



Turun yliopisto
University of Turku

BUSINESS INTELLIGENCE VIEWPOINT ON MANAGERIAL DECISION-MAKING

Ill-structured problems and Decision Support Systems

Master's Thesis
in Management and Organization

Author:
Joonas Soukki

Supervisor:
Ph.D. Timo Lainema

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Turun kauppakorkeakoulu • Turku School of Economics

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1 INTRODUCTION

1.1 Introduction

Data plays a crucial role in decision-making. Nowadays many companies have available an enormous amount of data, which can be utilized in decision-making. According to International Data Corporation (2011) the overall amount of data in the world increased by 48% in 2012 from the previous year. Furthermore, over 90% of the available data is unstructured, which cannot be utilized without the required capabilities, resources and tools. On the one hand, unstructured data, such as videos, audio files and images, are loaded with rich information, which companies can use alongside structured data in decision-making. On the other hand, structured data, such as financial figures, customer history, documents and e-mails, is a prerequisite for successful managerial decision-making. The present state-of-the-art technologies enable companies to integrate unstructured data into structured data in order to gain the full advantage of available data in decision-making. However, collecting a large amount of data and information is unnecessary, if companies cannot turn it into knowledge (Pirttimäki 2007, 109).

The importance of data in business decision-making has already been recognized. According to Brynjolfsson, Hitt & Kim (2011) companies with data-driven decision-making (DDD) perform better than companies, which do not know how to leverage data. Chaudhuri, Dayal & Narasayya (2011, 88) go so far as to claim that in the 21st century is almost impossible to be a successful company without leveraging the Business Intelligence (BI) technology. All in all, the importance of data in decision-making increases because the amount of data in the world is growing every second.

In order to utilize data effectively, companies need to align their BI capabilities with both their real business needs and the business strategy. Additionally, a BI process should be understood similarly in a company since data is extracted, transformed and loaded before it can be disseminated to the decision-makers – these activities may include employees from different business units. Moreover, companies have to take actions, which are included in the business strategy in order to avoid BI pitfalls: a decision-making process is disconnected and fragmental if a company has not defined its BI strategy alongside its business strategy. (Pant 2009.) A well-defined BI strategy ensures that the commonly agreed actions are taken and data is governed sufficiently, otherwise data cannot be managed and furthermore utilized in decision-making.

According to Gorry and Scott Morton (1971) an understanding of managerial activity is a prerequisite for effective systems design and implementation, which are needed in order to gain the business benefits by utilizing data. The first business processes were automated in the mid-20th century. In the 1960's the use of information systems grew

rapidly and both Executive Information Systems (EIS) and Management Information Systems (MIS) became common – in those days EIS and MIS were referred to as “central nervous systems”, which demonstrates their importance to companies. In the 1970’s Decision Support Systems (DSS) became a popular assistance tool for specific decision-making tasks. Nowadays, BI is the most popular way to obtain support for decision-making when decisions are made in the name of business performance. (Negash 2004.)

Complicated, and often very high-priced, information systems offer various types of solutions to support decision-making. BI and DSSs are the most well-known and common ways to support decision-making by utilizing data, which is gathered from the operative systems (Power 2007, Courtney 2001). At the same time, the need for exploiting external data is increasing: due to the volatile and turbulent business environment, companies should know what changes have taken place and what will happen in the future (Xu and Kaye 1995, 22). Furthermore, Gartner Inc. (2011) has stated that the willingness of the top managers to achieve improved decision-making is the major driver of BI purchases. In addition to this, Chief Information Officers predict that the IT function’s top priority will be repositioned from service provider to critical strategic enabler over the next few years (IBM Institute for Business Value 2013, 18).

The previous research has shown that data-driven decision-making (see Brynjolfsson, Hitt & Kim 2011; Lavalley, Hopkins, Lesser, Shockley & Kruschwitz 2010; Davenport and Harris 2010) correlates positively with companies’ business performance, however the field of BI lacks studies, which describe BI’s relation to managerial decision-making. Especially the research between IT and business alignment has flourished during the last twenty years. Managers consider BI important but, at the same time, it is difficult to carry out in practice especially when strategic decisions are made. Since the technology aspect of BI has been covered well by the previous BI-related research, this study will highlight the decision-making aspect of BI.

Even now, managerial decision-making is a highly complex process: on the one hand, computers make automated business decisions, utilizing huge amounts of data, every day. On the other hand, managers make decisions intuitively when they lack adequate data or information (Dane and Pratt, 2007). Furthermore, beliefs and personal goals have a strong presence in decision-making (Baron 2000, 7). In order to grasp the practical point of view, this study analyzes decisions based on decision-making levels and decision types through the case study analysis. Additionally, through MIT90s model, the BI-related constraints and enablers in managerial decision-making are introduced when the cases studies are analyzed. All in all, companies are faced with challenges that are related to all aspects of BI. At the same time, the business environment is changing rapidly and therefore the best practices related to BI are changing as well. Regardless of the changes, the primary purpose of BI has remained the same: companies aim for better business performance through available data, information and knowledge.

1.2 Research approach and material

There are multiple research approaches in the qualitative research literature. A research can be conducted by using the following strategies: *experiment*, *survey*, *archival analysis*, *history* or *case study*. When choosing a strategy, there are three different conditions to be considered: *Type of research question*, *the extent of control an investigator has over actual behavioral events* and *the degree of focus on contemporary as opposed to historical events*. (Yin 2003.) The *case study* strategy will be used in this study, since it aims to answer questions that are representatives of either the “how” or “why” types of questions. In addition, the investigator has little control over events and the focus is on contemporary events that exist in a real-life context. Furthermore, the boundaries between phenomenon and context are not evident. Different research strategies can be found from Table 1.

Table 1 Relevant situation for different research strategies (Yin 2003, 5)

Strategy	Form of research question	Requires control of behavioral events?	Focuses on contemporary events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case study	How, why?	No	Yes

According to Yin (2003) the nature of a study can be either explanatory, exploratory or descriptive. This study is descriptive by nature and describes the studied phenomenon that occurs in a real-life context. Furthermore, this descriptive case study can be divided into two parts. The first part is theoretical, that is, where the key concepts are explored by reviewing the relevant literature. The objective of the theoretical part is to lead the reader to the subject by providing a preliminary understanding about the research area. Moreover, the theoretical part of the research also creates a framework, which is used in the carrying out of the empirical part of the study. The empirical part focuses on three selected case companies. The objective of using a multiple-case study method is to obtain an understanding of the real world situation when it comes to the theoretical part of this study. The selected case companies are further described in Chapter 4.

The material of the theoretical part of this study is collected through a literature review. On the one hand the latest studies are used to support the classic studies of Business Intelligence and decision-making. On the other hand, semi-structured interviews were used when empirical data was collected. Interviews were recorded and independently analyzed afterwards. All case studies are described and analyzed separately. Due to the nature of the research subject, a comprehensive comparison cannot be done. As a whole, the research findings are represented together to form a contrast to the studied subject and individual case companies. Chapter 4 includes more detailed information about the interviews.

1.3 Structure

As mentioned above, this research is divided into theoretical and empirical parts. Based on both of these parts, the Conclusions chapter summarizes this study. Figure 1 below demonstrates the research structure by separating research parts and main chapters. The chronological order of the study is visible when moving from the upper-left corner to the bottom-right corner.

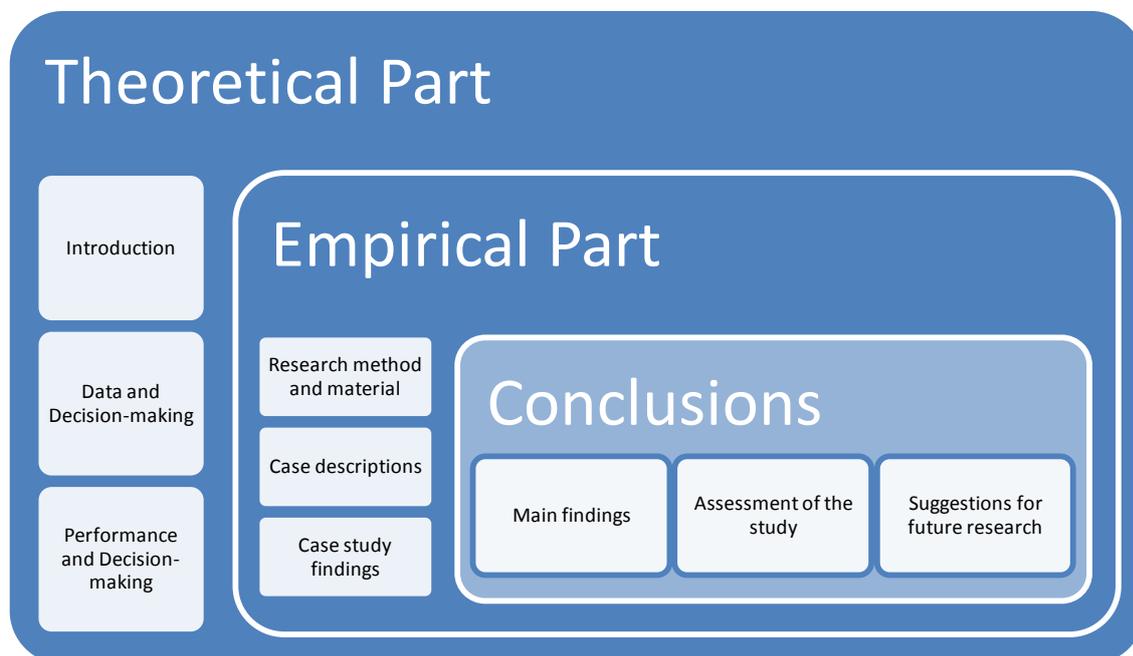


Figure 1 The structure of thesis

The theoretical source material has been collected through a literature review including many academic journals and scientific publications. The theoretical part comprises three chapters: *Introduction*, *Data and Computer-aided Decision-making* and *Performance and Decision-making*. All of these are based on the literature and research from this particular

field of study. After the introduction, Chapter 2 describes Business Intelligence and Decision Support Systems concepts and introduces different viewpoints on these. In addition, the different types of data are described. The final subchapter, *Data and decision-making*, concludes Chapter 2 and, in addition, the purpose of use of data in terms of decision-making is described in further detail. The third chapter, *Performance and decision-making*, defines the managerial activities and describes different approaches to decision-making. Chapter 3.2, *Decision Support Systems and decision-making process*, summarizes two main chapters by introducing the concepts of the computer-aided decision-making process and the Business Intelligence value chain. Additionally, both the performance and the performance measurement viewpoints on computer-aided decision-making are introduced in the final subchapter (Chapter 3.3).

Furthermore, the empirical part includes four chapters, which together aim to answer the research questions by utilizing the theoretical part of the research. The first chapter of the empirical part introduces interviewees and case companies shortly. In addition to this, Chapter 4.2 gives a further analysis on the chosen research method, material and model. *Case descriptions* (Chapter 4.3) describe studied themes in the context of the case companies based on the semi-structured interviews. Finally, the case study findings are analyzed in terms of the model used. In the fifth chapter, *Conclusions*, the main results of the study are described. Additionally, the assessment of the study and suggestions for future research are included in Chapter 5.

1.4 Research theme, objectives and limitations

Business Intelligence connects themes from various fields of study. Due to its interdisciplinary nature, it can be studied from various angles and viewpoints. I also find this subject interesting and challenging because there is no right way to study it. It requires analytical thinking and balancing between different viewpoints when researching it. Previous studies have had an impact on the statement of the research question and sub-questions. BI-processes have been studied widely from their technical point of view, but there are only a few studies that have been conducted with regard to managerial decision-making and BI – because of this, the human and decision-making perspectives are highlighted in this study. Power, Burstein and Sharda (2011, 42) pointed out that *from the scholarly perspectives, the lack of underlying theory and, as a result, limited academic impact is recognized as needing the attention of future DSS researchers. However, the impact should not be a sole purpose of researchers, rather, the outcome of solid development of tools and techniques, which address the real problems of real people.* Pirttimäki (2007) also suggests in her dissertation that future studies could concentrate on the nature of

information produced by BI. On these accounts, I have chosen this theme and the objective of this study is to provide an answer to the research question, which is stated as follows:

How does Business Intelligence (BI) support managerial work when a company aims for better business performance?

Furthermore, the research question can be divided into different sub-questions:

1. *How is data utilized from the managerial perspective?*
2. *What is the balance between internal and external information in managerial decision-making?*
3. *How Business Intelligence Systems provide insightful information for company's strategic decision-making?*

The sub-questions will be partly answered by reviewing earlier studies. In addition, the empirical part adds complementary information to sub-questions. The main research question will be answered by combining findings, not only from the theoretical and empirical parts, but also from the sub-questions. The theoretical and empirical parts are reviewed acknowledging the limitations in a research.

Due to the various definitions of the Business Intelligence related terms, limitations are required in this study. Firstly, the viewpoint of this research is rather human-centric than technology-centric, and thus the managerial decision-making is highlighted. Secondly, when it comes to decision-making, the research focuses on the managerial problems that need to be solved in order to perform more efficiently – especially on those problems that have an unstructured or ill-structured nature. The managerial activities are described in further detail in Chapter 3.1. Nevertheless, an understanding of the principles of Business Intelligence is required when computer-aided decision-making is researched. Because of that, the technology-aspect cannot be entirely ignored. Moreover, the field of Business Intelligence changes continuously and on that account the key terms are not stabilized. However, all of these terms are defined in the text when the term is introduced for the first time.

2 DATA AND COMPUTER-AIDED DECISION-MAKING

2.1 Defining Business Intelligence and Decision Support Systems

2.1.1 Business Intelligence definition

Business Intelligence is a highly complex concept, which makes it hard to define completely. In fact, the definition might depend on the person and or his or her background. Originally the term was coined by Gartner Group referring it to a collective term for data analysis tools (Baars and Kemper 2008, 132). Alternative definitions also exist. According to Pirttimäki (2007), BI is an enrichment process that modifies business data into important information – in this way, executives will receive an aiding tool in order to discover business opportunities. Moreover, it can be defined as a DSS discipline that provides accurate information and analytical capabilities to support decision-making (Clark 2010, 10). Gilad and Gilad (1988) argue that the term Business Intelligence denotes both a process and a product. Firstly, it can be seen as a set of different information systems that gather important data and information creating a product called Business Intelligence. Secondly, it can be seen as an organized process that involves and integrates best practices among employees and executives. The latter definition refers to a management style, which is required when companies utilize BI products effectively.

Solomon Negash (2004) states in his article that BI is a set of practices that collect and store data, which is utilized during the planning and decision-making processes via Business Analytics (BA) tools. The main point is that internal and external information are available at the right time to the right personnel. From a wider perspective, Business Intelligence can be considered as an umbrella term. This means that BI consists of different systems and applications that are in use in the different departments of an organization. (Șerbănescu 2008; Power 2007.) On the other hand, some scholars argue that BI is an entity, which includes different practices, methodologies and Information Systems – the figure (Figure 2) below illustrates the field of different systems and courses of actions that are included in BI. It has eight different dimensions that together create a company's unique Business Intelligence unity. It should be acknowledged that the relationship between dimensions most likely differ between companies. In fact, the aspects of the goals of the system, corporate culture and resource limitations have an effect on BI and its dimensions. Furthermore, the conceptual intangibility of BI is emphasized since there is no right way to organize it. (Negash 2004.)

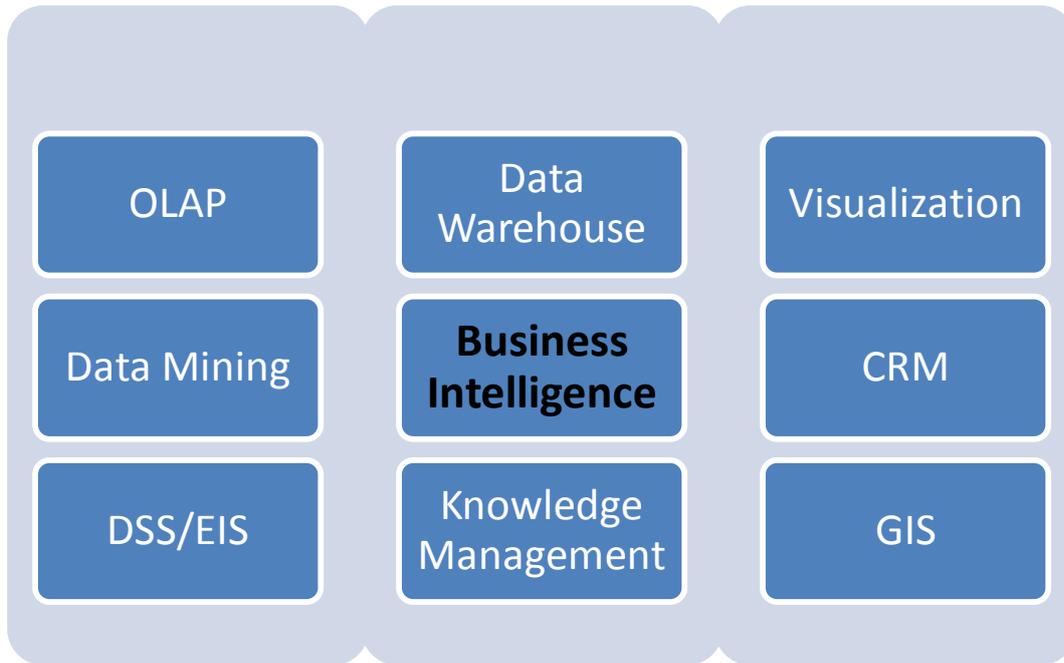


Figure 2 BI relation to other information systems (Negash 2004, 179)

OLAP stands for *Online Analytical Processing*, which includes common BI operations such as filtering, aggregation, pivoting and drilling-down. *Data mining* is a more sophisticated version of OLAP – after information has been processed into a usable structure, complicated predictive models can be enabled by the in-depth analysis. (Chaudhuri et al. 2011.) In the leftmost lower corner are *Decision Support Systems* (DSS) and *Executive Support Systems* (EIS) – these are discussed more widely in Chapter 2.1.3. *Knowledge Management* (KM) is the broadest concept under the BI umbrella due to its intangibility. According to Pirttimäki (2007, 87), KM focuses on the human interaction process offering practices and methods that are vital for Business Intelligence. She also highlights the importance of KM systems when tacit knowledge is included in a BI process, which collects data from various data sources. (Pirttimäki 2007; Negash 2004.)

In many instances, there is a need for collecting external structured data to support decision-making. In these instances, the role of *Customer Relationship Management* CRM is highly important. *Data Warehouse* and *visualization*, which are both on the top line, are extremities of the BI process. Firstly, operational business data is stored in *data warehouses* and finally it is visualized through a specific *visualization tool*, which usually includes charts, tables and crosstabs. In addition to these systems, *Geographic Information Systems* (GIS) help managers to understand spatial phenomena when data include geographical information. (Negash, 2004.) All in all, BI supports companies in transforming their business operations from being data rich and information poor, to becoming

information rich, which in turn will lead them to better decision-making (Abukari and Jog 2003, 15).

2.1.2 *Process view on Business Intelligence*

The process viewpoint of Business Intelligence highlights the different stages of an intelligence cycle, which are also applicable to the management style (Gilad and Gilad, 1985). It also includes assumptions that relevant business data is constantly available and managers should choose data they want to use in a certain situation. Furthermore, the process role of BI is to model, analyze and interpret data for the decision-making purposes, but the managers are responsible for the outcomes. Troublesome situations arise because the management does not always know what kind of information and sources are needed in decision-making. Furthermore, because a process involves various different stages, and because many subject-matter experts (SME) are involved, the decision-maker might not even be aware of all possibilities of utilizing data during the process. (Gilad and Gilad, 1988.)

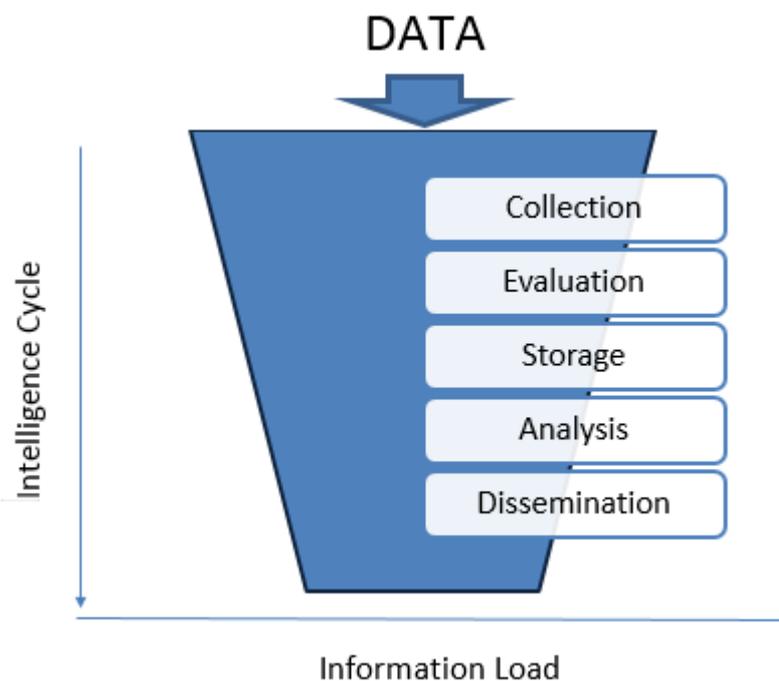


Figure 3 A BI process (Gilad and Gilad 1985, 69)

As Pirttimäki (2007) mentions, there is no need for collecting vast amounts of data, if the company does not have the capabilities and knowledge to turn it into intelligence.

Figure 3 illustrates the relation between the intelligence cycle and the information load when the vast amounts of data are processed. When the load of information diminishes, the intelligence increases and vice versa.

The BI process (Figure 3) has five different stages which all have a considerable role in a process. In the first stage, data is **collected** from multiple sources – according to Gilad and Gilad (1985, 69) the most traditional sources provide data about competitors, technologies, industries and the government. Added to sources and targets, priorities are also validated during the collection stage. The second stage, **evaluation**, takes a stance on the usefulness of data by serving a quality control mechanism that filters useless data. The usefulness of collected data to the decision-makers should be assessed via *source reliability* and *data reliability* analyses before it is **stored**. The objective of a third stage is not only to store data but also to make it usable for the decision-makers. Data should be *abstracted* and *indexed*, otherwise it cannot be effectively utilized. The storage stage is vital for the **analysis stage**, otherwise neither the analysis framework nor useful high quality information are provided. Before the final stage, the managerial input is needed when the need-to-know procedure is assessed. It avoids the pitfalls that are associated with a *want-to-know* philosophy. If managers have an access to all information, they are provided with unnecessary information and reports, which managers seldom have the time to read. When the most important and value-added information (see Figure 5) is defined, data is **disseminated** through insightful reports and other visualization tools. (Gilad and Gilad 1985.) Chapter 2.3 provides more information about data that is either wanted or needed. In summary, Watson and Wixom (2007, 96) state that a BI process is all about getting data in and getting data out.

In spite of the definition of BI, it requires a well-designed architecture. Whether it is seen as an operation or as a tool, similar architectural system components exist. The Figure 4 introduces the traditional and generic architecture of BI. All these components need to co-operate with each other; otherwise, data cannot be turned into information and into useful knowledge (Niu et al 2009, 21).

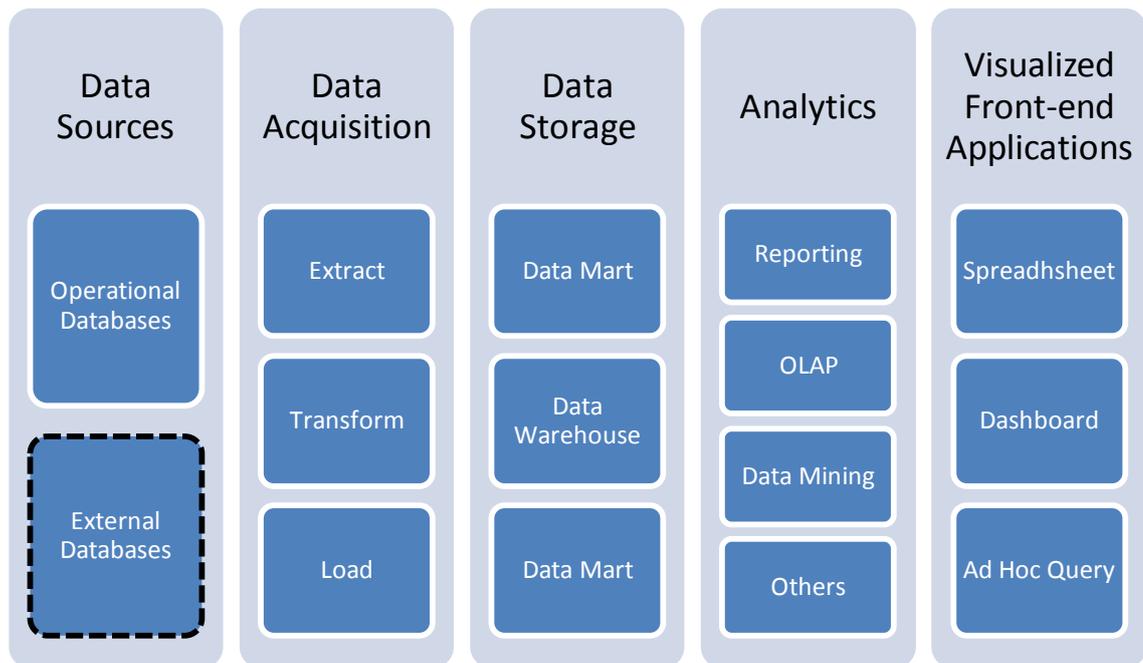


Figure 4 A generic BI architecture (modified from Chaudhuri 2011, 90; Niu et al 2009, 21)

As it appears in Figure 4, a generic BI architecture has several similarities with figures 2 and 3 but it emphasizes a data viewpoint. **Data Sources** collect data from the operational and external databases. Operational databases include business data for example from Human Resources (HR), CRM and the Finance department. The importance of external databases has increased during the last few years when the amount of data, especially in an unstructured form, has rapidly increased. **Data Acquisition** is an ETL-process that includes activities, which extract data from databases, transform it into the coherent form and finally load business data to repositories. (Olszak & Ziemia 2007, 138.) According to Turban, Sharda, Aronson and King (2008, 225) a *cleanse* phase is an important part of the modern ETL-process since the amount of data increases continuously. The questions to where and how data is loaded, depends on a company's data storage policy because data can be loaded into the data marts in lieu of one company-wide data warehouse. The ideal situation would categorize data marts to meet decision-makers' needs enabling faster and more effective decision-making (Pirttimäki 2007, 82-83). Moreover, a **data storage** team is responsible for data usefulness and meaningfulness for decision support (Watson and Wixom 2007).

Analytics and **Visualized Front-end Applications** are the most visible parts of a BI entity. With these analytical applications, which are strictly connected to the data storage, managers are able to see the processed data and furthermore to make their decisions. Business reports such as sales reports, product reports and human resource reports are displayed via spreadsheets and dashboards. As a result, the reports include different pieces of information that are gathered from operational and external databases. OLAP

and data mining techniques enable managers to create ad hoc queries to a database and to browse business data from multiple sources. (Niu et al 2009, 21-22.) Radebaugh and Gray (1997) specify that non-routine ad hoc reporting provides vital information for situations concerning strategic and tactical decision-making – especially for the ones that have not been faced before.

2.1.3 *Decision Support Systems*

Decision Support Systems (DSS) are vital in daily decision-making because of their ability to enable companies to prepare against threats and identify possible market opportunities (Gilad and Gilad, 1988; 1985). DSSs, as the whole information technology industry, have developed significantly during the last decades. Briefly, DSSs are *interactive computer-based systems that help people to use computer communications, data, documents, knowledge, and models to solve problems and make decisions* (Power and Shards 2009, 1539). DSSs evolved from the theoretical studies of organizational decision-making and the technical work and research that was carried out at the Massachusetts Institute of Technology in the 1960's (Shim, Warkentin, Courney, Power, Sharda and Carlsson 2002, 111). One notable single turning point was in 1967 when Scott Morton made his dissertation field study at Harvard University. As far as is known, it was the first time that a model-driven management decision-making system was demonstrated. Later on in 1971, Gorry and Scott Morton used the term *Decision Support Systems (DSS)* for the first time in their article, and introduced the framework for Management Information Systems (MIS). (Power, 2007.) According to Watson et al. (1991, 15) it is one of the best-known and most useful frameworks in its context even though it was introduced decades ago.

A DSS is a set of features that together create procedures for processing data and judgments that support managers in their decision-making (Turban, Aronson & Liang 2005; Sprague and Watson 1996; Gorry and Scott Morton 1971). In addition to this, Turban (1988) lists four features that are characteristics for DSSs such as:

- incorporating data and models
- assisting managers in their decision processes in ill-structured problems
- supporting, rather than replacing, managerial decision-making
- improving the effectiveness of the decisions.

Even if the past of DSSs has been turbulent, the field of study is still relevant. Power, Burstein & Sharda (2011) stated that the scope of a DSS has expanded and it can be considered as a multidisciplinary field. It has become an important component of any Management Information System (MIS). Moreover, Enterprise Resource Planning (ERP) systems as well as the personal computing tools, used by middle and top management,

include pieces of DSSs regardless of the field of company's business. The general belief among scholars is that a computerized DSS is still *in its infancy* even some new terms, such as Business Intelligence and Knowledge Management, have emerged during the last decades (Inmon 1992; Power et al. 2011). Nonetheless, Power et al. (2011) argue that working with DSSs requires outstanding collaboration between decision-makers and system designers – especially when a managerial viewpoint is highlighted.

Power et al. (2011) interviewed the pioneers of DSSs and performed an analysis of its implications for today's businesses. In this context, the research will be introduced in terms of *Complexity of context, Opportunistic view on technologies and theories, Future directions and challenges*. By reviewing the experts' comments, an overall picture of the challenges of DSSs is visible. The most important comments are introduced and quoted below.

Complexity of context

James F. Courtney¹ states that *everything is connected with everything else, at least in so-far-as important problems are concerned*. Frank Land² also highlights an interconnection viewpoint that DSSs have on other issues: *understanding of group behavior and design rationale is important*. Scholars have a mutual opinion that DSSs are not independent unities. Moreover, its relations to the other components should be thoroughly understood. William H. Inmon³ added four specific matters that will be emphasized in the future:

- The politics of DSS
- Unstructured data
- Business metadata
- Non-numerical visualization

¹ **James F. Courtney** Professor of Management Information Systems at Louisiana Tech University. A co-developer of the software *Systems Laboratory for Information Management (1981)*, which supports research and education in Decision Support Systems. (Power et al. 2011, 44.)

² **Frank Land** A fellow of the British Computer Society. Establisher of teaching and research in systems analysis in The London School of Economics on National Computing Centre. (Power et al. 2011, 45.)

³ **William H. Inmon** He is recognized as the "father of the data warehouse". As an author, Inmon has written about a variety of topics on building, usage and maintenance of the data warehouse. (Power et al. 2011, 44.)

Opportunistic view on technologies and theories

Power's et al. (2011) research reveals that the scholars still have an opportunistic view on the future of DSSs. On the other hand, Michael S. Scott Morton⁴, the pioneer of DSSs, state that the same ideas and concepts that were already found in the early 1970's still exist. He also adds that these ideas and concepts are rarely used effectively. Another pioneer, Hugh J. Watson⁵, agrees with Scott Morton by stating that *the technology may be new and vendors may hype the ideas as new, but the basic concepts have typically been around for quite a while*. Clyde H. Holsapple⁶ and Gerald R. Wagner⁷ both have slightly more future-oriented approach to DSSs. They say that new theories would be discovered while the *new* DSS will be a combination of art, technology and psychology being the part of a bigger picture. Added to this, Andrew M. McCosh⁸ mentions that from the managerial viewpoint user-friendliness should not be ignored: *Make sure that DSS is a flexible and understood by the company executive who has to use it*.

Future directions and challenges of DSS

According to Power's et al. (2011) research, the majority of interviewed scholars think that the concept of DSS should be more accurately defined - especially in decision-making related issues. James F. Courtney summarizes the dilemma of DSS solutions: *a good*

⁴ **Michael S. Scott Morton** Professor of Management at Sloan School of Management at the Massachusetts Institute of Technology. His dissertation, at the School of Business at Harvard University, in 1967 was the first systematic study of a computerized management decision system. (Power et al. 2011, 44.)

⁵ **Hugh J. Watson** Professor of MIS in the Terry College of Business at the University of Georgia. He has authored over 20 books and over 100 scholarly journal articles. He helped to develop the conceptual foundation for Decision Support Systems. (Power et al. 2011, 46.)

⁶ **Clyde W. Holsapple** Rosenthal Endowed Chair in MIS at the University of Kentucky. His research focuses on supporting knowledge work, especially in decision-making contexts. He received a Ph.D. in 1977. (Power et al. 2011, 45.)

⁷ **Gerald R. Wagner** The founder of Execucom, which became a leading force in DSS. In 2003, he founded the International Academy for Advanced Decision Support (IAADS). (Power et al. 2011, 45.)

⁸ **Andrew M. McCosh** Eminent Scholar of Finance at College of Business Administration at the Florida International University. He has published research in the areas of business processes, decision support technology and financial strategy. (Power et al. 2011, 46.)

solution to the wrong problem may actually make it worse adding that the focus should be on the individual and organizational perspectives. Other scholars also emphasize the challenge of a problem definition. Andrew M. McCosh argues that companies should *spend more time on decision analysis and decision definition*. Nonetheless, Hugh J. Watson says that the greatest days for DSS are still ahead while Clyde W. Holsapple adds that DSSs will have *major impacts on productivity, agility, innovativeness and reputation*. However, these improvements remain out of reach if DSS focuses on only historical data without having ability to rehearse the future (Gerald R. Wagner).

2.2 Types of data

2.2.1 Structured and unstructured data

Decisions and data can be roughly divided up depending on their form or their degree of structure. March and Simon (1958) mentioned and categorized for the first time the various decisions based on their forms of origin. They stated that managerial problems are either *programmed* or *nonprogrammed*. The first category includes those problems, which are solved repetitively and routinely, while the latter one consists of problems that have not arisen before. However, March and Simon (1958) add that there are no stabilized solutions for nonprogrammed problems. In addition, the distinction between programmed and nonprogrammed problems is important since they require different problem-solving methods.

According to Evans (2008, 255) there is a clear line between cognitive processes, which are either fast, automatic and unconscious or slow, deliberative and conscious. Moreover, other names for the problem types can be found. Evans (2008, 257) states that different authors have proposed a number of names for the categorization such as *automatic and controlled; experiential and rational; heuristic and systematic; heuristic and analytic; intuitive and analytic; implicit and explicit*. However, In 1971 Gorry and Scott Morton introduced terms *structured* and *unstructured* problems, which are separated based on the problem-solving process. Furthermore, the term *semistructured* refers to a problem, which is a mix of structured and unstructured problem (eg. Courtney 2001; Olszak & Ziemba 2007; Niu et al. 2009). The terms structured, semistructured and unstructured will be used when the managerial activities are introduced in Chapter 3.1.1.

Data, as well, can be divided by the degree of its structure. Structured business data is usually stored in the enterprise data warehouse or in smaller operational data marts. It contains history data, which is collected and loaded from the external and internal data

sources. Structured data is directly assigned to a problem and furthermore it can be processed by computing. (Baars & Kemper 2008, 132.) E-mails, customer history, documents and support calls to a particular customer are forms of semistructured data that are utilized in companies (Chaudhuri 2011, 90). On the other hand, unstructured data such as customer and market related web pages, sales reports, image files, telephone conversations and research paper repositories are also needed when semistructured and unstructured problems are solved (Baars & Kemper 2008; Negash 2004, 180). All in all, Maguire and Suluo (2007, 25) specify that informed decisions are always derived from well-structured internal and external information.

According to Baars and Kemper (2008) unstructured data should be integrated into structured data in order to gain the full advantage of available information in decision-making. They also mentioned that two different perspectives should be recognized: scholars with strong focus on technical and algorithmic challenges focus on the extraction of structured data from unstructured content. At the same time, some experts are approaching this problem from a systems integration perspective. Additionally, the Knowledge Management viewpoint is highlighted when the problems are stated as follows: *how unstructured content, which has generated during the analysis of structured data, can be effectively distributed*. Based on the prior literature, Baars and Kemper (2008) present three different data management approaches, which focus on the integration of structured and unstructured data.

The integrated presentation approach aims to create a simultaneous access to structured and unstructured data through integrated user interface, which is automatically generated by the system. Moreover, structured and unstructured data can together uncover and visualize otherwise neglected relations between these two data types. Baars and Kemper (2008, 134) gave a practical example which illustrates this approach: when a manager navigates in sales data and makes a query on structured data, a parallel search for fitting unstructured content from market research is executed. As a result, the manager sees unstructured content based on an initial query.

The **Analysis of content collections** method approaches different types of data from an alternative perspective. Based on metadata, large collections of unstructured data are analyzed and connected to structured data. For example, the author, the date of creation, length and product information are types of structured metadata in unstructured data that can be addressed directly to structured data. These identifiers of content items are treated as facts, which are connected directly to the subject of an analysis. In practice, this approach allows the association between individual documents and numerical facts since both types of data have mutual dimensions. Thus, when metadata descriptions of content items are harmonized, joint analysis, combining both information types, can be executed. For example, the manager has the ability to investigate a certain subject that is addressed to a certain organizational unit within a given timeframe. Ultimately, the manager can

answer questions such as ‘*what types of problems arise with what kinds of products in what regions at what times*’.

The third approach, **distribution of analysis result and analysis template**, is the most complex one to implement. In addition, the cost of usage, maintenance and support is relatively high from the end user perspective since the contents must be compiled and enriched for distribution. On the other hand, it enables companies to reuse BI knowledge efficiently. However, this approach presupposes that a company’s maturity level is high enough to create BI knowledge. Furthermore, the approach focuses on how the processes of concrete analyses can be reused for other purposes by offering reusable analysis and analysis templates. There are three steps that are involved in the third approach: data extraction, data analysis and refinement, and transfer of analysis result or analysis templates. As a result of this approach, the more effective and efficient use of analysis systems and methods can be facilitated throughout the company.

2.2.2 Internal and external data

Besides dividing data based on the structuredness, it can be roughly divided depending on its source. Companies have a vast amount of data all around them: for example, newspapers, blogs and various analyses include vital and valuable information about markets, competitors and customers. External data sources are more and more important to companies: the external environment can define companies’ success or failure by their ability to adapt to markets in order to gain the best performance (Maguire and Suluo, 2007). On the other hand, internally collected structured and unstructured data reflect the present states of companies. For example, business information in ERP systems or information about business processes can never be replaced with external information. (Negash 2004).

The role of external information is emphasized when strategic decisions are made since they have a long-term focus and balance towards the company’s external environment. Xu and Kaye (1995, 23) propose that managers should direct their attention to monitoring and scanning functions. The importance of these activities has increased since companies are more interconnected than ever. By being conscious about the environment, companies can predict the future rather than look back and analyze ‘*what has been done*’. (Aguilar 1967.) Monitoring and scanning functions involve activities that enable companies to gather data and information concerning their key stakeholders such as customers, prospects, suppliers and competitors. Moreover, economic conditions, innovations and the socio-cultural and legal aspects of the environment should be monitored and scanned actively, in order to obtain the most relevant information regarding decision-making (Xu & Kaye 1995).

Information about production, sales and the expertise of employees is typically gathered from internal sources – whereas external information is exploited when the business environment, technological advances, competitors, partners or customers are under review (Pirttimäki 2007, 44). The most vital pieces of information, in the name of strategic decision-making, are *external and internal strategic information*. The first emphasizes information about the company's external environment that might change its current activities and strategy. The latter plays a major role when strategic decisions in the company are made based on its current capacity and performance. Alternatively, internal information is required for controlling current practices while external information is more dynamic and the key in the strategic decision-making process. (Xu and Kaye 2007, Xu and Kaye 1995.)

2.3 Data and decision-making

Data plays a crucial role in decision-making. As it was revealed, companies with data-driven decision-making (DDD) perform better compared to companies, which make decisions intuitively. Data-driven decision-making means that, as business information becomes more current, decision-making should be more numbers-driven. As a result, the overall quality of decisions improves on average leading companies to higher productivity, return on equity and market value. (Brynjolfsson et al. 2011.) On the other hand, the top-performing companies are more willing to use data based insights to guide their future strategies and daily operations than the lower performers (Lavage, Hopkins, Lesser, Shockley & Kruschwitz 2010, 4).

Well-organized BI-processes assume that the right information is not only timely and correctly distributed to managers – it should be gathered from all coherent sources, otherwise it is impossible to create business value based on data. According to Pirttimäki (2007), data is divided based on its level of importance for decision-making. Firstly companies should know what their information requirement is in terms of decision-making. Aguilar (1967) states, that a company should *scan* its environment and collect data, which helps the managers to prepare future activities. Moreover, companies that are well organized might create their *strategic scanning* function by merging the viewpoints of technological, competitive, commercial and sociological activities (Brouard 2007, 123). Managers should also acknowledge their information needs, know what information is received and know what information they require – otherwise they cannot determine that information which is the *most value-adding* in terms of their business and processes (Pirttimäki 2007, 43).

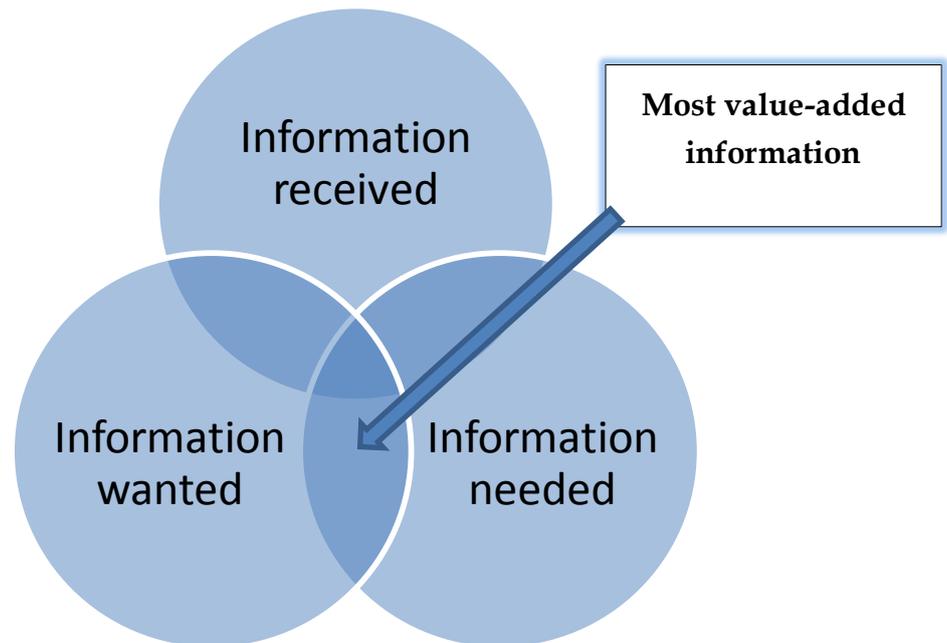


Figure 5 Information Gap (Pirttimäki 2007, 43)

As illustrated in Figure 5 (Pirttimäki 2007, 43), information can be divided into four different groups. The core of the figure is the group entitled *most value-added information* which is an overlap of dimensions *information wanted* and *information needed*. Data in this area should be fully utilized. In practice, companies can make a fully rationalized decision only when they receive that information which is both wanted and needed. The area in the middle, where all three categories overlap, reflects the company's present state of decision-making. When moving deeper into data-driven decision-making, different data sources as well as data forms should be analyzed or the utilization process remains fragmented.

Ill-structured (the mix of structured and semistructured) problem-solving requires both structured and unstructured data from both internal and external data sources. Regardless of the source or origin, it is the case that relevance, truth-value, understandability, sufficiency, significance and timeliness are the components of data that determine whether or not it is useful for the company. (Gilad & Gilad 1988, 103-104.) Figure 6 below separates decisions by both the nature and by the degree of a problem structure. It is important to note that semistructured decisions play a major role in the decision-making field. Courtney (2001, 19) states that the ill-structured nature of the decision-making environment encourages managers to interconnect with colleagues. He also adds that the latest improvement within technology, that has enabled operative systems to interact directly with storage systems, is one of the reasons why ill-structured problems can be solved more precisely. According to Shim et al. (2002, 113) ill-structured problems force BI and IS systems to be flexible.

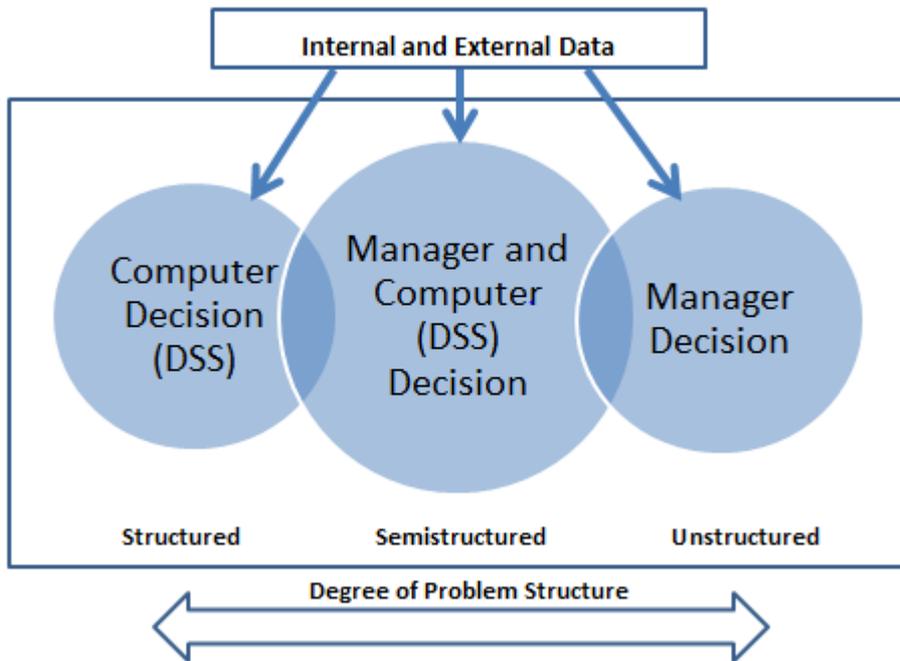


Figure 6 Data and decision-making (partly adopted and modified from Turban et al. 2005, Alter 1980, Gorry and Scott Morton 1971)

Figure 6 shows the relation between the degree of problem structure and the different types of decisions. When moving from left to right the degree of structure of data decreases. The leftmost bubble (*Computer Decisions*) consists of decisions that are made through utilizing structured data. The middlemost bubble (*Managed and Computer Decision*) necessitates both structured and unstructured data. In that case, the right information is distributed on time via predetermined systems to the decision-maker. Furthermore, managers have the responsibility of choosing the right tools, which are provided by the BI personnel or an external vendor. The last category (*Manager Decisions*) requires companies to have the ability of taking advantage of unstructured data. In the extreme situations, DSSs cannot be utilized at all and the decisions are made based on manager's intuition. The importance of external information increases when long-term and infrequent strategic decisions are made. (Pirttimäki 2007; Bocij, Chaffey, Greasley and Hickie 2003; Mintzberg 1973.) However, empirical studies have shown that managers tend to rely as much on internal information as on external information when strategic uncertainty is high (Daft, Sormunen and Parks 1988). Additionally, Courtney, Kirkland and Viguerie (1997, 68) state that under uncertainty traditional approaches to strategic decision-making can be dangerous and therefore the situation should be analyzed from all available perspectives. All decisions in these three groups are furthermore divided by Anthony's (1965) categories of managerial activities (see Chapter 3.1.1).

3 PERFORMANCE AND DECISION-MAKING

3.1 Defining managerial decision-making

3.1.1 *Managerial activities*

Different people make different decisions in organizations – usually the most complicated decisions have an ill-structured nature and hence DSSs are needed when solving them. An understanding of managerial activities is a prerequisite for an effective use of DSSs. Moreover, the key for successful decision-making is to know all of the components that are involved in a decision-making process. Decisions can be divided up in many ways from which the most notable method is Anthony's (1965) categorization. According to his model, the managerial activity field has three distinct groups, which are *strategic planning*, *management control* and *operational control*. The approach was introduced to broaden the traditional perspective of information since the use of information was considered to support only accounting activities (Otley 1999, 364). Additionally, Scott Morton's (1991, 12-13) way to divide managerial activities has similarities with Anthony's (1965) categorization. Scott Morton (1991, 12-13) mentions that managerial activities can be divided in *direction* and *control*. The former is concerned when internal and external environments are sensed and business information about the environments is connected to the company's activities. Furthermore, the latter *control* activity has two aspects: it includes managerial activities that not only measure a company's current state but also interpret such measures against the business plan. Both approaches, Anthony's and Scott Morton's, give a framework whereby different managerial activities and decisions can be categorized.

According to Monsalve, April & Arban (2010, 2-3) Anthony's model is still the most popular approach for classifying managerial activities. The main task of *strategic planning* in Anthony's approach is to create a framework for the company, which helps managers to decide on the objectives of the organization. The process involves steps that drive organizations to attain these objectives under governing policies. Furthermore, *management control* ensures, by means of performance management, that resources are being used effectively and efficiently when companies are reaching their objectives. It is directly connected with *strategic planning* since all the activities must be performed within the context of previously determined policies. The difference between operational control and strategic planning is that the former assures that all specific tasks are carried out effectively and efficiently (Anthony 1965, 16-18; Gorry and Scott Morton 1971; White 1971).

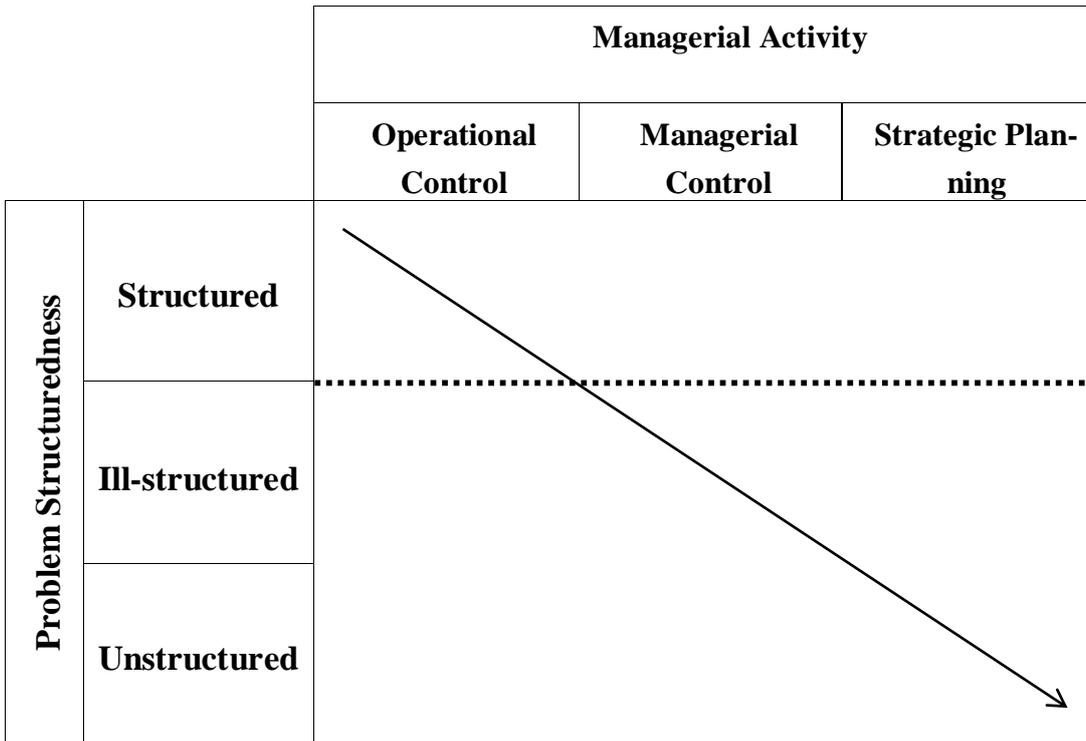


Figure 7 Decision-making levels by managerial activities and problem structuredness (modified from Turban 1998; Gorry and Scott Morton 1971; Anthony 1965)

Figure 7 shows the correlation between the problem structuredness and managerial activities. The dashed line, which vertically penetrates the figure, separates ill-structured and unstructured problems from structured problems. Additionally, an arrow, which moves from the left top corner to bottom right, reflects the share of a DSS utilization in decision-making – when the problem structuredness decreases, the use of DSSs decrease as well. Furthermore, the real life examples of decisions of categories in Figure 7 are given below in Table 2.

Table 2 Examples of decision types (Courtney 2001, 18)

	<i>Operational Control</i>	<i>Managerial Control</i>	<i>Strategic Planning</i>
<i>Structured</i>	Billing	Purchasing	Dividends
<i>Semi-structured</i>	Assignments	Budgeting	Forecasting
<i>Unstructured</i>	Grievances	Career paths	E-commerce

3.1.2 *Approaches to decision-making*

Now when managerial activities (Chapter 3.1.1) and data viewpoint on decision-making (Chapter 2.3) are introduced, different approaches to decision-making are argued in more detail. A decision can be considered to be a choice of action. Additionally, the choice of not acting is a decision. (Baron 2000, 6.) According to Grampp (1948) an economic man – created by Adam Smith – is an individual who acts rationally with complete knowledge. Moreover, the economic man is a rational creature that invariably seeks to fulfill his own interest in order to maximize his own benefit. However, when immersing deeper into decision-making, it is obvious that managers have to consider various optional alternatives, from which not all necessarily maximize the company's benefit. Even the consequences of the simplest rationality-strived decision might end up extremely crudely, if the overall effect is thrown aside. (Simon 1955.) Baron (2000, 6) states that decisions may attempt to satisfy the goals of others, when the external factors are analyzed, as well as the selfish goals of the decision-makers. According to Courtney et al. (1997, 70) the companies should also analyze different external factors, which affect the final outcome, and create scenarios based on the analysis. For these reasons, all available information should be gathered and analyzed wisely; otherwise, the best possible outcome might not occur.

The managers make numerous business decisions continuously. All of these have an effect on future business outcomes since the success lies in decisions. The current state and the future consequences of a company is the sum of the decisions made in the company. Usually, a good decision guarantees a good outcome, but on the contrary, sometimes even the best choice, which is based on the most value-adding information, might be harmful for the company because we cannot wholly predict the future. (Clark 2010; Pirttimäki 2007; Daft, Sormunen & Parks 1988.) In fact, the traditional concepts of rational decision-making, such as the max-min rule, probabilistic rule and certainty rule, require the ability to specify possible outcomes exactly, when unexpected consequences are entirely excluded (Simon 1955). According to Baron (2004, 19) solution scenarios about the outcomes can be evaluated based either on probability theory, utility theory or statistics. However, since there are multiple solutions to the problems the future outcome depends on the chosen solution.

A decision-making process is a set of actions and dynamic factors that begins with the identification of a stimulus for action and ends with the specific commitment to action (Mintzberg, Raisinghani and Théorêt 1976, 246). According to Mintzberg and Westley (2001, 89) a process is easily simplified: first define the problem, then design a possible solution and finally implement the best choice. The same decision-making continuum appears in many approaches. When analyzing the previously mentioned process steps of a decision-making process, it is clear that problems will arise. According to Simon (1960)

decisions can be analyzed since the decision-making process can be divided into intelligence, design and choice phases:

Generally speaking, intelligence activity precedes design, and design activity precedes choice. The cycle of phases is, however, far more complex than the sequence suggests. Each phase in making a particular decision is itself a complex decision-making process. (Simon 1960.)

According to Simon (1960) the phases are introduced as follows: The **intelligence** phase, which aims to identify a problem or a business opportunity, includes various methods such as listening to people, environment scanning, internal and external database querying and employee brainstorming. Personal attitudes and the nature of a decision have an effect on the chosen methods. Problems and business opportunities should be widely analyzed and then addressed in the **design** phase. Benchmarking, researching and reviewing the literature are examples of numerous ways through which alternative solutions can be generated and furthermore analyzed. Added to this, the objectives of the decision are also stated. The **choice** phase is the most demanding part of the decision-making process because all the developed alternatives are evaluated. The last phase is also a final determinant for the success of a process: the end product of a process is a selected and implemented choice, which will be carried out. Moreover, Forman and Sely (2001) add that all important decisions have multiple objectives, which all have an impact on how the final outcome is perceived and experienced.

As Simon (1960), Baron (2000) argues that there is a clear line between the decision-making steps. First of all, Baron (2000, 7) states that when analyzing future decisions, the effect of personal goals should not be underestimated: when the personal goals are set, a decision about the future decisions has already been made. Baron's (2000) decision-making framework, the search-inference framework, asserts that thinking consists of search and inference – both of these are affected by actions, beliefs and personal goals. Furthermore, the search step can be divided into three categories since the decision-makers tend to focus upon three different factors: possibilities, evidence and goals. After the decision-maker has evaluated these factors, the inferences from and about them are made. In the inference process each alternative is either strengthened or weakened based on the decision-maker's personal goals.

Gilad and Gilad's BI process (see Figure 3), Simon's (1960) decision-making process and Baron's (2000) search-inference framework have multiple conceptual similarities but, in addition, parallel activities can be found. When these two processes and the framework overlap, computer-aided decision-making can be seen as organized based on the cognitive perspective of the decision-making process and problems can be solved without methodical conflicts. Moreover, all steps of decision-making (intelligence, design and

choice; search and inference) can be conducted using courses of BI actions. However, BI itself does not take a stand on the decision-making factors and therefore the processes, in which the human input is included, vary. Intelligence gathering requires expertise and know-how of gathering data from internal and external data sources. When the decision-maker has access to structured and unstructured data, all different choices should be analyzed accurately – this represents the design phase. Finally, the right option should be made based on the analysis. All in all, the structuredness of a problem defines the actions to be taken: according Gorry and Scott Morton (1971, 14) the final choice is a result of ill-structured or structured problem-solving – if all three phases are structured, then the problem can be solved by a DSS and so on.

A precise numerical analysis is considered to be a rational approach to decision-making whereas an intuitional approach is defined as a *non-sequential information processing mode, which comprises both cognitive and affective elements and results in direct knowing without any use of conscious reasoning* (Sinclair and Ashkanasy 2005, 356-357). Despite the fact that the numerical analysis provides accurate information about the external and internal business environment, in some cases the managers use their own intuition by ignoring numerical analyses – especially when there is an inconsistency between the numerical analysis and the managers' intuition. According to Forman and Sely (2001, 23), further analysis should be done when quantitative and qualitative analyses give contradictory results. They also mention that managers, who make their decisions based on all available information, reduce their own responsibility if an outcome is unfortunate.

As mentioned earlier, the structuredness of a problem influences the decision-making approach. Sinclair and Ashkanasy (2005, 354) state that empirical evidence on a process, which requires both intuitional and rational behavior, has been provided by multiple researchers. Especially in ambiguous situations or under uncertainty decision-makers use their intuition to provide support for the rational analysis – ill-structured problems are often solved by using both approaches. Moreover, the unstructured end of a continuum of structuredness includes situations where generally accepted decision rules may not occur (Dane and Pratt 2007, 45). Therefore intuition tends to support situations where irregularity is present and the managers face inadequate information or conflicting facts (Dane and Pratt 2007; Sinclair and Ashkanasy 2005). According to Agor (1986, 9) intuitive decision-making is required when the following conditions exist:

- when little previous experience exists
- when possibility for predictions is lacking
- when “facts” are limited
- when analytical data is limited
- when other solutions exist with good arguments
- when the deadline is pressuring the decision-making.

3.2 Decision Support Systems and decision-making process

Despite the fact that Gorry and Scott Morton's (1971), Antony's (1965) and Simon's (1960) theories were created many decades ago, the most recent relevant studies are often incorporated in and reflected with these classical studies (Isik, Jones & Sidorova 2010, 2). Gorry and Scott Morton (1971) integrated Anthony's (1965) categories of managerial activities into Simon's (1960) description of decision types to their theory – other scholars have used the same perspective as well. For example, when the direct access storage devices enabled the use of interactive operating systems in a technically and economically wise fashion, spreadsheet solutions came to support managerial decision-making (Watson et al. 1991, 14). After this, the general improvement in information technology has expanded the scope of decision-making tools to assist every step of the computer-aided decision-making process (Rajteric 2010; Brynjolfsson et al. 2011).

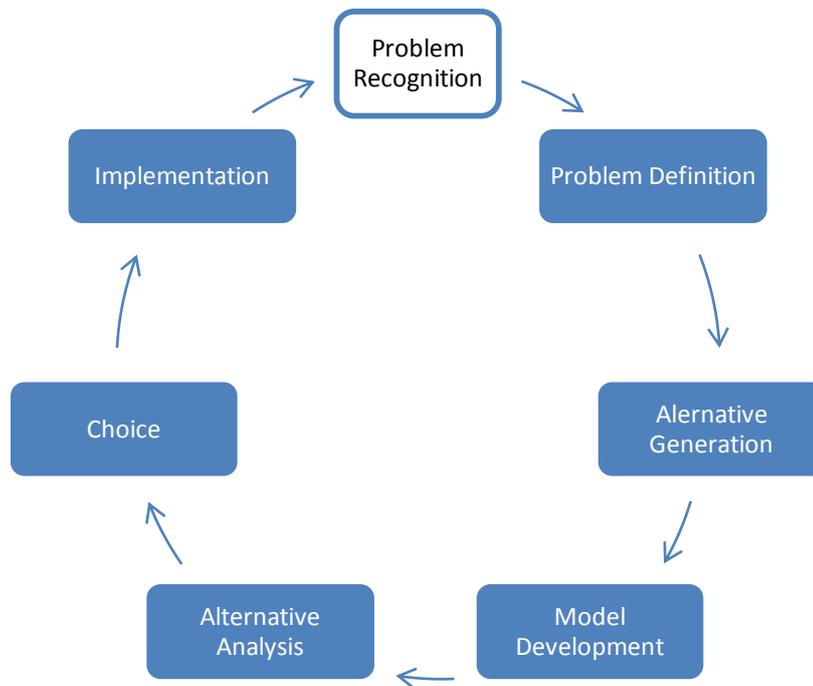


Figure 8 The conventional DSS decision-making process (Courtney 2001, 19)

According to Courtney (2001, 19) the conventional DSS decision-making process (Figure 8) can be illustrated as follows. First of all, the problem should be recognized and then defined more precisely before the alternatives for the model are generated. After the model has been developed, based on the *alternate generation*, different alternatives should be analyzed via *alternative analysis*. This is the phase, during which different decision-making related BI tools are emphasized since the alternatives are analyzed by utilizing current capabilities enabled by BI. Moreover, when all alternatives are analyzed,

the final choice can be made considering all possible outcomes. Finally, the last phase, *implementation*, sums up all previous steps that have been taken during the process. All in all, the conventional DSS decision-making process is an iterative process in which different phases blend and overlap creating a continuum that recycles earlier steps. The similarities are found in the previously mentioned decision-making processes in Chapter 3.1.2.

All computer-aided decision-making should provide answers to existing problems by providing insights from available information. According to Davenport, Harris & Morison (2010, 7) insights are created for both the past, present and future states of a company – these are also the dimensions of a decision-making process. Firstly, information from *reporting* tools describes the company's past state by answering questions such as *what happened*. Moreover, additional insight can be created if a company knows *how and why it happened*. In terms of understanding the present state of a company, different *alerts* and *recommendations* of the next best actions will be required. Ultimately, insight into the future can be created by answering questions such as *what is the best or worst that can happen* can be found. *Prediction, optimization* and *simulation* competencies are required when a company creates insight into and possible scenarios about its future.

In order to create insights from information, the conventional DSS decision-making process (Courtney 2001) is translated into the language of BI. Powell (1996, 161) introduces a BI value chain that partly contains the same steps and phases that exist in the DSS decision-making process. Figure 9 below illustrates the process through which data is turned into actionable and insightful results through collection, aggregation, communication, application and execution activities.

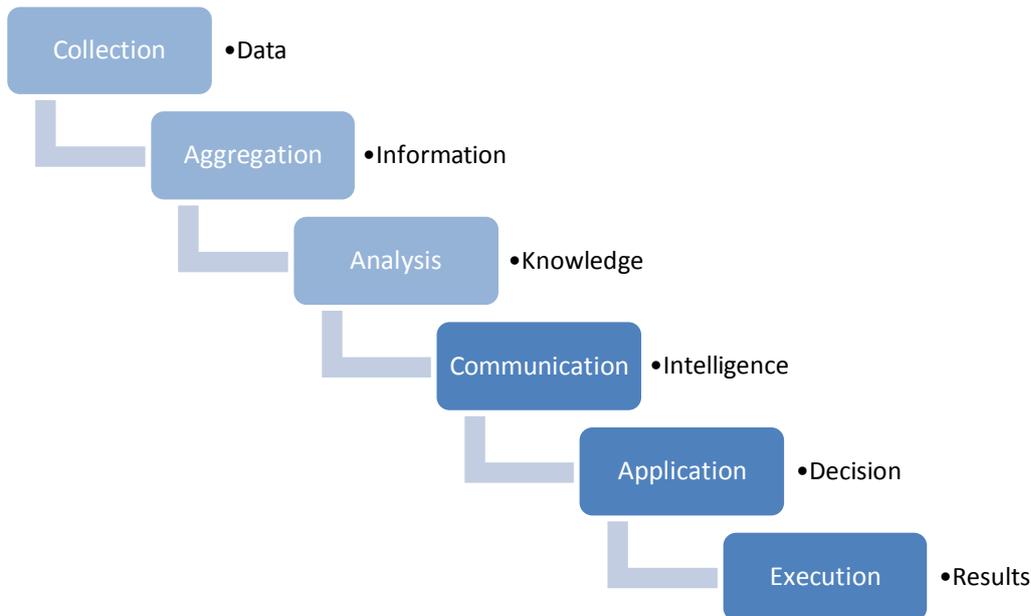


Figure 9 Business Intelligence value chain (modified from Powell 1996, 161)

According to Powell (1996, 160-162) a BI process can be described as a value chain, which illustrates the correlations between each step that is involved when data is turned into results. When compared to Gilad and Gilad's (1985) BI process (Figure 3) the difference is evident – the BI value chain makes a clear separation between a BI viewpoint and human aspects in the process. First of all, data should be *collected*, *aggregated* and *analyzed* before it can be turned into information and further into knowledge. These first three steps are generally considered as basic steps of BI (Pirttimäki 2007, Powell 1996, Gilad and Gilad 1985). Moreover, the value creation commences when intelligence is created based on the *communication* phase. The result is an output of *execution* and depends on the decision that is made in an *application* phase. When ill-structured problems are concerned, both numerical analyses and intuitional decision-making are present. The Business Intelligence value chain provides a solution, which emphasizes both of these two points of view.

3.3 Business performance view on decision-making

3.3.1 Performance management

Now, when the approaches to computer-aided decision-making and BI value creation have been introduced, a business performance viewpoint can be reviewed more thor-

oughly. Gartner (2011) states that BI plays a key role when companies analyze information in order to obtain better decision-making and performance management (PM). To be precise, performance management provides a framework for companies, through which to track their current and past activities by monitoring company specific metrics, which are generally called key performance indicators, KPIs. Companies use KPIs to gauge the current state of their business and in order to achieve set goals and targets. (Gartner 2011, 11.) Nowadays BI and KPIs are increasingly being used in order to enhance corporate performance by helping businesses develop the right courses of action by summarizing large amounts of data (Prashant 2009, 11; Watson and Wixom 2007, 98)

According to Vitt, Luckevich and Misner (2002) performance management is an entity that is above BI. Alternatively, they suggest that BI is an ongoing cycle, which aims to offer a framework for performance management. Negash (2004, 179) highlights the strategic importance of performance management as follows: according to previous market surveys, PM is the most important strategic output of BI. Moreover, to achieve the best performance from the strategic output, organizations need to answer two constant questions continuously (Otley 1999, 365):

- *What are the key objectives that are central to the organization's overall future success, and how does it go about evaluating its achievement for each of these objectives?*
- *What strategies and plans has the organization adopted and what are the processes and activities that it has decided will be required for it to successfully implement these? How does it assess and measure the performance of these activities?*

In order to maximize the strategic output, a precise guideline for the management is required. Kaplan and Norton (1992) introduced the best-known example of measuring the company's performance. They argued that traditional accounting measures can give misleading signals in terms of continuous improvement and innovation. They also add that these measures, such as return-on-investment and earnings-per-share, worked well during the industrial era but now when the business environment dramatically changed, other metrics are needed. After a yearlong research project, they devised a *balanced scorecard*, which is a set of measures, which together create a comprehensive view of the business for top managers. Kaplan and Norton (1992, 72) listed four different perspectives that are tracked by the set goals and measures - perspectives are financial, internal business, customer and innovation and learning. In performance management, these perspectives are compared with benchmarks and previous business performance and, as a

result, companies *will get watched things done* (Watson and Wixom 2007, 97). In this research, perspectives will be used to describe actions taken in case study companies.

The current states of BI and performance management can be measured by using a maturity model. It is a tool, which enables companies to compare their performance and organizational units with those of competitors. Moreover, maturity models help organizations to understand their current progression and how they can improve by answering the following BI-related questions. (Rajteric 2010, 48-50)

- Where in the organization is most of the reporting and business analysis being carried out today?
- Who is using business reports, analysis and success indicators?
- What drives Business Intelligence in the organization?
- Which are the strategies for developing Business Intelligence in use today?
- What business value does Business Intelligence bring?

Multiple BI-related maturity models have evolved from different authors. All maturity models have unique approaches and angles that are considered when companies' current maturities are defined. On the one hand, a data warehouse point of view can be emphasized (TDWI 2009), but on the other hand Knowledge Management (Deng 2007) or business information (Williams and Thomann 2003) viewpoints can be highlighted. In this context, the BI-related Performance Management maturity model is introduced in further detail.

According to John Hagerty (2004) Business Intelligence / Performance Management Maturity Model is a four-stage framework for business and IT leaders to assess the current maturity level of a company. Included stages are *reacting*, *anticipating*, *collaborating* and *orchestrating* – all stages are interconnected and, in order to reach the next step, all previous stages should be completed in chronological order. The first step, reacting, aims to answer the question *where have we been*. In this step, neither company-wide approaches nor mutual metrics exist. All activities are primarily technology-centered while problems are solved with simple BI-tools. To capitalize on activities included in the first step, existing tools should be used more efficiently and further investments in BI-related capabilities are needed. In the second step, anticipating, projects are evolving from tactical toward strategic while the capabilities are distributed to other departments. In terms of resources, data issues stand out and more time for data refinement processes is required. Furthermore, the visibility of operations increases since the first dashboards can be utilized and the data is more interconnected.

As Hagerty (2004) listed, two remaining steps are future-oriented aiming to answer questions such as *where are we going* and *are we all on the same page*. The third step, collaborating, aims to improve performance with clear operational and financial metrics, key performance indicators (KPI). These indicators drive businesses and are mapped back

to the business strategy providing better transparency in the company's decision-making. In addition, scenarios and models provide alternatives to decision-makers and enable them to analyze different outcomes between multiple decision alternatives. Dashboards and scorecards are not only used to align resources and objectives but also scenarios, models and KPIs are visualized through these BI-tools. The final step of Business Intelligence / Performance Management Maturity Model (Hagert 2004) is called orchestrating. To reach this maturity, performance management should be recognized as a cultural philosophy with a top-down goal setting from executives through to operations. It requires rapid data analysis and decision-making. Moreover, actions required to improve performance are taken based on scenario modeling. Compared with the first two maturity model steps, collaborating and orchestrating is a more organizational culture than technology oriented. When the company reaches the final steps of the maturity model, the commitment of managers to implementing activities to the organizational culture is required.

3.3.2 Business Intelligence performance measurement

According to Brynjolfsson et al. (2011) strategic decisions, which typically have a prominent impact on performance, in more and more companies rely on a managers' *gut instinct*. However, on the other hand, recent studies have shown that companies making data-driven decisions show better performance (see Brynjolfsson et al. 2011; Lavallo et al. 2010; Davenport and Harris 2010). The benefits of enhanced decision-making can be measured by using various methods. In this context, two different approaches are introduced in order to provide concrete examples of the benefits.

The benefits of computer-aided decision-making appear through better business performance. According to Cook and Cook (2000, 14) the main benefit of BI is that it enables companies to act proactively. Gilad and Gilad (1986, 86) partly agreed with them by stating that the main benefit of BI is its ability to share processed data and information with decision-makers. According to many sources (see Pirttimäki 2007; Negash 2004; Cook and Cook 2000; Paare 1976) a measurement of the direct financial benefits of BI is a difficult task - the intangible nature of the results and outcomes complicates the measuring of benefits which are also often dispersed throughout a company. Pirttimäki (2007, 55) also adds that success features can be identified and listed, but any actual performance metrics cannot be easily be specified. In order to minimize process costs, Turban et al. (2005, 220) suggest that companies should focus on the most value-adding data.

Watson and Wixom (2007, 97) argue that the measurability of the BI benefit correlates with the degree of impact of the benefit – when the business impact moves from local to global it becomes more difficult to measure. For example, the most mature uses of BI enables managers to facilitate strategic decisions, such as entering a new market or

launching a new product line, which might have a global scope and are therefore difficult to measure. The spectrum of BI benefits is illustrated below.



Figure 10 Spectrum of BI benefits (Watson and Wixom 2007, 97)

As it appears in Figure 10, Watson and Wixom (2007, 97) suggest that the spectrum of BI benefits is double-sided. On the one hand, the benefits can be categorized based on the ease of measurability, but on the other hand the scale of impact affects the benefits. They also argue, that the use of BI reduces both tangible and intangible business operation costs. Even the intangible costs can be measured if an in-depth analysis of computer-aided decision-making is performed. Moreover, Popoviç, Hackney, Coelho and Jakliç (2011) suggest that measurement items are divided into six categories, namely, data integration, analytical capabilities, information content quality, information access quality, the use of information in business processes and analytical decision-making culture. Both Watson and Wixom (2007) and Popoviç et al. (2011) models are used when the BI benefits of case companies are analyzed from the performance management viewpoint.

4 CASE STUDY ANALYSIS

4.1 Case companies and research method

Various methods can be used to collect case study information. These sources of information and evidence include documentation, archival records, interviews, direct observations, participant-observations and physical artifacts. The interview, which is rather a guided conversation than a structured query, as a method is one of the most important sources of case study information since it focuses directly on the case study topic and provides perceived causal inferences. (Yin 2003, 86-89.) Depending on the questions that the interviewer poses, the interview can be open, semi-structured or structured (Järvinen & Järvinen 2004, 145). In this research, the interviews are semi-structured having an open-ended nature. According to Yin (2003, 90.) an open-ended nature ensures that the facts of a matter can be questioned. Moreover, it also enables an interviewer to ask the respondents to propose their own insight and opinions into certain occurrences.

The research material includes three semi-structured interviews, which were conducted and recorded between 19.4.2013 and 18.10.2013. The interview questions can be found from Appendix 2. Prior to the initial contacts, which were made based on the direct enquiries and hints, the case companies and interviewees were selected based on the following criteria. Firstly, all companies have a Business Intelligence tool or tools to support their decision-making – this was guaranteed through a short telephone interview, which was a prerequisite for choosing cases. Secondly, the companies play a major role in their field of business in Finland. Additionally, the interviewees were selected based on their current positions and responsibility areas in the company. Furthermore, all interviewees have subordinates and play a role in strategic decision-making. In this context, other selection criteria such as interviewees' technology knowledge about Business Intelligence, age, gender or nationality are irrelevant since the decision-making and its impacts on the performance are studied. Information about the selected case companies and the interviewees are listed below in Table 3.

Table 3 Case companies and interviewee details

Case Company	Industry	Interviewee's title	Years in a current position	Years in a company
Alpha	Construction	Chief Executive Officer	4	4
Beta	Service Sector	Senior Director	<1	3
Gamma	Service Sector	Head of Division	6	27

All case companies are described separately based on the case interview. Each of the interviewees answered the questions based on his or her knowledge and viewpoint. Even though a comprehensive comparison between the companies cannot be made, the research findings are represented together based on the research model components, which are introduced in Chapter 4.2. Furthermore, each component includes five statements, which are introduced in Chapter 4.4. Based on the theoretical part of this study, these statements are considered as critical prerequisites for successful computer-aided managerial decision-making. Furthermore, these statements are scored based on the case interviews: if the statement is true, one point is given; if the statement is partly true, half a point is given; otherwise, no points are given. The maximum score from each of the categories is five, which is the number of statements. And lastly, if the total score of the category is above 2,50, the category can be considered as an enabler. All categories below 2,50 are considered as constraints.

4.2 Research model and analysis process

The research model, MIT90s Model, was developed during The Management in the 1990s Research Program. The program was started in 1984 in the MIT Sloan School of Management and was a close collaboration between academic researchers and representatives of major corporations. As Chan and Reich (2007, 303) stated, it served as an initial attempt to harness the strategic use of IT. While each chapter of the final report was written by different authors based on the same subject, the model has been used in several various ways and is still used in academic researches. The model is not about providing exact answers to questions related for example to IT or Human Resources, rather it is about how these new technologies change the ways in which people think or work and furthermore how corporations collaborate and compete when interrelated components have an

influence on all levels of the corporations. (Scott Morton 1991.) According to Scott Morton's (1991) framework, the value that IT gives to the company is captured at its best when all these processes are aligned and working in synergy together (Tsipi, Nava & Kathleen 2006; Avila, Goepp & Kiefer 2009.)

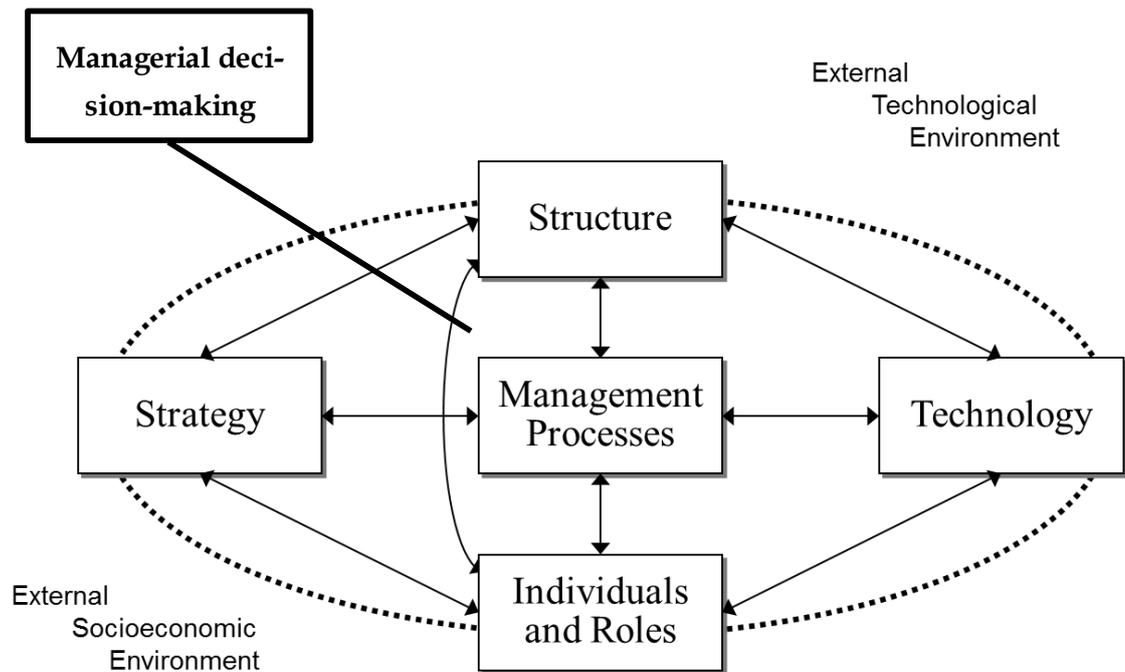


Figure 11 MIT90s model (Scott Morton 1991, 20)

The model includes four different components that have a simultaneous effect on management processes. These components are used in a case study section of this research. On the one hand, semi-structured interview questions are formulated by using model components, but on the other hand, case study findings (Chapter 4.4) are introduced and analyzed in the context of MIT90s Model. Furthermore, the theoretical part of the research supports a case study analysis by providing additional information on four components.

The analysis process phases are *Theoretical part*, *Research model*, *Case study analysis* and *Case study findings* that together create *Main findings*. Furthermore, the process flow proceeds as follows. First of all, the theoretical part of this study is used to provide a coherent framework for the use of MIT90s research model, which has four previously mentioned components. After the introduction of the research model, all case studies are individually described and analyzed within the research model context. Finally, case study findings are conjoined by utilizing all previous phases. The relationships between the phases of a research analysis process are illustrated below in Figure 12.

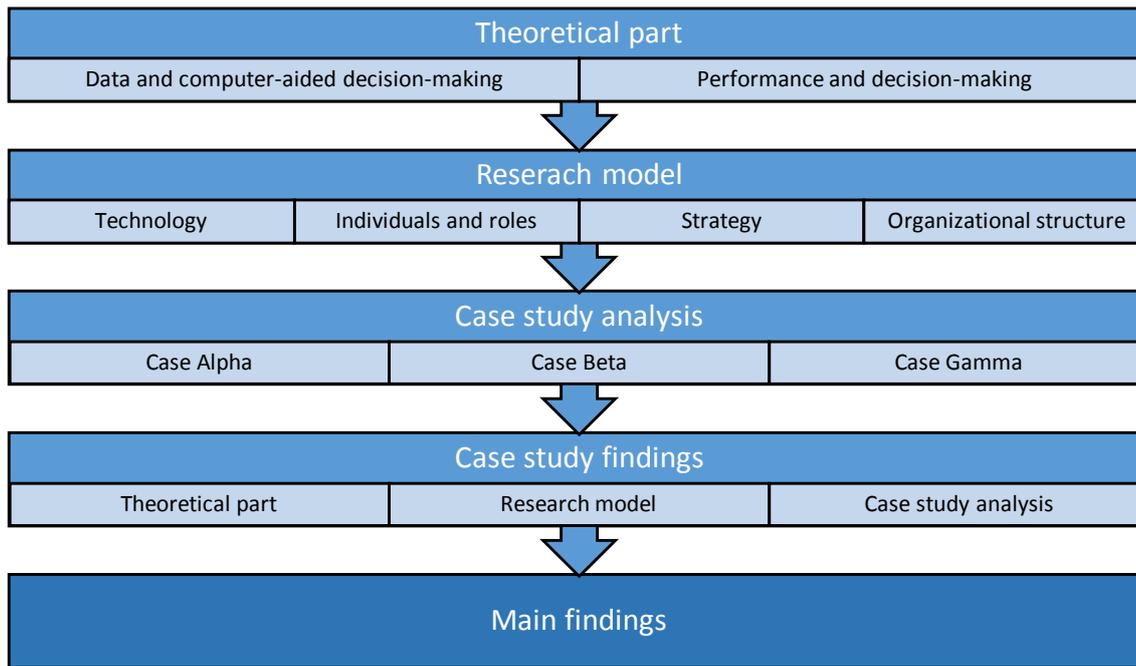


Figure 12 The research analysis process

The main target of the analysis process is to provide additional information for the theoretical part of this study in order to obtain an answer to the research questions. Furthermore, the analysis process is required since the research questions cannot be answered on the basis of the theory. The following main research question and sub-questions are answered in Chapter 5.1 by analyzing the findings of this study:

How does Business Intelligence (BI) support managerial work when a company aims for better business performance?

1. *How is data utilized from the managerial perspective?*
2. *What is the balance between internal and external information in managerial decision-making?*
3. *How do Business Intelligence Systems provide insightful information for a company's strategic decision-making?*

4.3 Case descriptions

4.3.1 Case Alpha

The interviewee in case Alpha is the president and CEO of the company. Alpha is in the construction business with several major projects in simultaneous progress. The company operates mainly in Finland. Alpha employs over a thousand employees and generates a turnover of hundreds of millions of euros. According to the interviewee, the importance of BI systems is significant. BI systems provide the company with correct and accurate information, which is constantly required for precise decision-making. In spite of the benefits of BI, the interviewee is not currently in charge of any BI-related projects.

Alpha neither has a Business Intelligence Competence Center (BICC) nor uses the term *Business Intelligence* on a daily basis. Instead, the company uses the term *Management Information Systems*. However, according to the interviewee, the term *Business Intelligence* could also be used, but it is merely a question of terminology. He also added that a BI term would actually describe more precisely their current use of the systems since the different reporting tools and drill-down functions are involved. According to the interviewee, these tools together with the operative team, which supports the strategic team by collecting data on the markets and customers, are the core of company's BI.

The interviewee admitted that the field of BI in Alpha is still fragmented. He also stated that the harmonization of different BI functions had been a top priority during the last few years. As a result, the unification of the functions has progressed considerably. However, there is still a great deal to improve before the management is satisfied. He also admitted that Information Systems in general – especially BI-systems – play a major role when different internal and external business operations are under review. Especially, operations related to Sales and Operations Planning (S&OP) require advantaging different systems. Alpha has improved its financial performance by reorganizing its processes and organizational structure. Furthermore, recent progress in IS and BI has enabled the change, however, nothing could have been done without the substantial financial investments.

Even though the importance of data utilization is recognized, the arms race between competitors has not yet started, due to the nature of the industry. The interviewee listed three restrictive factors, which exist in the construction business: firstly, competitors and markets are mainly located in Finland and therefore the business is primarily domestic. Secondly, the customers are often from the public sector and therefore the bidding processes are constrained: since the public sector makes its acquisition decisions mainly based on the price, there is no room for differentiation. Lastly, resources are usually dedicated to long-term contracts restricting the company's external operations and resource

planning. In Alpha, the interviewee felt their current situation in IS constrains internal and external activities.

“Probably we will use it more and more in the future when we get our sales figures and customer accounts integrated into the system. This is how we would see opportunities and prospects before our competitors.”

The interviewee stated that they could utilize data more efficiently if they had well-defined and organized databanks or data marts. The reason for lacking BI actions is not technology-related – their organizational culture has not reached the required level of maturity for the systematic use of Information Systems. One given example relates to CRM-systems: salespersons do not update systems regularly. The outdated CRM information affects Alpha in many ways. When data is not up-to-date, correct decisions cannot be made.

“So our main challenge now is to get the most updated information about our prospects to our database. If there is a multi-million project marked as open, which is already dead, it has a huge effect on our tactical decision-making since we don’t get the actual number of our available resources.”

Roles are defined hierarchically so the managers see a dashboard of their own responsibility areas. The levels of authorities are also restricted based on the managers’ position in the company hierarchy: the managers have a full access to the numbers of their own responsibility areas. In reporting, problems arise since the BI-process is inconsistent – one group of employees inputs data and the other group makes decisions based on that data. If the whole process cycle is not completely communicated to employees, they are not able to see the importance of the single steps that are involved during the process. According to the interviewee, issues like these require better leadership skills rather than a complete knowledge of Information Systems.

“The biggest question is ‘how do we communicate the importance of doing things right to our employees’. It is not easy to get thousands of employees to do things correctly. --- Management of change is also needed when new technologies are introduced and implemented – I would say that we should always remember that there is a human to work with these systems. Human beings are relatively intelligent and they always want to know the reason for why something must be done like it is done.”

Alpha has different strategic periods and they do strategic planning in three-year periods. According to the interviewee, however, a three-year period is too short for strategic

planning since a major portion of company's resources is bound to multiyear projects. The interviewee also stated that their current strategic planning is reminiscent of tactical planning.

"Strategic decision is more likely, what kinds of capabilities we need to create or acquire if we want to increase our market share in five years. It's always about resources."

Alpha's business is highly volatile due to upswings and downswings in the general market trend. Therefore, Alpha wants to be well aware of current and upcoming trends. They have a spreadsheet program for this purpose – or, as they call it "*Excel-based Information System*" - which is updated manually.

"The goal of strategic decision-making is to retell current market trends. On the other hand, we live from tactical decision-making, which steers us towards predetermined strategic goals. --- The next challenge is to find the most important issues, which should be reviewed, because today's world enables us to supervise, follow, report or analyze these things until the end of the world."

Regarding a company's performance management, BI-systems offer a sophisticated way of gaining an enhanced insight into a current market situation. Alpha uses the "*Profit slide*" tool, which enables them to compare different scenarios. The management obtains an extensive overall picture of markets by combining external and internal data. Since a few large companies dominate this field of business, it is important to know the position of competitors as well. For example, if Alpha knows that the competitors are utilizing their full capacity, this can be taken into account when the bidding process starts. Although *Profit Slide* seems to be working, they are not operating based on information provided by it since more courage and confidence is required.

"In theory we have tools to make a very radical decision, but in practice we don't have enough courage to make decisions based solely on the numbers. For example, our system might tell us to raise margin by three percentage but we don't dare to do that yet."

When it comes to BI-strategy, Alpha analyzes its current state. They have also determined the next BI-steps in their strategy. Moreover, the company is willing to drive technology-based solutions in order to perform more efficiently. According to the interviewee, the recent IS-development has progressed as planned in their strategy. The company has focused especially on financial reporting. The management needs both financial and management accounting figures to support their tactical decision-making on a daily

basis. Reporting is also needed when the requirements of external stakeholders, such as the authorities, are met.

"I have to say that luckily Business Intelligence and Information Systems are nowadays easy to understand even if you are just a basic engineer. Of course we have to talk about it (technical issues) but mainly the latest applications are easy to adopt."

When thinking about the strategic alignment between the technology and business strategies, Alpha's technology strategy supports its business strategy. On the other hand, it is obvious that the company has gained a major internal advantage in performance due to IS reorganization. During the last five years, Alpha has reduced the number of its employees by hundreds, mainly those from administrative positions. The change could not have been made without streamlining and reorganizing the company's processes. For example, Alpha's management has decided to digitalize the back office function in accordance with the improvements in IS.

Alpha's data is currently managed in separate databases, which are based on the operational functions. Moreover, databases supply data for the reports and management dashboards. The current reporting tool has a drill-down function, which is vital for ad hoc reporting as new types of problems arise.

External data is required for the market pricing. This data can be utilized in many ways, but only at the business function levels since the process is mainly manual. As a whole, external unstructured data is not fully utilized – the interviewee gave an example of the manual process, which includes a manual step of collecting pieces of relevant business news. On the one hand, business analysts are responsible for the manual evaluation of competitors' strategies by examining their financial statements, annual reports and press releases. Additionally, Alpha collects internal structured data effectively. The main internal sources of information for decision-making are operational systems such as ERP and CRM, which collect data from multiple sources. Alpha stated that they do not define different data sources by their importance even if it would be useful; however, they know that they are collecting a large amount of irrelevant data.

4.3.2 Case Beta

The interviewee in the second case company plays a major role in her company having over 800 subordinates. She is personally in charge of developing current operational activities and, furthermore, she ensures that her division goes along with the company's strategy. According to the interviewee, the company has issues with internal efficiency. Many stages of the work are still executed manually, which is not an optimal alternative

resource-wisely. On the contrary, the importance of leveraging the latest BI-related phenomena, such as *big data* and different analytical solutions, is recognized in the company. From the computational point of view, Beta has slightly outdated ICT. It constrains them especially when data is collected and refined for further actions. According to the interviewee, in Beta BI is considered as a set of tools and procedures that are utilized by the analysts when insightful information is provided to the decision-makers. She also adds that on the one hand BI is an ongoing process including multiple stabilized process steps, but that on the other hand, BI plays a major role in the solving of new types of problems on an ad hoc basis.

Beta operates only in Finland but also collects information from abroad. It has numerous different customer segments that are more or less homogeneous. Additionally, the customer base remains constant year after year. These facts restrain Beta's business and create great challenges – new business opportunities are not easily created. The safest way to keep stakeholders satisfied is to perform more efficiently. Currently, Beta has only three analysts responsible for creating analyses to support decision-making. The interviewee also stated that there is always a need for human reasoning, even if the BI systems work well.

“We can't fully utilize our customer opportunities due to the limitation of available resources. Our focus is to maximize profit by using as the minimum amount of resources as possible. That is the core of our business.”

Beta has aligned IS technology with the company's strategic pricing operations by creating a tool called *Business Machine*. The tool gives them operative and tactical guidance through analyzing data and different business rules, which are defined by the domain experts. The interviewee stated that data about the customers, which is collected through various systems, is the most extensively analyzed data in her division. However, manual work still exists when the spot checks to data and ad hoc queries are performed. Furthermore, inconsistency in data analyses always requires further investigations. As a result, current BI-related activities provide only a little assistance to company's long-term strategic planning and decision-making since the strategic period is five years.

“Decision-making is partly intuitive, but we have also a great amount of data that we can continuously utilize by drilling-down into it. That gives us an insight to different phenomena and gives guidance to our actions. --- We should have more numbers to support our decision-making.”

When it comes to Beta's internal business performance, which is one of the focus areas in the company, it could be more effective. The interviewee stated that they need more

information about markets, customers or their internal activities that would support decision-making. Even the simplest parts of CRM are still lacking – Beta cannot follow their customers' behavior based on historical data. On this account, unprofitable offices and actions still exist. Therefore, the modifications to organizational strategy and structure, based on actual numbers, cannot be made.

The previously mentioned *Business Machine* is an example of a sophisticated application that collects and analyzes data from various sources, providing support to decision-making. Beta has the ability to analyze unstructured data through a text-mining tool, which allows them to analyze customers' sentiments that are in written form. In addition, market movements and trends can be predicted as well, if the company considers it vital for its business. From the available data sources, the company uses its own databases, which collect information not only about their internal operations, but also from the authorities. Many of their clients give the needed information directly to Beta. This, in turn, enables better customer service. Transparency between Beta and its clients is a weighty factor in two-way interaction. In some cases, data, given by the customer, needs an extra security check because there is a possibility of data manipulation: the future customer transactions are based on the last year's numbers. According to the interviewee, one solution to this threat could be a direct access to clients' data and vice versa. Unfortunately, the company's current IS environment does not provide a solution for this problem.

“It would be reasonable to have a full access to all possible databases. That makes possible to serve our clients better and faster... this is still very wishful thinking but probably possible in the future. There are still many issues to be solved and privacy policy is not the first one on the list.”

The nature of Beta's business also affects their Information Systems acquisition policy since the benefits of investments are nebulous. Even the short-term marketing campaigns are hard to measure. The interviewee gave an example, which illustrates the problem.

“The (financial) numbers of investments are not easily measurable. That is why we can't prove acquisitions to our steering group. The same problems apply to marketing because we don't have the ability to measure and calculate the general effect on our other customer segments. Only regional marketing campaigns can be measured. Problems arise because we don't have capabilities or suitable Information Systems”

Beta's market position constrains their access to certain information and requires well-managed Information Rights Managements (IRM)⁹. Even though the analysis phase in the company is mainly automated, many employees are designated as being responsible for collecting data according to data privacy policies. As a result, mandatory actions are significant items of expenditure in the company's Income Statement. However, Beta has already downsized without having a negative impact on business operations. On the other hand, the company has released its resources to more profitable operations by automating processes. Nevertheless, the intangibility of the benefits of IS applications challenges Beta when business cases are created for proving the importance of future acquisitions.

“We have mandatory actions that are needed to carry out by our employees. These are not the most profitable for us but we have to do these. There is no sense in automating these by creating Information System worth a million euros if we can't see positive Return on Investment. -- In many cases it's not a question about ROI, it's a question about proving ROI to the ICT steering group”

In additions to automation, Beta has gained efficiency by streamlining its operations. These changes could not have been made without the recent development of Information Systems or computer applications. For example, a few years ago, when incoming post wasn't digitized, tens of employees were designated as being responsible only for scanning and typing information into databases – now the human resources can be utilized more wisely. Recent resource reallocation has constituted a remarkable change in the company's organization structure. Today, employees can focus more on data collection, validation and loading phases. The change also provides more accurate information for BI systems and furthermore for decision-making. Additionally, the recent automation has reduced the number of human errors.

Currently, Beta's strategic and tactical decisions are based mainly on managers' own intuitions. From the analytics point of view, the interviewee stated that they still need to learn and improve. Beta's competitors, which mainly operate overseas, already have Business Intelligence Competence Centers (BICC) that focus solely on creating intelligent information from data. The interviewee admitted that especially the field of analytics is still a *black hole* and requires a significant amount of work before they reach the level of the top-performing competitors. On the other hand, she stated that it is important to keep Business Intelligence and analytics next to their core business even though a pure use of those does not lead the company to achieve the desired results. From the managerial perspective, the company wants their employees – especially the ones who work with the

⁹ **Information Rights Management (IRM)** A set of procedures, which aims to protect companies' highly sensitive information (Network Intelligence 2012, 5.)

data – to understand precisely the business side of numerical analysis. Currently, Beta’s employees have a strong number-oriented background and the company uses resources educating them about the core business – if the market analyses are not rationalized, they will remain only partly understandable and might mislead decision-makers.

“We need to have the same language with the analyst team. There is no point to get the state-of-the-art systems and the best employees if we can’t understand the systems. It’s easy to calculate a number 16 but the question is what does it mean to us and what decisions we should make based on this number. We have the same problem that many organizations have: the management can’t see the reasons for the analysis and analysts can provide the information. There should always a connector between analysts and management.”

4.3.3 Case Gamma

Case Gamma is described based on the interview of the Head of Division from a service sector company. Nowadays the division employs more than 120 employees in the Helsinki Metropolitan Area. In total, the company has tens of thousands of employees. The division, which is run by the interviewee, practices internal and external businesses and provides services not only for customers but also for other company divisions. The interviewee has a long background in the case company. He joined the company in 1986 and has worked in his current position for six years now. Many of the interviewee’s previous work tasks are related to information systems and IS development. On top of that, he is a part of the steering group, which sets targets and goals for other divisions as well. Therefore, the interviewee’s background and current position provide a good view on the decision-making environment in case Gamma.

According to the Head of Division, they use and analyze internal and external data extensively in Gamma’s division. He also stated that the division knows what constitutes the most value added data for them. This data is not only vital for the internal operations and performance management but also for providing services. From the perspective of internal operations, the company has a centralized reporting tool that provides general information for its divisions. The centralized reporting tool does not fully satisfy the interviewee’s demands and therefore division-specific reporting tools are used. Due to the use of multiple DSSs, the managers have to allocate their time to combine data and information. The interviewee stated that the processes are often overlapped and therefore frustrating. Due to the unstable DSS environment, the division has tailored its own project management system, which provides information about the current projects.

“The centralized reporting is not working properly and manual work is still needed to stylize the reports. The situation is not the best. --- We also have a tailored system to give information about our ongoing projects. In this way, we get accurate information about costs and human resources. --- To get the systems work properly, we should improve our organizational collaboration”

The tailored project management system provides predetermined performance indicators for the project measurement: numbers of employees, used person-hours, average project volumes and direct project costs. As a result, the manager is able to visualize the specific unit costs, which are required in the calculation of the following project prices and offers. Currently, the tailored system is in use only in Case Gamma’s division. Hence, the interviewee’s opinion is that each division in the company has its own BI environment, which varies in accordance with the division’s core business. In Gamma, BI is viewed as a set of different tools and technologies. Furthermore, both the company level reporting and budgeting tools and the tailored information systems are the most visible part of BI. In addition, from his point of view, the importance of the information dissemination phase is often underestimated when BI is viewed as a technological solution.

However, the interviewee stated that the other divisions could use the tailored system as well, although the company does not require its divisions to report on the accurate numbers of ongoing projects. However, if the other divisions used the system, it would need tailoring when it comes to performance indicators and other parameters. The interviewee stated that in addition to the measurement of the projects, the system helps him to identify possible market opportunities especially within the current customers-base since the contracts are usually perennial. The interviewee is concerned about the future of their project management system since the system ownership has become lacking. Overall, the knowledge sharing among the co-workers should be better. The importance of sharing knowledge is highlighted in the company since the policies are lacking or inconsistent.

“The system maintenance is a time-consuming and challenging process. We do not have the needed resources to keep on the development work. Actually, the developers are going into retirement in the near future and therefore we have an acute problem of continuing the IT life cycle of a system.”

According to the interviewee, the managerial activities are not easily categorized, neither in the division nor at company level. The vast majority of his decisions, which he considers as tactical decisions, are driven by daily operations. Additionally, he stated that the key to successful decision-making in their environment is to act proactively. However, the long-term strategic decisions, which are made every four years, require more preparation. As stated by the interviewee, the length of a strategic period is too long in today’s

business environment, because the customers play a major role in changing the markets. He also said that the division has not focused on developing their current BI-environment and the main role of IT is to support daily operations. However, he admitted that the strategic use of BI would be more important in the near future. All in all, the decision-making, with or without computers, should be more proactive highlighting the customer viewpoint.

“Proactiveness, anticipation and planning should always be included in decision-making. In our company, those activities are lacking many times and it bothers me. Often we just extinguish a fire rather than solving the whole problem. Many times our solution is only to jump from a stone to another.”

From the interviewee’s perspective, problems arise when goals and targets are set at the company level. Even though the Heads of Departments are involved in the division level steering groups, their decision-making power is low. He also stated that since the general market trends drive the business, the division budget varies from year to year. Hence, their approach to the division level decision-making is to be as effective as possible within the proposed annual budget. He also highlighted that the collaboration between internal and external stakeholders needs to be good in spite of the annual budget.

In addition to internal operations data, the division produces data and information that are required when new services are established. They also use the external data to guarantee that the level of services meets the requirements. From the data policy viewpoint, the division plays a role in the data sharing since it is the most important data producer of the company. The interviewee accentuated that the current data sharing process is still in its infancy and not working properly. Therefore, the company needs a centralized solution, which other divisions could use as well.

“Typically, a division produces data but they don’t have the capability to distribute it systematically. I am one hundred percent sure that we should have a centralized solution. Particularly in our company, in which many divisions lack the necessary skills and people.”

In data-related issues, the interviewee is concerned about the company’s information policies especially when it comes to *open data*¹⁰ initiatives. The senior management has decided that the case division must offer pieces of data to the markets free of charge. The interviewee stated that according to the company, *open data initiatives catalyze economic*

¹⁰ **Open data** A piece of data or information that can be used, reused and redistributed by anyone for free (Bauer and Kaltenböck 2012, 10.)

activities by developing current services through old and new applications. On the one hand, the interviewee admitted that the co-operation between companies and the authorities would improve if there were an easy access to data. As a result, it would lead to improved overall business performance since the duplicate data producing processes are minimized. On the other hand, however, he was skeptical about the assumption that the companies would perform more successfully through open data.

“It is more assuming than knowing since the researched facts are lacking. Due to its (open data) intangible nature, a comprehensive study cannot be done. Everyone assumes that the economic benefits of the new business opportunities will exceed the direct sales proceeds, which will be vanished.”

According to the interviewee, the decision-makers often ignore the overall costs when implementing the new information policies and procedures. When the company instructs their divisions to change processes, the direct and indirect costs are considered to remain the same. In reality, the outcome may be very different in comparison to that which was initially expected. The interviewee stated that when data is published, they have to continue to work on it. The data quality and validity are ensured by the continuous maintenance process, which ties up their resources. This means, that if the labor force is not increased, they have to reallocate the current resources.

“When the open data projects are started, the costs are not obvious. From the data provider perspective, the activities are often associated with considerable operation costs. Once data is published, we have to guarantee that the data structure is up-to-date and the distribution channel is working properly.”

4.4 Case Study Findings

4.4.1 Technology

From the theoretical point of view, the advantages of Business Intelligence and Decision Support Systems are understood similarly in all case companies. Firstly, the case companies face similar difficulties in their computer-aided decision-making environment. Secondly, all companies have envisioned their desired states but they lack the tools, resources and capabilities required in order to achieve the desired results. As a result, it was revealed that all companies suffer from an information gap (Pirttimäki 2007) especially, when it comes to strategic decision-making. Due to the information gap, the

BI-process does not provide all the information that is *wanted* and *needed* for successful decision-making.

However, in Alpha and Beta BI is understood as Gilad and Gilad (1988) define it: On the one hand, it is a set of different information systems that enables the analysts to collect and analyze important data and information. However, on the other hand, it is an organized process that involves and integrates best practices among employees and managers. On the contrary, in Gamma BI has a more technology-oriented nature since it is understood as Serbânescu (2008) and Power (2007) define it: BI consists of different tools and applications that are in use in the different departments of an organization.

Since the systems do not meet the requirements of the management, the constraints were discussed. All companies revealed that the problems are usually linked to the internal resources and capabilities. Furthermore, in case Gamma, the interviewee stated that the company policies constrain their division-level decision-making. Additionally, the interviewee of case Alpha specified that the actions of employees complicate the situation when rules, which are commonly agreed upon, are ignored. He added that for this reason, the importance of leadership skills are highlighted when a company develops its current systems or creates a new one.

All case companies collect data from multiple data sources, which are mainly internal. Additionally, some unstructured data is also used; the analysts of case company Alpha use unstructured business news to provide the decision-makers with market reviews and customer analysis. On the other hand, Beta uses unstructured data through a text-mining tool but only for tactical purposes. From the strategic point of view of data utilization, the importance of manual work is highlighted, because the most value-added data is usually unstructured and hence manual steps are involved. Even if the possibilities of utilizing unstructured external data were recognized, none of the companies could utilize it at desired level. The interviewed managers are aware of BI's positive implications for decision-making, but they are not able to prove a positive return on investments since the nature of possible incomes are intangible. The interviewees of Alpha and Gamma stated that finding a good business case is a key to prove the positive return on investment. Moreover, they said that BI-related investments are moving closer to their core businesses since sophisticated systems are necessary in the solving of specific business problems.

All case companies have complex BI-processes, which are required when the data is processed into a usable form for decision-making. The quality of data raised concerns among the interviewees especially when external data was discussed – when there is a need for manual work, the possibility of human errors exists. The interviewees of Alpha and Beta agreed that the problems are often human-specific rather than technology-specific. The interviewee of case Alpha added, that humans make the errors and therefore the processes should be well-managed. Additionally, he stated the systems should include the functionality, which would force employees to take the right courses of actions. In

turn, the interviewee of Case Beta is concerned about their external structured data collection process since the customers can provide wrong information. This allows their customers to manipulate upcoming bills. In addition to this, the interviewee of Gamma is concerned about their current reporting tool, which is not working properly. In contrast, the managers in Alpha have access to the financial figures, which they can investigate on an ad hoc basis through the reporting tool. All in all, all companies use different problem-specific tools and systems in order to aid their decision-making. According to the interviews, these tools are usually implemented since they are easy to update and manage. The interviewee of Gamma added that it is often the fastest way to solve problems since it does not require a system procurement process.

The interviewees can mostly trust the data they use in decision-making although they are not fully satisfied with the current processes. None of the interviewees said that data itself restrict their daily decision-making. In case Beta, random spot-checks are still needed when external customer data is validated. Moreover, the interviewee is confident that the most sophisticated analytical systems with the relevant algorithms would solve the problem. However, the company lacks resources and capabilities and hence has not reached the needed maturity level, which is needed for the implementation of analytical solutions. All in all, according to the interviewees, the validity and reliability in data decrease when multiple manual data refinement steps are involved.

The managers, as all employees who have decision-making responsibilities, require trustworthy data in order to know the truth about a specific situation. In terms of data analysis, it revealed that the analysts of the companies might easily end up with different conclusions even when having the same data. From the managers' point of view, all agreed that contradictions in data analyses always require a further analysis. The interviewee of Beta added that when being faced with contradicting results, all process steps should be evaluated and changed if needed. All in all, the mutual agreement is that data must be reliable and valid or else the decision-making process becomes fragmented.

Table 4 Case study findings - technology

	Alpha	Beta	Gamma
The company collects data from multiple internal and external sources. (A1)	Yes	Yes	Partly
The company collects data from multiple structured and unstructured sources. (A2)	Yes	No	Partly
The company's decision-makers can trust collected, gathered and processed data. (A3)	Partly	Partly	Yes
BI-processes are well defined and managed. (A4)	Partly	Partly	No
Technology provides information, which is needed in order to solve the ill-structured problems. (A5)	Yes	Partly	Partly
Total	4	2,5	2,5

4.4.2 *Individuals and roles*

A successful decision-making process requires that the process roles are well-defined. As it appears in the theory section, the managers have the final call when strategic decisions are made. Nevertheless, decision-making is a collective process, which involves employees with different backgrounds from various teams. According to the interviewee of Beta, analysts usually have a strong analytically-oriented background. That type of background is needed when the different analytical models and numeral details are evaluated. Furthermore, she added that sometimes the background might restrict the analysts from thinking *outside of the box*. Other interviewees also stated that the cooperative teams, which assist decision-making, should have both analytical and business knowledge about the problems. All interviewees stated that the secret of putting together a successful team is to sense the chemistry between team members. Even the team with the most competent experts might fail if the team members cannot work together. Moreover, the interviewee of Gamma stated that he, as a manager, is often concerned about the dissemination phase of a BI process (see Figure 3): if the results cannot be disseminated to the right decision-makers, it is obvious that the managers cannot make the decision based on the actual numbers.

In Alpha and Beta the managers are not involved in BI-related development projects or processes due to their busy schedules. They both admitted that it would be reasonable to take part in the projects inasmuch as it would provide a better view on the systems they are using. Furthermore, the unexpected usability problems could be recognized at as early a stage as possible. On the other hand, Gamma's interviewee stated that since he has the knowledge of their current systems and a proper background, he feels that it is his duty

to participate in the projects. He added that, as a project facilitator, he obtains a good view of the process and furthermore becomes acquainted with the project members. All in all, in the interviewees' opinion, the systems are easy to both use and adopt, regardless of users' background.

According to the interviewees, the Business Intelligence roles of decision-making are clear but the managerial input in the process is lacking in every case company. This might lead to a situation, in which the most important and value-added information cannot be provided. Additionally, all interviewees have a BI ownership problem. Especially in Gamma, in which case the company-level policies and procedures affect the work of an independent division. On the other hand, however, Alpha and Beta's interviewees hope that in the future, they would have a group of dedicated people to work solely with their internal Business Intelligence. This would allow the employees not only to concentrate on the system development but also to find new solutions, which would enable the companies to perform more efficiently. As case Beta revealed, there is evidence that even complicated business problems could be solved with the help of the sophisticated and systematic use of BI-driven analytics. Partly due to lacking ownerships, companies are not able to harness the full potential of their current BI-systems.

All case companies offer technological training if needed. Moreover, case Gamma, which is an expert organization, has a unique problem since the vast majority of employees have their own dedicated responsibility areas. The interviewee stated that due to this, the employees themselves do not actively seek training because they do not want to leave their work tasks. In contrast, Beta offers exact education about their business to its analysts. In Beta, the internal information sharing is considered as being an equally important source of information and knowledge as the external training sessions are. In contrast, in Alpha external technological training is provided if needed. Furthermore, the interviewee said that he encourages his subordinates to apply for suitable training sessions. From a wider perspective, all interviewees are concerned about the knowledge transfer between divisions and departments, which cannot be solved by the mere use of computers. As in all companies, the teams work well together but there is little co-operation among other teams and divisions.

The co-operation is not perfect if the managers and the analyst have a different business language. One mutual concern among the managers is how obtain a full understanding of the analyses. Even if the roles are well defined, there seems to be critical issues regarding the communication between managers and analysts. Due to communicative misunderstanding, the best performance of BI-systems might not be present. Additionally, if the results of the analyses are suspicious, further investigation is required. According to the interviewee of Beta, the problem may sometimes occur simply because of differing mindsets. On the other hand, each company has a slightly different perspective on

education and training. The attitudes reflect the companies' desired states of the BI environment. In Alpha and Beta, the managers know what skills are required and hence such education and training are provided.

Table 5 Case study findings - individuals and roles

	Alpha	Beta	Gamma
Decision-making roles are well-defined. (B1)	Yes	Yes	Partly
Managerial roles are well-defined in the steps of a Business Intelligence process. (B2)	No	No	Yes
Roles and responsibilities are defined by the steering group. (B3)	Partly	Partly	Yes
Technological training is provided when needed. (B4)	Yes	Partly	Partly
Business content related co-operation between the managers and the analysts is good. (B5)	Partly	No	No
Total	3	2	3

4.4.3 Strategy

All case companies have a similar definition for the term *strategy* although the length of a strategic period varies between companies. Nevertheless, all interviewees take part in strategic planning, which affects daily operations in their responsibility areas. Furthermore, they all consider strategic decision-making as a continuation of tactical decision-making. When tactical decision-making consists of daily and weekly decisions, a strategic success is the sum of all these decisions. Additionally Alpha and Beta mentioned that strategic decision-making provides wide guidelines to their short-term decision-making. Additionally in Alpha, tactical decision-making is considered as an aiding tool, which is used when the strategic goals are reached.

Currently, none of the companies has reached that maturity level, which would enable them to make strategic decisions, or even tactical decisions, based strictly on their Business Intelligence Systems. In other words, BI provides only restricted help in the solving of ill-structured problems, but from the strategic viewpoint, the companies have acknowledged the possible advantages of using BI systems as a part of decision-making. None of the companies has gained any strategic advantage by the sole use of their BI Systems. Furthermore, the deliberate decision, that BI's role is only to support the case companies' strategic decision-making, has been made. In Alpha, strategic decisions could be made

based on the current systems; the interviewee stated that since this approach is new to them, they need more courage before it can be fully implemented.

None of the case companies has defined the most value added information for their decision-making. In Alpha and Beta, the interviewees stated that they have not thought about such an approach but it would be useful. Additionally, in Gamma the interviewee's division makes a clear separation between data, which they need for the management and data, which is used for providing services. If the case companies do not know their own data, the field of computer-aided decision-making remains fragmented. As an example of this, companies present BI Systems provide answers to questions such as '*what have we done*'. The most insightful strategic decisions remain untouched since the companies cannot answer questions such as '*what should or could we do*' or '*what will happen next*'. Due to this, BI systems do not assist in the *choice* phase of strategic decision-making and therefore the alternatives cannot be extensively analyzed. As Simon (1960) stated, the choice phase is the most demanding part of the decision-making process because all alternatives are evaluated. It is important to note that BI can never replace personal goals or beliefs (see Baron 2000), which are included when the inferences from and about the alternatives are made. Nonetheless, the interviewee of Alpha stated that they can create different scenarios, which answer to questions such as '*what would have happened with or without this*'. The next logical step is to seek aid through BI when strategic decisions are being made.

In relation to this, none of the companies drives their Business Intelligence capabilities to align their actual business requirement. Therefore, it is obvious that the case companies cannot fully utilize BI's ability to create new business opportunities or to gain competitive advantage. Nevertheless, Alpha and Beta not only expressed their desire to utilize BI in strategic decision-making but also to align it with the real business needs. In contrast, the interviewee of Gamma sees the future differently. He is skeptical about the future of sophisticated BI in his division because of tight annual budgets. All in all, the overall utilization of BI in external operations is negligible.

The most visible BI-related strategic impact on the case companies' operations is linked to internal operations. In all companies, the interviewees have made decisions, which correlate strictly to the company's internal efficiency when either the fixed costs are reduced or the workforce is reallocated. In addition, the unprofitable processes can be tracked through the basic reporting solutions. As an outcome, gross profits are increased and the employees have time to concentrate on work, which is more profitable. Thus, BI has a double-sided influence on performance. Companies can find new external business opportunities and increase their revenues. Alternatively, companies can improve efficiency that will lead to higher profits or lower costs. As the first interviewee stated, BI does not provide any competitive advantage itself and therefore the correct resources are required in order to achieve business benefit through it. All in all, from the *management*

control viewpoint (see Figures 7 and 8), the managers can ensure through BI that resources are being used effectively and efficiently when they are reaching business targets and goals.

In terms of the current use of BI, all companies mentioned that BI Systems empower their decision-making despite the fact that data cannot fully be utilized in strategic decision-making. For example in Alpha, current decision-making processes involve manual work when the analyses are performed. Furthermore, the managers in Alpha do not have simultaneous access to structured and unstructured data and hence the analysts have to analyze valuable market data manually before it can be used in decision-making. Moreover, all case companies mentioned their intentions to improve the use of external data. As a whole, even though the direct strategic benefits of BI are lacking, it is important to notice the indirect benefits. As the interviewee of Beta stated, *even the direct benefits through BI are difficult to measure, the strategic decision-making process needs it or the available information is inadequate*. Partly because of this, BI systems play a supportive role rather than an enabling role in decision-making, and therefore the potential benefits remain limited.

Table 6 Case study findings - strategy

	Alpha	Beta	Gamma
The manager has defined the most value added data for strategic decision-making. (C1)	No	No	No
The company has aligned its business needs with the capabilities of Business Intelligence. (C2)	Partly	No	No
The company has gained competitive advantage using BI as a part of decision-making. (C3)	Partly	Partly	No
The Business Intelligence vision is defined and it is a part of the company's business strategy. (C4)	Yes	Yes	Partly
The company has identified new business opportunities through Business Intelligence. (C5)	Partly	Partly	No
Total	2,5	2	0,5

4.4.4 *Organizational structure*

Since the IT industry has developed enormously during the last decades, it has provided companies with new opportunities. The general improvement in IT has also enabled companies to restructure their organization and its divisions. As all interviewees stated, changes in organization structure enable companies not only to reallocate their competencies and resources, but also rethink their current operations. Both of these activities affect companies' internal efficiency and performance. All case companies admitted that they have gained efficiency through workforce reallocation or by abolishing unprofitable activities. The change has been remarkable especially in Alpha, where the number of employees has decreased by hundreds after the interviewee started the organizational restructuring. Due to this, it can be stated that in Alpha BI plays a significant role in a managerial *direction* activity. As Scott Morton (1991, 12-13) stated, through the *direction* activity, companies can connect vital business information about their internal and external environments to their activities. In contrast, in Beta, a CRM system lacks historical transaction data about stores and therefore unprofitable stores and offices can not be tracked.

According to the interviewees, the focus of BI has moved from the back-office towards the middle- and front-office activities – it has traditionally been thought that the purpose of BI is solely to provide valuable data and information. Based on the interviews, the case companies have had the majority of resources tied to back-office work duties such as data collection and refinement, but recent investments in IS have enabled companies to automatize these activities. Due to process automation, the decision-making accuracy has increased as the number of errors has decreased. Moreover, BI plays a major role when new operations models are developed. The result of restructuring organization structure has led all case companies to make faster decisions. For example, in Alpha, the middle management has the same reporting environment, which enables the top managers to access directly the most up-to-date information. This allows decision-makers to act based on the actual numbers regardless of the organization level.

Alpha is the only company, which has a separate group of people in charge of the company's BI activities although they have other work tasks as well. The interviewee mentioned that a portion of analysts' working hours has been allocated to solve BI-related problems. However, none of the case companies has a separate Business Intelligence Competence Center (BICC), whose responsibility would be solely to concentrate on developing the company's BI providing better BI-related performance across the company. Due to this, the BI-related problems are solved mainly locally leading to an inharmonious BI environment.

The role of BICC is emphasized especially when problems arise and ad hoc -queries are required. Furthermore, the managers tend to solve content-related problems themselves while the technology related problems are forwarded to the analysts or IT personnel. According to the interviewee of Beta, the focus of solving BI-related problems lies too often on developing a single analysis rather than the systems or process itself. In her company, the problem is related to insufficient organizational resources: the analysts should develop BI alongside their daily work tasks. All in all, the structure of BI varies in the case companies but, nevertheless, several commonalities are found as well.

All interviewees admitted that the role of BI is not only to support the decision-making process by providing valuable information. From the organizational viewpoint, it should also force the employees to take the correct actions regardless of the level of their organizational hierarchy. If all employees act as agreed, the divisions can co-operate better and the organizational transparency increases. Currently none of the companies has a company-wide collaborative solution for BI environment and therefore the drawing of a comparison between different organization units is difficult. On the other hand, it has a direct effect on the speed of decision-making because the analysis processes vary from time to time. Moreover, the interviewee of Beta stated that because the processes vary, there are no standardized problem-solving procedures. Due to this, the decision-makers need to understand the steps that are included in the process. Furthermore, the interviewees of Alpha and Beta stated that the irregular nature of computer-aided decision-making processes is both frustrating and time-consuming since the errors cannot easily be tracked.

At the moment, Alpha is the only case company that has started to harmonize its BI-operations but it takes several years before a collaborative solution can be implemented. Through the harmonization of BI, Alpha aims to achieve a unified platform, which would make data transfers between organization units possible. The interviewee of Beta, on the other hand, sees the harmonization as a prerequisite for further BI acquisitions. She stated that no system solves the problems that they currently have in their internal operations. Additionally, in Gamma the decision-making problems are often related to organizational rigidity. He coined the term *boundaryless organization*, where the data and information accesses are not restricted by a predefined organizational structure.

Table 7 Case study findings - organizational structure

	Alpha	Beta	Gamma
Business Intelligence has created value (e.g productivity, efficiency) by restructuring the organization. (D1)	Yes	Yes	Partly
The company has aligned its organizational factors to make decision-making more effective. (D2)	Yes	Yes	No
The company has a separate group of employee, which is responsible for Business Intelligence (BICC). (D3)	Partly	No	No
The company has a collaborative solution for its BI environment. (D4)	No	No	No
The organizational structure supports computer-aided decision-making. (D5)	Partly	No	No
Total	3	2	0,5

4.4.5 Summary

From the decision-making point of view, data can be utilized, at least partially, regardless of the decision type. It is obvious that the companies face challenges in the BI processes. Especially the communication between managers and analysts constrains the process; even the best analysis might fail if there is a communicative misunderstanding between managers and analysts. For these reasons, all the process perspectives should be acknowledged and analyzed.

All three case companies were evaluated through an evaluation model, which was composed based on the theory and the MIT90s model. The evaluation model, as the MIT90s model, includes four different components: *technology*, *individuals and roles*, *strategy* and *organizational structure*. Each component includes five different statements, which are evaluated on the basis of the interview. Furthermore, these statements are scored based on the input given by the case interviewees: if the statement is *true*, one point is given; if the statement is *partly true*, half a point is given; otherwise, no points are given. The maximum score from each of the categories is five, which is the number of statements. As an example of this, Alpha's score in the technology component is 4,00 because three statements are *true* and two statements are *partly true*. Figure 13 visualizes the scores by each company and the averages of model components. Moreover, a dashed red line is the median point (2,50), which separates the enablers from the constraints.

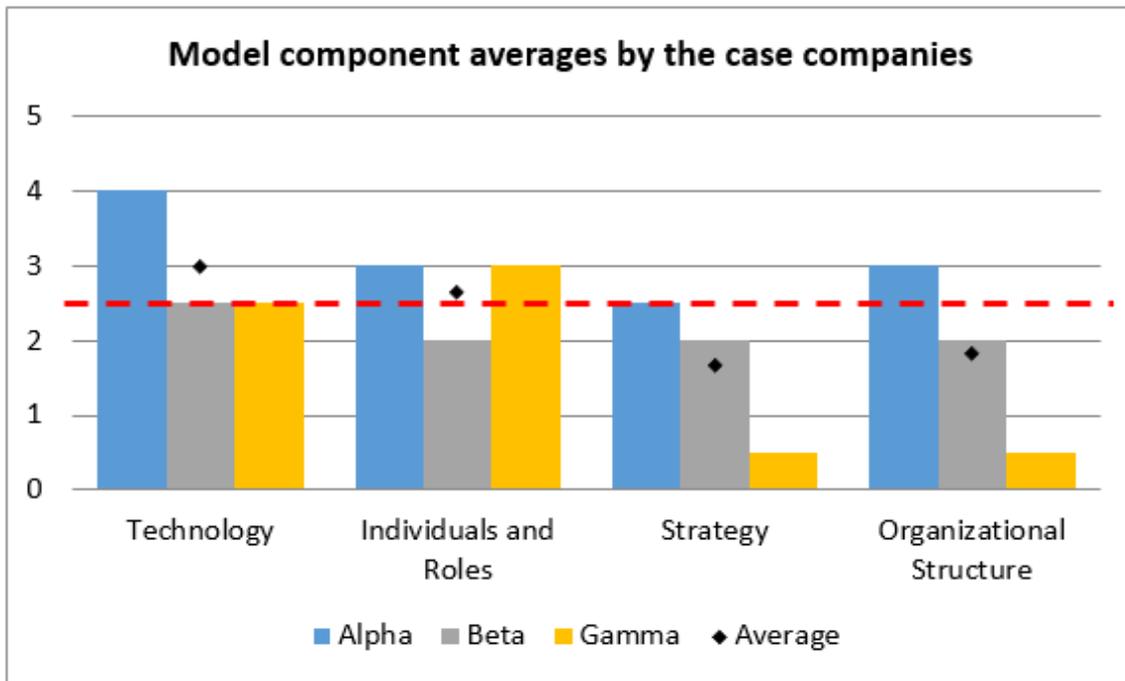


Figure 13 MIT90s model components by the case companies

Even though a comprehensive comparison cannot be made, the case companies are illustrated together in Figure 13. As it appears, the technology component has the highest average (3,00) when the case companies are evaluated. In contrast, the case companies have the lowest average (1,67) in the strategy component. Moreover, Alpha has the highest total score (12,50) over all components and Gamma has the lowest score (6,50). All in all, the differences are obvious when managerial decision-making is examined. The exact scores, totals and averages are summarized below in Table 8 and Table 9.

Table 8 Scores, totals and averages - case companies

	Technology	Individuals and roles	Strategy	Organizational structure	<i>Total</i>	<i>Average</i>
Alpha	4,00	3,00	2,50	3,00	12,50	3,13
Beta	2,50	2,00	2,00	2,00	8,50	2,13
Gamma	2,50	3,00	0,50	0,50	6,50	1,63

Table 9 Scores, totals and averages - model components

	Alpha	Beta	Gamma	<i>Total</i>	<i>Average</i>
Technology	4,00	2,50	2,50	9,00	3,00
Individuals and roles	3,00	2,00	3,00	8,00	2,67
Strategy	2,50	2,00	0,50	5,00	1,67
Organizational structure	3,00	2,00	0,50	5,50	1,83

As appears from the tables, the technology (3,00) and individuals and roles (2,67) components can be considered as enablers since they scored averages above 2,50. On the other hand the averages of the strategy (1,67) and organizational structure (1,83) components are far below the median point 2,50. Since the cases are equally weighted, Gamma's scores significantly reduce the averages of the strategy and organizational structure components. As the interviewee of Gamma mentioned, it is noteworthy that these two components are heavily affected by the company-level policies and procedures. However, a comparison between the individual case company and the component averages can be found from Appendix 1.

When compared to the theory, the constraints and enablers affect managerial decision-making (see Anthony 1965) through a BI value chain (see Powell 1996) and the management process components (see MIT90s model). Additionally, the utilized data sources, which are introduced in Chapter 2.1.1, provide the initial input for the managerial decision-making processes. As a result of this study, a data-driven framework for managerial decision-making is introduced below in Table 14.

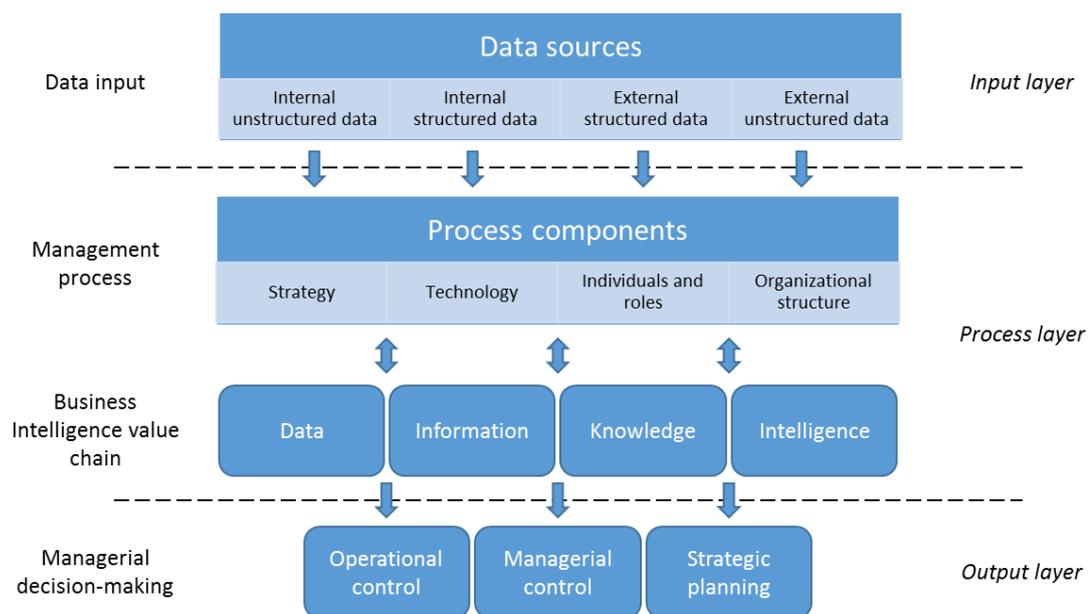


Figure 14 A data-driven framework for managerial decision-making

The framework consists of four different interrelated stages: **data input**, **management process**, **Business Intelligence value chain** and **managerial decision-making** as an output. Multiple data sources, which are the basis for computer-aided decision-making, are utilized in order to create an extensive picture of the current situation. In addition, data is collected from internal and external data sources regardless of its degree of structure. The management process and Business Intelligence value chain are the stages in which data is processed. In the framework illustration, two dashed lines are used to

separate the iterative management process from the data input and managerial decision-making stages, which are an input and an output of the process.

On the one hand, the management process itself provides neither adequate data, information, knowledge nor intelligence for the managers if BI is not included. On the other hand, the success of the managerial decision-making process depends on BI because it produces the output as illustrated in the Business Intelligence value chain. The value chain illustrates the correlations between each step when data is turned into information and, furthermore, into knowledge and intelligence. As the double arrows indicate, the value chain is strictly connected with the management process and is therefore affected by the constraints and enablers that were introduced when the case studies were analyzed. When compared to Powell's value chain (1996, 160-162), this framework suggests that data is not always a prerequisite for information, and furthermore, information is not always a prerequisite for knowledge, and so on: the managers use the external sources not only in order to obtain data or information but also to gain knowledge or intelligence support for decision-making.

From the BI value chain process viewpoint, the concrete process steps can be seen alongside the framework. Firstly, data is *collected* from the available data sources. Secondly, the collected data is *aggregated, analyzed* and then *communicated* through an *application*. These four steps together create an iterative process, which is affected by the constraints and the enablers. However, depending on the iterative process, the end product is disseminated to the managers either as data, information, knowledge or intelligence. Finally, depending on the form of the end product, the managers *execute* the decision as a part of managerial decision-making.

Managerial decision-making consists of three different types of decisions: operational control, managerial control and strategic planning. The framework shows the BI value chain level, in which the decision-making process can be strengthened by BI. In operational control, the process provides the decision-makers with data and information that are disseminated through reporting, OLAP and ad hoc query tools. In addition to the previously mentioned tools, more sophisticated applications are required when managers are faced with managerial control related problems: for example, KPI information is monitored as a part of performance management and different scenarios are created in terms of budgeting. Additionally, knowledge can be created through analyzing customer sentiments, which are an example of an end product of text-mining tools. However, in addition to knowledge, intelligence is needed in strategic planning. In such instances, for example predictive analytics and modeling are used when the future is predicted by processing huge amounts of data.

5 CONCLUSIONS

5.1 Main findings

Nowadays the business environment is changing rapidly, creating new business opportunities, which can be utilized through the sophisticated use of Business Intelligence. Additionally, it has been proven that the companies with data-driven decision-making perform better than companies, which make decisions intuitively. At the same time, the amount of data increases and, hence, the data-driven decision-making process management has become more complicated. Furthermore, companies are faced with challenges, which are not always caused by the technological issues: Even though the most important technological resources and capabilities are identified, an organizational structure and individuals and their roles effect on the managerial decision-making process. Therefore, managers need excellent leadership skills in order to manage BI processes.

The theoretical part of this study provides multiple approaches to Business Intelligence and introduces managerial decision-making and different decision types. In addition to this, the case study analysis describes how these themes occur in a real-life context. As a result of this study, a data-driven framework for managerial decision-making is introduced. The chosen approach to BI, and hence the definition, vary between companies: on the one hand, some companies consider BI as an umbrella term, which includes different systems and processes, but, on the other hand BI is seen as a technology including various different problem-solving tools. From the managerial perspective, the visualized front-end applications are the most visible part of BI. However, managers are well aware of the fact that processes consist of many interdependent phases, which are all required when operational control, managerial control or strategic planning decisions are made.

Various BI tools are used in companies. Firstly, in operational control, BI provides the decision-makers with data and information that are disseminated through reporting, OLAP and ad hoc query tools. The managers or their subordinates make ad hoc queries to structured data when new ill-structured problems arise. Secondly, when the managers make the managerial control decisions, more sophisticated tools are required since knowledge is also needed: BI enables companies to create different budgeting scenarios, which are used when the management controls their internal resources and capabilities. In strategic planning, BI needs to provide the managers with knowledge and intelligence in order to strengthen the decision-making process. As an example of this, intelligence can be created through predictive analytics and modeling. In order to achieve successful results from these activities, a certain maturity level is required. Additionally, companies do not actively define their current data and information needs, which is a prerequisite for successful data-driven strategic decision-making.

From the performance management viewpoint, KPI's are used when current activities and company specific metrics are tracked and measured. On the one hand, companies are struggling to define specific BI performance indicators. On the other hand, BI has an indirect impact, which has been acknowledged but not specified. All in all, the benefits of BI are hard to measure exactly even though the companies are aware of BI's implications for business performance. Better performance appears in many ways: Companies are able to increase their internal efficiency through Business Intelligence. Additionally, companies can improve their external operations when Business Intelligence is utilized. In contrast, Business Intelligence's impact on performance can also be negative if the constraints play a dominant role in a computer-aided decision-making process. Thereby, the constraints should be identified as well as the enablers. The constraints, enablers, required resources and capabilities vary between companies because each company has its own business environment.

Even though the BI tools are used by individuals, an organizational structure might constrain BI. Firstly, the organizational boundaries restrict managers' access to information. Secondly, the company level policies restrict the Business Intelligence activities since the procedures are strictly regulated. Moreover, managers are cautious about investments because the fluctuating market trends affect companies' annual budgets. Furthermore, when the financial figures are reported quarterly, the return on investment is negative for many quarters before the benefits have been capitalized. Due to this, the investments are risky and difficult to rationalize. For example, when companies consider Enterprise Resource Planning systems as obligatory, Business Intelligence systems have not reached the same level yet.

In the theoretical part of this study, the main objective was to find out '*how does the Business Intelligence support managerial work when a company aims for better business performance*'. Companies use data more and more in their decision-making processes. Compared with wholly intuitive decision-making, BI enables managers to use data from multiple data sources, in structured and unstructured form, to support their decision-making processes, however all possibilities are not utilized yet. Comprehensive data utilization, regardless of the source or form, is a prerequisite for a sophisticated use of BI when ill-structured and unstructured problems are solved. Furthermore, a BI process does not provide value to decision-making if the process and its goals are not aligned with the real business requirements – the importance of alignment is highlighted especially in strategic decision-making.

5.2 Assessment of the study

The research related to Business Intelligence and managerial decision-making is challenging because the Business Intelligence terminology is not fully stabilized. From the theoretical aspect, even the theoretical definitions vary between researchers. On the one hand, some researchers define it as an umbrella term, which covers everything from the data governing policies to the front-end reporting tools. On the other hand, other researchers consider Business Intelligence as a tool or a process. Furthermore, as was revealed in the case studies, the concept of Business Intelligence is understood differently between companies. On the contrary, the concepts of managerial decision-making are stabilized among scholars and practitioners. All in all, the theoretical part of this research was not only able to define the Business Intelligence concepts but also reflected how the concepts appear in managerial work.

According to Yin (2003, 34-39) an empirical research can be assessed with four tests, which are relevant to case studies. These four tests are *construct validity*, *internal validity*, *external validity* and *reliability*. Firstly, a construct validity test assesses if the studied concepts are measures with the correct measures. Secondly, an internal validity test assesses the causal relationships between certain conditions: *a researcher tries to determine whether event x led to event y*. Moreover, the research design has failed if the research determines the causal relationships without considering other possible events. Thirdly, an external validity test examines if the research's findings can be generalized or not. A research theory must be tested by replicating the findings in other circumstances as well, where the same results should occur. Finally, a reliability test assesses if the research can be repeated or not. From the reliability test viewpoint, the case study procedures should be documented accurately in order to allow other investigators to repeat an earlier case study.

When discussing the construct validity, multiple sources of evidence were used in the theoretical part to support the chosen frameworks. In addition, it can be stated that this research utilized frameworks, which are related to managerial decision-making. Furthermore, the same frameworks were used when the case companies were studied and analyzed. Moreover, this ensured that the correct concepts were discussed with the interviewees, and the case companies were analyzed through the same concepts.

It is difficult to evaluate the internal validity of this research since the causal relationships in managerial decision-making are highly complex. Because of this, the researcher specified the key concepts separately, with the interviewees, in every case study since the understanding about the researched concepts vary between companies. However, the research does not include strong conclusions related to causal relationships and therefore the research fulfills the test of internal validity at least to some extent.

As Yin (2003, 37) states, the external validity problem is a major barrier in carrying out case studies. The research does not fulfill the test of external validity entirely: the results of this research cannot be generalized broadly since the results are based on three selected case studies. On the other hand, the primary purpose of this study was to describe the studied concepts in different case companies, rather than to produce broadly generally applicable results. The generalization can be made only if a much larger and wider research is carried out. However, it can be said that the results appeared in three case studies and can therefore be generalized at some level.

The research material used, the approach and the methodologies are described in detail. Additionally, the research analysis process is described step by step and therefore the analysis can be repeated. Furthermore, the analysis process steps are made as operational as possible – this is the general way of approaching the reliability problem (Yin 2003, 38). On top of that, this research defines how the data is collected, what are the themes and questions used in the semi-structured interviews, and how the analyses are performed. When these details are documented, another researcher could perform the same research. When it comes to the results of this research, it is important to note the fact that the case studies are anonymous and hence another researcher is not able to interview the same companies.

5.3 Suggestions for future research

This research focused on identifying the Business Intelligence concepts as a part of managerial decision-making, especially when ill-structured problems are solved. Business Intelligence's implications for different decision types were also studied. However, in the future it would be interesting to examine specific Business Intelligence tools as a part of decision-making especially when strategic decisions are made. In addition, the classical frameworks and concepts of decision-making could be studied from different perspectives. Even if Gorry and Scott Morton's (1971), Anthony's (1965) and Simon's (1960) theories are generic and easy to adopt by other researchers, the nature of business has changed tremendously since these theories were introduced.

Traditionally, decisions are categorized based on their type and future outcomes, and it seems that the decision-making process has not been thought to impact on the decision categories. When thinking more broadly about the decision categories, nowadays many strategic problems can be solved by BI. Therefore, it would be interesting to study how the decision-making process itself influences the decision type: if a manager has a minimal role in a strategic decision-making process, does he or she consider the decision as strategic? As an example of this, forecasting has been considered as a strategic semi-

structured managerial activity, but nowadays BI can provide numerous forecasted scenarios to managers at short notice. In order to provide an answer to this question, further extensive research, which includes people from the business and BI functions, of organizational decision-making is needed. Such extensive research could also reveal the boundary between the questions that computers can solve and the problems that require human reasoning.

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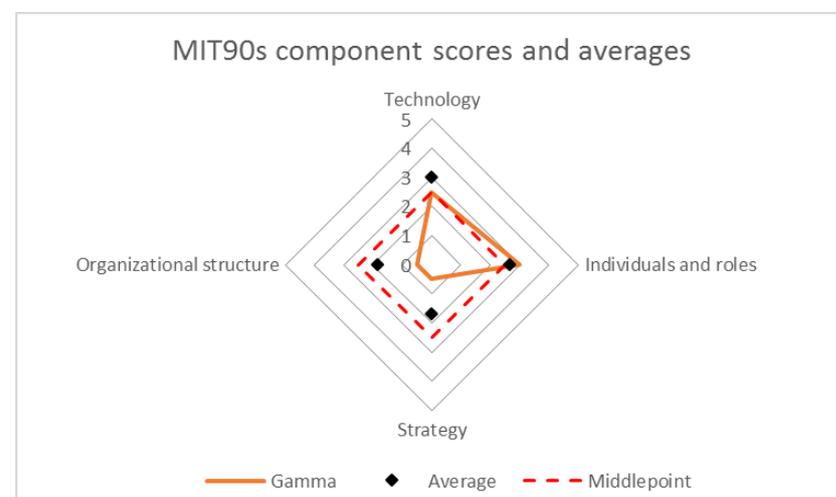
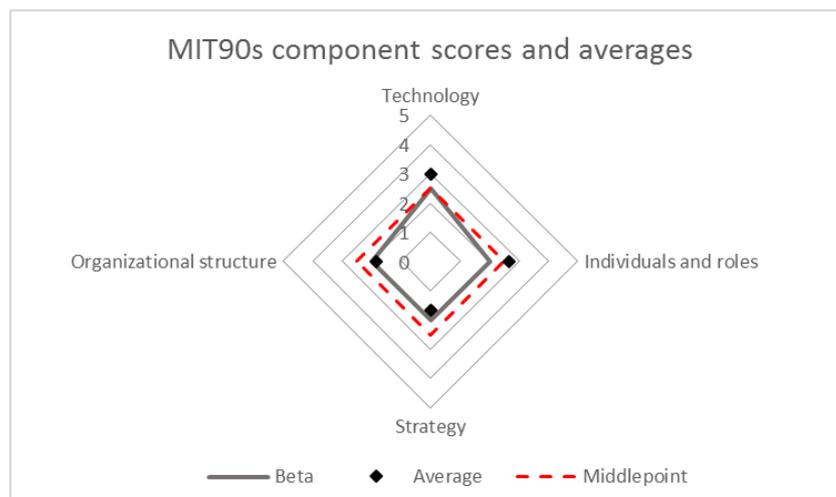
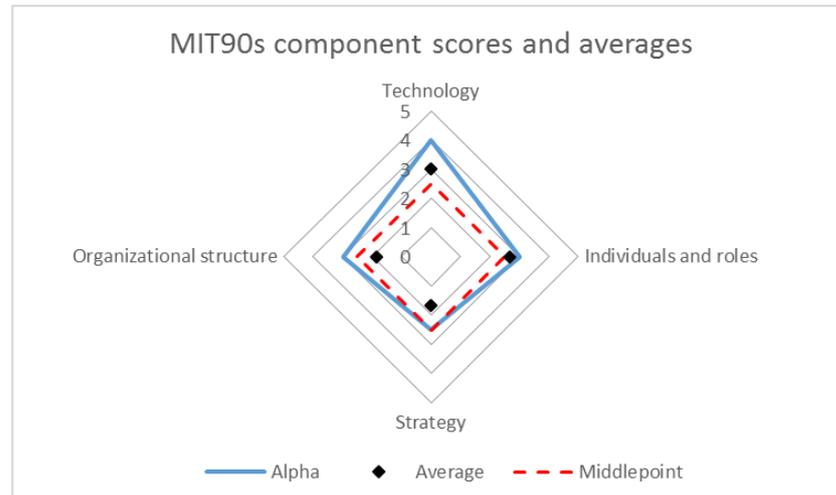
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APPENDICES

Appendix 1.

Case analysis results by the companies



Appendix 2.

Case interview form**The start of the interview:**

1. Could you first tell about your current job and describe your background? What is your official title and main responsibilities?
2. In few sentences, how would you define terms Business Intelligence, Decision Support System and Strategic (planning) decision-making?
3. What kind of experience do you have related to Business Intelligence, Decision Support Systems and decision-making in general?

Questions on managerial computer-aided decision-making (ill-structured) in a case company:

1. What is the typical BI decision-making process in your company when it comes to:
 - a. Operational (control) activities
 - b. Management (control) activities
 - c. Strategic (planning) activities
2. How the decision-making roles are defined? What kind of impact do the characteristics of *individuals (and their roles)* have on computer-aided decision-making?
3. Have you aligned your *management processes* (especially the strategic decisions) to the capabilities of Decision Support Systems? If so, how?
4. Has your company gained any business advantage due to Business Intelligence? Examples on internal (e.g performance management) or external operations (e.g pricing).
5. Do you have an example on a situation when data was turned into valuable actions in the name of business *strategy* and decision-making?

Questions on Business Intelligence in a case company

1. What is the current state of Business Intelligence in your company? How about the vision?
2. What kinds of different data you use continuously?
 - a. Examples on internal and external data
 - b. Examples on structured and unstructured data
3. Have you defined the most value added data or information for your company?

4. Are there any customized tools for managerial use?
5. Who was responsible for / what was your role when your company:
 - a. Chose the solution
 - b. Ran the implementation process
 - c. Evaluated the process and tools.
6. *How* data is exploited from your (managerial) point of view? Do you trust your data?
7. What is the balance between *technology* and *strategy*? What about the effects of *internal* and *external* environment on BI-tools and decision-making?

Final questions

1. From the managerial point of view, what are the major problems in your company related to computer-aided decision-making when it comes to? How they are related to?
 - a. Organization structure
 - b. Strategy
 - c. Structure
 - d. Technology
 - e. Internal and external environment
2. How BI-related (managerial decision-making) problems have been / could have been tackled?
3. What matters should be highlighted when solving ill-structured problems (BI & managerial viewpoints)?
4. Do you think that managerial activities (operational, tactical and strategic) or organizational structure have changed due to the improvement in Business Intelligence field?
5. How would you develop computer-aided decision-making in your company? (e.g Business strategy, organization structure, technology, individuals & roles and internal & external environment)
6. Have you made any wrong decision through Business Intelligence? If so, what were the reasons for that? Do your current BI-tools support your decision-making properly? If not, what management process related (MIT90's) improvements you would like to have?