generate the report when needed. It also makes it easier to access historical information and figures and make analysis, which also make it easier for making decisions.

A good example is that the university received more applications this year if you compare the number to the previous year. But if one look into the data deeper, it can be found that the number of qualified applicants is less comparing to last year. With the help of a BI system, it is easier to check and analyze the data from different perspective and provide more meaningful information for decision support.

-----------------------

Q: In your experience, do you think that there are specific factors that make the implementation of BI system successful and more effective during decision-making process?

What is your comment about the importance of the following factors:

- Senior management support:
- User involvement:
- Development tools:
- Planning and clear vision of the project
- Information quality

In your experience, which factor is considered most important in BI practice for getting an appropriate and crucial decision in the organization? Why?

A: It is the clear understanding of user requirements and easy to use. For example, if the system is not what the users really need, it is meaningless to develop a system even when all other factors are fulfilled.

-----------------------

Q: Is information quality a very important factor in BI system for getting suitable decisions in your organization? Can you explain the reason?

A: Information quality is very important for the university. For example, the university needs to report some data like number of students to the government; the data have to be correct. They will even send some people to examine the IQ.

-----------------------
**Q:** IQ dimensions: the importance and meaning of each of them in BI and decision-making process

**A:** The importance:
It is not possible to pick the dimensions.

------------------------

**Q:** Framework: (according to our thesis) is a structural plan containing a number of dimensions to assess the quality of information in Business Intelligence systems used in the organizations.

**General questions regarding framework used in the expert’s organization:**
Does your organization use any IQ framework? Can you tell us which framework it is and the why it is chosen?

**A:** They don't have a systematic way to check and improve the IQ. It is more dealt with only when some problem occurs. For example, if one of the subsystems updates how the data is presented, it might cause some problem in the main system. Then they will check what happened and fix it.

------------------------

**Q:** How do you judge whether the IQ level is acceptable? (Do you compare it with the result gathered before? Do you compare it with the result from other organizations? Or do you compare to a predefined criteria? And how was the criteria defined?)

**A:** Usually, each department need to check the information they provided, because it is only them who can know if the information is correct or not. They do run some analysis, but not in a systematic way. But, for the one particular report, the report regarding the number of students to the authority is to be paid for. The way to process the data is very clearly defined or regulated; this includes what it should contain, what they should look like, how it should be produced. They also check if the report from the university is consistent with another system. This is the way to check if the information quality is good enough or not.

---------------------------------------------------------------------

**Interview 4: EdgeGuide Business Solutions AB**

**Q:** What is your name?

**A:** My name is Peter Skoglund
Q: Could you describe the work that the organization does, your position, and the department you work in?

A: I work as BI consultant mainly focused on BI development and system architecture. We are small company that has 25 employees here in this office, and half of us are working with BI. We are pretty flexible and involved in and doing everything here. We usually do everything from writing the code to managing the projects, and sometimes we have different roles in the company.

-----------------------

Q: Do you mean that everyone sometimes doing project management, and sometimes doing programming and writing code?

A: Yes, we are pretty flexible. I think it is really common in BI world that you need to have more knowledge because you talk a lot with business side and you need to be involved in the business process.

-----------------------

Q: How long have you been working in the IT field?

A: I have been working with IT field since 1999. I worked internally in IT department before I became consultant.

-----------------------

Q: How long have you been working in BI field?

A: I started to work here 2009 as BI consultant. I was involved in BI field with my previous employer where I worked internally both in BI and business process. So, I would say 4 years with BI field

-----------------------

Q: Can you describe the typical tasks that your company does, and what kind of BI systems do you develop?

A: As I mentioned before, we work with QlikView which is one of the new competence of the BI market. They have a little bit different approach than the old BI or classical BI solutions in the market. They involved a lot with agile methods and they have a quick approach to data analysis; in the start you don’t work a lot with data modeling, what you do is to dig all the data and make it available to the users in a quick way. So, from the beginning you will be able to be involved within all of the organization, looking for a data, and making analysis from the start. So, that is what we do, and we have chosen this tool because it is fast growing tool and it is very interesting to work with because the challenges with the old way of BI where we have a data warehouse and you have a very long development cycle, so we go away from that to make a short project to deliver agile in iterations. We have a pretty broad approach to the market; we don’t focus on specific field or specific business.
We basically do all kinds of consultancy. We also focus on financial field because we have knowledge within our employees with financial background and they can work with different kinds of consultancy.

Q: What benefits do you see of using BI in the organization?

A: The largest benefit I see with this specific QlikView business that we are working with is to make people aware of the data, and creating some kinds of awareness within the organization of what information do we have, and that is one of the biggest benefits with this specific tool. If we talk about BI in general, I would say that to be able to make a quick decision in correct time. I think that is a common perception about what it is good with using BI. I also think that there is some benefits that you will be known about what kind of information you have about your customers; I think that is a big benefit that starts to grow within all the organizations now to be more interesting to get access to the valid data.

Q: You said that there is a difference between QlikView tools and traditional BI tools. This difference is that you don’t do very much analysis; rather your users have their data and they decide how to do the analysis. Could you describe more about this point?

A: You give the end users more possibility to analyze their own data instead of you doing this analysis for them. You don’t build modeling and you don’t create the structure in the same way. When you come to the classical BI that you have a data warehouse and you build the data cubes, and then you have chosen a way to do your analysis in the cube, and you can’t go outside that. But in QlikView, it is possible to do that because you can choose another way and come to the result; it means that you can use another way of analysis instead of the selected previous way to get the result.

Q: Can we say that the tool you provide them could have many different built-in analysis tools, and then it depends on how your users would select them, is this right?

A: Yes

Q: Does your organization use a specific type of BI system?

A: We only work with QlikView
Q: Is there any considerable change in the decision-making process after implementing BI system in your organization?

A: Definitely; I think it is a better awareness around the users about the business process that is going on. I think there is a better understanding for what it is actually happening in the business when you started using the BI systems. There is also one of the benefits that I can see is that you get better understanding why we do collect all the information than we do in the other systems within IT. If you get information system users, they usually have lower understanding about why we collect this type of information, why we do have all control of this information, and why we do need to collect all this information about the customers, and so on. Now, when you have BI, you show back the information to the users in a way that they understand why we do need to collect this information. Before, it was usually a small amount of people who understood the importance of this information; this is also reflected in the data quality because sometimes you don’t have high quality of information because you don’t understand why it is important. So, I think that the users of BI could actually improve the quality of the information.

-------------------------

Q: Could we say that before using a BI tool may be the analysis or the result that you get is mainly for management, and the users don’t really get to see the information? But now everyone can see the information, so is that the difference?

A: Yes

-------------------------

Q: Is there any big difference for management in making their decisions after applying BI technology?

A: I think the big difference that they can get the information when they need it to make their decisions. They can follow this information throughout the month. Also, as I mentioned before, that before using BI you waited until the box is closed in the end of the month and all of the financial people had done the analysis and reports and consultation of the information and send to the management, then at that time the management will make their decisions. Now the management follows all the business throughout the month and act on all disturbances. It is more following and quickness of the disturbances and focus on the decisions.

-------------------------
**Q:** In your experience, which of these key success factors (senior management support, user involvement, development tools, planning and clear vision of the project, and information quality), or may be other factors that are not mentioned here, which of them you consider is more important to get successful BI application and get effective decision-making process?

**A:** I think involvement from the organization both the senior management and also the users because this can be very helpful about investigation of how to make the analysis and how they react about the information that you see. Development tools are not important point and not one of the major points because most of the tools nowadays are similar and do the same things and depends little on about how your organization and the cost of the project. Clear vision is of course always an important factor that you need; otherwise you will run the project for several years without ever count of end. But also I think you will not take big bite of the scope in the start of the project. You have to start small, be humble, and you have something that is actually feasible and small amount of time because of course what you want to do is to solve all the business problems at once, but may be you will probably not be succeed any way to get the goal. So, you have to start with smaller amount, start with one or two subsystems, and start with one or two KPI to get these accessible. Also, to access to the information, first of all to see data quality, to work with data quality because that is usually when you come in to the company that have been using BI, so the first thing you need to do is to work with data quality to go back clear about amount of data that is not accurate or need to be update. There has been for few years a discussion about service oriented architecture, I think badly implementing in some organization because what you have done and what you have used is to synchronizing the information to the systems. So, at the point you don’t know who is the master of the information, what is the later information, you just have same information and several different systems. So, just start to get access to the data, and get the data out to the users and see if the data is relevant, and follow what you need to do to clean disasters for the users, and then start to build a good construction, and that is most important. You should just focus on to build BI application that is going to do this, and then you will go to do for months several projects. I mean you have to go with shorter approach to go through in different steps on the way to get the results.

**Q:** Is information quality a very important factor in BI system, or the level of IQ importance is the same like other factors?

**A:** I think if you talk about BI as a management tool in the long run, so information quality is very important, and is probably one of the most important things. If you are going to base your decisions on, the information you need to have quality, and you need to be able to say that this information is correct. So, of course that is very important. But, in the short term when you start the project, it might be other factors that could be prioritized higher than data quality. I think if you called time to the market; i.e. the time that you get the information out to the users, I think that is one of the key success factors for short term to
be able to get involvement from the organization because it’s their data and it’s their process, so if it is short term that is very important. Also, I think that business process knowledge is one of the top three that should be found because what you giving and you building the system that is going to support the business process and the decision around the business process. So, business process is very important.

----------------------------------------

**Q:** There are many dimensions that affect the quality of information to be high or low. We have here 16 IQ dimensions (but also might be found other dimensions). Which of them are important to get high information quality according to your experience?

**A:** I think the accessibility is important. For me that the most important thing is that if you can’t have uses of business access of the information, then you can’t have a control on the data quality. As soon as you have the accessibility, you will be able to solve in one way or the other way with the best of the dimensions. So, it is a little bit about what stage you are in, and what are you going to present. I mean that if you are talking about data quality to make good decision, so in that case you need a consistent error free and correct data. But if you are beginning to implement BI in the organization, and you don’t have access to the information in the systems before, so the accessibility is the first important thing as soon as you start work with data quality. The other thing is the understandability. For me that is also the same thing a little bit because if you don’t understand the data, so it is not accessible for you. So, for me these two are the most important to data quality. As soon as you have these two, then you can solve the rest.

----------------------------------------

**Q:** How do you deal with the accessibility when you develop BI system for your clients?

**A:** As I mentioned before, what we trying to do is that we are trying not to make to build the data model to start. What we are doing is that we retrieving the information very simply in ETL process or without even using ETL process, we just do EL to present the information to the user, and that what we can start discuss around; what we see, do we understand what we see, do we need explanation from someone, do we need to involve software supplier from the application, do we need to hire an expert in the specific area to know how to use the systems. I think that the common approach we use to get started and to get accessibility to the data. After that we can discuss about make building model for applying data into the way that comforts with the organization and the business you are working for at that moment. First of all, we just get the data out in the hands of the users and make them see what they have. That is very common about what you get when you are talking about data quality and you actually see it at first time.

----------------------------------------
Q: Does the organization use any specific IQ framework or specific system to evaluate the quality of information?

A: No. We don’t have. I think that you can do specific data quality checks, but that is so specific to the organization of business process, and I’m not sure that you will be successful to build general tool for that.

-----------------------------

Q: You said that there are very specialized IQ checking tools. Could you tell us a little bit about that?

A: There is no specific tools, but there is of course ways you can do to secure data quality. First of all, you can always have info checks, and you can do it more or less complex. Instead of use text, you can use top down selections whether the users are not able to type everyone, they can select from the list. In that way you can make higher data quality, but I think it is hard to find a common way that will work about how all the business process working and this is what I meant by specific tool. If someone manages to build a general tool, they will get high level of data quality.

-----------------------------

Q: When you help your clients to develop BI systems, then how do you make sure that the data quality is good enough and perceptible in this system?

A: What we do usually is that as soon as we find weakness in the data, what we trying to do is to try to include some kind of monitoring of this information faults in BI application, such as you have a dashboard that this type of information is not allowed to duplicated, but if it is duplicated you will show unless you will make a way to do something to show the users that you can have a data fault. Could you monitoring on the data is our usual approach to manage data quality. It is hard to say when it is enough. What it is good enough is that if the data is in the system, we are showing the data as it is, and trying to give the possibility for the using or dig down of the information which will be strange because it should be able to go down to as lower as possible to go down in the transaction to say ok this is a wrong in the transaction, so they can go back and correct.

-----------------------------

Q: Can we say that you use the feedback as a way to make sure if it is acceptable and also give the user the ability to check as dig as possible to find out if there is a data problem?

A: I also have the monitoring features within the BI application to monitor known data problems.

-----------------------------
Q: Do you mean that if they find out that there is something with the duplicated data, in this case or in the future you will monitor it?

A: You can monitor it and showing it to the users because we are not able to or try not to take care of the problem because the problem is not in the BI system; the problem is in the underling system. What we want to do is that we learn the users to taking care the data at the source because I think that is most important.

------------------------

Q: We show you IQ dimensions earlier, do you think that may be any other dimension that is important but not listed here according to your experience when you dealing with your clients?

A: I think the list is covered most of the important dimensions, and I can’t think about others right now

------------------------

Q: You said that your company helps to develop many different kinds of BI system, can you just if it is possible give us an example, and tell us about what kind of BI system it is, how do you help your clients to the business, etc..?

A: One of the our large clients start to hire someone to work short time in their company, and I work for that with them to keep track their financial information, they have few key points that they want to take care of the financial statements. We give them a flexible reporting tool that they can basically make the same important report, and the data they want within the financial part of the information. We also keep track of how much of the consultancy they hire and what availability they have, if there any issues with a lot of employees getting sick, and so on.

------------------------

Q: You said this is the system for the company which is helping the other company doing this kind of hiring, how was the system of this?

A: We are implemented BI system for the company that hires temporary staff for specific duties. Also, we help them in those financial data, about their employees, and the availability and how much percentage they outworking for the clients and so on.

------------------------

Q: Since we focus in our thesis about Information Quality, in your experience, is their too much focus on this factor in your organization, and is it very important in improving or developing decision-making process?

A: It is of course, I mean data quality is always important if you don’t make a decision, if you want to make a right decision, if the data doesn’t show the reality, or doesn’t show how the way the business is going on, so to make right decision, of course data quality is very
important. If you go earlier in the BI project, it couldn’t be much focus on data quality because it could block the development, it could block the thinking about what we can do with the tools instead of building functionality the focus will be on finding why doesn’t say this 0.2 instead of 0.3. You go into too much detail because you deal with data quality. This will create discussion and could block the project for a while if you are very careful. But of course as we said that to make quick decision you need to be trusted the quality of the data and need to say that the data that I see is actually correct. So it is important part, but it is also complex part, and it is really one of the worst case scenario is that you come into data quality discussion once the production system shows one thing, but underline data showing something else. In BI, we are working with underline data, could actually have great problem with that because that something has done with application layer, and the users see what it is in the application layer but they don’t see the underline data. If they will see the underline data, they will be conflict about what it is correct. You have two different sources collecting the same data but show two different things. It is not common but it is sometimes happened because sometimes it is going on in the application.