

Business Intelligence (BI) has been a flagship of Information Systems for almost a decade, and it has reached new heights with Big Data. BI has traditionally been viewed as a technology-driven, rational process, which would improve decision-making in organisations. A common problem is that BI solutions are rarely utilised to their full potential. Although BI research is plentiful, we lack knowledge about (1) how the users interact with the technology, and (2) what makes a BI solution useful over time.

This Ph.D. thesis applies the concepts of bootstrapping and adaptation from the Information Infrastructure theory. Bootstrapping means that an information system must be initiated through a self-sustaining, internal process, and adaptation means self-organizing growth. This thesis offers a conceptual reframing of BI; as a process with two phases. In the bootstrapping phase, focus should be on agile tools and the user. The adaptation phase requires a different focus, where a close interplay between the users and the developers is crucial, and traditional tools may be introduced. From this conceptual reframing four patterns are identified, which are operationalised into management guidelines for the industry. Hopefully, this thesis can lead to BI being utilised to a greater potential in any organisation, and thus benefit from the many advantages that BI can provide.



UNIVERSITY OF GOTHENBURG

## Business Intelligence Utilisation through Bootstrapping and Adaptation

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**Ph.D. thesis**

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Gothenburg, Sweden 2015

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Business Intelligence Utilisation through Bootstrapping and Adaptation

2015



ISBN 978-91-982069-3-7

IT Faculty

# **Business Intelligence Utilisation through Bootstrapping and Adaptation**

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ISBN 978-91-982069-3-7

Printed at Chalmers Reproservice, Göteborg, May 2015

## Acknowledgements

I could never have accomplished this project without the great people around me. I am but an outcome of a lifelong learning process driven by a mutual feedback-loop consisting of people, knowledge, and actions – much like the theories I have studied in this PhD thesis. Due to the lack of a better framework, I choose to present my gratitude chronologically.

**First, my family.** I thank my parents, Halldis and Edgar, who allowed me to become an independent person, and encouraged me to ask as many questions as possible (dear colleagues and supervisors: now you know who to blame). Lucky me who also has a host mother since I was on a student exchange in the USA. When I was 17, she let me be a part of her family for one school year. Thank you Mom Susan, and everybody I came to know! I will never forget how my uncle Jan Sigurd drove from his house to mine when I was about to start my bachelor of arts at the University of Oslo. He had his hands full of curriculum books for me to borrow, and encouraging words for me to keep with me always: *You can do this!* Yes, I did it: philosophy, French (but forget I told you this – it is rather rusty), psychology, and sociology. A bachelor of arts degree accomplished! And then I found out that I wanted to learn more about technology. A few years later I started on my bachelor degree in Information Technology (IT) at Westerdals, or the Norwegian School of IT (NITH) as it was called then. Next in line to be thanked is my brother, Jon Wegard, who helped me with programming homework. My husband and the rest of my family have been supportive throughout my studies.

**Second, my colleagues and employers at Westerdals (former NITH).** I appreciate that Bjørn Jarle Hansen (Head of Westerdals), and Eivind Brevik (Dean of Westerdals – Department of Technology) have allowed me to pursue a PhD as part of my job description. I thank my former colleague Professor Bendik Bygstad, for being an informal supervisor throughout the journey. My “library fairy”, Trude Westby, waived her magic wands (see the picture that she sent me on a rainy day) and supplied me with rare books and articles. Many colleagues have supported me during almost five years. The assistance spans discussing commas in publications (Kjetil Raaen and Bjørn Olav Listog in particular), discussing research questions (Asle Fagerstrøm and Hanne Sørsum), and my former student, Andreas Bjørn-Hansen, for making all of the graphics.



Picture of and by Trude Westby; my “library fairy” at Westerdals. (Printed with permission)

**Third, I thank my supervisors and staff at Gothenburg University.** Since I was, if not the first amongst the few in 2010 who chose to pursue a PhD in Business Intelligence, I could not find any qualified (by academic standards) supervisors in Norway. I googled and found people like Kalevi Pessi and Urban Ask in Gothenburg. Despite that I was to be the first non-resident PhD student, they immediately accepted to be my main and second supervisor, respectively. They are the best supervisors I could have ever dreamed of, cheering when I got papers accepted and solution-oriented when I encountered problems. I thank Pär Meiling, Agneta Ranerup, and Johan Magnusson for their continuous administrative support. Finally, I thank my PhD committee consisting of Jan Ljungberg, Anna Mette Fuglseth, Dick Stenmark, Mark Lycett, and Bjørn Erik Munkvold for providing excellent feedback and taking their time to assess my work.



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## Sammandrag

*Business Intelligence (BI) har traditionellt setts som en teknikdriven, rationell process, vilken skulle leda till ett bättre beslutsfattande i organisationer. Faktabaserade beslut förväntas minska kostnader och öka intäkter för företag, men också till exempel förebygga brott och sjukdom på en global nivå. Brist på data är inte problemet och datalagring och slutanvändarverktyg kan ge människor konsistent data, som är anpassad efter deras behov.*

*Problemet är att BI-lösningar sällan utnyttjas till sin fulla potential. Till exempel, även om BI-lösningar erbjuder avancerade tekniker för rapportering, ad-hoc frågor, "dashboards" och data mining är enkla tvådimensionella rapporter det som är mest utbrett i praktiken. Det är vanligt att användare erbjuds mer och uppgraderad teknik, men det ökar inte utnyttjandet av BI-lösningar. Trots att den befintliga BI forskningen är omfattande saknar vi kunskap om (i) hur användare interagerar med teknik, och (ii) vad som gör en BI-lösning användbar över tid. En BI-lösning kan köpas, implementeras och leverera allt som leverantörer utlovar, men det är slöseri med både tid och pengar om lösningen inte sedan utnyttjas till fullo.*

*Syftet med avhandlingen är att öka kunskapen om hur utnyttjandet av BI kan utvecklas. I avhandlingen tillämpas begreppen "bootstrapping" och "adaptation" från Hanseths och Lyytinens teori om informationsinfrastruktur. Bootstrapping innebär att utnyttjandet av informationssystem måste initieras genom en självgående, intern process medan adaptation innebär självorganiserande tillväxt. Genom att studera fem fall av utveckling av utnyttjande av BI, utforskas utnyttjandet av BI utöver användning av enkla rapporteringsverktyg, vilket i sin tur resulterar i flera fördelar för de studerade organisationerna. Forskningsfrågan lyder: Hur kan BI utnyttjande utvecklas genom bootstrapping och adaptation?*

*Utifrån en grundlig analys, baserat på tekniker från Miles och Huberman, identifierades flera aspekter. Utvecklingen av BI utnyttjande bör adresseras genom två faser med olika fokus: om användare först utsätts för enkla BI-verktyg (bootstrapping-fasen) är de senare mer benägna att vilja utforska mer avancerade verktyg (adaptation-fasen).*

*Avhandlingen ger både ett teoretiskt och praktiskt bidrag. Det teoretiska bidraget erbjuder en konceptuell omdefinition av BI som en självförstärkande installerad bas som utvecklas genom bootstrapping och adaptation. I bootstrapping-fasen bör fokus läggas på agila verktyg, teknisk demonstration och att väcka nyfikenhet hos användare. Bootstrapping-fasen kan på sikt övergå till adaptation, vilket kräver ett annat fokus. Ett nära samspel mellan användare och utvecklare är avgörande för adaptations-fasen, men användarna kan tolerera vissa förseningar i användbarhet. Från den konceptuella omdefinitionen av BI identifieras fyra mönster som operationaliserats i riktlinjer för praktiker, som antingen vill börja utnyttja (bootstrapping) eller förbättra sitt nuvarande utnyttjande (adaptation) av BI-lösningar. Förhoppningsvis leder det till att BI-lösningars potential kan utnyttjas i en högre grad i organisationer och att de därmed drar nytta av de många fördelar som BI kan ge.*

## **Abstract**

*Business Intelligence (BI) has traditionally been viewed as a technology-driven, rational process, which would lead to better decision-making in organisations. Fact-based decisions are expected to reduce costs and increase income for a company, but also, for example, prevent crime and illness on a more global scale. A shortage of data is not the problem and data warehousing and end-user tools can provide people with consistent data, which have been tailored to their needs.*

*A common problem is that BI solutions are rarely utilised to their full potential. For example, while a BI solution offers advanced reporting, queries, dashboards and data mining techniques, the most widespread product remains to be simple two-dimensional reports. Throwing more and upgraded technology at the users is common but does not increase utilisation. Although BI research is plentiful, we lack knowledge about (i) how the users interact with the technology, and (ii) what makes a BI solution useful over time. A BI solution can be purchased, implemented, and provide everything the vendor promises, but it is a waste of time and money if the people do not use the solution.*

*The aim of this PhD thesis is to increase our knowledge about how the utilisation of BI can be developed. The thesis applies the concepts of bootstrapping and adaptation from Hanseth and Lyytinen's theory of Information Infrastructure. Bootstrapping means that an information system must be initiated through a self-sustaining, internal process, and adaptation means self-organizing growth. Through the study of five cases of development of the utilisation of BI, this thesis exploits BI beyond the use of reporting tools, which again results in several benefits for the companies. The research question reads: How can BI utilisation be developed through bootstrapping and adaptation?*

*From a thorough analysis using techniques from Miles and Huberman, several aspects appeared. The BI process should be addressed in two phases with different focus: if users are exposed to lightweight BI tools first (in the bootstrapping phase), they are more likely to want to explore the more advanced tools later (in the adaptation phase).*

*From this PhD study emerges one theoretical and one practical contribution. On the theoretical side this thesis offers a conceptual reframing of BI; as a self-reinforcing installed base that endures bootstrapping and adaptation. In the bootstrapping phase, focus should be placed on agile tools, technology demonstration and arousing curiosity for the user. The bootstrapping phase may eventually turn into adaptation, which requires a different focus. A close interplay between the users and the developers is crucial for the adaptation phase; however, the users can tolerate some delays in usefulness. From this conceptual reframing four patterns are identified, which are operationalised into management guidelines for practitioners in the industry who either want to start using (bootstrapping) or improve their current use (adaptation) of the BI solution. Hopefully, this study can lead to BI being utilised to a greater potential in any organisation, and thus benefit from the many advantages that BI can provide.*



*People and technology have become intertwined.  
You cannot understand the one without understanding the other  
(Bo Dahlbom, 1996)*

## 1. Introduction

Business Intelligence (BI) has been *the* buzz-word for the last decade and it is currently experiencing a new boost conjoined with Big Data. Academic researchers and industry vendors equally illustrate a discipline with a lot of potential and the success stories are abundant. “*Today, it is difficult to find a successful enterprise that has not leveraged BI technology for their business*” (Chaudhuri, Dayal, & Narasayy, 2011, p. 91). Traditional BI solutions could help companies to increase income and cut expenses (Elbashir, Collier, & Davern, 2008). Continental Airlines and Harrah’s Entertainment are popular cases in the BI literature: the airline company avoided bankruptcy by using BI (Wixom, Watson, Reynolds, & Hoffer, 2008), and the hotel- and casino chain was the only company making money during the US recession by analysing their customer data (Turban, Sharda, & Delen, 2014). Combine BI with Big Data and companies can measure customer satisfaction, predict epidemics, prevent crime, and more (Chen, Chiang, & Storey, 2012; McAfee & Brynjolfsson, 2012). For example, by monitoring the occurrence of the word “flu” on blog posts the health clinics can stock medicine and allocate resources (Corley, Cook, Mikler, & Singh, 2010; McAfee & Brynjolfsson, 2012). In the wake of these emerging technologies McAfee and Brynjolfsson predict a *management revolution* in organisations, conjoined with other researchers who proclaim that the industry will soon be in dire need of *data scientists*, that is, people who speak the language of the technical developers, the business managers, and the end-users (Davenport & Patil, 2012). A company’s BI solution normally consists of several tools, even from various vendors. This medley constitutes a growing, complex architecture which poses managerial challenges (Henfridsson & Bygstad, 2013). Professor Davenport illustrated with a dialogue between himself and a manager at a retail grocery chain:

*Davenport: “What do you do with your data from the Point of Sales systems, your customer loyalty programs and your clickstream data from the websites?”*

*Manager: “We store it on disk, then we put it on tape. Then we store it under a mountain so that it is free from nuclear attack.”*

*Davenport: “But what do you actually do with it to manage your business?”*

*Manager: “Not much. That’s why we wanted to talk with you.” (Davenport, Harris, & Morison, 2010, p. 9).*

BI promises to improve data analysis (Chen et al., 2012) so that the ocean of data can be turned into information with the ultimate goal to support decision making. *Information overload* has been discussed for several centuries, for example, in the seminal article, *Management Misinformation Systems*, by Ackoff in 1967. Ackoff described how a manager receives too much data, of which large parts are irrelevant or redundant. The prevailing solution in the 1960s was to throw even more data and technology in the form of control systems at the managers. Ackoff’s solution was to embed a management information system in the control systems (Ackoff, 1967). This paradigm is still dominant today in the sense that it driven by technology and homo economicus, in other words: *We have a new version! More data equals better decisions! Buy it and the users will come!* This is what the vendors promise when a company purchases a new BI system. However, the technology may be implemented, and the users may try it, but eventually they tend to go back to their old habits, for example spreadsheets. Spreadsheets remain the most common BI tool (Watson, 2009). Quoting Dr. Barry Devlin: “*BI, in practice, too often means little more than the generation of reports filled with backward-looking data*” (Devlin, 2013, p. v). A recent survey of the practices of BI in Scandinavian organisations found that the general picture is dominated by a traditional use of BI consisting of static reporting and analysis of transactional data only, however “*...there are signs of beyond traditional use*” (Ask, 2013, p. 1).

Consultant Cindi Howson explained that people have political, cultural, and personal reasons for not wanting to use a BI solution to its full potential (Howson, 2014). Another reason is what she, along with Davenport, referred to as “*techno-babble*”. Professor Davenport was originally a sociologist, but

has over the past years written several books about data analytics and Business Intelligence. For example, in his book, *Information Ecology*, Davenport expressed concern over how the technical orientation and complexity of information modelling tended to drive away users. Davenport presented a definition of normalization of a database which was claimed to be written in a *non-technical way*:

*“The purpose of normalization can be stated in a non-technical way as: The application of a formal set of rules which determine those key attributes which uniquely identify each data attribute, and which place each attribute in an entity where it is fully identified by the whole primary key of that entity”* (Finkelstein (no date), cited in Davenport, 1997, p. 23).

Davenport reflected: *“If this definition is non-technical, God forbid that managers should be exposed to the technical one. I’ve frequently observed how negative managers respond to techno-babble”* (Davenport, 1997, p. 23). In another study, Davenport discovered that organisations tended to invest in huge BI solutions without a strategic plan as to who the users are and how it is supposed to be used (Davenport, 2010). A literature review study by Shollo and Kautz found that the majority of research within BI focused on technology and how to turn data into information, and less about people and how they interact with the technology (Shollo & Kautz, 2010). Grabski et al. also concluded that much research on BI has been either conceptual or technical in nature, such as developing a conceptual data model or explaining integration in technical terms. Many questions remain, they said, regarding issues in the use of BI tools. *“Finally, there is virtually no research related to the behavioural or sociological view of the use of BI/DSS tools. This is an under-researched area that deserves more attention”* (Grabski, Leech, & Schmidt, 2011, p. 53). From the current BI research agenda, two main problems were identified:

(1) The main focus on BI solutions is technology-driven without a socio-technical aspect (as found in (Ask & Magnusson, 2013; Chen et al., 2012; Grabski et al., 2011)). For example, BI is implemented without concern for individual preferences (Davenport, 2010; Lim, Chen, & Chen, 2013; Lönnqvist & Pirttimäki, 2006; Shollo & Kautz, 2010). Consequently, we lack knowledge about how the users interact with the technology.

(2) The knowledge about evolution of the BI solution over time is lacking (Davenport, 2010; Devlin, 2013; Grabski et al., 2011; Henfridsson & Bygstad, 2013; Lönnqvist & Pirttimäki, 2006). Even if the solution is successfully implemented within the estimated time, budget and functionality requirements, we do not know enough about what makes a BI solution useful over time.

Although modern BI tools are becoming more intuitive and sophisticated (Chen et al., 2012), it will be argued that we need a wider context to gain knowledge about the two above problem areas. Throwing new and/or more technology after what already exists is not sufficient in itself. Rather, the BI solution along with users and work processes face the challenges of *bootstrapping* and *adaptation*, two key concepts from the theory of Information Infrastructure. An Information Infrastructure is *“...a shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities”* (Hanseth & Lyytinen, 2010, p. 4). This means that several actors can access the system and contribute. The system has various types of technology and various types of user groups, which are constantly evolving. The Internet is a prime example of an Information Infrastructure.

In this thesis, I focus on the utilization of BI technology in organisations. By utilisation, I mean how a BI solution is bootstrapped and adapted through the dynamic interplay between people, technology, processes, and more. As a theoretical contribution, my aim is to explore the aforementioned processes of bootstrapping and adaptation in a BI context. Bootstrapping is about *getting the bandwagon rolling* and adaptation deals with keeping it rolling (Hanseth & Lyytinen, 2010). In order to get the bandwagon rolling, focus must be on the user and less on the technology. This includes designing for usefulness and persuading the user through tactics. Bootstrapping will eventually reach a tipping point (Hanseth, 2001) with two possible outcomes. Bootstrapping either transforms into adaptation, meaning that the infrastructure will be self-growing. This can be achieved by open standards of technology,

overlapping functionality and gateways between infrastructures (Hanseth & Lyytinen, 2010). The opposite outcome is that the infrastructure will fade out. This may happen if the technology lacks mechanisms for innovation, adoption, and scaling. The technology must be malleable and simple for users to explore (Henfridsson & Bygstad, 2013).

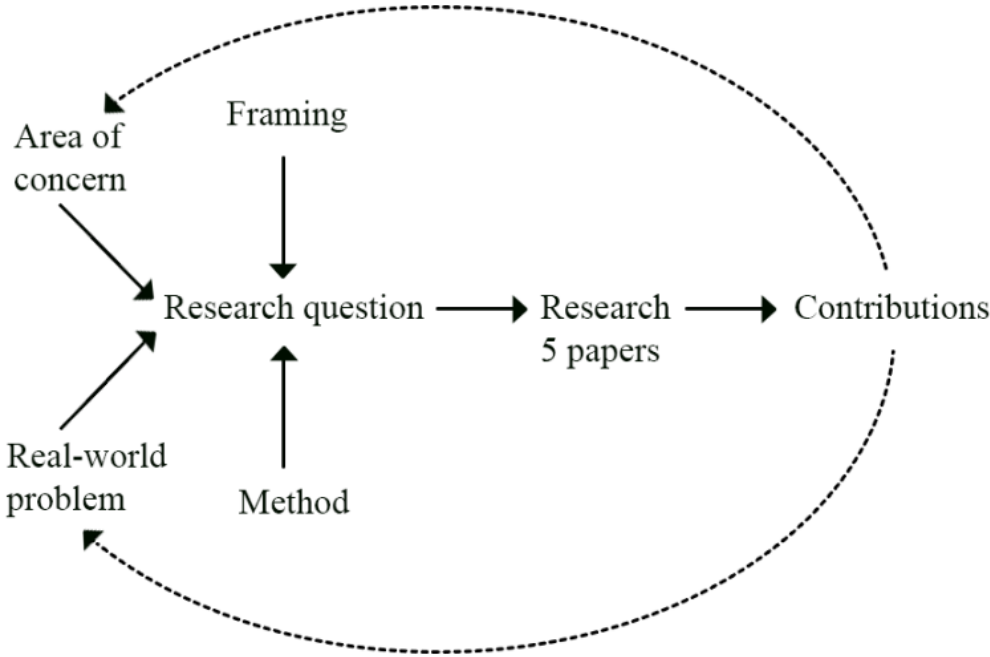
As a practical contribution, I seek to identify patterns for bootstrapping and adaptation of BI solutions. In order to achieve this, I have been inspired by software engineering patterns, which is “a solution to a problem in a context” (Larman, 2005) and cannot be planned; rather, they are identified. Just like the Internet in its present, ubiquitous form was not anticipated nor designed years ago, a pattern cannot be planned or designed either. Instead, a software engineering pattern must be identified from existing work processes and technical solutions (Gamma, Helm, Johnson, & Vlissides, 1995). Inspired by Larman and Gamma et al., I aim to identify “problem-solution pairs”, which can be reused in certain BI contexts and help organisations that have problems with bootstrapping and adaptation of their BI solutions.

**1.1 Research question and objectives**

From the introduction, we saw that even though BI technology can contribute major advantages to a company, the solution is nevertheless not always utilised to its full potential. My research question read:

*How can BI utilisation be developed through bootstrapping and adaptation?*

In order to answer this research question I drew on the article by Mathiassen et al. They described a PhD journey which consists of seven elements: Area of concern; Real-world problem; Framing; Method; Research question; Research; and Contribution (Mathiassen, Chiasson, & Germonprez, 2012). As emphasised by Mathiassen et al. the research question is at the centre of my doctoral study (see Figure 1).



**Figure 1: Designing my doctoral study based on (Mathiassen et al., 2012)**

In my study, the **Area of concern** was that BI solutions are often implemented with the focus on the technology, process, or product (Shollo & Kautz, 2010), which results in a lack of utilisation and evolution of the solution (Grabski et al., 2011). The **Real-world problem** was that organisations are only using a fraction of their BI solutions (Ask, 2013; Watson, 2009). This has several negative consequences for the organisations: they miss business opportunities like *customer intelligence*,

*supplier relations*, and *internal efficiency* (Elbashir et al., 2008), which can have more or less a fatal outcome (Overby, Bharadwaj, & Sambamurthy, 2006) and they spend money on solutions that are not used as intended (Davenport, 2010; Howson, 2014). My **Framing** consisted of the concepts of *bootstrapping* and *adaptation* from the Information Infrastructure theory (Hanseth & Lyytinen, 2010). My overall **Method** was a qualitative case study (Miles & Huberman, 1994; Yin, 1994). The **Research** consisted of five peer-reviewed publications and the **Contributions** are twofold. First, it offers a conceptual extension of the traditional BI paradigm, pointing back to the **Area of concern**. Second, from this reframing, four patterns are operationalized for the practitioners who are experiencing a **Real-world problem**. This will complete the PhD journey as Figure 1 illustrates.

A common challenge in qualitative studies is the boundaries between “... ‘*what my case is*’ and ‘*where my case leaves off*’. Abstractly, we can define a case as a phenomenon of some sort occurring in a bounded context. The case is, in effect, your unit of analysis” (Miles & Huberman, 1994, p. 25). A case can be an individual, a role, a small group, an organisation, a community, or a nation. It can also be defined spatially or temporally, or as a sustained process, as Miles and Huberman explained. My case was *the utilisation of BI in organisations*. Beyond the scope of this thesis were: project management, Critical Success Factors for BI projects, design of BI tools, implementation of BI solutions, how to motivate and persuade end-users, the effects and benefits of BI, and law enforcements and regulations. Although these topics were not my main aim, the boundaries were blurred, which is a common trait in case studies (Yin, 1994). Consequently, I occasionally encountered these themes.

## 1.2 Structure of the thesis

The rest of this thesis has the following elements:

**Chapter 2. Literature review:** This chapter describes the state-of-art of BI and how it has evolved from when the concept first appeared in an academic article. In order to provide a background for my study, I give examples of the promise of BI before I identify two main research gaps. In addition, I briefly discuss three well-known Information Systems theories related to people’s use of technology which have been employed in BI research (Technology Acceptance Model by Davis (Davis, 1989), The Information Systems Success model by DeLone & McLean (DeLone & McLean, 2003) and The Diffusion of Innovations by Rogers (Rogers, 2003)) and point to their strengths and limitations.

**Chapter 3. Theoretical framework:** This chapter starts with a presentation of the Information Infrastructure Theory, mainly through the lens of Hanseth and Lyytinen (Hanseth & Lyytinen, 2010), but also drawing on three identified causal powers by Henfridsson and Bygstad (Henfridsson & Bygstad, 2013) which are useful for understanding the evolution of an Information Infrastructure over time. I focus on three main concepts from the Information Infrastructure: *bootstrapping*, *adaptation*, and the *installed base*. Finally I describe software engineering patterns based on “the Gang of Four” and Larman (Gamma et al., 1995; Larman, 2005)

**Chapter 4. Research process:** The overall approach is a case study based on Yin (Yin, 1994) which guides the researcher how to study a real-life phenomenon in its natural context. I present the collected data in detail, such as the type of data and time of collection. Finally, I carefully explain how data was analysed using the techniques by Miles and Huberman and Carney’s *Ladder of Analytical Abstraction* (Miles & Huberman, 1994).

**Chapter 5. Findings and analysis:** The abstract of each publication is presented first, followed by the results of using my modified *Ladder of Analytical Abstraction*. The model is applied in each publication and includes key findings, aggregating the data into themes and trends, and explaining them by *bootstrapping* and *adaptation*. After each paper, I reflect on the findings and how they have developed during the five-year academic journey.

**Chapter 6. Contributions and suggested further research:** In this chapter, I return to the research question and present how it is addressed by suggesting a theoretical model for bootstrapping and adaptation of BI utilisation. As a practical contribution, I identify four software engineering patterns and present guidelines for the academics and the practitioners, respectively. I then discuss how they

address the two research gaps identified in Chapter 2. I also point to limitations of the study and suggest further research.

**Chapter 7. Conclusion:** In this brief chapter, by offering a model for bootstrapping and adaptation of BI utilisation as a contribution to the BI research field, I present the answer to the research question: *How can BI utilisation be developed through bootstrapping and adaptation?*. For practice, I offer four patterns which are operationalized into tangible guidelines.

**Appendix and Collection of published papers:** This is a paper-based thesis (as opposed to a monograph). Five papers form the essence of the study and they are found in the final part called Collection of published papers. Due to the fact that they are published I have chosen to keep the original layouts, page numbers, and cover pages. An overview of the publications which are part of the PhD thesis is found in the next section. I also include a list of the other publications which are not part of the PhD thesis in the Appendix.

### 1.3 Papers that constitute this thesis

This thesis is based on five publications, ranging from conference papers to journal articles. All of the conferences and journals are peer-reviewed.

1) Presthus, W., Papazafeiropoulou, A., & Brevik, E. (2010). *E-business in entertainment: Insights from the use of Business Intelligence in the Norwegian music industry* Paper presented at the Proceedings of the Sixteenth Americas Conference on Information Systems (AMCIS), Lima, Peru, August 12-15, 2010, 1-8.

(Please note that the AMCIS committee has the wrong order of authors on the cover page. It has also left out second author Papazafeiropoulou.)

2) Presthus, W., & Bygstad, B. (2012). Business Intelligence in College: A Teaching Case with Real Life Puzzles. *Journal of Information Technology Education: Innovations in Practice*, 11, 121-137.

3) Bygstad, B., & Presthus, W. (2013). Social Media as CRM? How Two Scandinavian Airline Companies Used Facebook during the “Ash Crisis” in 2010. *Scandinavian Journal of Information Systems*, 25(1), 69-90.

4) Presthus, W. (2013). Knowledge Infrastructure in Action. A case study of Business Intelligence in Higher Education. *NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi*, 145-158.

5) Presthus, W. (2014). *Breakfast at Tiffany's: The Study of a Successful Business Intelligence Solution as an Information Infrastructure*. Paper presented at the European Conference of Information Systems (ECIS) 2014. Association for Information Systems 2014, 1-14.

A list of my additional publications which are not part of this PhD is found in the Appendix.

*Get your facts first, then you can distort them as you please*  
(Mark Twain, n.d.)

## **2. Literature review**

This chapter presents and assesses the state-of-the-art BI in industry and research. In order to provide a context for the assessment, the history and characteristics of BI solutions (and its predecessors such as Management Information Systems and Decision Support Systems) are presented first in section 2.1. Then, to understand the current state and progress of BI research I drew on existing literature reviews on BI in Section 2.2. To be current, I searched for and read recent BI publications in mainstream journals, including top Information Systems journals (also known as the Basket of Eight), Management Accounting, and Accounting Information Systems journals. This section also includes a separate literature review that I conducted on BI with the focus on user adoption, evolution of use, and user satisfaction. Through a systematic review of journals in the Business Source Premier database during 2010 – 2014 (almost five years), I found 36 current articles. These are briefly addressed at the end of Section 2.2 where I present three theories on user satisfaction, technology acceptance, and diffusion of innovations, and critically assess their strengths and weaknesses in relation to my study. Based on a detailed analysis of the current state, I assess the current framing of BI and point to its limitations and research opportunities in Section 2.3.

### **2.1 Origins and definitions of Business Intelligence**

In this subsection, I take a broad perspective including textbooks, industry analysts, vendors and consultants as a complement to academic researchers. There are two main reasons for this. According to the frequently cited overview by Power (2007): “*The study of decision support systems is an applied discipline that uses knowledge and especially theory from other disciplines*”. Another trait of BI is that its origins are from industry and it is now making its way into academia (Wixom, Ariyachandra, et al., 2011). Until the end of 2000, industry was leading the BI field, and academic research was lagging behind (Shollo & Kautz, 2010).

Academics do not quite agree on the origins of BI. Some see its roots in the military (Carlsson & El Sawy, 2008), while others claim it emerged with capitalism (Lönnqvist & Pirttimäki, 2006, p. 32). Nonetheless, in both cases, the goal is to collect data about the enemy or competitor, respectively, turn the data into information and act accordingly. What we do know is that in academia, the term was used for the very first time in 1958 by Hans Peter Luhn in the IBM article, “A Business Intelligence System” where he discusses early ideas for automated textual processing (Devlin, 2013). Quoting Luhn: “...*a comprehensive system may be assembled to accommodate all information problems of an organisation. We call this a Business Intelligence System*” (Luhn, 1958, p. 314).

Although not employing the concept of BI, Ackoff (1967) has contributed several papers on Management Information Systems. In a seminal paper, he debunks the myths of (i) managers not having enough information and (ii) more information and technology will lead to better decisions. The problems are rather that (i) management are exposed to *information overload* consisting of irrelevant and redundant data, and (ii) technology is implemented without training. What we need is one flexible and adaptive system that can help management control information, and three groups must collaborate in creating it: Information Systems specialists, operations researchers, and managers (Ackoff, 1967).

The predecessors of BI are multiple (Power, 2007). The frequently cited study by Power, “A Brief History of Decision Support Systems”, explores the development of Decision Support Systems (DSS), financial planning systems, spreadsheets, Data warehouses, Executive Information Systems, Online Analytical Processing (OLAP) and Business Intelligence from the 1960s to the 1990s in the industry (Power, 2007); see Table 1 below. Regardless of the various characteristics, the common denominator is decision support.

When	What	Characteristics
1960s-1970s	Decision Support Systems	Model-driven, which means an interactive, computerized quantitative model typically for financial planning and simulation
1970s	Executive Information Systems	Data-driven support for senior executives by providing access to historical data
1980s-1990s	Data warehousing and Business Intelligence	Data-driven support with focus on analysis on historical and real-time data, for managers as well as senior executives
1990s	Knowledge Management	Communications-driven DSS use network- and communications technologies to facilitate decision making for a group of people. Document-based systems for management planning and control
2000s	Artificial Intelligence	Knowledge-driven DSS can suggest or recommend actions to managers; the technology thinks on behalf of the people

**Table 1: The predecessors of BI based on Power (2007)**

Similar to Power, Chen et al. offer this description of BI's development:

*The term intelligence has been used by researchers in artificial intelligence since the 1950s. Business intelligence became a popular term in the business and IT communities only in the 1990s. In the late 2000s, business analytics was introduced to represent the key analytical component in BI (Davenport 2006). More recently big data and big data analytics have been used to describe the data sets and analytical techniques in applications that are so large (from terabytes to exabytes) and complex (from sensor to social media data) that they require advanced and unique data storage, management, analysis, and visualization technologies. (Chen et al., 2012, p. 1166)*

Chen et al. categorise the Business Intelligence & Analytics (BI&A) evolution in three stages, called BI&A 1.0, BI&A 2.0, and BI&A 3.0. The first was data-centric with data warehouses along with the accompanying front-end tools. Such a solution can mainly handle structured data such as numbers and categorised text. BI&A 2.0 originated in 2000 as the web and the Internet began to offer a collection of unstructured data. BI tools such as Google Analytics are capable of providing analysis of a customer's behaviour on a webpage, and furthermore data mining tools may elucidate patterns within comprehensive sets of data. Finally, the third stage includes mobile- and sensor-based data which can be analysed and used for locating and tracing goods, animals and people. According to Chen et al, BI&A 2.0, and especially BI&A 3.0, are stages requiring further research.

As Power (2007) points out, the history of decision support has been less neat and linear than it appears in Table 1. Perhaps this is one reason why BI enjoys many definitions, of which some of the most common are presented in Table 2.

Definitions of BI	Author(-s) and background
<i>Business intelligence (BI) is a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions (p. 487).</i>	(Watson, 2009) <b>Academic</b>
<i>Business intelligence (BI) is an umbrella term that includes the applications, infrastructure and tools, and best practices that enable access to and analysis of information to improve and optimize decisions and performance. (Web-page)</i>	(Gartner, 2013) <b>Industry Analyst</b>
<i>Business intelligence (BI) is an umbrella term that combines architectures, tools, databases, analytical tools, applications, and methodologies...[...]...The process of BI is based on the transformation of data to information, then to decisions, and finally to actions (p. 19).</i>	(Turban et al., 2014) <b>Textbook</b>
<i>It is an architecture and a collection of integrated operational as well as decision-support applications and databases that provide the business community easy access to business data (p. 4).</i>	(Moss & Atre, 2003) <b>Academic</b>
<i>Business Intelligence allows people at all levels of an organization to access, interact with, and analyse data to manage the business, improve performance, discover opportunities, and operate efficiently (p. 2).</i>	(Howson, 2014) <b>Industry Consultant</b>

**Table 2: Definitions of BI, adapted and extended from Chee et al. (2009, p. 97)**

From Table 2, we note that the definitions are rather similar in the sense that the majority regards BI as a complex discipline. Consequently, several academic publications differentiate BI into technology, product, and process; see for example (Ask, 2013; Chee et al., 2009; Shollo & Kautz, 2010). Chee et al. provide a collection of various BI definitions from various sources: textbooks, consultants, vendors, and academic publications. They present a summary of 14 definitions and conclude that they can identify three main categories: BI as technology, BI as product, and BI as process. Some definitions fall strictly into one category, while others span two or all three (Chee et al., 2009). Each of these categories will be described below.

**BI as technology**

Chee et al. (2009) concluded that BI as technology can be defined as: “...the tools and technologies that allow the recording, recovery, manipulation and analysis of information” (p. 98). This includes data warehouses, data marts, reporting & analysis tools, data mining, dashboards, and more which are composed into a BI architecture. Figure 2 illustrates all the typical modules of BI technology (Chaudhuri et al., 2011, p. 296). On the left hand side of the figure we find data sources, which can come from Enterprise Resource Planning (ERP) or Point of Sales (POS) systems, other transactional systems (OLTP) such as ATMs, operational databases, or external data from for example web pages. Next, the data is moved by means of the Extract-Transform-Load (ETL) process consisting of several steps, including extracting data from one or several data sources, transforming them, and loading them into the data warehouse. The data warehouse stores the data. Data can be accessed through the mid-tier servers. Less programming-skilled users may use middleware from vendors to interact with the data. Examples are SAP Business Objects, a whole suite of applications for reporting, analysis, and data mining.

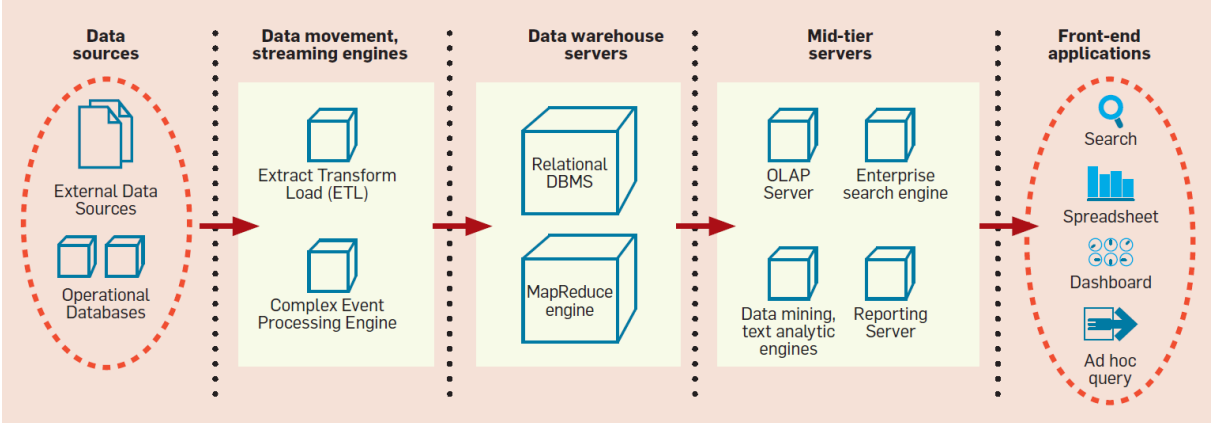


Figure 2: Typical business intelligence architecture (Chaudhuri et al., 2011, p. 296)

**BI as a product**

Chee et al. (2009) regard a “BI product” as the result, meaning the actionable information of analysis. Likewise, Chaudhuri et al. (2011) consider products such as searches, spreadsheets, dashboards, and ad hoc queries. The BI products (results of the *Front-end applications*, at the far right-hand side of Figure 2) are what the end-users are exposed to. Reports remain at the very top of BI products, both in the US (Howson, 2014) and in Scandinavia (Ask, 2013). A report is a two-dimensional (rows and columns) generation of a dataset, typically created in Microsoft Excel. According to Watson (2009) the reason for the extensive use of Microsoft Excel is twofold: First, it is cheap, because the technology is usually already installed on the user’s computer. Second, it offers a familiar interface with little need for training. Although spreadsheets may be the ruling BI product, Howson (2014) and Ask (2013) identify the merging trend of dashboards as a popular product. Figure 3 illustrates an example of a dashboard, as found in (Watson, 2009, p. 502).



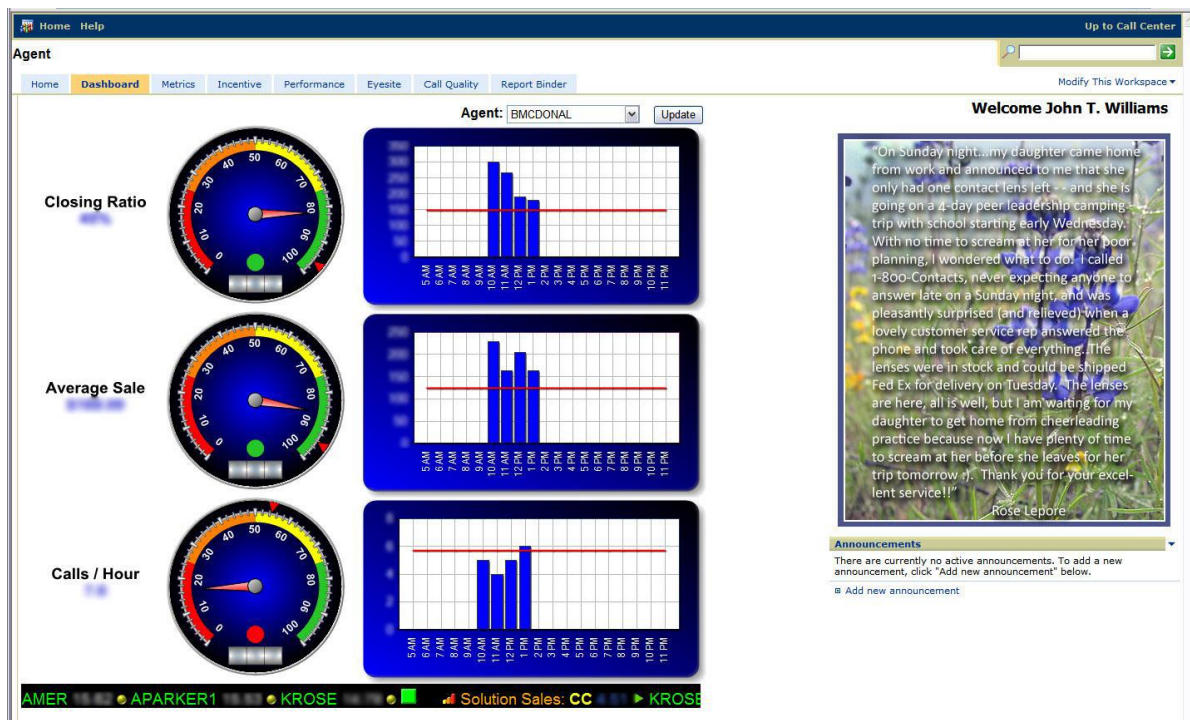


Figure 3: An example of a BI product – a dashboard for a customer service agent (Watson, 2009, p. 502)

A dashboard is a visual presentation of selected data (often called Key Performance Indicators), allowing the decision maker “to stay close the data” (Davenport et al., 2010, p. 4). Watson further explains that at 1-800 CONTACTS “...dashboards are used to monitor and motivate the customer service agents who handle calls. The dashboards are updated every fifteen minutes, and the agents and their supervisors can see how they are doing on key metrics and compare their performance to other operators” (p. 502).

### BI as a process

Shollo and Kautz (2010) describe BI as a process as follows: “Initially data is gathered and stored, then transformed into information by analysis. This information is then transformed into knowledge to support decisions” (Shollo & Kautz, 2010, p. 5). Building on this definition we can illustrate BI as a rational and linear process, as shown in Figure 4:



Figure 4: Illustration of the BI process based on Shollo & Kautz (2010)

Shollo and Kautz further explain that various techniques can facilitate in each step. In the first step, *Gathering & Storing*, data can be collected from within the company or externally. The internal and external data can be either structured or unstructured and reside in transactional systems, web pages and other sources. In the second step, *Analysing*, the data must be turned into information by means of data mining, browsing, and visualisation. Step three, *Using*, has a strong focus on the individual, which has to – simply put – use the information from the previous step. The final step, *Acting*, involves decision making and depends on the initiative by each individual. In the same study Shollo and Kautz conducted a literature review of BI, where they analysed 103 articles in mainstream journals during the decades from 1990 to 2010. Regardless of the journals, Shollo and Kautz conclude that none of them describe how BI is used; the journals’ main focus is on technology and overlook the end-users’ perspective. In other words, BI literature has been more concerned with the first two steps (*Gathering & Storing* and *Analysing*) and less on the process afterwards such as how users employ and benefit from the information (*Using* and *Acting*).

## 2.2 Theoretical foundation of Business Intelligence and existing research

According to Power (2007) and textbooks such as Turban et al. (2014), two of the main theoretical pillars of BI are credited to Simon (Simon, 1977) and Gorry and Scott-Morton (Gorry & Scott-Morton, 1971).

In a way we can say that Nobel Prize winner Herbert Alexander Simon puts the *intelligence* in Business Intelligence. Simon examined the process of management decision and claimed that prior to making a decision the person has undergone a “...lengthy, complex process of alerting, exploring, and analysing that precede that final moment, and the process of evaluating that succeeds it” (Simon, 1977, p. 40). He continued: “The first phase of the decision-making process – searching the environment for conditions calling for decisions – I shall call intelligence activity (borrowing the military meaning for intelligence)” (p. 41). Simon also discussed the difference between *programed* [sic] and *nonprogramed* [sic] decisions, and the techniques for the two. A *programed* decision is repetitive and routine with well-known procedures which are applied every time they occur. Examples are pricing customers’ orders and reordering office supplies. *Non-programed*, on the other hand, are novel and unstructured. A good example of a *non-programed* decision is whether a company should establish itself in a new country. Traditionally, a company uses habits or standard operating procedures to solve programmed decisions, and human judgment and intuition for the *non-programed*. Simon has also contributed to the concept of *bounded rationality*, meaning that people have difficulties making rational decisions, especially in *non-programed* situations. He foresees that computer technology will be able to improve people’s capability of making better decisions for *non-programed*, difficult, complex situations.

Traditionally, as described by Power (2007) above, the main aim of BI was decision support for management. Gorry and Scott-Morton presented their framework in 1971. This framework helped categorise the various types of decisions that were made in an organisation, not only for the senior executives and management, but also at the operational level. Gorry and Scott-Morton suggested different types of computerized decision support for nine different types of decisions (Gorry & Scott-Morton, 1971).

Recent studies on BI offer several contributions, such as categorising BI research, explicit and intangible benefits of BI, measurements of BI, and application areas of BI.

Having analysed 167 articles from 1997 to 2006 Jourdan et al. (2006) identified five **categories of BI research**: Artificial Intelligence, benefits, decisions, implementation, and strategies (see Table 3).

Category	Topics	No. of articles
Strategies	Collaboration, Competition, Customization, Integration, etc.	59
Artificial Intelligence	Algorithms, Classification, Machine Learning, Prediction, Web Mining	37
Implementation	Customer Relationship Management (CRM), DSS, Data Warehousing, e-Business, Enterprise Resource Planning (ERP), Knowledge Management Systems (KMS), Project Management	35
Decisions	Data Modelling, Decision Making, Decision Modelling	26
Benefits	Data Mining, Enterprise-wide IS	10

**Table 3: BI categories, based on Jourdan et al. (2006)**

The majority of the 167 journals came from the fields of management and Information Systems. The most diverse category was Strategies, with the focus on how to apply BI tools and technologies in a business environment. At first I found this large attention to be good news. However, as the authors pointed out, the predominant research type for this category was formal theorization and literature review. They concluded that this was unfortunate, and claimed that further BI studies need to employ a wider variety of research types, such as surveys and field experiments. Finally, they wrote: “...much of the research in our sample addresses new technologies and issues in BI without attempting to explain the fundamental issues of information systems research as it relates to BI” (Jourdan, Rainer, & Marshall, 2008, p. 126).

The focus has also been on the **benefits of BI and how to measure them**. Lönnqvist and Pirttimäki (2006) had two main purposes for their paper: (i) determining the value of BI; and (ii) managing the BI process. The value of BI can appear as reduced costs, enhanced revenues, improved resource allocation, and enhanced business performance, such as stock price and customer satisfaction. Managing the BI process could be measured by monitoring how many managers use a BI tool and how often the BI tools are reviewed. Among the issues related to the use of BI tools were the efficiency of the BI personnel, the effective allocation of available resources, the quality of the BI products, and the satisfaction of the users. The satisfaction of the users was dependent on quality, relevance, timeliness, action ability, and accuracy of the information provided. In their conclusion, the authors found that the literature focussed more on the measurements of BI rather than the management of the BI process. Quoting Lönnqvist and Pirttimäki: *“Of course, the effects of BI are created as a result of the BI process and are thus related”* (Lönnqvist & Pirttimäki, 2006, p. 35).

A study by Gibson et al. (2004) focussed **on the intangible benefits of BI** and how this should be evaluated. They started by defining BI as *“...a technology that provides significant business value by improving the effectiveness of managerial decision-making”* (p. 295). Examples of intangible benefits of BI were greater business knowledge and improved work processes, which were found to be more difficult to measure and evaluate than tangible benefits such as investments. They believed that poor identification of the benefits of an information system could explain why investments in IT have failed to produce larger improvements in industrial productivity. They also believed that the intangible benefits from the use of BI systems were significant (Gibson, Arnott, & Jagielska, 2004).

Finally, a recent survey of BI research (Aruldoss, Travis, & Venkatesan, 2014) studied BI literature from 2008 to 2013. The authors found **that BI is applied in many domains**, such as market management, production, education, consumer heterogeneity, internet service provider, inventory management, pharmaceutical, business performance, and real-time architecture. They divided ongoing BI research into seven categories: applications, intelligence techniques, extraction techniques, integration with other techniques, prototypes, performance assessment of BI systems, and challenges in BI implementation. The authors concluded that a large majority of the research were within applications, which they define as: *“A typical BI application is made up of many numbers of components such as data warehouse, ETL, data mining, analytical tools, data visualization and analysis, dashboard, score board, CRM, Enterprise Resource Planning (ERP), OLAP and any other related component”* (Aruldoss et al., 2014, p. 832). The other six categories had considerably less ongoing research.

Research on user satisfaction, technology acceptance, diffusion of technology, and similar areas is abundant within Information Systems. Through my literature review, I found several articles with these theories in a BI context. Four of the recent publications have applied well-known theories such as the Technology Acceptance Model (TAM) (Davis, 1989) or the Information Systems Success Model (DeLone & McLean, 2003), and found that they to some extent can explain the (lack of) utilisation of the BI solution (Hou, 2012, 2013, 2014; Wieder, Ossimitz, & Chamoni, 2012), while others have tried to develop their own framework to evaluate the use of BI software, as found in (Amara, Sjøilen, & Vriens, 2012). In a more quantitative study Wixom and Todd combined the two (TAM and the IS Success Model) and argued that the combined model could predict utilisation (Wixom & Todd, 2005). I also found that Roger’s Diffusion of Innovations (Rogers, 2003) has been applied in BI studies, see for example (Gonzales, Udo, Bagchi, & Kirs, 2011). They found that the diffusion of BI and data warehousing tend to follow the S-shape curve over time (the S-shape is credited to Tarde and dates back to 1903 (Rogers, 2003)). Rogers also provided advice on how to speed up the diffusion process in organisations, for example by understanding the needs of the individual, i.e. being client-oriented, understanding the culture, and identifying an opinion leader. This advice all potentially applies to a Business Intelligence solution.

### **2.3 Limitations of the current research of Business Intelligence**

By studying the existing literature presented above, two issues emerged:  
i) BI is gaining a larger foundation within academia, but focus is not theory building, rather...

ii) ...BI research focuses on technology, strategy, benefits, success factors for implementation, and architecture and modelling, but less on the socio-technical aspect and how utilisation evolves over time.

From a technological view, the current framing of BI is well-documented. For example, we have seen that Power (2007) investigates model-, data-, document-, communication-, and knowledge-driven decision support systems, while Chen et al. (2012) present an overview of three BI versions: BI&A 1.0, BI&A 2.0, and BI&A 3.0 and provide examples of how BI technology can provide benefits for virtually any industry. However, they find that research is lacking in BI&A 3.0, which consists of mobile and sensor-based BI, visualisation, and Human-Computer Interaction. A current trend is to frame Business Intelligence by a tripartite view: technology, product, and/or process. There are several limitations with this view:

### **BI as technology**

The majority of the literature implies that given the many benefits that BI can provide (as identified by Lönnqvist and Pirttimäki (2006) and Gibson et al. (2004)), people will automatically use the technologies. BI technology has traditionally been an in-house, silo solution with a complex architecture, as illustrated in Figure 2. A BI solution is complex and it requires the user to have considerable skills and training. Traditional BI tools, such as SAP, have a high threshold for use. New vendors, like Qlik, are beginning to develop more intuitive tools. Nonetheless, the most common BI tool is still Microsoft Excel (Watson, 2009) which should warn companies that it does not help to add more technology if what already exists is not used to its potential. A technology does not have any value unless people are using it (Gibson et al., 2004).

### **BI as a product**

The common view of BI as a product is that it is a predefined report, cube, or dashboard, often created from a one-size-fits-all philosophy. In reality, a BI product is never really finished because users have different needs and preferences. Furthermore, BI products must be continually improved (Lönnqvist & Pirttimäki, 2006) and people's uses and needs evolve over time.

### **BI as a process**

BI as a process is seen as linear and rational, and assumes that technology will automatically support the transformation from one phase to another (Shollo & Kautz, 2010). The problem with this view is that it ignores the fact that business value is made from the actual use of BI, and the process is usually neither linear nor rational. For example, some users will wait for others to start to use the solution because they are uncertain about the "return of investment" for taking the time and trouble to learn the BI technology. In real life companies do not necessarily manage the whole process (Howson, 2014). In previous BI research, more focus has been on turning data into information than making decisions and taking action (Davenport, Harris, De Long, & Jacobsen, 2001; Shollo & Kautz, 2010).

The user perspective of BI has been neglected to date, both on how to attract them and how they can be persuaded to use the BI technology and continue to use it (Devlin, 2013). While some of the recent literature acknowledges the importance of user satisfaction and user acceptance, very little BI research has provided thorough, step-by-step guidelines for how to obtain this, with some exceptions, see for example (Wixom, Watson, & Werner, 2011). The majority of the articles agrees that user adoption and related issues are under-explored concerns in BI research (see, for example (Wang, 2012)) which needs considerably more attention.

Summing up, my interpretation of BI based on the extant literature is that technology/product/process is a viable foundation, but it needs to be extended. It is interesting to try another lens and investigate how the Information Infrastructure Theory can explain the cases that I have studied. Using key terms from the Information Infrastructure Theory I will suggest that the tripartite view of tool-product-process constitutes the *installed base*, but must include *bootstrapping* and *adaptation*. These concepts are described in more detail in the next chapter.

### 3. Theoretical framework

As mentioned in the previous chapter I have chosen Information Infrastructure as a theoretical framework. This theory is extensive with many contributors. I mainly draw upon the work by Hanseth and Lyytinen but I also include Henfridsson and Bygstad to better understand the evolution of an Information Infrastructure over time. Finally I describe software engineering patterns which have been an inspiration for my practical contribution.

#### 3.1 A brief presentation of the origins and characteristics of Information Infrastructure

The Information Infrastructure theory emerged in the 1990s, addressing the need for a new perspective on Information Technology including the socio-technical aspect. The unilateral focus on systems, tools and design was no longer sufficient; networks, infrastructures, and cultivation was also needed (Hanseth, 2010).

An Information Infrastructure is defined as “...a shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities” (Hanseth & Lyytinen, 2010, p. 4). Well-known examples of Information Infrastructure are the Internet Protocol, electronic marketplaces, and Wikipedia. **Shared** and **open** means that several actors can (potentially) access the system and make changes or contributions. **Heterogeneous and evolving** indicate that the system has various types of technology and various types of user groups, which are constantly evolving. The final characteristic, the **socio-technical installed base**, means that both technology and people are needed to make an Information Infrastructure. The installed base is the key element in Hanseth’s Information Infrastructure theory and denotes the number of technical components and users in the infrastructure (Bygstad, 2010). For example, the installed base of a music streaming service consists of technical devices (PCs, smart phones), an Internet connection, the music database, and the millions of clients.

The Information Infrastructure theory is comprised of three elements which will mutually interact and shape the installed base: process strategy, architecture and governance. Amongst others, **process strategy** concerns standards and flexibility. In a recent conference article, Hanseth and his co-authors (Hanseth, Bygstad, Ellingsen, Johannesen, & Larsen, 2012) discuss “...whether standards can be combined with flexibility. Standardized systems such as ICTs tend to become accumulatively change resistant as they grow and diffuse” (p. 3).

**Architecture** in an Information Infrastructure context does not mean houses and buildings, but to what extent the Information Infrastructure is generative and/or loosely coupled (Hanseth, Bygstad, & Johannesen, 2012). For example, the Internet is divided into layers (application, protocol, and physical) which allow several people to make contributions at the same time (Zittrain, 2008).

**Governance** concerns the balance between control and innovations. If a company tries to control the Information Infrastructure too much, it runs the risk of not getting the infrastructure started at all, meaning that it may never get bootstrapped (Hanseth & Aanestad, 2003). In contrast, if a company places too much emphasis on innovations, it may actually lead to unwanted side effects such as lock-in (Hanseth, 2001). Shapiro and Varian raise concern about lock-in: “Users of information technologies are notoriously subject to switching costs and lock-in: once you have chosen a technology, or a format for keeping information, switching can be very expensive. Most of us have experienced the costs of switching from one brand of computer software to another: data files are unlikely to transfer perfectly, incompatibilities with other tools often arise, and, most important, retraining is required” (Shapiro & Varian, 1999, p. 11).

A key characteristic of an Information Infrastructure is that it is constantly evolving. We recall the characteristics which are: shared, open, heterogeneous, evolving installed base (Hanseth & Lyytinen, 2010). As mentioned above the key elements of an installed base are people and technology. When introducing an information system, it is important to acknowledge that this installed base is never a

clean slate. People’s knowledge and prior experience will both enable and constrain the actions taken. The technology will also enable and constrain further development. For example, if users are familiar with one information system, this knowledge may enable bootstrapping of a new information system. On the other hand, if the users were unhappy with the old system, this prior experience may decelerate the evolution of the information system. Based on Grindley, Hanseth visualises how the installed base grows in a positive reinforcement cycle (Hanseth, 2001) (see Figure 5).

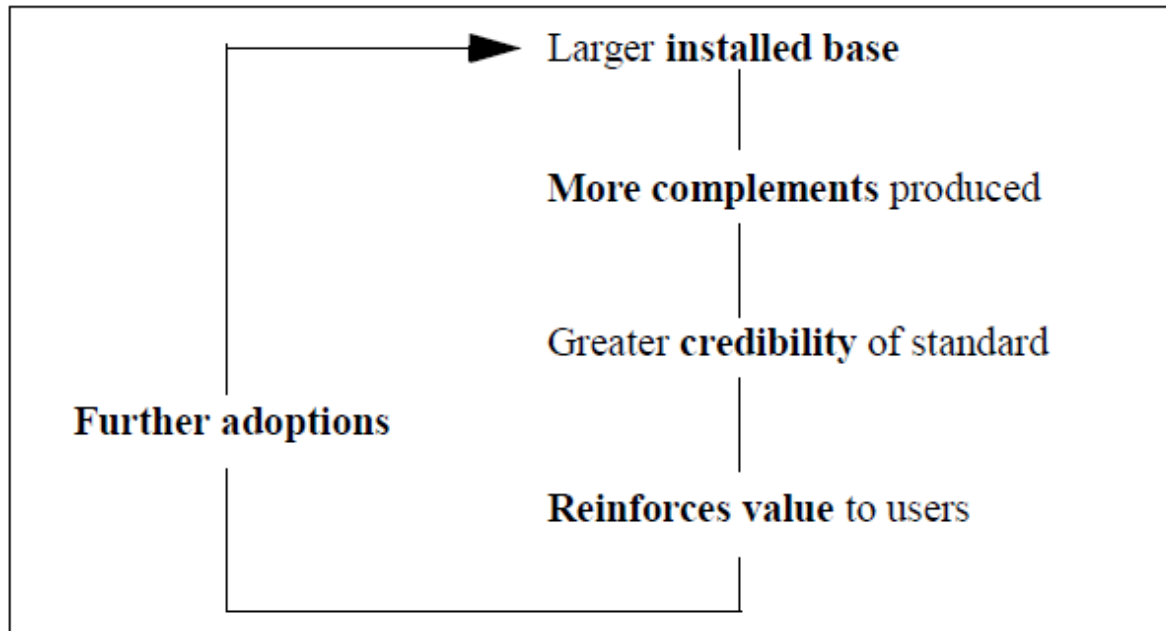


Figure 5: Grindley’s Standards Reinforcement Mechanism, from Hanseth (2001, p. 73)

Grindley’s model is rooted from Complexity Science which in turn comes from the natural sciences and economics. His model focuses on standards, but it can also be used to understand the evolution of an Information Infrastructure. Quoting Rodon and Hanseth: “[Information Infrastructures]...*which are built to last, grow over long timescales by integrating and extending the existing socio-technical installed base. In that sense, II emergence and growth is fundamentally a question of evolution*” (Rodon & Hanseth, 2013, p. 1). This evolution is twofold: bootstrapping and adaptation. We recall that bootstrapping means getting the infrastructure started by its own means (Hanseth & Aanestad, 2003) and adaptation means the continuous reinforcement of the infrastructure (Hanseth & Lyytinen, 2010). I will include another study by (Henfridsson & Bygstad, 2013) to further investigate causal powers (also known as mechanisms) for evolution.

Additional remark: The two concepts **adoption** and **adaptation** may look alike at first glance but they have different meanings. **Adoption** happens when users are attracted to the technology and start using it. **Adaptation** means customizing or changing in order to deal with a new situation.

### 3.2 Bootstrapping and adaptation of the installed base

Both concepts of bootstrapping and adaptation and the processes of innovation, adoption, and scaling acknowledge that the more people who use the technology, the more value it returns to each user (also known as Metcalfe’s Law) (Shapiro & Varian, 1999). Shapiro and Varian offer the example of the fax machine. Only one, or even a few, users of a fax machine will not result into much value for the people. As a consequence, people might wait for others to start to use the infrastructure, which resembles the chicken and the egg problem. The infrastructure will not provide value if no one uses it and no one wants to use it if there is no perceived value. As we know, the fax machine did indeed get bootstrapped, but it took more than a century after the Scottish inventor, Alexander Bain patented the basic technology for fax machines in 1843. Fax machines remained a niche product until 1982; only a few businesses had a fax machine. Over five years, the demand for and supply of fax machines exploded (Shapiro & Varian, 1999).

A more recent study describes how the airline company called Norwegian managed to successfully attract customers to purchase tickets online in 2004. After only two years, 85% of the customers preferred to purchase online. This, in turn, resulted in more resources to be put in to the website of Norwegian, where also other services were offered later. This example illustrates a successful bootstrapping of online ticket purchasing in 2004, but also its adaptation in the two following years (Henfridsson & Bygstad, 2013).

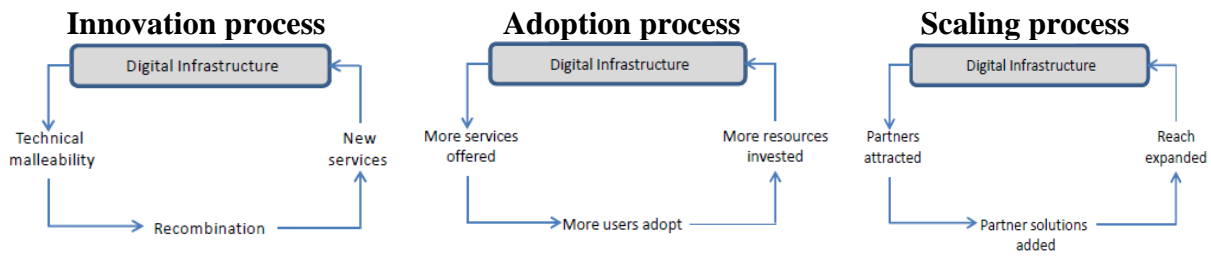
Bootstrapping has a strong focus on the user as an individual. For example, Grisot, Hanseth and Thorseng find that “...successful infrastructure innovations are based on a bootstrapping strategy addressing specific users’ needs, usefulness and evolutionary growth.” (Grisot, Hanseth, & Thorseng, 2013, p. 1). If we take a critical look at Grindley’s model (Figure 5), we find that it has one limitation; it assumes that all people have the same preferences. According to the Granovetter and Schelling model, described in Hanseth and Aanestad, people are different and their preferences differ accordingly. Consider yourself waiting with a group to cross the street on the green traffic light. One person thinks: “If **one** other person starts to walk on red, so will I”, while another thinks: “If **ten** others have walked on red, then I will walk also”. From this example, we see that even small changes (only one person) can have large effects over time. Consequently, Hanseth and Aanestad (2003) offer three “tricks” to get the self-reinforcing cycle started (or bootstrapped): identify users with knowledge about the technology; manipulate the preferences of a user; and build on the installed base.

Bootstrapping does not guarantee adaptation, but adaptation depends on successful bootstrapping. The processes of innovation/adoption/scaling as identified by Henfridsson and Bygstad have a perpetual nature and address the **evolution** of an infrastructure. Bootstrapping is concerned with getting the infrastructure **started**, and bootstrapping will at some point turn into adaptation. The opposite result is that the infrastructure will fade out. The tipping point is the point in time when the transformation gradually occurs. For example, The Norwegian Nordunet Project (which at first consisted of Open Systems Interconnection (OSI) champions) decided to hook up to an IP network (through the Nordunet Plug). This can be seen as a “tipping point” in IP’s favour, and “the beginning of the end” for OSI (Hanseth, 2001). (My comment: OSI is a conceptual model for communication between computers.)

The key question is how we can promote sustainability of Information Infrastructures. Not all information technologies survive over time. Examples of dead or dying Information Infrastructures include the Morse code and the X.25 protocol (Hanseth, 2001). Building on the theory of Information Infrastructure, Henfridsson and Bygstad identified three processes (innovation, adoption, and scaling) as causal powers for how infrastructures evolve over time (Henfridsson & Bygstad, 2013). **Innovation** is defined as: “A self-reinforcing process by which new products and services are created as infrastructure malleability spawns recombination of resources” (p. 909). Innovation implies that the technology must be malleable, allowing for offspring of new services. For example, Google’s huge success is explained by its infrastructure which is “Built to Build”, allowing Google to develop and roll out new services at rapid speed (Iyer & Davenport, 2008). However, all innovators, advertisers, content providers and consumers belong to the Google Platform, resembling the installed base element from Hanseth and Lyytinen.

The definition of **adoption** reads: “A self-reinforcing process by which more users adopt the infrastructure as more resources invested increase the usefulness of the infrastructure” (Henfridsson & Bygstad, 2013, p. 909). When people start to adopt the technology, more services will be developed, which again will attract more users, and more resources will be invested in the technology. As an example, smart phones are intuitive, with many functions that are easy for the users to find, which again causes more resources to be invested in the smart phone technology.

Finally, **scaling** is defined as: “A self-reinforcing process by which an infrastructure expands its reach as it attracts new partners by offering incentives for collaboration” (Henfridsson & Bygstad, 2013, p. 909). They use the airline company Norwegian as an example. Norwegian’s infrastructure was open, thus attracting new partners such as travel agencies and even financial institutions, which added solutions for online booking and payment. Each process is illustrated in Figure 6.



**Figure 6: Innovation, Adoption and Scaling illustrated (from Henfridsson & Bygstad, 2013, p. 909)**

Although I do not explicitly apply these three concepts directly in my study, they are useful to understand the temporal perspective of adaptation. Bootstrapping occurs prior to an adaptation, and at some point – called a “tipping point” in the Information Infrastructure literature – the bootstrapping will turn into adaptation. The causal powers of innovation/adoption/scaling help understand the underlying dynamics of adaptation and are seminal for my generic framework (Figure 15), which will come later. Based on the literature presented above my interpretation of the relationship between the concepts is as follows:

### **Bootstrapping**

- Identifying: Bootstrapping is less about persuading a certain *number* of people, and more about persuading the *right* people, and these must be identified.

- Manipulation: The preferences of a user can be manipulated. Instead of “buying users” (in the sense of subsidising), it is better to identify people who know (or are willing to learn) and to start using the technology. People have different preferences, and it is better to focus on early adopters (Rogers, 2003), rather than spend time and resources on persuading people who are late adopters.

- Building the installed base: When you have identified and persuaded the early adopters, they will constitute the installed base, and the late adopters will follow suit because the value of belonging to the group of users has increased.

### **Adaptation**

- Innovation: New products and services are created as infrastructure malleability spawns recombination of resources. This will facilitate adding new products, and so on.

- Adoption: The more users who adopt the infrastructure, the more resources will be invested, which will increase the usefulness of the infrastructure. This will attract more users, and so on.

- Scaling: Attract new partners and offer incentives for collaboration. The collaboration will attract new partners, and so on.

## **3.3 Software engineering patterns**

As mentioned in the Introduction, I will identify patterns in order to facilitate BI utilisation. I am inspired by software engineering patterns. These patterns date back to the architect Christopher Alexander. In several books, he described a *timeless way* to build houses and towns. In the book from 1977, he and his co-authors presented 253 patterns that span constructing verandas to bus stops and road crossings. The 253 patterns are not rules; rather, they should be cherry-picked depending on the project in question and together they would assemble a building (Alexander et al., 1977). Building on Alexander, Larman and the Gang of Four have created several patterns in a software engineering context. Larman explained that experienced software developers have built a repertoire of general principles and idiomatic solutions that guide them when creating software. “*These principles and idioms, if codified in a structured format describing the problem and solution and named, may be called **patterns***” (Larman, 2005, p. 278). Larman continued by stressing that a pattern is a named description of a problem and solution that can be applied to new contexts, with advice on how to apply it. Finally, the term pattern attempts to codify long-repeating and “*...existing tried-and-true knowledge, idioms, and principles; the more honed, old, and widely used, the better*” (p. 279).

There are some differences between Alexander’s patterns and software engineering patterns. The Gang of Four pointed to the fact that people have been making building for thousands of years, but we



have only recently began to create Information Systems. Alexander provided an order, in which the patterns should be used, but this is not the case in software engineering patterns, and while Alexander claimed that the 253 patterns would generate any building, this will not be guaranteed in Information Systems (Gamma et al., 1995). My BI patterns will have elements from the Gang of Four when it comes to BI being a rather young discipline and I will not claim that the patterns are sufficient for tackling all problems that a BI solution may encounter. However, my patterns should be followed in a certain order, as Alexander advised. In my case, this means that some patterns will address problems in the bootstrapping phase and some patterns will address problems in the adaptation phase.

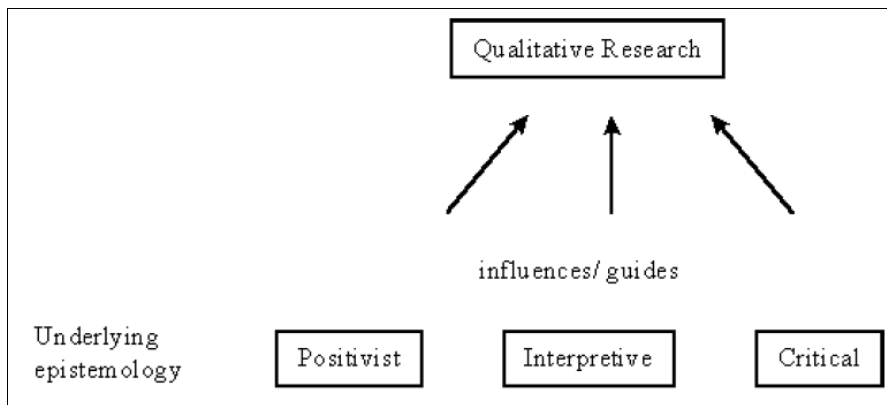
Summing up, an Information Infrastructure is a shared, open, heterogeneous and evolving installed base. The installed base must be self-reinforced, and an Information Infrastructure faces two challenges: bootstrapping and adaptation. Bootstrapping has to do with getting the Information Infrastructure started in the sense of attracting both the right users and enough users for others to realize the value of the infrastructure. Adaptation concerns a continuous growth of the infrastructure. The study by Henfridsson and Bygstad seek to explain why some Information Infrastructures evolve and why others do not evolve over time. Software engineering patterns are solutions to a problem in a context which are identified rather than manufactured. By studying ongoing BI solutions which have been bootstrapped and adapted, it is possible to identify both a common problem, a solution that works and a context in which to apply the pattern.

The next chapter describes the overall research approach, along with a detailed presentation of data collection and data analysis.

## 4. Research process

In this chapter, I present what I have done in order to investigate my research question (*How can BI utilisation be developed through bootstrapping and adaptation?*). First, I will justify my overall epistemology and research approach. Then, I thoroughly describe my collected data and how I analysed them using a technique called *The Ladder of Analytical Abstraction*.

Epistemology is defined as the assumptions about knowledge and how it can be obtained (Myers, Section Editor (living version)). Studies within Information Systems are divided into three main epistemological camps: positivist, interpretive and critical, as illustrated in Figure 7.



**Figure 7: Underlying philosophical assumptions (copied from Myers, living version)**

My overall approach was case study, building on practises from Yin (1994) and Pettigrew (1990). As stated by Myers, I acknowledge that Yin and Pettigrew lean towards different epistemological camps. Hence I find myself somewhere between the positivist and interpretive epistemology in Figure 7 above. While I lean somewhat to the positivist stance, I do not study causal effects in the sense of predicting; rather, I study processes and outcomes (Pettigrew, 1990). According to Pettigrew, organisational processes must be studied both horizontally and vertically. The horizontal level studies the different events over time and how they are connected. The vertical level refers to the analysis of each event and how they influence each other.

Following Yin’s definition of a case study, I chose this approach because I study a real-life phenomenon in its natural context, and as a researcher, I have little control over the events (see Table 4).

Yin’s definition	My study
Real-life phenomenon	Utilisation of Business Intelligence solutions
Natural context	Managers, developers, and end-users in Norwegian organisations
Limited control over the events	Business Intelligence tools are already in use in the organisations

**Table 4: Yin’s definition of a case study and how this study corresponds**

Although my overall approach is a case study I have conducted action research in paper 2 and paper 3 includes a small experiment. The reason for this is that these methods provided the best data collection in order to answer the research question in each publication.

### 4.1 Data collection

My empirical data are grounded in case studies documented in five publications which have been peer-reviewed. All cases are from Norway and were specifically chosen for two main reasons. As Eisenhardt pointed out: *“The cases may be chosen to replicate previous cases or extend emergent theory, or they may be chosen to fill theoretical categories and provide examples of polar types. While the cases may be chosen randomly, random selection is neither necessary, nor even preferable”*

(Eisenhardt, 1989, p. 537). First, since I reside in Norway it was easier to gain access to the companies. Second, I deliberately chose cases which allowed me to study various ongoing BI solutions and how people are interacting with the technology on a daily basis, as opposed to cases where no BI solutions were in use. As summarised in Table 5, two cases are within education. This allowed me to study BI utilisation, but in a different context, which usually strengthens the external validity (Eisenhardt, 1989), meaning to what extent my findings can be generalised (Yin, 1994). The environment in a classroom was different in the sense that the users were students and lecturers, and the main aim was to fulfil learning objectives, rather than to make good decisions in order to “increase income and cut expenses” for an organisation (Elbashir et al., 2008). On the other hand, the overall goal was still to prepare the students for working life, and the learning objectives included hands-on skills of a state-of-the-art Business Intelligence tool. Another decision I had to make was how many cases I should investigate. As a rule of thumb, Eisenhardt (1989) advised between 4 and 10 cases. I ended up with five cases, of which three are from the industry and two are from education. More details are found in Table 5.

Paper #	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
<b>Published</b>	AMCIS 2010	JITE 2012	SJIS 2013	NOKOBIT 2013	ECIS 2014
<b>Case</b>	Music Industry	Education	Airliners	Education	Manufacturing
<b>Empirical sources</b>	8 interviews. Physical artefacts (BI tools in use).	1 survey, 21 respondents. Observation in classroom.	Data mining of 29 035 postings on Facebook. 1 interview.	9 surveys (90 respondents in total). Documentation.	10 interviews. Documentation. Physical artefacts (BI tools in use)
<b>Type of data</b>	Qualitative	Qualitative and quantitative	Qualitative and quantitative	Qualitative and quantitative	Qualitative
<b>Data collected</b>	Spring 2008	Fall 2010	Spring 2010	From Fall 2008 to Spring 2013	Fall 2013

**Table 5: Summary of case and data which constitute this thesis**

A good case study will want to use as many sources as possible (Yin, 1994, p. 80). Based on Yin, I categorised four main sources of evidence: documentation, interviews, observation, and physical artefacts. Each of these sources has their strengths and weaknesses (see Table 6).

Source	Strengths	Weaknesses	Yin’s examples
<b>Documentation</b>	Stable: can be reviewed Unobtrusive: not created as result of the case study Precise: contains names, references, details of an event Broad coverage: long span of time, many events	Retrievability can be low Biased selectivity Access may be blocked due to privacy reasons	Letters, agendas, proposals, formal studies, newspaper clippings Organisational charts, budget, maps, personal records (telephone, diaries, calendars)
<b>Interviews</b>	Targeted: focuses directly on case study topic Insightful: provides perceived causal inferences	Bias due to poorly constructed questions Response bias Inaccuracies due to poor recall Reflexivity: interviewee gives what interviewer wants to hear	Most commonly, interviews are open-ended. Survey can be used in conjunction with, or part of, case study
<b>Observations (By making a field visit to the case study “site”)</b>	Reality: cover events in real time Contextual: covers context of event	Time-consuming Selectivity Reflexivity: event may proceed differently because it is being observed	Observe meetings, factory work, or classroom. Observing the condition of a building/work space.
<b>Physical artefacts</b>	Insightful into cultural features, technical operations	Selectivity Availability	Technological device, tool, instrument, work of art, other physical evidence

**Table 6: Sources of evidence with strengths and weaknesses (based on Yin, 1994)**

Amongst the sources in Table 6 Yin found the interview to be the most important in a case study because “...most case studies are about human affairs” (p. 80). A survey can also be used in conjunction with a case study. As shown in Table 5 above, this PhD study builds on a several sources.

Interviews and surveys are predominant, while observations are the least frequent. Although (almost) all of the interviews were conducted on site of the company, this does not qualify for calling it observation. Paper 4 is the exception, since I, as the role of lecturer, spent the whole semester in the classroom together with the students and fellow lecturers and/or assistants. This overview by Yin was very useful when I collected the data for each publication in two ways. First, it made it easier for me to plan the interviews, and to allocate enough time to conduct and transcribe them afterwards, which indeed proved to be time consuming. In Table 6, in the right-hand column, we see that Yin claimed that most interviews are open-ended. This has not been the case in any of my interviews; rather, they have been semi-structured. I chose semi-structured interviews because the answers are easier to compare in the analysis phase. Second, I became aware of the many forms of physical artefacts that I could use, and I made sure to ask for these when I visited the case companies.

The only problem I experienced was how to categorize data as a type of source. For example in papers 1 and 5, there were demonstrations of the BI tools which the companies use. At first I thought this could be viewed as observation, but these were rather snap-shots created by the users upon my request, and for this reason I categorize them as physical artefacts. Below is a detailed overview of the collected data.

#### **Paper 1 (AMCIS 2010)**

Seven face-to-face interviews: quotes.

One written interview with a legal expert.

Print screen of mapping music & gender.

Physical artefact of BI tools in use: SAP, Excel, Google Analytics (print-screens.)

#### **Paper 2 (JITE 2012)**

One survey with a total of 21 answers from contemporary students.

Observations in classroom during lecture and exercises.

Course plan and curriculum.

#### **Paper 3 (SJIS 2013)**

10 189 postings from SAS' Facebook page.

18 846 postings from Norwegian's Facebook page.

One face-to-face interview with CIO of Norwegian: quote.

SAS's homepage on the Internet.

Norwegian's homepage on the Internet.

#### **Paper 4 (NOKOBIT 2013)**

Six years of lecture notes, course plans, curricula, "how-to's" from BI technology vendors.

Eight surveys with a total of 90 answers from previous Bachelor and Master's students.

Observations in classroom during lecture and exercises.

#### **Paper 5 (ECIS 2014)**

Ten face-to-face interviews: quotes.

Documentations and models of business processes and the BI architecture.

Physical artefact of BI tools in use: QlikView (print-screens.)

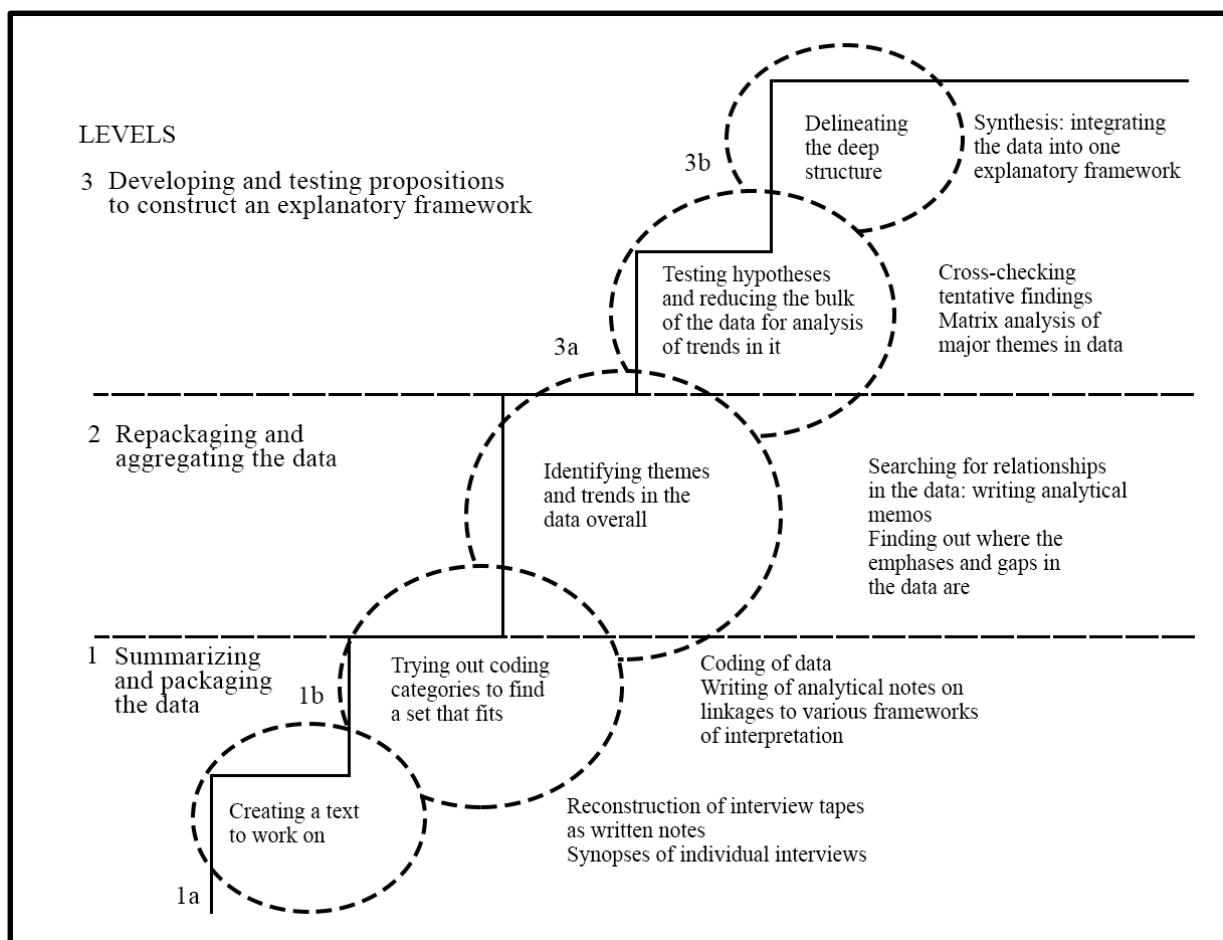
According to Myers (living version), it is common practice to distinguish between primary and secondary sources of data. Primary sources are unpublished and collected directly by the researcher from the people or the organisation. Secondary sources refer to any previously published materials such as books and articles. In this study, all publications are based on primary data which I collected first-hand. In the next section, I describe how the collected data was analysed.

### **4.2 Framework for data analysis**

The majority of my data are in the form of text, which is created from interviews, observation, surveys, and web pages. Quoting Myers (living version):

*“The motivation for doing qualitative research, as opposed to quantitative research, comes from the observation that, if there is one thing which distinguishes humans from the natural world, it is our ability to talk! Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live.”*

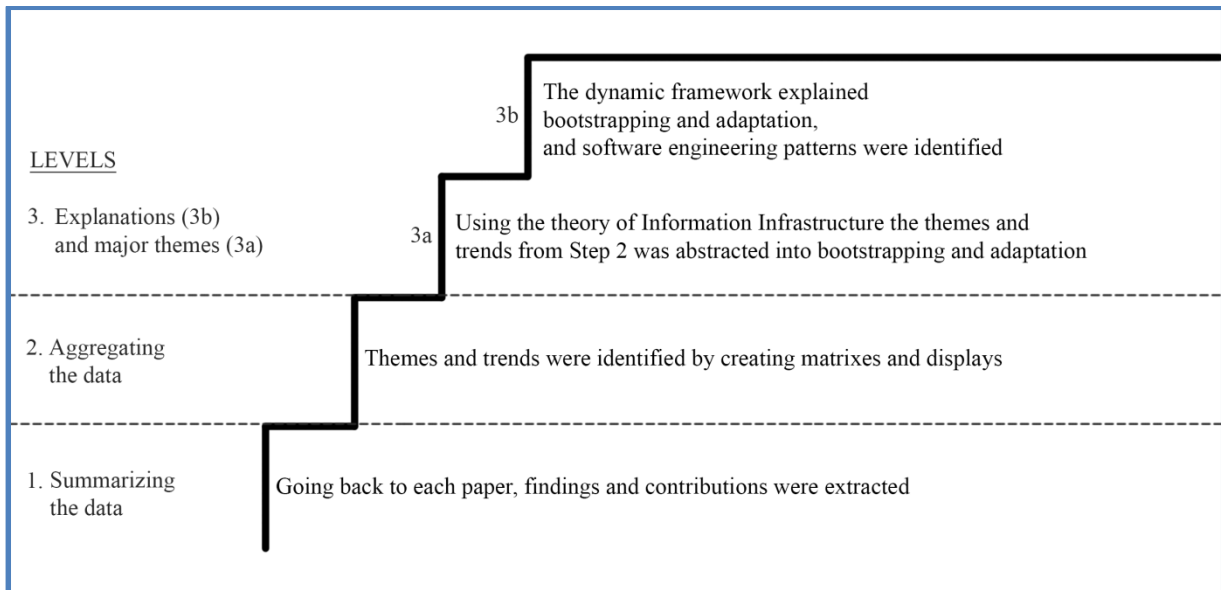
Pettigrew (1990) argued that a qualitative study allows the researcher to ask: *“if this is your outcome, tell me what processes you went through to get there”* (p. 55). The collected data were analysed by using techniques by Miles and Huberman (1994). The authors argued that qualitative research is about both describing and explaining a phenomenon. The researcher must tell a story, going from describing what happened, and what happened next, via constructing a map, to building a model or theory (Figure 8). A theory can also be tested instead of built. I built my own model by extending the existing BI literature and I customised the Information Infrastructure theory in order to analyse and explain the findings.



**Figure 8: Reproduction of Carney’s *Ladder of Analytical Abstraction* (from Miles & Huberman, 1994, p. 92)**

The ladder illustrates how data is transformed over time by the researcher. Despite the illustration of the step-wise ladder, this is still an iterative process, and the researcher must move up and down between the steps throughout the research project. My interpretation of the ladder in Figure 8 was that it is meant for analysing only one research project at a time. My challenge was to analyse five different projects, and in addition this had to be done in retrospect while at the same time trying to synthesise the papers into two consistent contributions (one for theory and one for practise). In order to do a cross-case analysis, I needed to make some changes to the ladder, as shown in Figure 9.

Figure 9 below shows the main traits of my adaptation and each step in the ladder is explained in more detail underneath.



**Figure 9: My adaptation of the Ladder of Analytical Abstraction**

### **Step 1: Summarising data**

The first step was not too difficult. Since I had chosen to do a paper-based thesis, I had already collected and processed data in the papers at the time of this analysis. For each paper, I had previously created text to work on, either from interviews, observations, and/or existing documents, or extracted from webpages. These data sets were summarised sequentially at different times for each paper, over a time span of six years.

I studied five the papers simultaneously, which was useful since several years had passed since I published the first paper. I reviewed each paper again, and extracted the main findings and contributions from each (these are presented in the next chapter).

### **Step 2: Aggregating data**

Following Miles and Huberman’s techniques, I searched for themes and trends in my findings from Step 1: Summarising data. I found that themes correspond somewhat to what Pettigrew refers to as vertical processes, which we recall is about how events influence each other. Similarly, trends correspond somewhat to horizontal processes, which have the time aspect (Pettigrew, 1990).

Themes can be made by means of clusters and matrixes. The reason for creating themes is that qualitative data, usually in the form of text, are sequential and spread out through several pages. This makes it hard to get an overview of the whole case. By coding and reducing data into clusters or matrixes, data can be processed at a glance, making it easier to identify patterns and explanations later (Miles & Huberman, 1994). I created themes mainly by clustering, meaning that I grouped similar concepts from the text from Step 1 by manually drawing and making notes on a large piece of paper. Slowly, the themes started to emerge, such as “agile/traditional tools”, “ease of use”, “training”, “rapid feedback”, and “useful”.

Creating a trend involves time perspective, and Miles and Huberman suggest making a matrix with columns and rows to illustrate how events occur over time. In my case, I would have to discover relationships between the themes. For example, it was during this exercise that I found that lightweight BI tools would generate short-term usefulness for the end-user. This would after some time motivate the user to explore other BI-tools with a higher user threshold, which again would result in more value for the end-user.

### **Step 3: Explanations and major themes**

Existing theory was introduced in Step 3.a: Major themes. My general conclusions were drawn on two main concepts from the Information Infrastructure theory: *bootstrapping* and *adaptation*. (These two concepts were employed in papers 4 and 5.) Following the ladder, I cross-checked and found that these

two concepts could apply to the themes and trends found in Step 2: Aggregating data. It was in this step that the different time perspective of the two concepts (bootstrapping and adaptation) started to materialize, but not without some trial-and-error:

Feeling a bit like Goldilocks, I first studied the Structuration Theory as found in the works of Ackoff, for example in (Sengupta & Ackoff, 1965). It became clear at an early stage that this theory was too complex to explain the themes and patterns I had identified from Step 2: Aggregating data in the ladder. Then I studied the TAM by Davis (Davis, 1989). This theory proved to be incomplete; it did explain some of the themes such as *ease of use* and *perceived usefulness*, but it did not apply when I tried to explore the dynamics and my other themes and trends. Finally, quoting Goldilocks, the two concepts from the Information Infrastructure theory proved *just right* for analysing the cases.

In my study, Step 3.b: Explanations was twofold, because I offer a theoretical and practical contribution. First, I explained my findings using the concepts of *bootstrapping* and *adaptation* (Hanseth & Lyytinen, 2010). I demonstrated how the prevailing, tripartite view of BI (technology/product/process) can be extended into a framework of an installed base which is reinforced through bootstrapping and adaptation. Second, I identified patterns. Here I chose to draw upon the concept of software engineering patterns. A pattern is per definition a problem/solution pair (Larman, 2005), and also a reusable building block which can be used by others in similar contexts (Gamma et al., 1995). My reason for employing patterns is that a software engineering pattern is not something you create or make; rather, a pattern is identified. This coincides with the study of Business Intelligence as an Information Infrastructure that I explored in publication 5. An Information Infrastructure also “has a life of its own”, meaning that it is difficult to force people to use a technology or follow a process. For example, the very origin of *bootstrapping* from computer science means “getting the system started by the system itself” (Hanseth & Aanestad, 2003). Finally, I operationalized each pattern into management guidelines. Using data from Step 1: Summarising data and Step 2: Aggregating data I was able to provide more specific steps for management to follow.

The researcher must expect to make several iterations between the steps. In my analysis, I found that going from Step 1: Summarising data up to Step 2: Aggregating data was easier than reaching the final step. And once I had reached Step 3: Explanations and major themes, I had to dive back and revisit the text in my papers in order to ensure that the chosen theory would fit with my explanations. Not only did I have to go back and forward between the steps, but I also had to contemplate five different publications at once. As mentioned, the papers had been published over a time period of five years (2010 – 2014), and I had matured over the years. For example, I only applied the Information Infrastructure theory in the last two publications. I asked myself if it would have facilitated the analysis if I had based my publications on the concepts (bootstrapping and adaptation) earlier. In this process I found Eisenhardt’s article useful:

*...theory-building research is begun as close as possible to the ideal of no theory under consideration and no hypotheses to test. Admittedly, it is impossible to achieve this ideal of a clean theoretical slate. Nonetheless, attempting to approach this ideal is important because preordained theoretical perspectives or propositions may bias and limit the findings. Thus, investigators should formulate a research problem and possibly specify some potentially important variables, with some reference to extant literature. However, they should avoid thinking about specific relationships between variables and theories as much as possible, especially at the outset of the process* (Eisenhardt, 1989, p. 536).

Consequently, the answer to my question was actually no: I could disregard my concern about not knowing about the Information Infrastructure and focus on the fact that I allowed myself to be more explorative and non-biased in the first three publications.

Summing up, my object of study is Business Intelligence utilization in organisations. I use case study as the main research approach to study this real-life phenomenon. This is a qualitative study and data are analysed by using techniques by Miles and Huberman. The next chapter presents the five papers which were analysed and the findings which I illustrate in five Ladders of Analytical Abstraction.

*The secret of getting ahead is getting started.*  
(Mark Twain, n.d.)

## 5. Findings and analysis

This chapter presents the abstract of each paper, and how each paper contributes to the concepts of bootstrapping and adaptation. I use the *ladder of analytical abstraction* as presented in Figure 9 to illustrate this process.

### 5.1 Summary of each paper, data analysis and my reflections

As presented earlier, five publications constitute this thesis. A summary of each of the five papers, in chronological order, follows below.

#### Paper 1: BI in the music industry (AMCIS 2010)

The abstract of this conference paper reads:

*Business Intelligence (BI) is a concept that has been widely used to describe technologies which support e-business by gathering valuable data, and provide analysis for decision making. This paper discusses BI in the Norwegian music retail industry. We contacted the two larger music providers in the country and examined their strategies in using BI in their when selling digital music. The key findings indicate that BI is useful in identifying customer preferences while it is less useful when predicting which music will sell, because music is a rather volatile product. Our cases show that users believe that existing tools are rather sophisticated but difficult to handle while emphasizing the need for a “personal touch” but improving data quality, based on intuition and experience. Our results can be useful to music retailers looking to improve their customer relationships and exploit the existing BI technologies.*

LEVELS	
3. Step Explanations	<p><b>Bootstrapping:</b> The usability of the stand-alone/agile BI tools enables bootstrapping.</p> <p><b>Adaptation:</b> The perceived usefulness/value from the results of stand-alone/agile BI tools enables further adaptation of BI tools and BI process.</p>
2. Step Identify themes and trends	<p><b>Themes:</b> Information quality is important. Users experience a need for a formal BI system. There are regulations for personalized marketing and privacy.</p> <p><b>Trends:</b> Increasing use of BI tools, but in symbiosis with existing knowledge. Favour of stand-alone tools (Excel, Google Analytics) but curiosity about traditional technology (SAP). BI technology is becoming more sophisticated and easier to use.</p>
1. Step Document key findings	<p>BI is useful in identifying customer preferences. Users believe that existing tools are rather sophisticated but difficult to handle while emphasizing the need for a “personal touch”.</p>

Figure 10: Data analysis of paper 1

This paper was my very first academic publication with peer reviewers. It was while I conducted these interviews at the two case companies that my curiosity was awakened and that I began to question the rational process and the technical focus on which BI was currently founded. My co-authors and I were surprised to learn that: *“None of the participants expect the data to be perfect. They trust most of the data source, based on their own control routines. As pointed out by several participants, no system is perfect, and it should be used as a tool to support decisions, not make them alone. The statement of the bank manager ‘In God we trust, all others bring data’ is in the case companies changed to ‘In ourselves we trust, and data jog along’”* (Presthus, Papazafeiropoulou, & Brevik, 2010, p. 6).



The participants used BI technology in symbiosis with their previous experience and existing knowledge when it came to customer preferences and sales prediction. At the time of this conference paper I did not know how to explain this finding on an abstract level, because I had yet to learn about the Information Infrastructure theory. In retrospect I recognize the dynamic processes of bootstrapping and adaptation through the lens of Information Infrastructure, as shown in Step 3 in Figure 10. The participants, along with their musical experience and BI technology are part of the installed base. Bootstrapping happens through the agile BI tools, which are perceived as easy to use. The bootstrapping in turn enables adaptation because the users experience value from using the tools, which in turn attracts more users to the BI tools.

## **Paper 2: Real-life puzzles for the business school lecturer (JITE 2012)**

Summary as found in the abstract:

*Modern Business Intelligence (BI) is about the process of turning data into actionable information, using an assortment of tools, techniques, and applications. Although BI, or its predecessor Decision Support Systems (DSS), has been applied in the industry for about half a century, it has only recently been taught in business schools. In the report “State of Business Intelligence in Academia 2010” Wixom and Ariyachandra found that the discipline faces many challenges in its way from practice to academia. For the lecturer, challenges include access to data sets and finding suitable cases, as well as providing realistic and meaningful examples. For the students, on the other hand, the problem is that BI is ripe with concepts and acronyms and appears too theoretical and abstract.*

*In this study we report from an introductory Bachelor course in Business Intelligence and reflect on the learning process. Our focus is how to make Business Intelligence education more fun and motivating for the students, while at the same time providing the BI lecturer with some examples from real life. We conducted a small action research study in a university college with a class of third year e-business students. Drawing on principles from Problem-Based Learning and Puzzle-Based Learning, we employed a framework of real life puzzles. Each puzzle consists of real life problems, real life data, and real life solutions.*

*Our main contribution is that the real life puzzle approach is a powerful method to teach Business Intelligence concepts and processes. We argue that the similarities between the BI process and the puzzle solving process prepare the students for Business Intelligence learning, in an indirect way. Through the gradual realization on how these puzzles work, the students are able to connect the logical structures of puzzles with the rational way of BI queries. This prepares the students for Business Intelligence learning, and also for practice in working life. This insight should be of interest to any lecturer of BI.*

<p>LEVELS</p> <p>3. Step Explanations</p>	<p><b>Bootstrapping:</b> Exposing real-life puzzles to the students at early stages of the course enables bootstrapping because the students become curious while at the same time having fun during the learning process.</p> <p><b>Adaptation:</b> Since the students previously experienced a feeling of mastering and satisfaction they are motivated for continuous learning about BI process and tools.</p>
<p>2. Step Identify themes and trends</p>	<p><b>Themes:</b> The lecturer may use the real-life puzzles framework to provide meaningful datasets and real-world cases. There are similarities between the BI process and the puzzle solving process which prepare the students for Business Intelligence learning.</p> <p><b>Trends:</b> N/A</p>
<p>1. Step Document key findings</p>	<p>Four examples are exposed to the students in the form of a real-life framework (real-life problem, real-life data, real-life solution). The majority of the students found the puzzles both fun and useful for their learning process.</p>

Figure 11: Data analysis of paper 2

Figure 11 above illustrates the whole publication using the ladder of analytical abstraction. The main contribution of this article is the real-life puzzle framework as a resource for the BI lecturer as well as the students in business schools. This paper is less about pedagogy although the framework was inspired by two pedagogical principles (Problem-Based Learning and Puzzle-Based Learning). The framework was evaluated and assessed based on feedback from the students. Their feedback was mainly positive. But what makes this real-life puzzle framework work on a more general level? At the time of this publication (in 2012) the Information Infrastructure was still unknown to me, but when I analyse the findings anew the concepts of bootstrapping and adaptation explain the themes. Since the data material in this article is based on a survey it is hard to identify trends; trends usually require data over a longer period of time while a survey typically provides a “snapshot” of a situation at a given time. The students and the course are bootstrapped by exposing the real-life puzzles at the beginning of the course. The satisfaction of solving the puzzles leads to adaptation of the next weeks of lectures.

### Paper 3: Facebook as agile CRM for Norwegian airliners (SJIS 2013)

The abstract of this article is as follows:

*Some researchers predict a paradigm shift within Customer Relationship Management (CRM), moving from the traditional large in-house CRM systems to social software such as Facebook. In this article we investigate two issues. First: are there inherent problems in traditional CRM systems that Facebook may resolve? Second: if so, can social media replace CRM systems? We conducted a case study of two Scandinavian airliners’ use of Facebook for customer communication during the ash crisis in April 2010. Our analytical approach was a Business Intelligence analysis using web- and text mining based on 28.000 postings on Facebook. We offer two findings. First, Facebook resolves some shortcomings of traditional CRM. The openness of Facebook allows for more dynamic interaction between company and customers. Facebook has a self-reinforcing mechanism for diffusion, meaning that short-term usefulness triggers more use, which again will increase the usefulness. Second, we do not believe that social media can replace traditional CRM systems, but it constitutes an interesting challenge. If not a full CRM, Facebook can serve as a “social CRM”. In contrast to traditional CRM, companies may not be the strongest part, since personal information is controlled by the customer. This is indeed an interesting arena for researchers.*

<p>LEVELS</p> <p>3. Step Explanations</p>	<p><b>Bootstrapping:</b> Rapid response from the airlines enables bootstrapping for passengers and airlines.</p> <p><b>Adaptation:</b> The shared, open, and transparent character of Facebook supports adaptation, in the sense that it could be used for unusual and unexpected purposes.</p>
<p>2. Step Identify themes and trends</p>	<p><b>Themes:</b> Airlines use Facebook as CRM system in crisis situations. It takes only minutes between a posting from a passenger and an answer from the airlines.</p> <p>The ambiance is good (good tone from passengers).</p> <p><b>Trends:</b> Airlines use Facebook extensively in crisis situations</p> <p>The airlines communicate as well as solve problems.</p>
<p>1. Step Document key findings</p>	<p>Using BI techniques, we find that Facebook resolves some shortcomings of traditional CRM.</p> <p>Personal information is controlled by the customer.</p>

Figure 12: Data analysis of paper 3

This journal article is based on a previous conference paper (Prethus & Bygstad, 2010). It is a paper about how companies can use BI to handle BI&A 2.0 (as found in Chen et al. (2012) described in Chapter 2). In this case we do not look at bootstrapping and adaptation of BI tools, but we assess the use of Customer Relationship Management (CRM) systems versus Facebook. Facebook is an example of an Information Infrastructure, and this article can be used to illustrate how it enables bootstrapping and adaptation so that BI practitioners can learn from this successful case in the future. CRM is, after all, one of the areas which benefits from BI (Elbashir et al., 2008). This paper also shows the importance of the installed base; the fact that the companies knew that many of their customers were users of Facebook made this case a success.

**Paper 4: Teaching BI in Higher Education (NOKOBIT 2013)**

The abstract of this paper is as follows:

*Business system studies are in demand in higher education, and current research is addressing how this should be taught from a pedagogic angle. This paper describes a different framing of the phenomenon. Building on Hanseth’s information infrastructure theory and Larman’s pattern principles, a case from higher education is used to investigate how a knowledge infrastructure can be built in higher education. The case is a course of Business Intelligence at a university college which has evolved over six years. Two contributions are offered. The first is the proposal of an alternative theoretical framing of Business systems studies, where the “knowledge infrastructure in action” model highlights the dynamics of the interplay between the structural level and the actionable level. The second contribution consists of four practical patterns for establishing a business systems course in an educational or industrial organisation. This research should be useful for lecturers of business systems, both in college and the industry.*

<p>LEVELS</p> <p>3. Step Explanations</p>	<p><b>Bootstrapping (attracting students):</b> Using state-of-the-art BI technology at an early stage facilitates bootstrapping.</p> <p><b>Adaptation:</b> Draw on experiences from the first course. Study the students' learning curve and their feedback, adding more functions from the BI tools.</p>
<p>2. Step Identify themes and trends</p>	<p><b>Themes:</b> Theory must support technology. Build theory around the BI technology.</p> <p>The BI technology determines the course plan (when licenses are distributed from the BI vendors or Academic Alliances, and when lecturers from BI vendors or Academic Alliances are able to give demonstration/training for the lecturer).</p> <p><b>Trends:</b> BI tools are becoming a sound part of the course. The students become more and more satisfied for each year.</p>
<p>1. Step Document key findings</p>	<p>An alternative theoretical framing of Business systems studies, as an Information Infrastructure rather than pedagogy.</p> <p>Four patterns for establishing a business systems course in higher education.</p>

Figure 13: Data analysis of paper 4

In this paper, I wanted to continue the study of BI in education (paper 2) but from the lecturers' and the institution's perspective. At this moment in time I had studied the Information Infrastructure theory at the University of Oslo (fall semester 2013), and I wanted to analyse the case of successful teaching of BI in higher education through this lens, while at the same time providing software engineering patterns for any lecturer of BI.

**Paper 5: Manufacturing (ECIS 2014)**

The abstract of this conference paper is as follows:

*Business Intelligence (BI) solutions are complex and abstract. "You can build the solution, but users will not come," Cindi Howson writes in her famous BI book, indicating that even if it is successfully implemented, a BI solution may not be used to its full intention. Guided by the research question, "How do we bootstrap and adapt a BI solution?" this study investigates a successful BI solution at a large Norwegian company. Based on a case study, this paper argues that it is fruitful to regard a successful BI solution as the growth of an Information Infrastructure rather than the implementation of a certain technology alone. Drawing on the definition by Hanseth and Lyytinen, an Information Infrastructure is a shared, open, heterogeneous, and evolving socio-technical system (which they call an installed base) consisting of users, a set of IT capabilities, operations, and design communities. This paper attempts to describe how the case company is sustaining their successful BI solution and what we can learn. As a practical contribution, it offers three guidelines for BI practitioners. This study should be of interest to both users and managers of Business Intelligence solutions in the industry.*

<p>LEVELS</p> <p>3. Step Explanations</p>	<p><b>Bootstrapping:</b> Demonstrating the ease of use and usefulness to the end-users enables bootstrapping.</p> <p><b>Adaptation:</b> The BI competence is kept in-house and is available, which facilitates adaptation. When end-users of BI experience a problem with the BI tool there is an easy and rapid process for a solution.</p>
<p>2. Step Identify themes and trends</p>	<p><b>Themes:</b> Loosely coupled architecture enabled exchange of BI technology. The BI department is highly competent. The end-users are supporting each other.</p> <p><b>Trends:</b> Starting with Cognos, QlikView has almost replaced this technology and is becoming a key part of the BI solution.</p>
<p>1. Step Document key findings</p>	<p>The case company's successful BI solution resembles an Information Infrastructure rather than the implementation of technology. Three patterns for BI practitioners.</p>

Figure 14: Data analysis of paper 5

The aim of this paper was to study the company's successful BI solution as an Information Infrastructure. At this time I had graduated from a PhD course in Information Infrastructure at the University of Oslo and I had studied a broad spectrum of related research. I acknowledge that once I had the hammer in hand it was very tempting to look for nails (Maslow, 1966).

Summing up, all the findings in the five publications could be explained by bootstrapping and adaptation and the next section explains these concepts in more detail.

**5.2 Bootstrapping and adaptation in the five publications**

In Chapter 2 we saw that the traditional, tripartite framing of BI is either about implementing technology, or a linear process, or designing products. Based on the findings and analysis in the previous chapter this framing can be extended as an installed base with particular emphasis on *bootstrapping* and *adaptation*.

Building on Hanseth's *Information Infrastructure Theory* (Hanseth & Lyytinen, 2010) and the causal powers (Henfridsson & Bygstad, 2013) described in Chapter 3 I synthesised a generic framework. Figure 15 consists of two dimensions, called *Installed Base* and *Action*. We recall that the key element of an Information Infrastructure is the installed base, which is evolving and socio-technical.

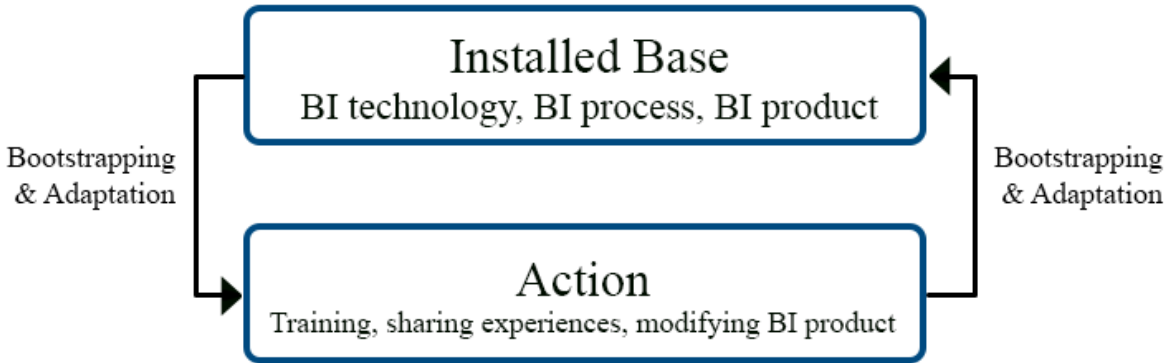


Figure 15: My generic framework for bootstrapping and adaptation of Business Intelligence

The installed base consists of technology, process, and product, but also vendors, people (for example end-users, experts, and developers), routines, business processes, data, and more. The lower dimension is the action taken, such as training users, sharing experiences, modifying products, and more. Between the two dimensions are bootstrapping and adaptation, illustrated by the arrows.

The following tables illustrate how I used this framework (Figure 15) to identify bootstrapping and adaptation in each case. More elements exist in real life, but I am intentionally keeping the examples as simple as possible. Please note that these are just my constructed snapshots of continuous processes.

The installed base is never void. In the first paper (AMCIS 2010), the installed base consists of skilled users in three companies; some with high expertise in music and others with high technological expertise. Bootstrapping was triggered by the usability of the lightweight BI tool Google Analytics (Snapshot 1 in Table 7). Google Analytics is a free tool which allows the owner of a website to monitor the visitors' behaviour, what they search for, time of visit and more (Snapshot 2). If users searched often for a popular artist, the webpage was altered to display this artist better (Snapshot 3). Next, the employees observed if the searches declined (Snapshot 4). Since the users experienced value from using the agile BI tools, this in turn enabled further adaptation of BI tools and the BI process. As the installed base is reinforced, it grows to include more and more technology and users.

Snapshot 1	Snapshot 2	Snapshot 3	Snapshot 4
Initial stage	Focus on action	Focus on installed base	Focus on action
<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Employees, artists, knowledge about music, customers' preferences and behavior on website, information from newsletters/magazines, BI tools (Google Analytics, Excel, SAP), sales numbers, album release                 </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     (No action yet)                 </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Employees, artists, knowledge about music, customers' preferences and behavior on website, information from newsletters/magazines, BI tools (Google Analytics, Excel, SAP), sales numbers, album release                 </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Employees observe webpage about search for artists by means of Google Analytics                 </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Employees, artists, knowledge about music, customers' preferences and behavior on website (is altered), information from newsletters/magazines, BI tools (Google Analytics, Excel, SAP), sales numbers, album release                 </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Employees observe webpage about search for artists by means of Google Analytics                 </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Employees, artists, knowledge about music, customers' preferences and behavior on website (is altered), information from newsletters/magazines, BI tools (Google Analytics, Excel, SAP), sales numbers, album release                 </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Employees checking whether numbers of searches about artist has declined                 </div>

Table 7: Bootstrapping and adaptation in paper 1 (AMCIS 2010)

In paper 2 (JITE 2012) the installed base mainly consists of students but the lecturers and vendors are also a part of it, as well as real-life puzzles, curriculum, and technology (Snapshot 1 in Table 8). In this paper bootstrapping is about keeping the students from dropping out/attracting them to show up in class every week of the Business Intelligence course. The journal article shows that exposing the students to real-life puzzles at an early stage enables bootstrapping because they have fun and experience a strong feeling of satisfaction (Snapshot 2), again making them curious about the rest of the course content (adaptation), which reinforces the installed base (Snapshot 3). The data material in the journal article was from one semester only, but paper 4 extends this case.

Snapshot 1	Snapshot 2	Snapshot 3	Snapshot 4
Initial stage	Focus on action	Focus on installed base	Focus on action
<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Students, curriculum, real life puzzles, lecturers as omniscient, BI tool (Excel)                 </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     (No action yet)                 </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Students, curriculum, real life puzzles, lecturers as omniscient, BI tool (Excel)                 </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Students solving the puzzles (with and without tools), students giving positive feedback                 </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Students, curriculum, improved real life puzzles, lecturers as omniscient, BI tool (Excel)                 </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">                     Students solving the puzzles (with and without tools), students giving positive feedback                 </div>	(As snapshot 2)

Table 8: Bootstrapping and adaptation in paper 2 (JITE 2012)

Paper 3 (SJIS 2013) has a slightly different framing. By using Business Intelligence techniques we analysed what made this case successful. In this study the installed base is dominated by the airline passengers who also were users of Facebook, but it also comprises the employers at SAS and Norwegian who (voluntarily) worked extra night shifts to respond to the many requests through Facebook (Snapshot 1 in Table 9). The fast and helpful response from the airlines bootstrapped the process (Snapshot 2), which again lead to more passengers using the social medium. The (somewhat surprisingly) friendly tone between the airline employees and the passengers could also contribute to

adaptation (Snapshot 3). Please note in Snapshot that the airlines’ websites are not adapted in this situation and are no longer part of the installed base.

Snapshot 1	Snapshot 2	Snapshot 3	Snapshot 4
Initial stage	Focus on action	Focus on installed base	Focus on action
			(As snapshot 2)

Table 9: Bootstrapping and adaptation in paper 3 (SJIS 2012)

The NOKOBIT paper incorporates the study from JITE into a six year study, from 2008 to 2013. The findings in this paper are thus on a more abstract level. Bootstrapping was facilitated by using state-of-the-art BI technology at an early stage of the courses (Snapshot 1 in Table 10). This motivated the students to show up and learn the technology (Snapshot 2). Also, exposing the students to functions with an increasing level of difficulty secured adaptation (Snapshot 3).

Snapshot 1	Snapshot 2	Snapshot 3	Snapshot 4
Initial stage	Focus on action	Focus on installed base	Focus on action

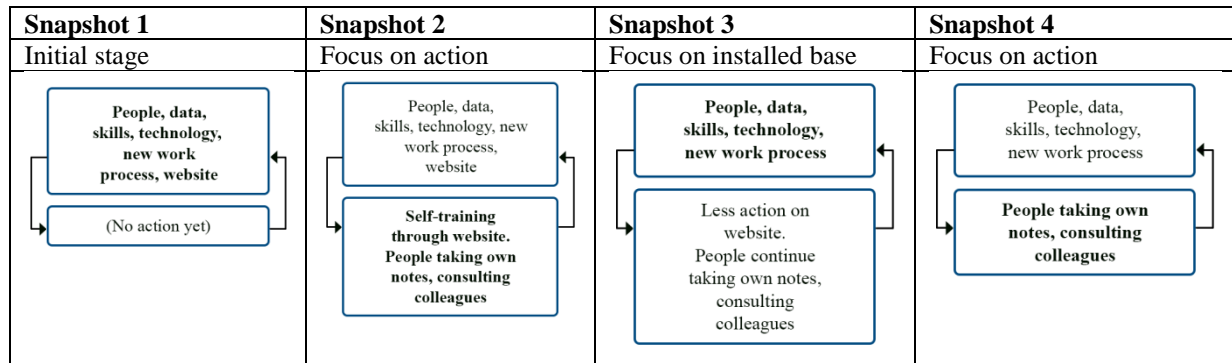
Table 10: Bootstrapping and adaptation in paper 4 (NOKOBIT 2013)

Finally, paper 5 (ECIS 2014) shows that existing skills, demonstration, and perceived ease of use and usefulness to the users enabled bootstrapping (Snapshot 1) in Table 11. Further, it is an explicit proof that keeping the BI competence in-house facilitates adaptation: training is given one-to-one and face-to-face; the users explore the new BI tool (Snapshot 2). The installed base has grown (Snapshot 3). People’s skills and technology are reinforced. In addition, a new work process (from spreadsheets to BI tool) has been established as part of the installed base. The people’s positive experience enables another action of creating an internal web site for self-training which becomes embedded in the installed base. Users can communicate through the website and share their experiences (Snapshot 4).

Snapshot 1	Snapshot 2	Snapshot 3	Snapshot 4
Initial stage	Focus on action	Focus on installed base	Focus on action

Table 11: The installed base is reinforced by bootstrapping and adaptation in paper 5 (ECIS 2014)

The model used in the illustrations above can also be used to analyse the lack of bootstrapping and/or adaptation. Table 12 continues the case from paper 5 (TINE) but demonstrates bootstrapping only (Snapshot 1) and no adaptation, as people do not like the web site. They start to take their own notes or consult colleagues (Snapshot 2). Note in Snapshot 3 how the website has vanished from the installed base. Since the internal web site is not reproduced, it will not be given resources for maintenance, the people will view it as obsolete and it may finally disappear from the installed base (Snapshot 4).



**Table 12: The website is not adapted by the users and disappears from the installed base in paper 5 (ECIS 2014)**

Table 13 provides an overview of the empirical evidence from this chapter and allows for cross-analysis. The table illustrates the various elements that enabled bootstrapping and adaptation in each paper. Considering the findings in Table 13, a key observation is that the elements under bootstrapping versus adaptation are quite different. Bootstrapping is characterised by “easy use”, “usefulness” and “rapid response” as opposed to adaptation which is characterised by “interplay”.

Paper	Bootstrapping due to:	Adaptation due to:
1 AMCIS	The easy use of lightweight tools (except tool for recommending music)	Tools perceived to provide value, interplay with colleagues
2 JITE	Curiosity and fun when solving the puzzles, rapid response from lecturer	Solving puzzles motivated further use of BI tools
3 SJIS	Facebook useful for unexpected purposes, passengers already users, rapid response from airliners	N/A
4 NOKOBIT	Using state-of-the-art BI tools	Lecturers building on experiences from first course and improving “How-to’s” through interplay with students
5 ECIS	Easy use and usefulness of tools, rapid response from BI department	Interplay between users & BI department and malleable technology (except webpage for training)

**Table 13: Cross-analysis of bootstrapping and adaptation in the five papers**

In the five papers, only one tool failed to bootstrap. In the AMCIS paper, a tool for automatically recommending music failed to bootstrap because it was not perceived to provide enough value. And as it never bootstrapped, it could not endure adaptation either. Adaptation failure happened in paper 3, where using Facebook as CRM on a daily basis was not upheld. In addition, TINE’s webpage for training did not sustain adaptation because it was not updated often enough.

Summing up, this chapter presents five publications and how the data was analysed using techniques from Miles and Huberman. It demonstrates how bootstrapping and adaptation occurs in each paper. The implications of these findings for academia and practitioners are discussed in the next chapter.



*One must learn by doing the thing,  
you have no certainty until you try.*  
Aristotle, Greek Philosopher, n.d.

## 6. Contributions and suggested further research

In this chapter, I describe the theoretical and practical contributions. I also point to limitations of the thesis and suggest further research.

### 6.1 Theoretical contribution

From the Introduction and Literature Review chapters we recall two main research gaps. We lack knowledge about (i) how the users interact with the technology, and (ii) how the BI solution evolves over time. Guided by the research question which reads: *How can BI utilisation be developed through bootstrapping and adaptation?* I will discuss the theoretical contribution, which is a reframing of BI using key concepts from the Information Infrastructure. As found in Chapters 2 and 3, the mainstream BI theory has a specification-oriented approach, meaning that we first describe what the organisation needs, and then we provide the technology before we train the users, usually within a predefined timeframe. In contrast to this approach, Hanseth introduced the Information Infrastructure theory, which focuses on cultivation rather than design, and network effect rather than tools (Hanseth, 2010). Important concepts in Information Infrastructure are bootstrapping and adaptation; in other words, how we *get the bandwagon rolling* and how to keep it rolling through self-reinforcing growth (Hanseth & Lyytinen, 2010).

The distinction between bootstrapping and adaptation is not always clear. Several iterations are needed to bootstrap an Information Infrastructure, and if successfully bootstrapped, it may eventually reach a tipping point and begin to make adaptation iterations. A common denominator from the data analysis is the temporal element in the two different phases. Lightweight BI tools lead to short-term usefulness, which facilitates bootstrapping. This will, in turn, enable adaptation, as the motivation to explore the richness of BI tools will lead to long-term value. The emerging question is: when and why does the tipping point actually occur? Below is a deeper analysis of the tipping point between bootstrapping and adaptation.

#### Bootstrapping phase

Utilisation of BI is not completely self-reinforcing. As Figure 15 illustrates the *installed base* consists of BI technology, BI product, and BI process, but also *action* such as training, sharing experiences, and modifying BI products. This model allows us to analyse the interplay between the utilisation of BI tools and the user's actions. When a user starts to use BI technology, she will usually choose a tool which she knows or one that look familiar, such as Excel. (Most of the participants in this study were experienced users of information technology in general – both students and people in industry.) Bootstrapping starts with the introduction of lightweight BI tools such as Excel or Google Analytics. These tools have a low threshold for utilisation and deliver rapid benefits.

For example, in paper 1, the participants said that Excel was *user friendly*, but *slow*. All of the participants who were involved in online sales used Google Analytics extensively, and they were more or less self-taught. In paper 2, Excel was also used to introduce the students to the subject of BI. As the students were already familiar with Excel, it enabled them to focus on the real-life puzzles and reflect on the business value, making them curious and motivated to learn more powerful BI tools towards the end of the semester.

In an interview in paper 3 the CIO of Norwegian commented that they already knew that many of their passengers were followers on Facebook due to a campaign the year before: *“When the ash crisis started, we discovered that many passengers started to ask questions on Facebook. We trained our customer support centre to reply in a way that made the dialogue constructive and problem solving, and set up a 24/7 service. The people who staffed the service became so enthusiastic that they did not want to go home in the evening”* (Bygstad & Presthus, 2013, p. 12). Unfortunately, data from this paper does not support what made the staff enthusiastic (we did not interview the staff); however, we

can detect why the passengers chose to use Facebook instead of the call centre (which broke down almost immediately after the ash crisis started) or the airline's own webpages. First, the passengers already had a profile on Facebook. Second, as the CIO informs, the staff actually solved problems in addition to providing information. This example is found in paper 3:

*Passenger: We are 7 desperate ladies in Malaga who are booked on the flight to Oslo tonight. We just received a message about the airport being closed. Found out that there is a flight scheduled to leave Alicante at midnight. Everything is chaos down there.*

*Norwegian: Hello! Arrangements have been made for a bus from Malaga to Alicante. You need to contact the representative of Norwegian at the airport in Malaga. Hope it will work out.*

*Passenger (later): We are on the bus now!* (Bygstad & Presthus, 2013, p. 14).

From this example, we note that Norwegian took action and indeed solved problems, and that the passenger even made the effort to express gratitude. Perhaps the friendly tone also contributed to reinforcing the installed base (which consists of both the staff and the passengers, refer to Table 9) during the bootstrapping phase. Rapid response is also identified as the major enabler of bootstrapping in paper 3. According to data extracted from Facebook, my co-author and I noted that requests and response were posted only minutes apart.

In paper 4, the use of state-of-the-art BI tools enabled bootstrapping. As one student reflected: *"I am satisfied with everything! It has been a pleasure to follow this course and I think it is quite relevant for working life. Not enough SAP and a lot of theory, but still fun!"*. However, not all students found SAP easy to work with: *"I am less satisfied with the SAP application; I think it is a cumbersome application, and difficult to learn with limited time"* (Presthus, 2013, p. 151). Nonetheless, the majority of the students acknowledged the value of hands-on experience with BI tools which they achieved by working their way through the lab exercises.

In paper 5, all participants agreed that the QlikView tool as easy to use from the very beginning. As discussed in the paper, TINE has previously used Cognos which may have affected the use of QlikView in a positive way. In addition to using QlikView, the end-users wanted Excel: *It is impossible to remove Excel; cannot live without it; I would miss it if it was taken away from me* (Presthus, 2014, p. 11).

Among the five papers, I found only one BI tool which failed to bootstrap. In paper 1, one respondent talked about a tool which would automatically recommend music similar to a customer's current music preferences. This tool had been demonstrated to the participant, but the value of the tool was not perceived high enough at the time of the interview to justify the investment of money.

A common trait from the five publications is that the utilisation of lightweight BI tools rapidly increases because they are easy to use, and users are often familiar with Excel. Bootstrapping is facilitated because the users quickly master these tools, but after a while the users experience the lack of functions, or too much data for the tool to handle, or a lack of input from colleagues. At a certain point, the lightweight tools face a tipping point.

### **Tipping point**

A key question is the tipping point; when does bootstrapping turn into adaptation? The bootstrapping phase is necessary, but temporary, and it will either transform into adaptation or simply fade out. A tipping point is not a separate or time-stamped phase. Rather, it is the overlapping iterations of both bootstrapping and adaptation. I observed in papers 1, 2, 4, and 5 that successful transformation has two main characteristics: first, the user realises the need for more advanced tools, second, the user has identified a user community of state-of-the-art BI tools, which is either within the company (paper 5 about how TINE had its own BI department) or within the industry (paper 1 about the music industry where the users were more or less self-taught). What happens next is that the user starts to explore more advanced tools, which can be SAP Business Warehouse or QlikView. This is the beginning of

the transformation to the adaptation phase. It is difficult to pinpoint a universal time for the tipping point because a very skilled user of IT in general may realise the need for more advanced tools at an earlier time than a more novice user. As already mentioned, the Information Infrastructure literature indicates that all infrastructures must endure bootstrapping, followed by adaptation, thus making it impossible to remain in the bootstrapping phase “forever”. We can imagine that in some cases, the user will remain content with lightweight tools. In such a case, the bootstrapping phase will perhaps last longer, but it will turn into adaptation eventually because an Information Infrastructure is per definition evolving. Alternatively, as we saw in paper 3, there was a tipping point when the ash crisis was finished, and the perceived value of using Facebook fell sharply. In this case we witnessed that there was a tipping point, but no adaptation.

### **Adaptation phase**

In this phase the user becomes a stronger part of the network which consists of developers and co-workers. For example, QlikView is now installed and the user has been given a dashboard with advanced functions with data that have been quality assured by the developers. After a short time the users will need access to more data. This is usually a task for developers and may take a number of days. The interplay between the user and the developer is crucial in the adaptation phase. The user experiences (i) more functions, but also (ii) more interdependency on developers and colleagues. Adaptation is about the introduction of traditional BI tools and how these are customised to meet the user’s needs. The term *adaptation* is used to emphasise that the introduced technology is not a finished tool or BI product, but that it will be adapted in parallel with the user’s increased experience. The user’s positive experience with the lightweight tools will facilitate the adaptation of other tools. In addition, the user will not abandon the lightweight tool, but it is continuously used in addition to the advanced tool. Typically, the data from the advanced tool is exported into Excel, which the user personally customizes.

As mentioned in the bootstrapping section the participants working with music in paper 1 found Excel delivered value, but that the tool became too slow after a while in the sense of processing data. Nonetheless, they continued using Excel, but in cohort with other, more dedicated BI tools in the adaptation phase.

The students in paper 2 became motivated and “self-going” through the puzzles which they managed to solve in about one hour each. This gave them a strong feeling of satisfaction which enabled further use of BI tools later in the semester. Paper 4 is related to paper 2, but there are two main differences. First, paper 2 studied one course, but paper 4 had more material which covered 10 courses of BI lecturing. Second, the focus is not primarily on the students’ use of BI tools, but rather how the institution can build an installed base of BI. Building on experiences from the first course, while at the same time gradually reinforcing the installed base enabled adaptation. Creating so-called “How-to’s” (see paper 4, p.158) is found to be a key enabler, both for the institution, the lecturer, and the student. The “How-to’s” allowed the lecturer/assistant to train her-/himself and prepare for the lecture, while at the same making the material personal. Second, it ensured the institution that the knowledge about BI technology did not walk out the door (Davenport & Prusak, 1998) with the lecturer/assistant when she or he decided to switch jobs. Third, it allowed the student to work at her or his own speed, as well as providing the opportunity to make one’s own notes. The “How-to’s” were published one-by-one for the students in an effort not to scare them off. For the student the “How-to’s” also made it possible to catch up if she or he missed a lecture. As Figure 2 illustrates, the students had to go through all steps in the BI architecture (source data, ETL, storage, multidimensional cube and end-user products) using SAP in order to pass the course.

The case company in paper 5 was the only one who had a dedicated BI department with six developers in addition to a BI Competence Centre (BICC). The various users have very different needs regarding their BI products. For example, one participant said that: “*the controllers want to see ‘everything’ in one report, so they can choose later. People in sales want only what they need*” (Presthuis, 2014, p. 9). An adaptation enabler in this case was the rapid response from the BI department. Each of the BI products created in QlikView (for example, a dashboard) was tagged with the name of the developer,

making the communication fast and easy. The developer would alter the product within a few days. Having the developers in-house was a strategic choice in TINE, and BICC was established to support the developers.

Almost as interesting as *what* enables adaptation is *what does not*. As shown in Table 13, I identified two technologies (Facebook and TINE's website) and one product (presentation by guest lecturer) which had been bootstrapped, but which faded out after the tipping point. In publication 3 (airliners' use of Facebook in the ash crisis), the use of Facebook as CRM was not considered to provide enough value on a daily basis. During the ash crisis, Norwegian had a team of 18 dedicated people to respond to Facebook requests. After the ash crisis it was considered too expensive to have the same amount of people using Facebook for CRM purposes; there was also a sharp fall in the number of requests from the passengers after the crisis (please see Figure 2 on page 12 in paper 3, (Bygstad & Presthus, 2013)). The participants in paper 5 informed that TINE's website for learning QlikView was not updated often enough to sustain adaptation, and the users preferred consulting each other instead. In paper 4 about BI in higher education, the guest lecture delivered a guest lecture and left the presentation slides which were uploaded on the school's learning platform, but the students did not pay any attention to this later. Perhaps even more important, the lecturer could not extract much value from the presentation slides in the next semester; they are less useful without the guest lecturer. In all three cases, the events provided instant value and the technologies and the product are easy to use, but after the tipping point, the value was not perceived high enough to persuade further effort. This lack of perceived value and use cause the installed base to suffer from reinforcement, and after a number of iterations, the technologies will vanish from the installed base.

### **Implications**

Prevailing BI literature often regards BI as a technology, product, or process (Ask, 2013; Chee et al., 2009; Shollo & Kautz, 2010). My findings indicate that we need to reframe this tripartite view, which has two main implications for Business Intelligence theory.

First, this implies that the prevailing view of BI as a technology, process, and product is not either-or. Rather, technology, process, and product constitute the installed base together. An installed base must be reinforced through various forms of action, and the framework in (Figure 15) can be used to analyse what works and what does not work in the matter of reinforcement. For example, the action of introducing new technology should reinforce the installed base in some way; if not, it is doubtful if even more technology will lead to improvements. In paper 1, the tool for automatic recommendation was not considered mature enough by the users. Contrarily, if the use of Microsoft Excel contributes to the installed base (as it does in paper 5), this tool should be embedded in the BI solution instead of being proclaimed as unwanted by management.

Second, it implies that it is fruitful to divide the development of BI utilisation into two phases. The extant BI literature recognises the BI process as an ongoing journey (see, for example, (Wixom & Todd, 2005)), but it does not divide it into different phases. Although bootstrapping and adaptation have the common trait of being iterative phases, different focuses should be placed in each phase. By regarding the BI process as twofold, an organisation can allocate different resources depending on the phase. Drawing on the empirical evidence presented in Table 13, in the bootstrapping phase the focus should be demonstration, arousing curiosity, and using lightweight tools. Rapid response is also a key factor. "Rapid" is a relative term, which can span from minutes (paper 3) to days (paper 5). In the adaptation phase, richer and more advanced tools can be introduced. A critical aspect in the adaptation phase is the interplay between users, developers and/or super-users.

### **6.2 Practical contribution**

By analysing the cases as found in the previous chapter, I have identified four Business Intelligence patterns, shown in Table 14 below. Drawing on The Gang of Four (Gamma et al., 1995) and Larman (Larman, 2005), we recall that a Software Engineering Pattern consists of a name, context, problem, and configuration. These BI patterns have a somewhat abstract nature. The first reason is that they are reusable. The second reason is due to the evolving character of an Information Infrastructure. Specific

tactics can have varying results based on the situation, per the example with the booking system which was successful for an airline company, but failed in a railway context (Henfridsson & Bygstad, 2013). Another example is the The DocuLive project at Rikshospitalet in Norway. The project followed several Critical Success Factors: involving users, acknowledging current work practices, and favouring a bottom-up development strategy (Hanseth, Jacucci, Grisot, & Aanestad, 2006). Nevertheless, the project was terminated in 2004 without the initial goal. It failed both bootstrapping and adaptation.

The first two BI patterns address the bootstrapping problem and the last two concern the adaptation problem. An Information Infrastructure is constantly evolving and it will fade away if it is not used over time, which is called the *adaptation problem* (Hanseth & Lyytinen, 2010): *When the bandwagon starts rolling, the designers need to guarantee that the Information Infrastructure will grow adaptively and re-organize constantly with new connections between the components* (p. 13).

Name of BI pattern	Context	Problem	Configuration (use when)	Main supporting publication(s)
<b>1. Do it all but do it small</b>	We are going to use BI tools for the very first time	Limited experience with vendors and tools (bootstrapping)	You do not have any (or limited) prior BI solutions and experience	AMCIS 2010 (Music industry) NOKOBIT 2013 (Education)
<b>2. Befriend the installed base</b>	Our existing BI solution is obsolete	Attracting users to the new technology (bootstrapping)	You have a solution which has been successful.	SJIS 2013 (Airliners) ECIS 2014 (Manufacturing)
<b>3. Use overlapping tools</b>	The users will not give up spread-sheets	We have built it, but they do not come (adaption)	You have a case (puzzle) or example (BI product) where you can demonstrate the usefulness	JITE 2012 (Education) ECIS 2014 (Manufacturing)
<b>4. Keep the expertise close</b>	The solution is not used to its potential	We want to use it, but we do not know how (adaption)	You have one or two people who have a genuine interest for working with tools	AMCIS 2010 (Music industry) ECIS 2014 (Manufacturing)

Table 14: Four patterns are identified

### BI pattern 1: Do it all but do it small

BI literature shows concern about getting people to start using the technology; in other words, there is a *bootstrapping* problem. In two of my publications, I found that starting out small was one common trait. One of the music retail companies studied in the AMCIS 2010 paper were trying out several agile BI tools, such as Google Analytics and Excel (Presthus et al., 2010). These agile tools made the users curious about the more advanced tools. For example, one respondent was following the evolution of a BI tool which could recommend similar songs based on sound. At the time of the study, the respondent found that the technology was too expensive and not mature enough, but he informed that he would consider using such a tool later in time.

This pattern advises to start out small by trying out several tools and vendors before choosing a few which can be cultivated over time. Some BI tools are even free of charge, especially for schools, and some vendors offer a try-out version which will for example either expire after a time period or handle a limited amount of data. Instead of a “Big Bang strategy” which rarely proves successful (Bygstad, Nielsen, & Munkvold, 2010), it is better to explore several tools and to observe to what extent it becomes a sound part of the installed base. If the installed base is reinforced, it is easier to build on the solution, which again will attract more users, as illustrated in Figure 5. A well-known concern of this cycle is the lock-in effect (Shapiro & Varian, 1999). We recall that the lock-in effect occurs when companies find that it becomes too time-consuming or expensive to exchange the current BI solution. The QWERTY keyboard is a prime example of the lock-in effect. None of the respondents in the music retail companies studied showed any concern of lock-in, and one of the contributions in the NOKOBIT 2013 study is indeed, addressed at the lock-in problem by drawing on university alliances. Nonetheless, the accumulated data material from these two publications does not support enough

evidence to claim whether a bonus of this pattern could be an anti-lock-in effect. I return to the issue of lock-in in the next pattern.

### **BI pattern 2: Befriend the installed base**

A key component of any Information Infrastructure is the installed base (Bygstad, 2010), and the users potentially have the powers to make or break the evolution. We recall that the Installed Base consists of users of a technology (Shapiro & Varian, 1999) as well as data, the features of the technology, people's skills and previous experiences, work processes, and more, depending on the Infrastructure in question. The main point is that the Installed Base is a huge repository with a complex mix of people and technology. People will have previous experiences and preferences, and the technology will have different characteristics of malleability (Henfridsson & Bygstad, 2013). An installed base can affect the development of the BI solution in either a positive and/or negative way. As Hanseth's text shows, the TCP/IP camp won the fight of standardization of computer networking both despite of *and* because of their installed base. Drawing on Grindley's model from 1995 (Figure 5), and concepts from the complexity science, there is always a risk of *path dependency* or *lock-in*. The good news is that the installed base can also work in our favour. As cited by Shapiro and Varian: "*An installed base is a terrible thing to waste*" (p. 162). It is important to keep in mind that the aim of Shapiro and Varian's book is to inform companies how to make a profit in the network economy. They actually encourage companies to lock in their customers. However, Shapiro and Varian also put on the customer's hat and provide a lock-in strategy of buyers (p. 136). In both cases, be it from the vendor or buyer, the advice is to benefit the most from the installed base.

In the *Scandinavian Journal* article, the successful use of Facebook in the ash crisis was partly due to the fact that many of the stranded passengers and the airliners were on Facebook prior to the crisis (Bygstad & Presthus, 2013). The installed base in this case consisted of the stranded passengers, people working at the airliners, Facebook, and mobile technology such as smartphones. Instead of establishing a forum on the webpages of the respective airliners both SAS and Norwegian observed that their passengers were communicating through Facebook.

This pattern concurs with Shapiro and Varian's advice: explore the installed base with a positive mind and make the most of people's skills and preferences. The installed base will always influence the new BI solution because people come in with existing knowledge and preferences. This pattern is about acknowledging this fact and turning it into an advantage. The good news is that users in all of my cases (besides the SJIS 2013 where data supports this claim) are interested in exploring new BI tools, although the utilisation was more voluntary than mandatory for some participants. As mentioned in Section 4.1 Data collection, my participants have both been students and working people in the industry. As the students were in the last year of their Bachelor degree and first year of Master's, they were skilled within IT (including Microsoft Excel), but they encountered BI tools (SAP and QlikView) for the first time. Learning these tools was a mandatory part of the course. On the contrary, the majority of participants in the industry had extensive experience with BI tools, and they were less obligated to use the tools in question. Interestingly, the various degree of experience did not seem to have too much of an effect when it came to attracting the people to work with the tools. The reasons for the students' motivation include the preparation through puzzles and the strong possibility of getting a job, which is discussed in more detail in paper 4.

### **BI pattern 3: Use overlapping tools**

The BI literature shows evidence that even though a BI solution has been implemented successfully, it does not guarantee that the users will employ the solution as intended over time. Even if a BI project has been successfully implemented and attracted users, these users will have continuous requests for new information. Another challenge is that the company will face changes and requests from their customers, suppliers, and government. These changes may result in a need to make changes to some elements of the BI solution.

My ECIS study illustrates this pattern. TINE realised that parts of their BI solution (Cognos) had become obsolete. Cognos became too slow and cumbersome for both the end-users and the developers. The BI team at TINE decided to exchange it with QlikView. However, they did not shut

down Cognos at once, and at the time of my investigation, the users were still able to access the system and withdraw data. One developer informed that this overlapping process made the project a little bit easier. The end-users did not specifically say that they appreciated the overlapping process. The reason may be that the new tool was quickly favoured over the old one (literally, nobody missed it), and one participant said that she had forgotten the logon password to Cognos. Another issue at TINE is the predominant use of Excel. We recall from the literature how this is the most deployed BI tool. Perhaps not too surprisingly, the BI developers see this as a larger problem than the end-users. One manager at TINE has the ambition of becoming *The Excel-killer*. This may prove to be more challenging than getting rid of Cognos. The end-users at TINE typically stated: *It is impossible to remove Excel*; or that they “cannot live without it” and “I would miss it if it was taken away from me” (Presthus, 2014, p. 11). When I asked what the BI department did when they observed users employing Excel instead of QlikView the strategy was to demonstrate how much better the new tool was at solving the same tasks.

Paper 4 also contributes to this pattern. At the university college, the BI tools evolved almost every semester. Either there was a new version of SAP or there was a new up-and-coming technology like QlikView. Instead of scrapping the use of SAP when QlikView became in-demand by some students, the lecturer and assistants integrated a small part of QlikView at the end in one semester (see the tables on page 157 for the evolution of the use of BI tools). Over the years, QlikView gained a larger part of the curriculum (Presthus, 2013).

#### **BI pattern 4: Keep the expertise close**

This pattern is also about solving the adaptation problem. Building on the well-known proverb: “Keep your friends close, keep your enemies closer – and keep your BI expertise in your house!”, all of the cases studied (except the airliners, as found in SJIS 2013, where I do not have any data about this) had some sort of expertise in-house. Both companies studied in paper 1 had people who mastered the BI tools in-house. At the telecommunication company (Telenor), one of the participants was a data warehouse expert who mastered the SAP technology as well as appurtenant BI tools. TINE specifically stated that they needed to keep the BI expertise in-house. They had previously tried to outsource it to consultant companies but this had proved difficult. Unfortunately, my data does not provide information as to why they decided to terminate the outsourcing. What I did find out from the TINE case was that some of their success was due to the tagging of the BI products (for example, a dashboard) with the name of the developer. This made it fast and easy for the end-user to contact the developer if he or she needed additional information to be uploaded to the dashboard. All participants at TINE agreed that the user groups had very different requests. For example, an informant at TINE said: “*The controllers want to see ‘everything’ in one report, so they can choose later. People in sales want only what they need*” (Presthus, 2004, p. 9).

In addition, the cases from higher education illustrate how the lecturers and assistants learned the technology instead of outsourcing it or relying on guest lecturers. In fact, from analysing the NOKOBIT 2013 case, it became evident that guest lecturers do not contribute to the installed base. Rather than involving too many guest lecturers in a BI course, better advice is to explore the BI community which offers several videos for self-training, and most of the leading vendors offer Academic Alliances that schools can join.

The reason for keeping the expertise close is that – just like an Information Infrastructure – all elements of a BI solution must be cultivated over time. As shown in Table 12, the internal website at TINE was not adapted in the sense that people stopped using it and contributing to it which caused it to become obsolete. An opposite example is found in NOKOBIT 2013 where the “How-to’s” (the documentation on how to use the BI technology) in (Presthus, 2013, p. 158) were living documents which were updated every semester.

Each pattern can be operationalised to management guidelines. Based on the data from the papers, a stepwise how-to list for each pattern is offered below.

### **Guidelines for Pattern 1. Do it all but do it small**

- ☑ request hands-on demonstrations from vendors, or try out free versions (AMCIS 2010)
- ☑ let the user keep his or her spreadsheet, but integrate with the company's infrastructure (ECIS 2014)
- ☑ create small step-by-step "how-to's" with no short-cuts for the new technology (NOKOBIT 2013)

### **Guidelines for Pattern 2. Befriend the installed base**

- ☑ make a survey about the users' preferences and previous knowledge (SJIS 2013)
- ☑ find out if you have tools that are worth keeping and that do not interfere with the coming solution (ECIS 2014)
- ☑ make the potential users curious about the benefits of the new solution (JITE 2012)

### **Guidelines for Pattern 3. Use overlapping tools**

- ☑ let the users keep their access to the old tool while testing out the new tool (ECIS 2014)
- ☑ demonstrate the benefits of the new tools and compare with the old tool (ECIS 2014)

### **Guidelines for Pattern 4. Keep the expertise close**

- ☑ tag BI products with the name of the developer (ECIS 2014)
- ☑ identify and nurture people amongst the end-users who like to try out new technology (AMCIS 2010). The small step-by-step "how-to's" (from Pattern 1) must be updated regularly (NOKOBIT 2013)

Summing up this section, we recall the two main research gaps where we lack knowledge about (i) how the users interact with the technology, and (ii) how the BI solution evolves over time. For the BI researchers, I propose an extended reframing of the traditional view of BI and open up new research approaches, addressing the call-for-research by, for example, (Chen et al., 2012; Grabski et al., 2011). Concerning the BI practitioners, who do not have research on their top agenda but rather utilisation of the solution, four BI patterns with tangible guidelines are presented.

## **6.3 Limitations of the thesis and suggested further research**

All studies have shortcomings, and I have identified five main limitations in my thesis. I will list them below followed by a presentation of research opportunities.

First, I deliberately studied only cases where **BI was actually bootstrapped and adapted** (except paper 3 which includes a small experiment that demonstrates *how* BI can be utilised), and I have not pursued *why* some tools failed bootstrapping or adaptation. Examples are the tool for recommending music in paper 1 which failed to bootstrap, and using Facebook as CRM in paper 3 which failed to adapt after the ash crisis. Future research can go into greater depth as to why some BI tools fail to bootstrap and adapt by, for example, using other concepts from the Information Infrastructure such as lock-in, a concept which I discuss briefly in publications 4 and 5.

Somewhat related to the first limitation, the second is the **tipping point** between bootstrapping and adaptation. My data do not reveal enough to investigate *when* the tipping point occurs. Although I have one longitudinal study (publication 4) this was not the main focus at the time. As further research, it could be interesting to investigate if it is possible to identify the number of bootstrapping iterations the infrastructure must endure before it "graduates" and starts to make adaptation cycles? I doubt that one would find a magic number, however, it could be possible to identify a trend or shape, for example, similar to the S-curve from Roger's *Diffusion of Innovations*. Perhaps this is an interesting framing for studies within BI maturity models.

Third, the majority of my participants had rather extensive experience with information technology in general, even the students. The **various elements of the installed base** should be studied further. For example, how do users with less technological experience influence bootstrapping and adaptation of BI? Are some agile BI tools more suitable for bootstrapping than others?

Fourth, **ethical aspects** are not addressed in this thesis; however I have published a paper on this, called: *Catch me if you can! How technology is running away from ethics in Business Intelligence*



(more details in Appendix). BI can automate work processes (Davenport, 2010) which can make work positions obsolete, but also create new, more interesting ones (Sharda, Delen, & Turban, 2014). Dashboards, such as the one in Figure 3, monitor the employee which can cause stress and a feeling of being under close surveillance, which again may lead to the lack of adaptation. None of my participants showed such concerns, but ethical concerns should still be given considerable attention in the years to come, especially in the wake of Big Data which may challenge privacy (Chen et al., 2012).

Finally, I only studied Norwegian companies which were all in the private sector. Further research can investigate if the patterns and guidelines are valid in public organisations, as well as in other countries with **other cultures**. It would also be interesting to study how company regulations and enforced laws influence the use of BI solutions. I also acknowledge that the four identified patterns are not exclusive and I welcome more research on BI patterns, both confirming and contradicting the four I have identified.

*Success is not final, failure is not fatal:  
it is the courage to continue that counts.*  
(Winston Churchill, n.d.)

## **7. Conclusion**

Business Intelligence has been a flagship of Information Systems for almost a decade, and it has reached new heights with Big Data. Addressing the two main research gaps where we lack knowledge (i) how the users interact with the technology, and (ii) how the BI solution evolves over time, this thesis has been guided by one research question: *How can BI utilisation be developed through bootstrapping and adaptation?*

By extending the prevailing tripartite framing of BI as technology/process/product, a model for bootstrapping and adaptation is proposed. The framework illustrates how the installed base, consisting of people, technology, work processes and more are reinforced through bootstrapping and adaptation, and the tipping point between them. This reframing has two major implications for academic research. First, it can help analyse whether various actions contribute to reinforcing the installed base. Second, it implies that BI utilisation will often have two phases which need different attention.

From the analysis of how five cases have bootstrapped and adapted their BI solutions, four Business Intelligence patterns are identified:

- BI pattern 1. Do it all but do it small
- BI pattern 2. Befriend the installed base
- BI pattern 3. Use overlapping tools
- BI pattern 4. Keep the expertise close

The first two patterns address the bootstrapping problem and the last two aim to solve the adaptation problem of BI solutions in organisations. The four patterns are operationalised into tangible guidelines for practitioners in organisations.

This research should be interesting to both academics and practitioners of BI, in industry as well as in higher education. According to Chen et al., we “...*face unique opportunities and challenges in developing integrated BI&A research and education programs for the new generation of data/analytics-savvy and business-relevant students and professionals*” (Chen et al., 2012, p. 1169).

## **Appendix: Published articles and papers which are not part of this PhD**

In addition to the five publications which constitute my PhD I have nine other conference papers and journal articles. The two first publications below have been refined into the two journal articles which are part of this PhD.

- 1) Presthus, W. & Bygstad, B. (2010) Facebook as Agile CRM? A Business Intelligence Analysis of the Airline Ash Crisis. *NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi, 2010, Gjøvik*. Tapir Akademisk Forlag 2010, 67-80
- 2) Presthus, W. & Bygstad, B. (2011) Teaching business intelligence with real life puzzles. *Proceedings of the 16th annual conference 2011 UK Academy for Information systems*. Association for Information Systems 2011, 1-22
- 3) Presthus, W. & Bygstad, B. (2011) Conducting Research with Business Intelligence. *NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi 2011, Tromsø*. Tapir Akademisk Forlag 2011, 145-156
- 4) Presthus, W., Ghinea, G., & Utvik, K-R. (2012) The More, the Merrier? The Interaction of Critical Success Factors in Business Intelligence Implementations. *International Journal of Business Intelligence Research; 3(2)*, 34-48
- 5) Presthus, W. (2012) *Never giving up: Challenges and solutions when teaching Business Intelligence*. 35th IRIS conference (Information Systems Research Seminar in Scandinavia) in Sigtuna, Sweden, 1-15
- 6) Presthus, W. (2012) Catch me if you can! How technology is running away from ethics in Business Intelligence. *NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi 2012, Bodø*. Tapir Akademisk Forlag 2012, 91-104
- 7) Presthus, W. & Bygstad, B. (2012) "Design of Nine" for using Business Intelligence in Student Projects. Teaching Track, BI Congress 3 Pre-ICIS (33<sup>rd</sup> International Conference on Information Systems), Orlando 2012, 1-14
- 8) Presthus, W. & Bygstad, B. (2014) Strawberry Analysis. Writing a Paper-based PhD. *NOKOBIT - Norsk konferanse for organisasjoners bruk av informasjonsteknologi 2014*. Tapir Akademisk Forlag 2014, Volume 22, 1-14
- 9) Presthus, W. & Sæthre, S. (2015) The Secret of my Success. An explorative study of Business Intelligence management in the Norwegian Industry. Accepted for *ProjMAN - International Conference on Project Management*, Algarve, Portugal. Forthcoming (October 2015).

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*Americas Conference on Information Systems (AMCIS)*

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Association for Information Systems

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E-business in entertainment: Insights  
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# E-business in entertainment: Insights from the use of Business Intelligence in the Norwegian music industry

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## ABSTRACT

Business Intelligence (BI) is a concept that has been widely used to describe technologies which support e-business by gathering valuable data, and provide analysis for decision making. This paper discusses BI in the Norwegian music retail industry. We contacted the two larger music providers in the country and examined their strategies in using BI in their when selling digital music. The key findings indicate that BI is useful in identifying customer preferences while it is less useful when predicting which music will sell, because music is a rather volatile product. Our cases show that users believe that existing tools are rather sophisticated but difficult to handle while emphasizing the need for a “personal touch” but improving data quality, based on intuition and experience. Our results can be useful to music retailers looking to improve their customer relationships and exploit the existing BI technologies.

## Keywords (Required)

Business Intelligence, Customer Relationship Management, Norwegian music industry, case studies

## INTRODUCTION

The music industry is undergoing challenging times due to evolving technology such as file sharing and streaming. Music can even be consumed for free by for example Spotify ([www.spotify.com](http://www.spotify.com)) and Musicoverly ([www.musicoverly.com](http://www.musicoverly.com)). Business Intelligence (BI) is an umbrella term which comprises architecture, tools, databases, and applications to provide better decision making (Turban et al, 2007). BI may, among other, identify a customer’s preferences. As customers shop online, their shopping pattern may be traced. On the other hand, technology renders vast amounts of data for the company. The company must meet, and even predict, the customer’s needs (Kotler, 2003). The term BI appeared in 1989, when organizations in those days believed that decisions should be based on facts, and not personal opinions (Tapscott, 2008): “*In God we trust, all others bring data*” – a now famous expression of Dr. W. Edwards Deming, (Davenport 2001, p. 136; 2006, p. 4). Unfortunately, a survey in 2007 revealed that 64% of the managers did not feel they had access to the right information to perform their job. People have political, cultural, and intellectual reasons for not taking the next step (Howson, 2008) in using customer data. Overby et al (2006) give the example of Apple when successfully both sensing (the technological emergence in music distribution) and responding (launching iTunes music store in 2003).

In the music sector in particular, the Internet and digital music files like MP3 are examples of disruptive technology, which is simpler, cheaper and applies to a new, even unattractive, set of customers (Christensen & Raynor, 2003). Such disruption paralyses the industry leaders, because their processes are designed and tuned to fit existing technology, as by means of powerful search engines, consumers can find songs without the help of retailers. On the other hand, the online retailers can use data mining to chart consumer purchase patterns, understand preferences and create profiles (Lam & Tan, 2001). According to Davenport & Harris (2005), automated decision making is coming of age after problems and slow evolvement. Automated decision making may lead to reduced staff, but also dependence on employees with high expertise, who still need

to make the actual decisions. Lam & Tan (2001) and Turban et al (2007) believe Amazon.com is attractive neither due to the good deals nor the selection of music but because of its personal attention to users.

The questions arise; how can BI aid the digital music retailers? Unlike physical products, stock will not decrease. On the other hand, filtering and recommendations are crucial when selling digital music, as the consumer may chose from millions of tracks (Kennedy, 2008). The aim of this paper is to examine to what extent Business Intelligence (BI) is employed in the Norwegian music industry when selling digital music online in the context of Customer Relationship Management (CRM).

The paper is structured as follows. In the next section we give the theoretical background of the study including particularities of the music industry and BI followed by our research methodology, research findings, and finally discussion and conclusions.

## **E-BUSINESS IN THE MUSIC INDUSTRY**

The music industry is being considerably affected by technological development. Lam & Tan (2001) states the Internet and the invention of digital music files as examples of such new technology Leyson et al (2005) argue that there has been a crisis in the music industry, but the problems are deeper than MP3 and similar software formats. Another consequence of e-business within the music industry is that the sales of physical CDs are dropping; the access and selection of digital music is emerging rapidly. Premkumar (2003) chooses to focus on the possibilities of new technology, claiming it can mean effectiveness and new customers such as teenagers. The latter view is shared with Christensen & Raynor (2003). Premkumar refers to a survey where teenagers are to have expressed that CDs are too expensive. Premkumar calculates that labour, rent and store inventory make about 35% of the costs of music. Manufacture is only 5%, and the artist receives about 12% from royalty. Advertising and promotion takes another 20% of the total cost. The music industry has traditionally had four joints: artist, record company, retail store and customer. Premkumar presents several new combinations, for example: artist, record company, and customer, or: artist, online retailer, and customer. Burnes (2004) describes how the music industry, due to the Internet, no longer can play by the old rules, but are awaiting new ones. Smith and Telang (2009) emphasize product differentiation and market segmentation strategy can compete with free music. The example of Virgin, a British retail store selling music CDs, DVDs and books, illustrates how Business Intelligence managed to boost their sales (McAdams, 2006). Virgin's BI system, "Crescendo", can for example track sales by the hour, thus ensuring there are enough employees in the store to attend the customer, and well-filled stock.

There are many BI applications areas, and some of the most common are data warehouse reporting, sales and marketing analysis, and planning and forecasting (Thompson, 2004). Thompson reports on a survey, based on responses from almost 3000 persons, from 1047 organisations, from 48 countries, showing that BI can provide:

- Faster and more accurate reporting (81%)
- Improved decision making (78%)
- Improved customer service (56%)
- Increased income (49%)

Thompson (2004) is promoting sale of a report called "OLAP report", and focus is on positive traits on BI. On the other hand, the survey is referred to by Turban et al (2007), and it is interesting to have actual numbers on a detailed level. According to Li (2005), the primary aim of BI is to render data into high quality actionable information. BI can play a crucial role in almost every function in a retail organisation, such as CRM (segmentation, campaign effectiveness analysis), alternative Sales Channels (Internet, interactive TV), enterprise management (dashboard reporting) as well as human resources and finance. Smart retailers have reoriented their business around the customer. However, all user-groups must be consulted and the objectives must be clearly defined. Similarly, Gang, et al. (2008) claim that BI has a bright future within the retail industry; one reason being that other information systems such as Point of Sale (POS) as well as CRM is making a good foundation for BI. Having abundance of data is common according to Tapscott. He describes how many businesses have invested heavily in collecting their data, but fewer organisations manage to analyse and redeploy them (Tapscott, 2008). Companies are able to utilize information will for example better understand customer needs. Nevertheless, a survey in 2007 revealed that 64% of the managers did not feel they had access to the right information to perform their job. According to Tapscott BI addresses one important question for a decision maker: "Who are our most disloyal customers", but also: "Do we care if we lose them?" He claims that a BI tool will assist in both questions.

In the past, companies studied customers' needs and made a product that fit the need on the average. Today, some companies respond to each customer's individual need. By means of data warehouse and data mining, companies can use their database in several ways. It can identify prospects, decide which customers should receive a particular offer, deepen customer loyalty and avoid serious customer mistakes; give the right service to the right customer.

Davenport et al (2001) argue that companies possess enough data, but struggle to benefit from it, like the grocery store that only analysed 2% of the data. The core problem is how to convert the huge amount of data into business value. Despite having the tools, the company fails at turning data into knowledge and results. The authors’ solution is that the company must have a holistic attitude towards the value data may provide. Companies tend to focus on only technology and data when making a decision. Although technology and data contribute, there are several other crucial parts in decision making. Data must be reacted upon: the management in a bank believed firmly that their most profitable customers were doctors. Data mining revealed it was the employees of a chain of pancake houses. This discovery required new strategies, but was difficult for the managers to accept.

In the next section we describe the research methodology we used to study how music retailers in Norway take advantage of customer data and exploit BI technologies.

**RESEARCH METHODOLOGY**

Data are collected by a case study of two companies, as well as observation of the web pages of the companies under investigation and two additional interviews. Six employees were interviewed face to face, using semi-structured interviews. The aim was to include multiple levels of the organisation, and to interview people who were involved in selling digital music files. Each interview was conducted on location of the respective company. One participant was interviewed at a time, and each interview lasted between 30 and 50 minutes. Permission was requested to tape the interview on a minidisc recorder, assuring it would be erased after transcription. The participants did not see the questions before the interview, but they were told that the interview was about the use of Business Intelligence in their respective company. The interviews were carried out in Norwegian, and were translated into English by the researcher afterwards. The transcript, in English, was e-mailed to the participant within one week, with a request to read through and make possible changes. No major modifications were made by the participants, but all except two made some improvements. The collection of qualitative data in face-to-face interviews was chosen as definitions of Business Intelligence are ambiguous especially in the commercial world. If surveys had been sent out, with predefined questions, the validity of the data collection may have been impaired. For example, various respondents may have various opinion of what the meaning of the term Business Intelligence. Two pilot interviews were carried out, one in each company. The aim was to test the quality of the questions, as well as to gather information in the process. The final interviews were conducted with 6 participants (3 from each case study company). Table 1 includes the details of the interview participants.

Participant number	Role	Organisation
Participant 1	Senior Database Analyst	Telenor/djuice
Participant 2	Customer Relationship Marketing Consultant for Telenor Mobile	Telenor/djuice
Participant 3	Head of Content	Telenor/Aspiro
Participant 4	Head of E-commerce	Platekompaniet
Participant 5	Head the digital department	Platekompaniet
Participant 6	Co-worker on the mp3 files on the web shop	Platekompaniet

Table 1 Details of the interview participants

In addition to semi-structured interviews, the web pages of each company were also studied in order to observe how digital music files are presented to the customer. Two additional interviews were also contacted with a legal expert in Telenor as well as an established musician who gave his personal perception on how technology affects modern music. His name is Steven Van Zandt, also known as Little Steven, who gave a face to face interview in Stockholm. He is a songwriter, guitarist and vocalist in the E-street Band with Bruce Springsteen, as well as a solo artist, and runs his own record company (Wikipedia, 2010). The field data were analysed by careful reading and reflection on the field notes and transcribed data by frequent discussions between the authors in order to extract the key perceptions underlying use of BI in the case studies. The coding of the data was then made around the 4 main themes included in the theoretical framework (information gathering, information quality, need of a formal BI system and personalized marketing and privacy).

Platekompaniet Ltd and Telenor/djuice were chosen because they are the largest musical actors in Norway. Platekompaniet was founded in 1992 and is selling physical CDs, DVDs, computer games, and audiobooks. Today it counts 25 physical and one online store (Platekompaniet, 2010). In May 2009, sale of MP3 files in cooperation with Telenor/djuice was launched. Telenor delivers mobile services, telephone- and Internet subscriptions to 12 countries (Telenor, 2009) as well as digital music through the subsidiary company djuice (spelled with a minuscule first letter). Telenor/djuice collaborates with Aspiro on the technical part of the solution. Aspiro is the northern European market leader in mobile entertainment (Aspiro, 2010). A subscriber service called Wimp is also developed, currently in a beta version only. Wimp offers information about the artist, as well as related music (Wimp, 2010).

## RESEARCH FINDINGS

The research findings are presented around the main themes of the study and include information collected for both case study companies.

### Information gathering

One common feature is that all six participants do need a certain amount of data to perform their everyday tasks. Most of the data needed are the customers' demography and their purchase history, and information about new products (songs and albums) or new artists. In addition to needing this data, all of the participants also have possibilities to obtaining it, either by direct access to the database, or via front-end tools, or in some cases, by means of the assistance of co-workers. Only one participant specifically requires real-time data; *"it would be a wonderful dream"*. This participant is the only one who does not have direct access to data. According to Tapscott (2008), real-time data are beneficial, and even a few seconds difference in response can mean a difference between profit and loss. Indeed the participants say that having access to the right information as soon as possible is to be desired. One participant at Platekompaniet explains that if there is a delay in the input information, the products may not be exposed adequately on the web pages, and consequently, sales can be lost.

Three of the participants calculate they spend about 10% of their work time collecting necessary data, regardless of whether they have access to a BI application or front-end tool. One reason for this may be that the data needed, specifically at Platekompaniet, are knowledge about music. As one participant shares: *"Must be interested in music in order to keep up. Some information comes from reports from the record companies and oral communications between my co-workers."* As mentioned above, Platekompaniet do not store musical knowledge electronically in any database. The digital department of Platekompaniet is relatively small, thus communication flows easily. Could Platekompaniet benefit from such as knowledge database? The opinion from participant 4 indicates negative, pondering how relevant historical data are within music; *"What sounded cool ten years ago may sound dull today."* Some music can be regarded as fresh food, and when a new artist emerges, this artist has no previous record, and it is up to the co-workers to display the new artist and provide adequate attention.

### Information quality

All participants have experienced inaccurate data. The reasons are multiple: data can be entered wrongly; inaccurate queries and even if data are entered correctly and extracted correctly, people change them to match their expectations. Perhaps due to experiencing inaccurate data, all participants suspect inaccuracy, and have arranged matters accordingly. The control is either by means of another IT system, and/or manually. Even the senior database analyst, writing the SQL singlehandedly, does not take data quality for granted. Participant 4 at Platekompaniet use other systems to avoid errors: comparing other databases, as well as drilling down to assure that for example the prices and products are actually correct. Participant 6 draws on both intuition and Google Analytics daily. If there is a change in one graph, which is usually stable, possible errors are sensed. Participants 2 and 3 check their reports manually, using their intuition and experience. According to Participant 2, the only way to know if the numbers might be wrong are based on a feeling of *"this can't be right"*. Participant 3 agrees, although data in their systems are dependable in 99% of the cases. What if a person is brand new at the job, and does not yet possess the experience as drawn upon in the cases above? Participant 3 puts it clearly: *"No matter what, you need to know that no information system is perfect"*.

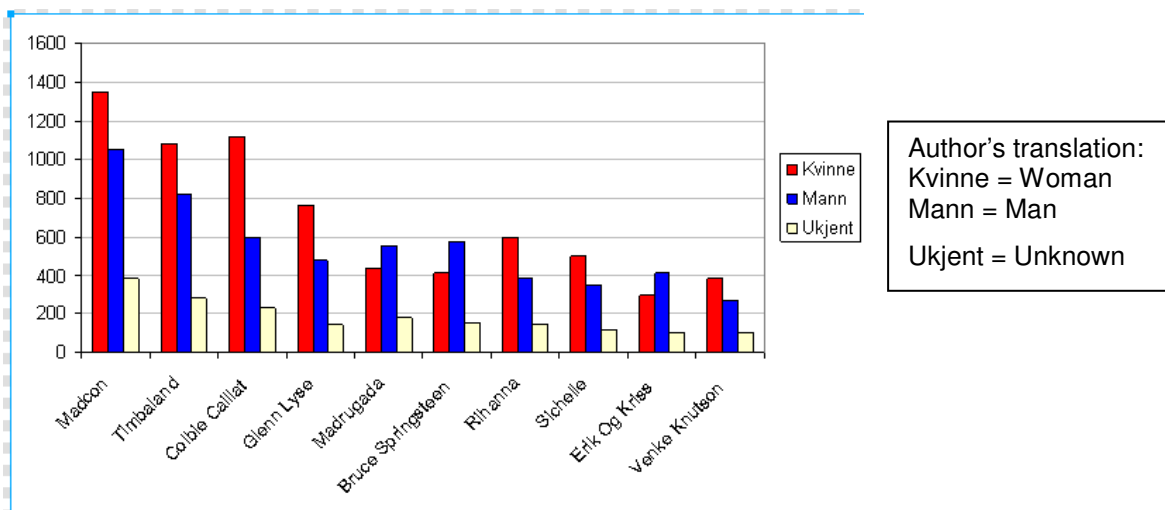
But how grave are the consequences if choices are made based on wrong data? 4 of 6 state substantial monetary losses as the primary disadvantage. Other concerns are law violations such as sales offering to someone under the legal age limit. Participant 3 says that data can be right, but can be used wrongly. Some mistakes do happen from time to time, but are usually sensed in

time. Participant 5 and 6 explain about exposing the products. It is unfortunate that new songs or albums are not exposed, but not too serious. There have been some cases of unknown artists that have escaped attention, and when they are exposed, the sale boosts. As summed up by Participant 4: It is extremely important to have good systems, as well as using your head. It is not wise to trust the numbers alone from the system. It is important to understand what lies behind the numbers – why they come out as they do.

**The need for a formal BI system**

Telenor/djuice currently have a dedicated BI application; Business Objects (owned by SAP), but also use Excel extensively. The branch were participant 3 is working has their own BI system, developed internally. At Platekompaniet, there is no dedicated BI application, but all three participants use Google Analytics in various degrees, and two use Excel as well. Interestingly, the person working with Business Objects is less satisfied than the ones using Google Analytics. It may not be fair to compare the two: Business Objects is a dedicated BI application with many functions, whereas Google Analytics is a lighter version, mainly used to track traffic on web sites. Does this indicate that the more agile the tool, the more satisfied the user? Given that Excel is an agile front-end tool; one might expect the users to be satisfied with this application. Four participants are using Excel extensively. However, the results lean toward not satisfied, because Excel is too slow.

The participants were asked if they could think of any cases where the tool assisted in unexpected purchases (Ryals & Knox, 2001). At Telenor/djuice, Participant 1 tells that they have mapped the artists up against the customer’s gender, as shown in figure 1 below. However, although data have been turned to information, the participant could not report on any further actions taken.



**Figure 1: Artists bought by male or female**

When it comes to any examples of unexpected purchases together, one participant mentions music for adults and for children. The reason is easily found: the customer buys for himself and the child at once. What is less obvious is that people seem to purchase several items that are released at the same time, rather than music that are similar. As mentioned above, this can indicate that music is to be considered as a fresh product. At Platekompaniet, the possibility of measuring the effect of campaigns is also regarded as a benefit. All three at Platekompaniet also use Google Analytics for tracking customer behavior on their web site: which words they frequently search for, and how many who actually make a purchase. Finally, participant 2 does not use any BI application, but draws on end-tools such as Excel. The participant is very positive towards using a dedicated application, expecting it would ease the work. When asked if anyone at Platekompaniet would like to use a dedicated tool, they do not see any immediate advantages for the time being. One the other hand, they bear in mind the digital store expanding.

### Personalized marketing and privacy

The web shop of Platekompaniet has recommendations, which can be a two-edged sword. Participant 5 explains that people appreciate getting personalized suggestions, but they can also feel awkward and insulted. Even on a web site, people seem to guard their image, and the customer may change her mind and delete the music from the basket if exposed to undesired products. Participant 4 adds that their theory was that the relation between the products within the same genre should be strong. Actually, they experienced the opposite by means of studying the data. People seem to purchase according to what is on sale and what is released at the same time. Participant 3 and 5 agree that people have individual tastes in music, and hence it can be difficult to develop a technological solution. The recommendation system is founded on Telenor's historical account, which goes back about 2,5 years. In the case of Musiccovery, the consumer can state her mood, and Musiccovery will suggest matching music. Participant 2 is skeptical to such a function: *"What makes me happy can vary from what makes you happy."*

Platekompaniet promises that people will discover music they did not know they liked on the web site. How do they plan on realizing this? Participant 5 has two plans: editorial recommendations as well as logic and systems, in order to analyze what the customers listen to. *"We aim to seek patterns which can be used for recommendations"*. As discussed, the customer wants recommendations, but on the other hand it must not collide with existing music taste and identification. Perhaps it is possible to analyze the music and find similarities based on comparing the music itself, instead of for example what other people purchased? Steven Van Zandt is an established musician, mastering both instruments and vocals. According to Van Zandt, it is possible to analyze music and thus make automated recommendations. The problem is that modern music lacks roots. New artists emerge too quickly on YouTube and MySpace, focusing too much on technology and less on the musical roots. If artists go through the "garage-stage" and practiced, their music will improve, and then it may be subjected to analysis and recommendations (Van Zandt, 2009). Participant 4 has been in contact with a Norwegian company who is working with such a system. The respondent did not get any good recommendations or hits, and the system is expensive – the price is more than a million Norwegian kroner. *"The idea is good, but I believe it is difficult to find objective criteria in order to compare."*

Participant 5 points to the importance of being able to resign from memberships from web sites. This restriction is also clearly stated by the legal expert. A web site must also state what they intend to use the data for. As long as they do that, it is possible to make both recommendations and keeping a profile of the customer's preferences.

### DISCUSSION AND CONCLUSIONS

This paper has studied two major actors within the Norwegian music retail industry. BI is defined differently by all six participants, but the common denominator is that it has to do with using the company's data to offer better services to customers. When it comes to tools used to analyze data, all six participants use Excel, and the level of satisfaction varies. Excel is perceived as versatile, but slow. Only one participant, at Telenor/djuice, works with a dedicated tool, Business Objects. At Platekompaniet, Google Analytics is used by all participants and perceived user friendly and dependable. Concern is expressed that a dedicated application would be time consuming and expensive, and the participant who works with Business Objects also indicates it takes much effort. One might argue that they are satisfied enough with Google Analytics to cover their needs at the moment. According to Overby et al (2006), agility is important. If for example the digital department at Platekompaniet grows bigger, it is easier to replace Google Analytics than a dedicated tool.

None of the participants expect the data to be perfect. They trust most of the data source, based on their own control routines. As pointed out by several participants, no system is perfect, and it should be used as a tool to support decisions, not make them alone. The statement of the bank manager *"In God we trust, all others bring data"* is in the case companies changed to *"In ourselves we trust, and data jog along"*. This can indicate that the music industry is less predictable than for example bank and insurance. All but one participant express great concern whether decisions are based on wrong data. The concerns deal with monetary loss, but also with legal issues. In the companies studied, they clearly comply with the current law. Recommending music based on purchase is a common, automated function, and extensively used. In addition, the interview with Little Steven indicates that music can be broken down and some analysis may be performed in order to recommend music according to consumer preferences. However, the findings of this paper may indicate that these tools are not sophisticated enough at present.

Automated recommendations in music may be possible, but the technology is not yet mature. All participants speak of recommendations if as almost a standard and they agree that automated recommendations have advantages, but for now they will lean on editorial recommendations provided by Platekompaniet. As long as the consumer is informed about use of the data she leaves on a Norwegian web site, as well as giving the consent, it is legal to make personal recommendations based on historical data within music.



None of the participants show signs of being “paralyzed” by technology, as Christensen & Raynor (2003) warn against. Only one participant demands a dedicated BI application, but does not specify which one. Perhaps he or she will be satisfied with an agile tool similar to Google Analytics.

This study can be extended to include record companies, musicians and consumers. Since the concept of BI is practicable, it could be interesting to conduct a quantitative survey on which kind of tools and applications that are used within digital goods. The law enforcements are confined to Norway. It can be interesting to pursue how musical roots can be analyzed and used for recommendations both for the consumer, as well as any decision-maker within the music industry.

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# Business Intelligence in College: A Teaching Case with Real Life Puzzles

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## Executive Summary

Modern Business Intelligence (BI) is about the process of turning data into actionable information, using an assortment of tools, techniques, and applications. Although BI, or its predecessor Decision Support Systems (DSS), has been applied in the industry for about half a century, it has only recently been taught in business schools. In the report “State of Business Intelligence in Academia 2010” Wixom and Ariyachandra found that the discipline faces many challenges in its way from practice to academia. For the lecturer, challenges include access to data sets and finding suitable cases, as well as providing realistic and meaningful examples. For the students, on the other hand, the problem is that BI is ripe with concepts and acronyms and appears too theoretical and abstract.

In this study we report from an introductory Bachelor course in Business Intelligence and reflect on the learning process. Our focus is how to make Business Intelligence education more fun and motivating for the students, while at the same time providing the BI lecturer with some examples from real life. We conducted a small action research study in a university college with a class of third year e-business students. Drawing on principles from Problem-Based Learning and Puzzle-Based Learning, we employed a framework of real life puzzles. Each puzzle consists of real life problems, real life data, and real life solutions.

Our main contribution is that the real life puzzle approach is a powerful method to teach Business Intelligence concepts and processes. We argue that the similarities between the BI process and the puzzle solving process prepare the students for Business Intelligence learning, in an indirect way. Through the gradual realization on how these puzzles work, the students are able to connect the logical structures of puzzles with the rational way of BI queries. This prepares the students for Business Intelligence learning, and also for practice in working life. This insight should be of interest to any lecturer of BI.

**Keywords:** Business Intelligence, business school, real life puzzles, teaching case

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## Introduction

The main aim of Business Intelligence (BI) is to support decisions for an organization, by providing access to existing data (Davenport, 2010; Li, 2005). Today, BI is regarded as an umbrella term combining architectures, tools, databases, applications, and methodologies. Its major objective is to provide

reliable data to decision makers (Turban, Sharda, & Delen, 2011).

Although the BI discipline originated in the business world, BI is now becoming a popular topic in higher education (Wixom & Ariyachandra, 2011). However, in their comprehensive report “State of BI” Wixom and Ariyachandra (2011) found that BI faces many hurdles in its way from practice to academia. They received responses from 173 universities, and the results revealed that the top challenges for the lecturer are access to data sets and finding suitable cases. Other concerns are providing realistic, meaningful experiences. Accordingly, the students require more and better real-world software and real-world data sets. The students typically states, “*It would help to be shown real-world cases or see how companies use BI in every-day operations*” and “*I find BI interesting, but in my class it’s really boring and uninteresting because all of the articles we read rehash the same ideas and solutions over and over again*” (Wixom & Ariyachandra, 2011, p. 13).

Thus, the students’ needs are exactly what the lecturer find challenging to provide. How can this problem be mitigated? Unfortunately, it is not enough to assure the students that BI discipline is both interesting and important in a business context. For the average BI student, business analysis may be years away while the boring class is highly present. Therefore, teacher enthusiasm is not enough to motivate the students, and in this situation a more short-term strategy is needed.

Drawing on Moursund (2007) our point of departure is that having fun is an important experience in human life and an undervalued feature of education. We do not argue that the teacher needs to be a stand-up comedian; however, thinking back most people will remember something from childhood when they could have fun and learn something at the same time. Often, working with puzzles is associated with having fun (Michaelewicz & Michaelewicz, 2007). Puzzles are amusing because they are based on a mystery or real world problem; you know that there is one correct answer and that there is rational reasoning behind the solution. We will illustrate that all these aspects are present in BI problem solving through our research question: *How can real life puzzles contribute to improved learning in BI?*

We proceed as follows: after reviewing the relevant literature and drawing on insights from Puzzle-Based Learning and Problem-Based Learning, we suggest a framework for real life puzzles in BI. Our method approach is a small action research project in which we conducted one cycle based on our framework with four real life puzzles given to the BI students at the Bachelor level. Then we discuss our findings, the viability and limitations of Puzzle-Based teaching. Our contribution is mainly practical: we wish to provide BI teachers in higher education with a framework for an engaging way of teaching.

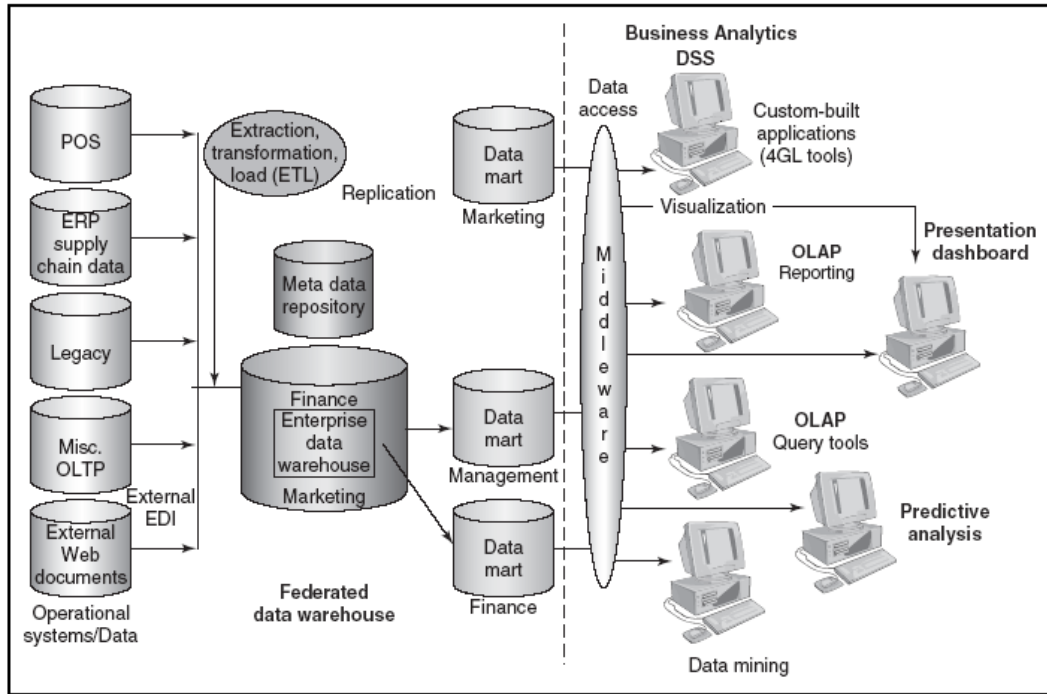
## Related Literature

In this section, we present the basic concepts of BI, and highlight some challenges for the lecturer of BI in academia. Then we review the concepts of Problem-Based Learning and Puzzle-Based Learning, which result in our framework.

### **Concepts of Business Intelligence**

The concept of BI emerged for the very first time in 1958 in an IBM journal article by Luhn titled “A Business Intelligence System”, which described principles for analyzing textual data automatically. In Power’s chronicle of Decision Support Systems (DSS) (2007), BI is regarded as an offspring from DSS in the late 1960s and 1970s, along with siblings such as data warehouses, Executive Information Systems, and OLAP which all came in the late 1980s and early 1990s. Modern Business Intelligence comprises various tools, applications, processes, databases and architectures for all levels of an organization by providing access to data (Turban et al., 2011). The major components of BI are illustrated by Turban, Aronson, Liang, and Sharda (2007) in Figure 1

and will be described in some detail to elaborate on the concepts which are discussed in this article.



**Figure 1: The major components of Business Intelligence (Turban et al., 2007, p. 201)**

Various sources of data are found on the very left of Figure 1. One example of Point of Sale (POS) is data from scanning retail products. ETL is an abbreviation for Extraction, Transformation and Load and is a key concept in any data warehouse, enhancing data quality. A data warehouse is “...a collection of data in support of management’s decision making...” (Connolly & Begg, 2010, p. 1147). The BI tool-kit on the right side of the dotted line in Figure 1 comprises online analytical processing (OLAP) reporting and data mining. The new trends in today’s BI are text- and web mining, which can serve as foundations for sentiment analysis, a technique used to identify customer’s positive or negative opinions towards a product (Turban et al., 2011).

The aim of BI is to turn a company’s data into actionable information. The BI process consists of four steps: gathering data, turning data into information, making decisions, and finally taking action (Turban et al., 2011). Research has shown that many companies do not make it through the whole BI process, and tend to halt after having achieved information, but not taking action (Dav- enport, Harris, De Long, & Jacobsen, 2001; Howson, 2008; Overby, Bharadwaj, & Samba- murthy, 2006).

### ***Business Intelligence in Academia***

Business Intelligence is now being taught at a growing number of universities and colleges around the world (Wixom & Ariyachandra, 2011), and research on teaching BI is beginning to emerge, not only in computer science programs, but also in business schools (Edgington, 2011; Mrdalj, 2011).

In 2011, The Teradata University, a teaching resource for Business Intelligence and Data Ware- housing, supported 2560 faculty members belonging to 1262 colleges and universities located in 85 countries (Wixom et al., 2011).

Publications on teaching BI include Fang and Tuladhar (2006) who described the concepts of data warehousing and OLAP and their experiences of successfully teaching this to technology students. Building on Fang and Tuladhar, Mrdalj (2007) argued that it is important to combine theory and practice, as well as use real-world examples in the lectures. This approach “...made this class exciting what otherwise used to be dry presentations of the analytical data mining techniques” (Mrdalj, 2007, p. 38). Moreover, Mrdalj advised using a large variety of data samples, but also pointed out that preparing for such a course was extremely time-consuming for the lecturer. Addressing the challenge of “access to BI software”, identified by Wixom et al. (2011), Mrdalj recently published an article suggesting cloud computing (Mrdalj, 2011). One of his major concerns is that BI will fail as a course for Master students of Business Administration due to technical issues. Mrdalj concludes that cloud computing may indeed contribute to better teaching of BI as this outsourcing will enable the students to focus on the business value of BI.

New courses for business schools are being created, focusing on various components of BI, such as text mining (Edgington, 2011). Similar to Mrdalj, Edgington’s new college discipline focuses on analysis and validity in addition to the use of the technology.

### ***Problem-Based Learning and Puzzle-Based Learning***

Problem-Based Learning (Savery, 2006) is an instructional approach that encourages creative thinking on real life problems with open-ended solutions. The teacher facilitates the students’ learning and reflection while the students work in groups. Problem-Based Learning has more focus on the learning process for the students and less focus on the answers reached.

While Problem-Based Learning allows for several outcomes, a puzzle will always have one fixed solution. In their paper, Michaelewicz and Michaelewicz (2007) reported how Puzzle-Based Learning can be used to teach engineering students to solve problems by thinking more creatively. There are multiple reasons behind most students’ enthusiasm for Puzzle-Based Learning. Puzzles are educational, thought-provoking, and make problem-solving entertaining. The conclusion of the puzzle can be transferred to solving real-world problems (Michaelewicz & Michaelewicz, 2007).

Well known examples of puzzles are crosswords, jigsaw, and solitaire (Moursund, 2007). Some puzzles can only be solved by thinking out-of-the-box, meaning that we need to think differently to solve the problem. An illustration is the “Gordian Knot”, which is impossible to untie (consequently, by thinking out-of-the-box you chop it off with a hatchet). According to Moursund, thinking out-of-the-box is important today because the students will need to solve global challenges.

We believe that the principle of Problem-Based Learning (real life problems) and the Puzzle-Based Learning principles (thinking out-of-the-box) are relevant for making BI education more fun and motivating for the students. Our approach was to take a real life situation and make a puzzle from it. This framework is described in the next section.

## **Real Life Puzzles as Framework**

Based on the review in the previous section, there are three aspects associated with Problem-Based Learning and Puzzle-Based Learning in a BI context that we find significant.

**Real life problems:** According to Problem-Based Learning, a problem should be ill-structured and come from the real world, which motivates the students to find a solution (Savery, 2006). We agree that the problem should come from the real world, but we do not believe that it needs to be unstructured. Rather, based on previous research (Davenport et al., 2001; Overby et al., 2006), we

believe that teaching BI should indeed train the students to pay attention to data analysis, but also on how to make decisions based on these data in order to solve the problem.

**Real life data:** Second, BI is often characterized by large volumes of real life data, for example data from point-of-sale (POS) scanning in retail stores (Davenport et al., 2001). This fact represents a unique opportunity of puzzle investigation in huge volumes of data. Such data can be found on web pages, by asking companies, or taking a documented case from the real world and recreating a puzzle of it.

**Real life solutions:** Lastly, Puzzle-Based Learning emphasizes that the fun aspect of puzzles is determined by the fact that there is only one correct solution. The correct solution can be surprising but completely logical according to the data material. Business Intelligence has a logical approach, and its main issue is about making decisions based on data instead of previous experience or intuition (Turban et al., 2011). Although data in real life may not always provide a clear pattern, even by means of the plethora of modern BI tools, we believe that in a learning situation there should only be one revealing answer.

These three real life aspects of problems–data–solutions will be used in our analysis and discussion.

## Method

Our article reports on a teaching case, conducted as a small Action Research project. Action Research is a recognized approach in several fields (Reason & Bradbury, 2007) including Information Systems research (Baskerville, 1999). Recently, there has been an increasing interest in using Action Research in higher education (Norton, 2009).

The teaching case was carried out at the Norwegian School of IT during the autumn semester of 2010. The class counted 28 e-business students, attending the ten ECTS Business Intelligence course in the fifth semester of the Bachelor of Information Technology. The main learning objectives of the BI course were as follows: master key concepts, acquire knowledge of business value and ethical issues, apply theories on practical problems, and handle an assortment of tools. Drawing on the principles of Action Research cycle (Baskerville, 1999), as shown in Figure 2, the following steps were conducted:

**Diagnosing:** The course in BI was introductory with certain pedagogical challenges. Unlike Edgington's (2011) brand new course, our BI course had been taught twice before by the same lecturer. First, a number of terms and abbreviations were needed to make a conceptual foundation. Second, the students may struggle to understand and differentiate the four steps of the process of BI (data – information – decision – action). Searching for new ways to make BI learning more fun, we reviewed the literature for possible approaches, resulting in our framework as described above.

**Action Planning:** Four puzzles, each of them illustrating key BI concepts from Figure 1, were constructed for the use in the class.

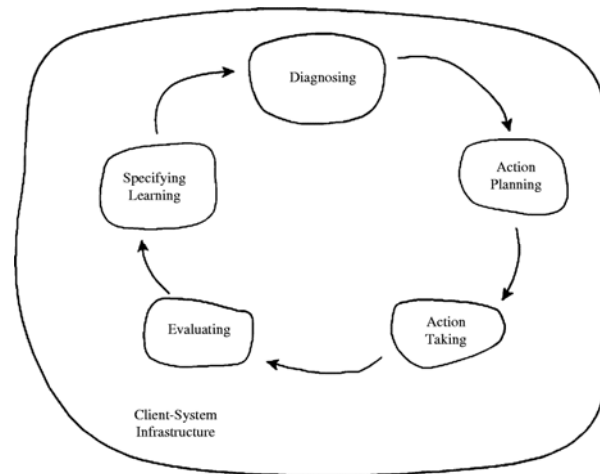
**Action Taking:** The four puzzles were introduced for the students in four consecutive teaching sessions. About 60 minutes were spent on each puzzle, except for puzzle three, where the students asked for an additional 30 minutes to complete the task. The students were observed as they solved the puzzles, for example, their questions and comments to the lecturer and to each other. Further details about the four puzzles are described in the next section.

**Evaluation:** Observation during the lecture was used to understand how the students solved the puzzles. In the fifth lecture, an anonymous survey was conducted with all students present to measure their perceived learning and satisfaction. The survey was distributed on paper to ensure



anonymity, and the students were requested to be honest, but to the point, in their replies. The questionnaire is found in Appendix A. Questions included whether the puzzles were fun and/or useful for learning the BI objectives. The students were also informed that the aim was to produce research similar to Fang and Tuladhar's paper (2006), which they had previously read. Such an agreement "*contributes to the internal validity of the research*" (Davison, Martinsons, & Kock, 2004, p. 69).

**Specifying Learning:** This stage is about reflecting on the outcomes so far. In addition to the quantitative data, the qualitative data analysis builds the approach as described by Miles and Huberman (1994). The outcomes of the actions were analyzed practically and theoretically, drawing on related literature. We scrutinized the four puzzles: how they were perceived by the students and the perceived differences between the puzzles.



**Figure 2: The action research cycle (Baskerville, 1999, p. 14)**

## The Four Puzzles

In this section we describe how the puzzles were presented, how the students attempted to solve them, and finally the results of the students' effort.

### ***Puzzle One: Rusty Meters in London***

The learning objective was to introduce the concept of data warehouse, defined above as a collection of data from several sources. The whole class solved the puzzle as one group. They had only one tool: making ad hoc queries to simulated databases residing in the head of the teacher.

**Puzzle:** The idea for this puzzle was taken from a paper describing how parking meters were mysteriously rusting in a confined area of London (Foss & Bond, 2005). The problem was that the meters were rusting from within and only in a given borough. Replacing them was expensive for the community. How could this problem be solved?

**Process:** The students were told that they had access to all possible information on the city, and it was further explained to them that this meant querying the lecturer.

The students immediately started guessing, forgetting any strategy for solving the problem. Typical random guesses were, "*The rusty meters are shorter, or made of different material!*" They had to be reminded of making use of data, which could only be extracted from the lecturer. Slowly,

the nature of questions changed. For example, they started to inquire about the income of the people living in the streets with rusty meters and received the answer: *“They make less money.”*

Students: *“Do we know where they shop?”*

Lecturer: *“Yes, in low-price stores.”*

Students: *“What do they buy?”*

Lecturer: *“Many plastic items, for storing food. In all shapes and forms.”*

The lecturer (like any database) would not respond if the query was incorrect:

Students: *“It has to be some kind of vandalism!”*

Lecturer: *“Your query does not return any data. Please rephrase your query.”*

Students: *“OK. Do the rusty meters show sign of tampering when examined?”*

Result: After about one hour one student suggested something with ice cubes. This was indeed the correct solution: the car owners in the streets with rusty meters made “ice coins” which would later melt inside the meter! The class also discussed how the authorities acted on this information.

### **Puzzle Two: Dr. Snow’s “Ghost Map” from 1854**

The next puzzle was placed in the context of “Business Intelligence anno 1854” and was also given to illustrate how people tend to make decisions not on information, but on previous experience or dogmas. In less than one year, from September 1848 to August 1849, there was a cholera epidemic in London taking 7466 lives (Snow, 1854, as cited in Water Institute, n.d.). The medical profession, authorities, and waterworks all agreed that cholera infects through “bad air”. When a new outbreak of cholera started in August, 1854, Dr. Snow eventually suspected the bacteria to spread through water and went from door to door in Soho, collecting data on his “Ghost Map”, (Johnson, 2006) shown in Figure 3.



**Figure 3: Dr. Snow’s Ghost map (based on picture from <http://www.theghostmap.com/>)**

Puzzle: The map (Figure 3) was shown to the students on a projector and given the question: *“What does it show? Which kind of information can you make from this map?”*

Process: Like in puzzle one, the students acted as one group and could only query the lecturer as omniscient.

Lecturer: “*Has anyone seen this map before?*” (No student had seen it.) “*Where is it?*” (Someone soon guessed London.) “*How old is the map?*” (Someone suggested fifty years old, after 3-4 attempts: 1850’s.)

Knowing that the map was over one hundred years old, they quickly matched the blue dots (🟦) with water supply (five in total in the map). Then they started their quest for the red dots (🔴). “*Horses?*” – but quickly landed on people. The students had clearly learned from puzzle one; the questions were now of the character: “*Do the people work at the brewery? Is it the map of a land owner, visualizing tenants who are late with rent?*”

Result: One student eventually connected the map with cholera outbreaks. Having revealed that the map indeed indicated death by cholera, they immediately matched the death having to do with the one water pump with the numerous red dots drawn to it in “Broad Street”.



**Figure 4: “Death’s Dispensary” (Pinwell, 1866, as cited in Water Institute, n.d.)**

Having turned data into information, “death is caused by water, not by air”, the students were challenged on “How to act based on this information?” The decision seemed obvious to the students, namely, “*Close down that pump*”, but it took the British authorities a whole week to act correctly on the new information (Johnson, 2006), which is illustrated with small fonts under the drawing in Figure 4: “Open to the poor, gratis, by permission of the parish” (picture retrieved from Water Institute, n.d.). Johnson (2006) reminds us that cutting off the water supply for a whole street in Soho was not an easy decision for the authorities; however, for the first time, the fight against cholera “...*would be challenged by reason, not superstition*” (p. 163).

### **Puzzle Three: Text Mining**

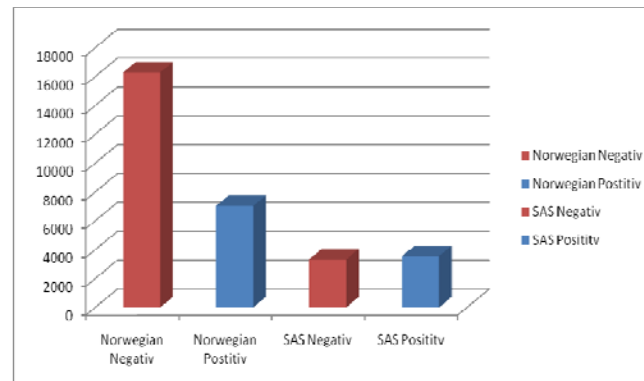
As presented in the literature review, web- and text mining are both increasingly popular (Edgington, 2011; Turban et al., 2011), which amongst others can make a foundation for sentiment analysis. During the ash crisis in spring 2010, the airline companies Norwegian and SAS used Facebook for communication with passengers (Prethus & Bygstad, 2010).

Puzzle: Prior to the exercise, all words from Norwegian and SAS pages on Facebook had been extracted in an Excel file, counting 60,000 words. The students were asked to categorize the data

into positive and negative words and to accumulate each category, in order to find out whether the sentiment, or mood, of the passengers was negative or positive.

Process: The class was divided into five groups. They were instructed to manually categorize the words and to use Excel for making graphs. At first the students were overwhelmed by the amount of words. The lecturer needed to motivate them by telling them that this task had been performed already and had taken less than two hours. Attention was also drawn to the fact that this was real data from real web sites.

Result: The students spent over one hour, even insisting on more time to complete the task. The result was five similar graphs from the students, of which one example is presented in Figure 5.



**Figure 5: An example of graph by the students having completed puzzle three**

All students reported the text analysis to be categorization, as we had a predefined set of categories: positive and negative words. They also correctly identified the mining as web content mining (as opposed to web usage or web structure mining).

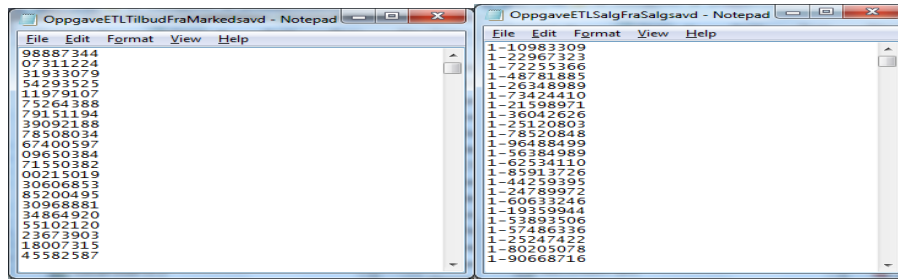
### ***Puzzle Four: ETL/Data Mining***

The learning objective of the last puzzle was to understand the ETL (Extraction, Transformation, and Load) process and to conduct numerical data mining.

Telenor is the largest telecommunication operator in Norway. In addition to telephone and Internet services, Telenor also offers entertainment such as digital music files. In 2009, Alexander Rybak represented Norway and won the European Song Contest with his song “Fairytale”, and Telenor offered selected customers a mobile subscription to purchase this song. Like puzzle three, the students were placed in groups and given two files with numeric data from Telenor’s Sales and Marketing department. One file shows how many customers received an SMS on their mobile offering to purchase Rybak’s single “Fairytale” (extracted from Marketing department). The other file shows how many customers actually purchased “Fairytale” regardless of having received an offer or not (extracted from Sales department).

Puzzle: The students were presented the following task: “The management at Telenor wants to know how effective the campaign was, meaning: How many who received an offer on their mobile, also purchased the single “Fairytale”?”

Process: The two files consisted of (modified) customer numbers. The one file, Offer, contained 100,000 numbers; the other, Sale, contained 5239. Moreover, the latter contained data in different format, as illustrated in Figure 6. Before the students could compare the data, they had to somehow remove the prefixes “1-”. Two customers had also purchased the song 4 times each.



**Figure 6: Two files, “extracted” from Marketing and Sales Department**

Result: Three groups presented the correct answer (2666 customers). The rest managed to transform the data and compare the two source files but failed to identify the two customers having purchased four songs each. When confronted with the fact that their response was not quite correct, one student shrugged and replied, “*How important can it be?*”

All four puzzles were based on a real life situation, using real life data. A summary of the puzzles are found in Appendix B. The students solved all puzzles but the last, where the majority was close to finding the correct answer. The next section discusses our findings.

## Findings and Discussion

We begin by returning to our research question: *How can real life puzzles contribute to improved learning in BI?* The puzzles were designed in order to combine fun and learning. Table 1 summarizes the students’ replies to the question: “Was the puzzle fun?”

**Table 1: Was the puzzle fun?**

Fun? →	Yes	Somewhat	No
Puzzle 1	15	4	0
Puzzle 2	16	2	1
Puzzle 3	11	5	3
Puzzle 4	8	5	0
Sum	50	16	4

As Table 1 shows, 71% of the students found all of the puzzles to be fun. The most popular puzzles were number 1 and 2, while puzzles 3 and 4 were perceived somewhat less fun. We proceed with elaborating what made the puzzles exciting but also pedagogically successful. Table 2 summarizes the students’ replies to the question: “Did the puzzle help you understand key concepts of BI?”

**Table 2: Did the puzzle help you understand key concepts?**

Useful? →	Yes	Somewhat	No
Puzzle 1	8	6	2
Puzzle 2	13	4	1
Puzzle 3	13	4	1
Puzzle 4	10	2	0
Sum	44	16	4

Table 2 illustrates that the majority (68%) of students also found the puzzles to be useful in understanding the key concepts of BI (data warehouse, data-, text- and web mining, the process of BI and ETL). The totals of responses in Tables 1 and 2 differ because not all students attended every puzzle.

### ***Real Life Problems: Intriguing and Dramatic***

We found that the students' enthusiasm was associated with interesting real life problems. As described in the previous section, the students asked many questions on the facts of the cases and generally engaged in the puzzles. We note, however, that the students were more engaged in the first three tasks. The students were very interested in the outcome of Dr. Snow's discovery but less in Telenor's campaign. The deaths of thousands of people in 19th century London was more intriguing than a relatively trivial business problem at a telecom company. In our survey, students typically reflect on puzzle two:

*"Interesting to see how long the government took to accept Snow was correct"*

*"Fun task; as it is from real life"*

Most research on how to teach engineering leans on constructed problems. Examples are murder mysteries (Highley & Marianno, 2001) or river crossing (Michaelewicz & Michaelewicz, 2007; Moursund, 2007). Moursund (2007) argues that it is up to the students to make the connection between the constructed examples and the real world. Our evidence points to another direction, and one reason may be that business students tend to perceive real world problems as more motivating than fabricated problems. Finally, we note that Mrdalj's (2007) data mining students reported that it was the real life problems which made the course interesting.

### ***Real Life Data: Genuine and Large Volume***

Our findings reveal that real life data was motivating. The volume of data was modest in the two first puzzles, while quite substantial in three and four. Working with real life data challenged the students' creative and analytical abilities and made them very curious to find the answer. Two typical student comments were:

*"Challenged creativity and logical thinking"*

*"Jumpstarted thoughts and became curious of the reason"*

One might wonder how much data is needed to conduct an interesting analysis. Mrdalj's students liked real life data, but wanted a larger amount (Mrdalj, 2007). Our experience is that the volume of data in itself is not crucial for how interesting the students find the exercise. Rather, it is the patterns of the analyzed data which contribute to solve the real world problem. Both puzzles two and three were perceived as nearly equally fun, although the amounts of data were very different.

A key feature is that Business Intelligence is based on certain logic in querying; you cannot ask directly for the solution, but you have to frame your questions following certain techniques related to the available data. It is the pattern of the data that will reveal the solution. These patterns may be surprising: a map with streets and dots actually lead to a new discovery on how cholera spreads.

There are also challenges with real world data. One challenge is that it puts a lot of pressure on the lecturer in order to supply these data, and the other is ethical issues associated with privacy, business property, and secrecy. We will return to these issues.

### ***Real Life Solutions: One Solution, Known to Exist***

Having been presented the puzzle, the students were quick to ask whether the answer existed. We find that the students should be told in advance that there is indeed one correct solution to the problem and that the answer can be derived only from the data. Moreover, the solution needs to be intuitive and have an impact on business value. Three students commented:

*"It made us understand how to reach a solution by analyzing a database"*

*“Fun to reach answer, it was not obvious”*

*“Very good to learn how this information can be used to make money”*

In contrast, the Telenor case was less motivating; even though the students knew there was one correct answer (2666 customers), some students failed parts of the ETL process and landed on 2672. When confronted that this was incorrect, some students replied, *“Isn’t it close enough”*? Perhaps the puzzle would be more motivating had the consequences of the solution been more radical, such as giving a large bonus or gift to the detected customers. This was not the case at Telenor and may be one drawback of using real life puzzles: real life consists of many mundane cases and situations.

Previous research has shown that there must be rules in order to solve the puzzle (Highley & Marianno, 2001). In our case, the students were not allowed to search the Internet, and they were informed about these rules in advance. None of the students broke any rules. Although Michalewicz and Michalewicz (2007) warn that it may take some time to reach the solution, we still believe that the solution should not be fabricated when using real life data. Moreover, the solution must be perfectly logical, based on the evidence. Having spent quite some time finding the correct answer, the students are not motivated for another fifteen minutes for the answer to be explained.

### ***Fun and Learning***

The findings in Tables 1 and 2 might indicate that there is a close relationship between fun and learning. We do not propose such a general relationship, as we think this is a quite complex issue. We do, however, briefly draw attention to these questions: Can there be too many puzzles in the teaching? Is there a risk that the students become passive and expect the learning to be wrapped in entertainment? A few students complained about too many “parlor games” and, according to the survey, they found the two last puzzles took too long:

*“Spent too much time, we would have got the idea with less words”*

*“Overall, too much time spent. Less interesting whether fun, should focus on useful”*

This may indicate that the students see the brainteasers for what they are meant to be, namely, a tool for learning BI concepts and processes. Real life puzzles do not replace the traditional classroom teaching but are meant as a complement to reading, reflecting, and lab work.

### ***Summing Up: What Make Real Life Puzzles Work?***

Overall, we argue that real life puzzles are a powerful approach to learn BI. Real life problems are conceived by the students as interesting and motivating. Real life data also create a rich and abundant source for problem solving using BI techniques. Real life solutions represent an exciting target for the students to reach, with a strong feeling of satisfaction when the solution is found. Moreover, the real life approach teaches the students to think out-of-the-box. This is illustrated with a number of characteristic comments from the students:

*“Very fun way to make us think differently”*

*“I would probably be clueless without this puzzle”*

What make real life puzzles work? In addition to being perceived as fun and motivating, we believe that there exists an underlying explanation for the positive outcome. The BI process is characterized by a certain structure: you have a question and there exists a large amount of data that may contribute to your solution. However, the answer can only be found by querying in a certain way, that is, you have to relate strictly to the structure of the available data.

The puzzle approach imitates this process. You start with a question or problem, with a description of the structure of the available data. If the students pose questions that do not relate directly to the data structure, the question will be rejected. (Recall that this was the case in puzzle one, where a student tried to ask about vandalism.) This teaches the students to formulate the questions based on the data structure.

We argue that the similarities between the BI process and the puzzle process prepare the students for Business Intelligence learning in an indirect way. Through the gradual realization on how these puzzles work, the students are able to connect the logical structures of puzzles with the logical way of BI queries.

There are however limitations and challenges to our research, which are briefly assessed in the next section.

### ***Limitations***

First, we have to acknowledge that this was a small study, consisting of a one semester course. Although we build on the students' own perceptions of their learning, our findings are nonetheless consistent with research described in the literature review (Wixom & Ariyachandra, 2011).

Second, previous research (Mrdalj, 2007) has emphasized that it is time consuming and difficult to identify such real life puzzles. Puzzles such as Rusty Meters and Ghost Map may only be used once for each cohort – even provided that no student has heard of it before somehow. The BI lecturer faces the risk of running out of puzzles from the real world. At the moment, there is no “World Puzzle Bank” although it should be possible to draw on other people's puzzles and cases, for example from Teradata University Network (Teradata, 2012).

Third, while today's BI techniques can extract large amounts of real life data from multiple sources such as Facebook and other web pages, ethical concerns may prevent use of real life data. For example, it would not be good practice to apply peoples' personal data extracted from real registers.

## **Conclusion**

In response to Wixom and Ariyachandra's (2011) call for a more relevant and practical schooling of BI, we have investigated how to teach some of the core concepts and practices of Business Intelligence at a university college, while at the same time making learning fun. The students were given four tasks covering learning outcomes of data warehouse, BI and ETL process, data- and text mining, as well as reflecting on the business value and advantages of a completed BI process.

Our conclusion is that real life puzzles are a powerful method to teach BI. Both puzzles and BI address solving a problem, with no obvious answer, using certain steps. Real life problems are interesting for the students, real life data create a rich source for problem solving using BI, and real life solutions provide a strong feeling of satisfaction when the answer is obtained.

We argue that the puzzle approach works because it imitates the BI process. You start with a question or problem and a description of the structure of the available data. If the students pose questions that do not relate directly to the data structure, the query will be rejected. This teaches the students to formulate the questions based on the data structure, which is essential for understanding the BI concepts and process.

There are also limitations to using real life puzzles for teaching BI. Puzzles do not replace the traditional classroom teaching, but serve as a complement. Preparing puzzles represents a challenge for the lecturer, such as collecting large amounts of data and addressing ethical issues. Finally, some puzzles may only be used once for each audience.



Further research on Puzzle-Based Learning can be conducted in subjects other than BI. For example, one might investigate in more depth the relationship between fun and learning. Within the BI field, related venues of research could be examined. Further research could investigate the mental process of Puzzle-Based Learning in relation to the specific challenges found in BI education. Such research might aim for a more causal explanation, for example, the direct effects of puzzles on student's grades.

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## Appendix A

(The questionnaire was given in lecture number 5. It was anonymous.)

The class has been given 4 exercises. Please circle the ones you have been attending:

- (1) Rusty meters in London
- (2) Dr. Snow’s ghost map (cholera)
- (3) Text mining data from Facebook (sentiment analysis)
- (4) ETL/Data mining data from Telenor’s Sales and Marketing department (effect of campaign)

For each exercise you have been attending, please answer:

(1) Rusty meters  
 Was it fun to solve this exercise? (Please circle) Yes      Somewhat      No  
 Please describe.....  
 Did it help you to understand the key concept of Business Intelligence?

(2) Dr. Snow’s ghost map (cholera)  
 Was it fun to solve this exercise? (Please circle) Yes      Somewhat      No  
 Please describe.....  
 Did it help you to understand the key concept of Business Intelligence?

(3) Text mining data from Facebook (sentiment analysis)  
 Was it fun to solve this exercise? (Please circle) Yes      Somewhat      No  
 Please describe.....  
 Did it help you to understand the key concept of Business Intelligence?

(4) ETL/Data mining numeric data from Sales and Marketing department at Telenor.  
 Was it fun to solve this exercise? (Please circle) Yes      Somewhat      No  
 Please describe.....  
 Did it help you to understand the key concept of Business Intelligence?

Any comments?

## Appendix B

The table below summarizes the four puzzles.

<b>Puzzle</b>	<b>Key BI concept</b>	<b>Learning objective</b>	<b>Outcome by students</b>
Rusty meters	Data warehouse	Collecting data from several sources to solve a problem	Found the answer within one hour
Dr Snow’s Ghost Map	Data mining, the BI process	Map can be data source. Importance of acting upon information	Found the answer within one hour
Norwegian and SAS on Facebook	Text-, web mining	Sentiment analysis	All groups reached similar results
Effect of campaign at Telenor	ETL process	Data sources often have different formats	Only three groups reached the correct answer

## Acknowledgements

First, the authors would like to thank the E-business class of 2010 at the Norwegian School of IT for solving puzzles and providing reflections in the survey afterwards. Additional gratitude goes to Knut Urbye for comments. This article builds on a UKAIS conference paper presented in Cambridge, April 2011, and the authors are thankful to the anonymous reviewers from this conference. Finally, special appreciation goes to Grandon Gill and the anonymous reviewers of Journal of Information Technology Education: Innovations in Practice for raising the quality of this article.

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6-30-2013

## Social Media as CRM? How two airline companies used Facebook during the “Ash Crisis” in 2010

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### Recommended Citation

Bygstad, Bendik and Presthus, Wanda (2013) "Social Media as CRM? How two airline companies used Facebook during the “Ash Crisis” in 2010," *Scandinavian Journal of Information Systems*: Vol. 25: Iss. 1, Article 3.

Available at: <http://aisel.aisnet.org/sjis/vol25/iss1/3>

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# Social Media as CRM? How Two Scandinavian Airline Companies Used Facebook during the “Ash Crisis” in 2010

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**Abstract.** Some researchers predict a paradigm shift within Customer Relationship Management (CRM), moving from the traditional large in-house CRM systems to social software such as Facebook. In this article we investigate two issues. First: are there inherent problems in traditional CRM systems that Facebook may resolve? Second: if so, can social media replace CRM systems? We conducted a case study of two Scandinavian airliners' use of Facebook for customer communication during the ash crisis in April 2010. Our analytical approach was a Business Intelligence analysis using web- and text mining based on 28.000 postings on Facebook. We offer two findings. First, Facebook resolves some shortcomings of traditional CRM. The openness of Facebook allows for more dynamic interaction between company and customers. Facebook has a self-reinforcing mechanism for diffusion, meaning that short-term usefulness triggers more use, which again will increase the usefulness. Second, we do not believe that social media can replace traditional CRM systems, but it constitutes an interesting challenge. If not a full CRM, Facebook can serve as a “social CRM”. In contrast to traditional CRM, companies may not be the strongest part, since personal information is controlled by the customer. This is indeed an interesting arena for researchers.

**Keywords:** CRM systems, social media, business intelligence, ash crisis, case study.

Accepting editor: Keld Bødker

## 1 Introduction

The recent surge of interest in social media has led marketing researchers to predict a paradigm shift in Customer Relationships Management (CRM) systems, sometimes named CRM 2.0 or “social CRM”, which denotes the integration of traditional CRM systems with social software, such as Facebook (Greenberg 2010b; Woodcock et al. 2011). All the key players within CRM (SAP, Oracle, and Microsoft) have announced solutions that combine their CRM systems with Facebook in various ways. The more innovative practitioners, however, have more far-reaching perspectives on CRM 2.0, which redefines fundamentally what CRM systems may develop into (Thompson 2007). For example, Clara Shih wrote in CRM Magazine in 2009 that “Facebook is the future of CRM”:

Facebook, Twitter, and other social sites have become CRM for individuals. They’re how a growing number of people manage relationships across personal and professional realms. Social media is reminding us - and vendors - that CRM should be about customers, not technology. The future of CRM will be transparent, customer-centric, and customer-driven (Shih 2009, p.1).

While such claims may appear a bit presumptuous, they clearly illustrate that social media challenge the thinking and the solutions of the traditional CRM vendors. But is this for real? The CRM systems business is a multi-billion dollar market, with IT heavyweight companies and very sophisticated software, being used by the world’s corporations in most industries. Can simple social software, such as Facebook, really challenge these giants? Or put differently, are there inherent and unsolved problems in traditional CRM systems that social software may resolve in new ways?

In this article we address this issue. Our empirical evidence is related to an incident that happened in April 2010. A volcano in Iceland, the Eyjafjallajökull, erupted suddenly and violently, and an enormous ash cloud covered shifting parts of Europe for about ten days. Most of the North and Central European airspace was closed, and hundreds of thousands of passengers were grounded all over the world. Nobody had any idea of how long the crisis would last, and the feeling of panic spread among the airline companies. The need for quick communication and instant problem solving was overwhelming.

The first thing that happened in the headquarters of the airlines was that the telephone services broke down immediately, leaving people rather desperate for information. However, as an improvised response, two airline companies in Scandinavia established a large-scale customer communications and problem-solving operation through Facebook (interviews with airlines), which actually solved much of the problems.

We think that this experience has bearings on the CRM discussion, for two reasons. First, it showed that the airline customer services were put under a lot of stress by the situation. Secondly, it was a big surprise that Facebook, which is mainly perceived as a kind of leisure time software for small news and gossip between friends, suddenly appeared as a useful and available channel in a crisis.

In this paper we discuss the underlying challenges of CRM systems, and the possible role of social media. We investigate this through two research questions: First: are there inherent and



unsolved problems in traditional CRM systems that Facebook may resolve in new ways? Second: if so, can Facebook replace CRM systems? We proceed by reviewing the CRM research, and assess how social media, such as Facebook, can solve some of the key challenges. Then we present our method and our case; the airlines' actions during the ash crisis. We present and discuss our findings, and conclude in the last section.

## 2 Research review

First we briefly introduce the concept of CRM and the CRM systems. Then we discuss some key problems with CRM systems, and compare traditional CRM with Facebook.

### 2.1 CRM and CRM systems

CRM is defined by marketing research as an “integrated sales, marketing and service strategy” (Kalakota and Robinson 2001). Turban et al (2011) state that the goal of CRM “is to create one-to-one relationships with customers by developing an intimate understanding of their needs and wants” and that CRM is an extension of traditional marketing. Often, CRM researchers emphasize that CRM is much more than technology. For example, Buttle defines CRM broadly as a “core business strategy that integrates internal processes and functions, and external networks, aims to create and deliver value to targeted customers at a profit” (Buttle 2008) p.15.

These rather grand visions cannot hide the fact that in practice CRM is much about information technology. Since the early 1990s CRM systems were designed to support customer related processes, such as maintaining customer data, conducting customer segmentation, extracting customer preferences based on previous sales and communications, administering the sales force and handling direct marketing.

Companies have invested heavily in CRM systems for two decades. According to Gartner, the world market for CRM systems was over 12 billion dollars in 2011 (Gartner, 2012), with SAP as the largest vendor. Expectations of economic returns from investing in CRM systems are therefore high. The benefits of CRM systems have been advanced by the vendors, highlighting the potentials, and by Information Systems (IS) text books, focusing on the normative aspects, i.e. what companies ought to be doing (Turban et al. 2006). Some researchers have found that CRM systems do improve one-to-one marketing effectiveness (Mithas et al. 2006).

However, overall empirical evidence is much less convincing, in terms of successful cases and in economic statistics. Indeed, there is no evidence of improvements in stock returns or profitability for firms that have invested in CRM (Hendricks et al. 2007). Many researchers have pointed out that the often technical focus of CRM implementation is ineffective and that in order to be successful a number of social, human and marketing issues should be understood better (Bygstad 2003; Nairn 2002).

Even more worrying, doubts have been raised regarding the potential of CRM technology to generate self-reinforcing adoption. Ciborra and Failla found that “CRM seems to have no built in mechanisms by which it acquires its own momentum and the diffusion becomes a self-feeding

process” (Ciborra and Failla 2000). Such mechanisms have proven decisive in the diffusion of IT; for example the quick diffusion of e-mail in the 1990s was in large part due to a certain dynamics: the immediate usefulness of e-mail attracted more users, which made e-mail more useful, attracting even more users and so on. (See also Markus, 1987, on critical mass of user adoption). If a technology cannot generate this kind of dynamics, its diffusion will be an uphill struggle, with lukewarm and even resisting users. This has indeed been a characteristic of many CRM implementations (Bygstad 2003; Turban 2011).

## **2.2 CRM and Facebook**

Bearing in mind this rather bleak picture it is no surprise that the business and software communities have been curious of the potential role of social media in improving customer communication, while retaining a low cost strategy. A recent CRM text book enthuses on the possibilities to integrate not only Facebook, but also the culture of social media into traditional CRM thinking, called “social CRM” (Greenberg 2010a). The newcomer Salesforce.com, which is regarded as the leading vendor in “social CRM” was the fastest growing CRM company in 2011 (CRM Magazine, 2012). Moreover, several traditional CRM vendors are actively trying to integrate Facebook (and other social media) with their products, at least in their strategy talks. It remains to be seen whether this integration is possible, and also whether it is acceptable for Facebook users.

However, this fascination for social media also provides an opportunity to assess the problems of CRM in a new context, because Facebook offers an interesting contrast to CRM systems in several respects. In particular, we will argue that Facebook includes some key features that mitigate some of the inherent problems in CRM systems. These problems relate to the way CRMs are conceptualized as traditional, closed in-house systems, designed to support complex business processes, operated and managed by staff. This makes them expensive to maintain, and, as observed by Ciborra and Failla (2000), lacking a self-feeding mechanism that allows them to grow without management push. Certainly, CRM and Facebook were made for completely different purposes, and we will only compare the attributes that relate to the problems described above. If we compare these attributes of CRM and Facebook, as illustrated in table 1, we notice that the differences are significant.

### **Access: Closed versus open**

CRM systems are in-house applications, designed to support the key marketing functions of the organisation. They are strongly guarded with strict access regimes to protect the confidentiality of the data. Although a key aim of CRM is to share information across business functions, only selected company employees are allowed access and use. Customers have no access to this information, and are usually unaware of what information the company has stored.

In contrast, Facebook is an information infrastructure (Hanseth and Lyytinen 2010), which is open and evolving. Anyone with Internet access can become a user, and there is a strong culture of sharing information.

<i>Attribute</i>	<i>Traditional CRM systems</i>	<i>Facebook as CRM system</i>
Access	Closed	Open
Technology	Commercial software	Social software
Data structure	Complex and highly structured	Simple and semi-structured
Ownership of data	Company	Mixed ownership
Maintenance of personal data	Company	Customer
Self-reinforcing mechanisms	Lacking	Strong self-feeding mechanisms for growth

Table 1: Traditional CRM systems compared with Facebook as CRM system

### **Technology: Commercial versus social software**

The largest CRM vendors are companies such as SAP and Oracle (Gartner 2012). The products are expensive and quite complex, requiring specialists for system configuration. Users need substantial training in order to use the software.

In contrast, Facebook is social software, linking millions of users. It takes only minutes to register as a new user, and the software is also available on (smart) mobile phones and tablet computers. Currently (2012), there are more than 1 billion Facebook users (one in seven of the world's population!), which is rather amazing for a product that was launched in 2004. In Norway, 51% of the population were registered Facebook users, while the number for Sweden and Denmark were 48% and 51% (Synlighet.no 2012).

### **Data structure: Complex and highly structured versus simple and semi-structured**

Traditional information systems are highly structured. Examples are categories for type of customer and type of offer or complaint. Although traditional CRM systems also may contain unstructured data in form of notes made by call-centres or e-mails by the customer, these data are stored in a database and can only be retrieved by queries.

Web pages typically contain unstructured data, despite being coded in HTML (Blumberg and Atre 2003). Although being a web site, Facebook offers semi-structured data classified as date, user, question, answer, and commercial ads. Since it is so easy to use, Facebook appears quite simple. On the other hand, the social network of Facebook is a quite complex structure of several users and links between them.

## **Ownership of data: Company versus contributor**

Data in traditional CRM systems are stored in-house, and owned by the company. However, traditional CRM systems do not necessarily provide adequate information, as was the case for an executive at a Fortune 500 telecommunications company. The manager complained that although they had up to 100 000 conversations with customers, he or she could only see the outcome, and not the content of the dialogues (Blumberg and Atrre 2003).

At Facebook, the whole content and history may be studied by both parties. One important question, then, is who owns the data? According to Facebook's terms, the data belong to each contributor, specified as "You own all of the content and information you post on Facebook, and you can control how it is shared through your privacy and application settings". (Facebook 2011). In our case, this means that some data are owned by the two airlines, respectively, and some data are owned by the numerous users of Facebook.

## **Maintenance of personal data: Company versus mixed ownership**

The implications of this mixed ownership are significant. While traditional CRM systems contain quite detailed information about each customer, the maintenance of this information has proved to be challenging (Bygstad 2003). Personal information is changing continuously, and it requires input from each customer ("I have a new e-mail address and a new telephone number") and action from the company (changing the customer information in the database). If this routine is not strictly followed, the system is quickly corrupted. Such problems are often underrated in CRM implementations (Reid and Catterall 2005).

In contrast, since the Facebook data belong to the customer, they are also maintained by each person. This solves a crucial problem with traditional CRM systems, since the Facebook user will usually maintain the basic contact information correctly, for practical reasons. However, the maintenance model of Facebook raises another challenge when it comes to more "transactional" data. The customer may choose to modify his/her text, and the company may modify its reply. Thus, the integrity of the entered information is weaker than in traditional in-house systems.

## **Self-reinforcing mechanisms**

As Ciborra and Failla (2000) observed, CRM lacks a mechanism for self-feeding growth. A CRM system depends on internal routines for entering and maintaining data. The individual employee (for example in a call centre) often has no incentive to this (it is an extra effort), but the data may have value for another employee in another department, for example in Direct Marketing. If these maintenance routines are not meticulously followed the system will quickly get corrupt and useless. This lack of a self-feeding mechanism often makes CRM into an uphill struggle with a lot of management push.

In comparison Facebook has a strong self-feeding mechanism for growth; short-term usefulness and ease of use attracts users, which makes the network more useful and attracts more users, and so on. A new "friend" on Facebook extends the information richness of your network, and also increases the diffusion of your own information. Thus, the value of this network increases

with each new user, as described in network economics (Hanseth 2000). This, of course, does not imply that all social media are successful, which we also discuss in our limitations section.

## 2.3 Summing up the research review

As this review reveals, Facebook has many attractive features compared to traditional CRM, even though Facebook certainly lacks the rich functionality of CRM systems. In particular, Facebook addresses several of the inherent problems of CRM systems, notably on openness, maintenance of personal data and self-reinforcing mechanisms for diffusion. If not a full CRM, can Facebook serve as a lightweight CRM?

## 3 Method

The overall approach was a case study (Yin 1994), aiming to investigate a phenomenon in its context. We chose to investigate how two airline companies, SAS and Norwegian, interacted with their customers on Facebook during the ash crisis in April 2010. SAS (Scandinavian Airlines) is the largest airline company in Scandinavia, and offers intercontinental flights to USA, Middle East and Asia, as well as within Europe (SAS, 2010a). SAS was rated amongst the top three most punctual airline companies worldwide in 2009 (SAS, 2010b). CEO, John Dueholm, proudly stated: “Our staff does a tremendous job to ensure our customers arrive at their destination in time, especially considering the sometime severe weather conditions we are faced with in Scandinavia during the winter months” (SAS, 2010b).

Norwegian (Norwegian Air Shuttle ASA) is the second largest airline company in Scandinavia, and offers flights within Europe, North Africa and the Middle East. They market themselves as a low-cost airline, and on their website one can read: “With competitive prices and customer friendly solutions and service, the company has experienced significant growth in recent years” (Norwegian, 2011).

Our two companies were selected due to their leading positions in Scandinavia, as well as their goals of being punctual and customer friendly, respectively. Moreover, the companies’ use of Facebook offered an opportunity to study how the two handled a large volume of customer communication in a crisis situation, allowing us to conduct a comparative study.

Our data collection and analysis built extensively on Business Intelligence (BI) techniques, supplemented by interviews. The reason for using BI was that Facebook offered a large text material, which was suitable for BI analysis. This section first defines and describes BI. Then we describe in detail how the data from Facebook were captured by means of Ruby code, and how we analysed them using the most common BI end-user tool: Microsoft Excel. Finally, we discuss the validity of our research.

### **3.1 Definition of BI as process and tool**

The primary aim of modern Business Intelligence is to support decision making on all levels of a company by providing a reliable database and tools for analysis (Davenport 2010). The process consists of gathering data, turning them into information upon which decisions should be made, and finally taking action (Turban et al. 2011). Hence, the process of BI is not new and has existed just as long as capitalism (Lönnqvist and Pirttimäki 2006). Today, the most common end-user tools are spread sheets, queries, dashboards and various forms of mining and analysis.

The BI literature envisions large benefits from using BI, the most common being faster and more accurate reporting and improved customer service. These benefits are obtained by making sophisticated queries to a database, one example being data mining. Data mining aims to uncover hidden patterns in large amounts of numerical data (Turban et al. 2011). Typical examples are which products are frequently purchased together, which can provide insights for campaigns and physical grouping of merchandise. Data mining has evolved into text- and web mining. According to Kosala & Blockeel, web mining was initially described in 1996 by O. Etzioni (Kosala and Blockeel 2000), and has the same purpose as data mining: discovering hidden patterns from data residing on web pages. Since web pages usually consist of text, one gets the challenge of analysing unstructured data. Overcoming this challenge can be worth the effort as web- and text mining enables sentiment analysis, a technique for detecting positive or negative opinions towards a product or service by using large quantity of textual data sources (Turban et al. 2011). As explained by Jeff Bezos, the CEO of Amazon:

If you upset your customers in the real world, they are likely to tell 6 friends each. On the internet, your unhappy customers can tell 6000 friends each (Digimind, 2008).

The next section illustrates how we performed web- and text mining.

### **3.2 BI techniques**

We chose a single case, namely the ash crisis in the European airspace in April 2010. The Facebook materials offered an opportunity to investigate how data captured from social media can be used for research by means of BI techniques. The basic research steps of data collection and data analysis are conducted somewhat differently in a BI design than in traditional IS research. Data collection is done through a process called ETL (Extraction, Transformation, Load), and the data analysis can be conducted by techniques such as data- and text mining (Turban et al. 2011). The ETL steps of creating a reliable source for BI analysis are:

- Extraction: capturing data from one or several sources
- Transformation: modifying the data by for example filtering or summarising
- Load the data into a data warehouse or into a spreadsheet

An ETL tool can be purchased from a vendor, or coded from scratch (Moss and Atre 2003). In our case, we had it developed by our programmer. After the ETL process, data can be subject for further analysis.

### 3.3 Data collection

We employed both web content mining (Kosala and Blockeel 2000) as well as text mining (Turban et al. 2011). Our ETL process was conducted as follows.

First, in the extraction step, we identified two web pages on Facebook, namely Norwegian (Facebook 2010a) and SAS (Facebook 2010b). Our programmer used the programming language Ruby, using Facebook's Application Programmers Interface called the "Graph API of Facebook" (<http://developers.facebook.com/docs/api>). The script amounted to around 50 lines of code. The data extraction was conducted in June 2010.

Then, in the transformation step, we filtered out the commercials, pictures, and names, focusing on the one tab called "Wall" on Facebook (see figure 1). We wanted a main database containing the postings of customers and the replies of the companies, as well as date and time. Finally, in the loading step, the result was saved in Excel format.

Four Excel artefacts were produced: (a) all words containing "ash" per day, (b) the number of inquiries from passengers and replies from the airline companies, (c) the number of minutes from question from passengers to answer from employees, and finally (d) all unique words written by passengers and employees.

Artefact (a) would help us assure that our analysis was in fact about the ash situation, and not about general activity on Facebook, as both airline companies were active on Facebook before and after the ash crisis. The artefact (b) would reveal to how many of the stranded passengers made use of Facebook – how many questions were posted during the ash crisis period? Artefact (c): we were also curious about the response time from a passenger posted a question to an answer was given by Norwegian or SAS – given many questions; it could probably take hours, or even days? The last artefact (d) would serve as basis for our sentiment analysis – were the passengers angry, ventilating their frustration through the only media in operation?

All of our captured data were semi-structured, including meta data (Blumberg and Atre 2003). Meta data in our case were the time of creation, authors and identifying question and answer, facilitating the subsequent text mining.

### 3.4 Data analysis

The main technique in the data analysis was text mining. The most employed end-user tool of BI is Microsoft Excel (Watson 2009), and we used it for data- as well as text mining. While data mining is defined as searching for patterns within large amounts of structured data, text mining is: "...the semi-automated process of extracting patterns from large amounts of unstructured data" (Turban et al. 2011). At a high level the text mining process consists of establishing the data sources (decide which data to use), introducing structure (adapt the structure of files) and extracting knowledge (produce output data, based on for example classification, clustering or association). The following steps were conducted in the data analysis, shown in table 2.

The first three steps were relatively straight forward, producing frequency charts. Step #4 was more complex. From the total word count (artefact d) we wanted to measure the "emotional temperature" by conducting a sentiment analysis (figure 5). In order to do so, we first conducted an overall word frequency analysis of the occurrence of unique words. We counted all words

used on the web pages, by applying Excel’s filter on each company, and removing all duplicates. From the webpage of Norwegian, we found 20.622 unique words, and SAS had slightly fewer; 18.600. The next step was performed manually by selecting all words with 5 or more instances, excluding prepositions and the like.

<i>Step and input</i>	<i>Description</i>	<i>Output</i>
1. Ensuring validity of data	Checking that the Facebook activity is directly related to the ash crisis	Number of instances of the word “ash” (Figure 1)
2. Analysing volume of Facebook traffic	Counting requests from passengers per day	Number of requests during the ash crisis (Figure 2)
3. Analysing response time	Measuring average response time, from request is posted to answer is provided	Response time in minutes (Figure 3)
4. Sentiment analysis	Identifying and accumulating positive and negative word per day	Sentiment graph (Figure 4)

Table 2: Steps in the data analysis

Starting on top of the list of word frequency list, the positive and negative words were manually identified. For example, words such as *thanks*, *good*, and *fantastic*, were classified as positive terms, and accordingly *resigned*, *chaos*, and *frustrating* were classified as negative. Some words with different meanings in Scandinavian and English (such as “true”, which means “threatening” in Norwegian) were discarded since there were only a few occurrences.

For each identified (positive or negative) word, we searched systematically for other occurrences with a) the same stem, b) the same word in another language (English and Swedish, in addition to Norwegian) and c) misspellings. For example, the concept “frustrating” had 16 different forms, which were accumulated in the count. Then, for the six most frequent positive and negative terms (see table 3), we checked contexts; i.e. whether the use of the word was consistent with our classification. We did find some occurrences of expressions such as “no thanks” (2 occurrences) and “no good” (21 occurrences). We considered these as so few that this problem was ignored.

From the final list, we constructed two indexes, one consisting of the frequency of positive words per day, and the other one consisting of negative words per day. Extracting the information, we used the most common form of mining called categorisation (Turban et al. 2011). This implicated that we looked for certain behaviour of passengers and the airline company in their dialogue. Our result of the sentiment analysis for both companies during the ash period is shown in figure 5 below.



### 3.5 Validation

How valid were our data, meaning to what extent could we trust them? To ensure that we were in fact studying passengers' inquiries concerning ash crisis and not, for example, vacancies or booking for summer vacation, we extracted all instances of the Norwegian word for "ash" for our predefined period, as shown in figure 1 below.

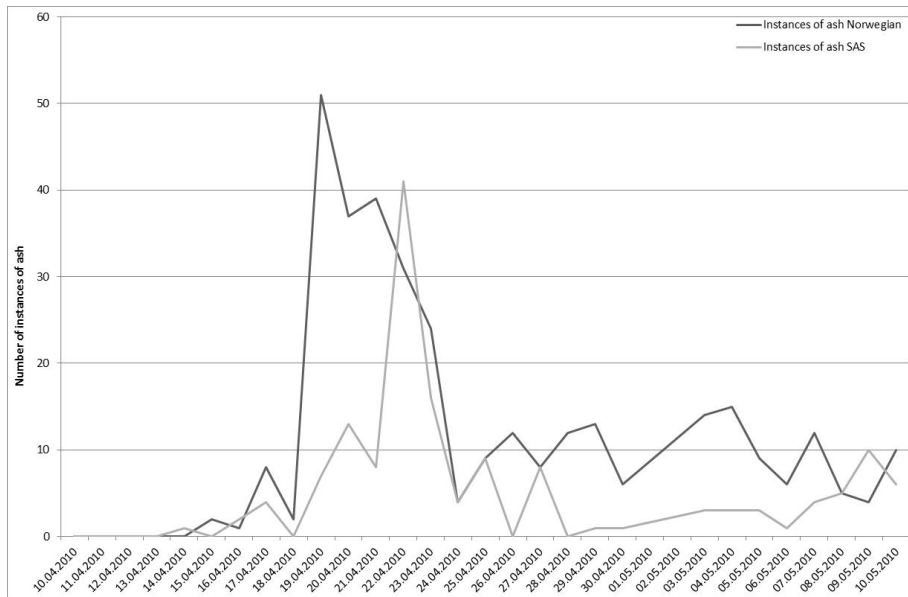


Figure 1: Number of instances of the word “ash” for the two airlines

The word “ash” appeared for the first time on April 13th, and during April 19th, the word “ash” was posted over fifty times on Norwegian’s Facebook page. We observed that the pattern was consistent with the ash crisis period, from the first warnings through the height of the crisis. The “ash” postings were only used as an indicator, and not used in the further analysis. We noted that the instances were few compared to the number of questions, as shown in figure 2 below. One explanation could be that the setting became established and most Facebook users interacting with Norwegian’s and SAS’s page were aware of the ash crisis.

## 4 Findings

The ash crisis started with the eruption of large volumes of ash from the volcano Eyafjallajökul on Iceland, in mid April 2010, which grounded most of the North European air traffic. It is significant to bear in mind that the airlines’ use of Facebook as a communication channel was improvised. As previously described, both Norwegian and SAS had been established on Facebook

in good time before the ash crisis. However, the medium had not been used for extraordinary situations before.

The CIO of Norwegian commented:

Last year we ran a campaign on “Win an airplane, for a free flight for you and your friends”, which resulted in a large number of followers on Facebook. When the ash crisis started, we discovered that many passengers started to ask questions on Facebook. We trained our customer support centre to reply in a way that made the dialogue constructive and problem solving, and set up a 24/7 service. The people who staffed the service became so enthusiastic that they did not want to go home in the evening.

At the peak of the crisis Norwegian had a team of 18 persons dedicated to respond to Facebook request (interview at Norwegian).

## 4.1 Number of requests in the ash period

Although both Norwegian and SAS had been using Facebook for customer communication earlier, the volumes increased strongly during the ash crisis. We limited our analysis to the period between April 10<sup>th</sup> and May 10<sup>th</sup> 2010. Our total material in the two Facebook entries consisted of 18.846 postings at Norwegian, and 10.180 at SAS. As figure 2 shows, during the busiest days in mid April up to 1500 requests per day were posted to Norwegian, and more than 500 to SAS. After the crisis, the numbers fell sharply.

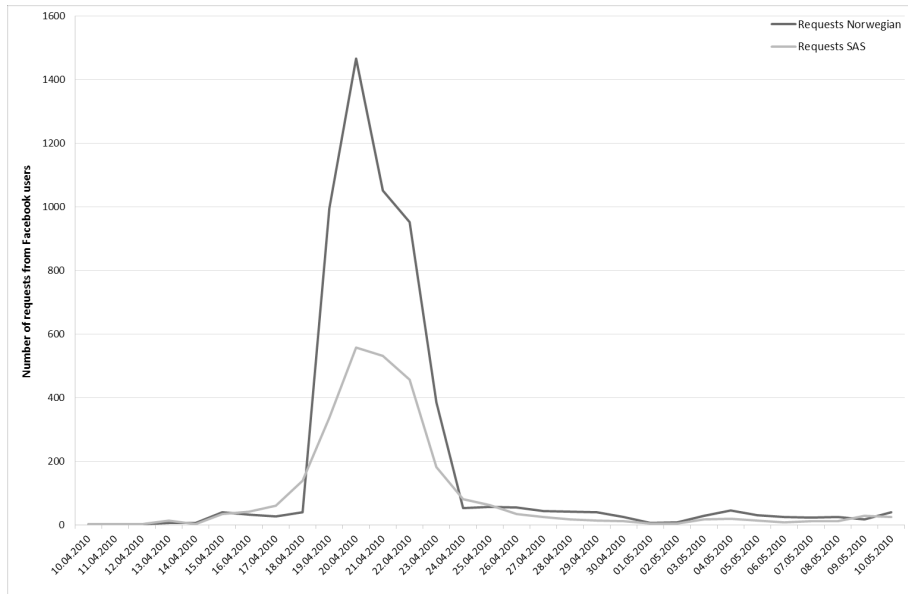


Figure 2: Number of requests for SAS and Norwegian during the ash crisis

Figure 2 indicates that Facebook was a useful channel for passengers during the ash crisis. As an IT service it scaled well, was easy to use, also from a mobile phone at a holiday destination or an airport. We note that there were significantly more postings on Norwegian than on SAS. Unfortunately, we do not have any data to explain this difference. However, one reason might be that Norwegian, as a low-cost airline, may attract younger customers who are more used to communicating through social media. Another possibility is that SAS might have been more available in their call centres. This difference, however, does not influence on the rest of our analysis.

## 4.2 Response time

We measured the response time from the two companies, i.e. the time in minutes from the posting of the request until an answer was posted on Facebook. As shown in figure 3, the response time was high before the start of ash crisis, but it quickly decreased to less than 60 minutes during the peak of the crisis. After the crises the response time rose, particularly for Norwegian.

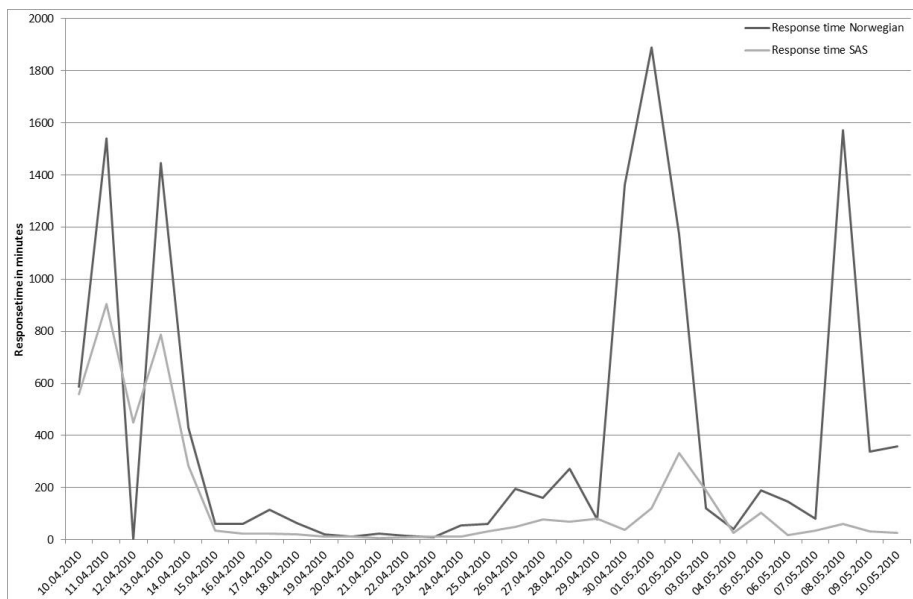


Figure 3: response time in minutes for SAS and Norwegian during the ash crisis

We think that the low response time is rather impressive, because “response” usually included some form of problem solving, for example a re-booking, or concrete advice on what the passengers should do. An illustrating example is the following exchange:

*Passenger:* We are 7 desperate ladies in Malaga who are booked on the flight to Oslo tonight. We just received a message about the airport being closed. Found out that there is a flight scheduled to leave Alicante at midnight. Everything is chaos down there.

*Norwegian:* Hello! Arrangements have been made for a bus from Malaga to Alicante. You need to contact the representative of Norwegian at the airport in Malaga. Hope it will work out.

*Passenger (later):* We are on the bus now!

As illustrated in figure 3, the response time from both airlines was significantly higher before and after the crisis. Closer analysis revealed that the postings before and after crisis, were more trivial, such as general requests whether pets are allowed on the flights. After the crisis, it appeared that the companies down-prioritised responding to Facebook requests. As the graph shows in figure 3, the response time increased up to 1800 minutes (about 30 hours) at Norwegian after the crisis, but the volume of requests was very low at the very end of April (refer figure 2).

### 4.3 Sentiment analysis

We also tried to measure the emotional temperature in the Facebook communication. We expected that a significant part of the communication would be somewhat heated, because many of the customers were finding themselves in a difficult and acute situation. As described in the method section, we conducted this investigation by a sentiment analysis, i.e. creating indexes of (emotionally loaded) positive and negative words. The result is shown in figure 4.

We were surprised by the result. As figure 4 indicates the emotional temperature in the Facebook postings was overwhelmingly positive, for both companies. The number of negative words was relatively low, and there was an almost complete absence of swearing and the like. Table 3 below shows the highest frequencies of emotionally loaded words. It shows that positive words clearly dominated the postings.

Again, we notice that the graphs for SAS and Norwegian show the same patterns. The differences between the two companies correspond roughly with the differences of the number of total postings in figure 2.

<i>Positive words</i>	<i>Frequency</i>	<i>Negative words</i>	<i>Frequency</i>
Thanks	1241	Resigned	56
Good	917	Frustrated	38
Fantastic	97	Chaos	27

Table 3: Frequencies of selected positive and negative word

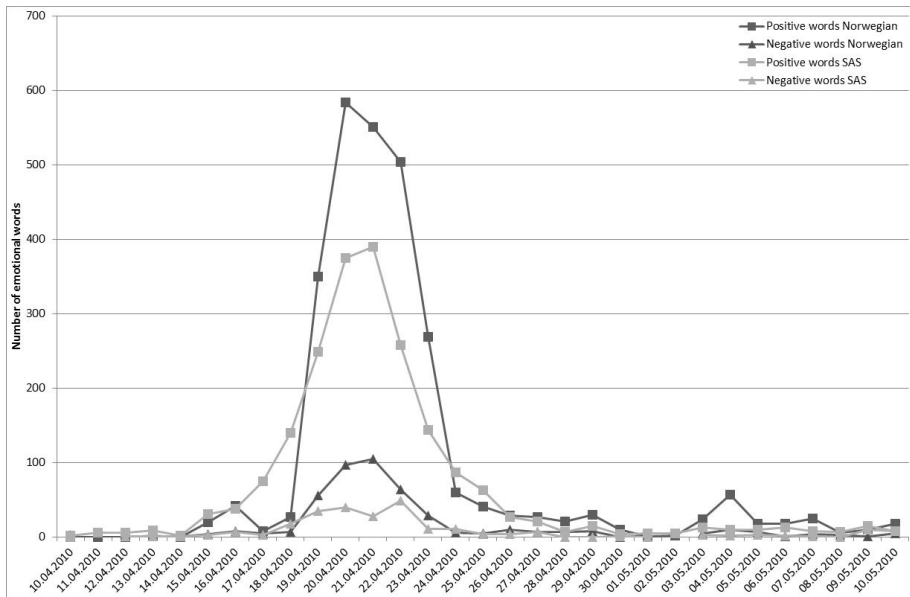


Figure 4: Sentiment graph for each airline company

## 4.4 Summing up findings

We argue that our data show that Facebook was successfully used for customer communication during the ash crisis, in several respects. Firstly, Facebook was a channel which many passengers found easy and convenient to use. Secondly, the airline companies succeeded in establishing an effective response service during the peak of the crisis. Thirdly, a detailed analysis of emotional loaded words showed that the atmosphere of the communication was quite civilised.

## 5 Discussion

In this section we return to our research questions. First: are there inherent and unsolved problems in traditional CRM systems that Facebook may resolve in new ways? Second: if so, can Facebook replace CRM systems? We also discuss limitations to our research.

## **5.1 RQ1: Are there inherent and unsolved problems in traditional CRM systems that Facebook may resolve in new ways?**

In our review we showed that there are a number of inherent problems with CRM systems that have made implementation and use an uphill struggle. These include particularly openness, maintenance of customer data and the lack of self-reinforcing mechanisms of diffusion.

Regarding openness, the ash crisis investigation shows that airline passengers in acute need perceived Facebook to be a convenient channel. Facebook is easy to use, and is available on mobile devices, which may be the only operating channel in a crisis. Moreover, the medium is transparent for all users (Blumberg and Atre 2003), meaning that it is possible both to read questions from fellow passengers as well as the answers provided by each airline company. This transparency increases the effectiveness of the channel as comments may be revisited. (This transparency is of course also a concern, which we return to in the Limitations section.)

Regarding the maintenance of customer data, our evidence clearly shows the benefits of Facebook. Since every Facebook user maintains his and her own personal information, the issues of customer identification and system access were solved. The airline companies did not have to do any extra input in their systems, but could match the name and problem description with the ticket information. The feedback to the customer could be entered directly below the request on Facebook. It is visually very clear who is supplying the information on both sides.

It is a matter for lawyers whether this may be in conflict with legislation on personal information. The answer is not obvious, since it is the individual (not the company) that enters the personal information on identity and travel details. However, it does have some other ethical and practical aspects that we will return to.

Regarding the self-reinforcing mechanisms of diffusion (Ciborra and Failla, 2000), we believe that the improvised and extremely efficient use of Facebook during the ash crisis shows that Facebook supports a self-feeding process. The self-feeding process is driven by the openness and availability of the solution; each customer that enters information and receives help also increases the value of the site, because it increases the amount of relevant information in a difficult and complex situation. It also scales, in the sense that the users do not get a “busy signal”, as does a call-centre telephone. It requires of course an effective organising for response from the airlines.

Summing up, we argue that both current research and our empirical evidence show that Facebook indeed mitigates some of the inherent problems with traditional CRM systems. What does this imply in practice? Can Facebook replace CRM systems?

## **5.2 RQ2: Facebook as a social CRM?**

In an article from 2007, Thompson claimed that social networks are “turning CRM upside down”. He pointed out that Facebook redefines the relationship between companies and customers, both parties being producers of information, and that the rich people information on Facebook represents an untapped source for dialogue with customers (Thompson 2007). Face-

book can obviously serve as a source of customer preferences and attitudes. But can Facebook really replace traditional CRM systems?

The CRM vendors certainly answer no, but aim at integrating Facebook with existing CRM systems. All major CRM vendors now have a form of Facebook strategy, working to make Facebook an add-on to their existing CRM systems (Greenberg 2010a). There are, however, mechanisms in Facebook to protect users from third party applications, such as external CRM systems. Hence, a Facebook user may choose to block such a third party CRM.

Our case shows that both Facebook users and companies are exploring the potential of social software. Questions yet to be answered are: how dangerous is it to tell the rest of the world that you are stranded on an airport? Is it an invitation to burglary in your home? Will the actual company, or other companies, misuse this information? We do not attempt to answer these questions here, but we believe that our case shows that Facebook proved to be quite efficient during the ash crisis. Our data may indicate that the benefits of sharing information were larger than the concerns, at least in this particular situation.

What are the benefits for the companies? They get immediate access to real-time data by real-life humans (Thompson 2007). Such data may be used in both analytical and operational activities. We observed that both SAS and Norwegian were efficient in solving problems in real-time. One question is whether this is cost efficient. Facebook is certainly a more inexpensive medium than call-centres. One reason is that requests are fully formulated in writing by customers, and can be processed efficiently and sequentially by staff. Another reason is transparency; other passengers can read the company replies and may not have to ask the same questions. Moreover, the identity of the customer (with its obvious limitations regarding authenticity) is provided by the Facebook user. On the other hand, Facebook communication is basically a one-to-one communication which is expensive for the company.

The process of Customer Relationship Management is not only the marketing and providing of services, but also the management of trust (Kalakota and Robinson 2001). Therefore, the atmosphere of the communication is also important. One interesting finding in our data is that customer sentiment was surprisingly positive as illustrated in figure 5. This indicates that the communication was trustful and friendly. The structure of Facebook enables follow-up questions and comments, and documents the dialogue between the customer and the company. One might question whether the positive atmosphere will endure if Facebook becomes a form of “standard” CRM channel, and not a bonus, as it may have been perceived to be in the ash crisis period? Perhaps the expectations of the passengers towards this medium were lower than when consulting a call-centre. As mentioned above, call-centres are infamous for long waiting time, and has traditionally been the only way of interacting with a company, apart from sending a letter, or actually appearing in person at a company’s location. The airline companies may investigate this further by mining other sources of sentiment such as Weblogs or other social media (Liu et al. 2007).

Summing up, we do not believe that Facebook will replace traditional CRM systems, because it lacks the rich functionality and security mechanisms of such systems. Facebook as of today also lacks internally generated data such as a passenger’s purchase history. However, data captured from Facebook can be merged with data from traditional CRM systems by means of the ETL process, and the lack of structured or categorised data in Facebook can be addressed by other BI techniques. Whether the Facebook users will accept this, remains to be seen.

### **5.3 Limitations and ethical issues**

Our study was conducted on the ash crisis, which was a rather special situation. This made it particularly interesting to study the potential of Facebook as CRM, because we could analyse how both the customers and the companies responded in a time of pressures. This setting makes our study a small natural experiment. On the other hand, this is also a limitation, because it may not be applicable to more normal settings. Moreover, in a serious international crisis, there is no guarantee that Facebook will be available to all traffic; for example, their servers may be overloaded. We should, perhaps, also add that we do not make any predictions on the continuing success of Facebook as a social medium; whether Facebook will continue to grow is probably not related to this CRM discussion.

We also acknowledge that there may be limitations to our research design. Regarding our data analysis, we concede that the construction of the positive and negative word indexes could have been more systematic. For example, we could have checked whether there were systematic differences in sentiments between airline postings and customer postings. Also, the variations in the number of postings with corresponding response times between SAS and Norwegian might have been better explained. We conducted our study with two Scandinavian airlines. Whether our findings are valid for other airlines or service industries is a matter for future research.

Finally, we should comment briefly on the ethical aspects of companies using Facebook for commercial purposes. The past years have witnessed a heated debate on privacy on Facebook. As argued by Grimmelmann, the privacy issues of Facebook are not easily solved because the main reason why people are on Facebook is because they indeed want to share personal information. Tightening the security on Facebook would soon render it meaningless (Grimmelmann 2008).

Regarding the use of Facebook data for research purposes, we certainly believe that IS researcher should relate to the Facebook openness in an ethical way. In this study we adhered to the following two principles (Fule and Roddick, 2004); first that the research objective was ethical and part of a research programme; second that we only published accumulated data, i.e. results at group level.

## **6 Conclusion**

In this paper we investigated (1) to what extent the most popular social media, Facebook, can be used to resolve some of the challenges of traditional CRM systems, and (2) whether Facebook can replace CRM systems. Our empirical evidence was a business intelligence analysis of around 28.000 postings in the SAS and Norwegian Facebook pages, during the ash crisis in 2010.

First, we find that the use of Facebook resolves some of the shortcomings of traditional CRM. The openness of Facebook allows for more dynamic interaction between company and customers. A recurring problem of CRM, namely the maintenance of personal data, is partly solved by the shared responsibilities of Facebook users. Moreover, Facebook has a self-reinforcing mechanism for diffusion, meaning that short-term usefulness triggers more use, which again will increase the usefulness of the solution. Our analysis shows that Facebook worked well as a social CRM in a crisis situation. What made it work? Facebook was a channel which



many passengers found easy and convenient to use during the ash crisis. Accordingly, the airline companies succeeded in establishing an effective response service during the peak of the crisis. In addition, a detailed sentiment analysis of emotional words shows that the atmosphere of the communication was quite civilised.

Second, we do not believe that Facebook can replace traditional CRM systems, but it constitutes an interesting challenge to them. We believe that in the coming years we will see that companies and customers will explore this potential of Facebook, in order to strike a balance between the networked power of social media and commerce. In contrast to traditional CRM, it is not obvious that the companies will be the strongest part in this exploration, since the customer controls his or her personal information. This is indeed an interesting arena for researchers, who should study the use of Facebook in different settings, for example we could investigate the role of Facebook in building and supervise the reputation of an organisation.

There are certainly also concerns. One issue is ethics and privacy; information on Facebook is accessible to anyone and can be misused, both by the company (using the information for other purposes) and the users (giving false or underspecified personal information). At a more technical level, there may be doubts whether information posted on Facebook will retain its integrity over time, since the owner of the data can change it at will. Moreover, for the companies, it is an open question whether Facebook will prove cost effective as a communication channel, particularly under normal operations.

## 7 Acknowledgment

An earlier and shorter version of this paper was presented at NOKOBIT 2010. We thank Mads Mobæk for programming the Ruby code and Knut Urbye for comments. We also thank the editor and three anonymous reviewers for helpful feedback.

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Norsk konferanse for organisasjoners bruk  
av informasjonsteknologi

# NOKOBIT 2013

Universitetet i Stavanger 18.–20. november 2013

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Norges teknisk-naturvitenskapelige universitet



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informasjonsteknologi

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ISSN 1892-0748

ISBN 978-82-321-0373-7

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# FORORD

Velkommen til NOKOBIT 2013!

NOKOBIT 2013 arrangeres av Universitetet i Stavanger.

Dette er det 21. NOKOBIT siden starten i 1993, og det er 14. gang at NOKOBIT arrangeres sammen med NIK – og fra 2008 også sammen med NISK.

I år har vi mottatt 23 bidrag, og det er 17 bidrag som skal presenteres. Alle bidrag har vært gjennom en grundig fagfelle vurdering (blind review) av tre uavhengige reviewere. Denne proceedings publiseres både på papir og elektronisk som serie på Tapir Akademisk Forlag ([www.tapironline.no](http://www.tapironline.no)). Hvert bidrag gir dermed forfatterne ett publikasjonspoeng.

I god NOKOBIT-tradisjon vil hver presentasjon ha en diskutant som er grundig forberedt, og bidragsytere må også fortelle hvordan de har forholdt seg til kommentarene fra reviewerne.

Jeg vil gjerne takke alle reviewerne for konstruktive tilbakemeldinger. Uten deres innsats hadde det ikke blitt noen konferanse. Jeg vil også takke styret i NOKOBIT for et utmerket samarbeid.

Til slutt vil jeg takke den lokale arrangementskomiteen, og spesielt Hein Meling. Det har gått veldig fint å samarbeide over distanse.

Vi gleder oss til en god konferanse!

Terje Fallmyr

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# KNOWLEDGE INFRASTRUCTURE IN ACTION. A CASE STUDY OF BUSINESS INTELLIGENCE IN HIGHER EDUCATION

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## Abstract

*Business system studies are in demand in higher education, and current research is addressing how this should be taught from a pedagogic angle. This paper describes a different framing of the phenomenon. Building on Hanseth's information infrastructure theory and Larman's pattern principles, a case from higher education is used to investigate how a knowledge infrastructure can be built in higher education. The case is a course of Business Intelligence at a university college which has evolved over six years. Two contributions are offered. The first is the proposal of an alternative theoretical framing of Business systems studies, where the "knowledge infrastructure in action" model highlights the dynamics of the interplay between the structural level and the actionable level. The second contribution consists of four practical patterns for establishing a business systems course in an educational or industrial organisation. This research should be useful for lecturers of business systems, both in college and the industry.*

Key words: Knowledge infrastructure, business systems studies, Business Intelligence, case study.

## 1. INTRODUCTION

Business system studies are popular in higher education (Hustad and Olsen 2011). Examples are studies within Enterprise Resource Planning, Customer Relationship Management, and Business Intelligence. These subjects started to appear in academia in 2000s but have existed as a discipline in the industry since late 1960s (Power 2007). This journey from the industry and into higher education has a strong impact on such studies. It is insufficient to teach the students to master the functions of the systems only. Rather, the students must first be made aware of the business process (the "diagnosis" of the company) before the correct business system (the "remedy") can be configured and implemented. Moreover, the students must understand how the new business system will affect the end-user and allow for proper training of the users. As a result, the origin and evolution of business system studies pose challenges when introduced in a college. For example:

- Students must master an intertwined mix of tools, skills, and business knowledge (Hustad and Olsen 2011)
- The discipline is coming from industry to academia (Wixom et al. 2011), and schools must keep up with developments in industry (Sircar 2009)
- Students must understand how technology affects business processes (Seethamraju 2012) as well as the users and employees (Davenport 1995)

I will argue that business system studies are different from other university disciplines. Unlike, for example, mathematics, physics, languages, and history, it is not about transferring theories and examples from the book into the mind of the student. According to Sircar, the schools must abandon the "silo" approach and embrace a wider scope in the curriculum and way of teaching. Instead of just teaching the students about the specialized functions of the business systems, knowledge about business processes is also crucial (Sircar 2009). The problem, Sircar argues, is that the business schools do this at the expense of practical relevance. This leads us to another problem. Ramilier and Pentland argue that the gap between research and practice will remain as long as academia only studies variables on an abstract level. For example, once a variable, such as "ease of use" is identified, the researcher will advise "*just increase x*" (p. 483) without bothering to focus on the actors, their actions, and the artefacts they use to accomplish the actions. The authors' argument is that "*...you can't make something from nothing*". Furthermore, their article criticises research for being too abstract. Typically, academics use abstract labels such as *users* and *information technology*. While exchanging these with more concrete labels such as *physicians*

and *telemedicine technology* will not indicate any action, it is a step in the right direction (Ramiller and Pentland 2009). Thus, the questions arise: *What are the dynamics of the knowledge infrastructure in business systems studies? Which successful patterns can be identified to help universities develop these studies into a stable part of an academic knowledge base?*

I attempt to answer these two research questions by drawing on the concept of knowledge infrastructure. My point of departure is that developing good business systems studies is about developing a dynamic knowledge infrastructure and not about “teaching” in the traditional sense of theories, variables, and constructed exercises. In order to reach this goal, I first briefly introduce the concepts of *information infrastructure*, *knowledge*, and *knowledge infrastructure*. Then I carefully describe the chosen method with description of the case: a course in Business Intelligence (BI) in higher education. Larman’s concept of *patterns* is also described here. I discuss the findings using “knowledge information in action” (my own framework based on Giddens, Hanseth, Volkoff and Lessard) before concluding and pointing to further research.

## **2. THEORETICAL PERSPECTIVE**

I first introduce the concept of information infrastructure, followed by the term knowledge management by drawing on Nonaka & Takeuchi and Davenport & Prusak. Building on these key concepts, I employ the Hanseth’s term *knowledge infrastructure* as my framework. Finally, I extend this framework by drawing on Giddens’s structuration theory, Volkoff et al’s three phases for technological embedding in organisational change, and a contribution from Lessard on how to analyse a knowledge infrastructure.

### **2.1 Information Infrastructure**

Information infrastructure is defined as: “...a shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities” (Hanseth and Lyytinen 2010) p. 4. In their article, Hanseth and Lyytinen exemplify each characteristic with the Internet. The theory of information infrastructure was developed in the 1990s by Hanseth and Monteiro (Hanseth and Monteiro 1997). First, they argued that research should change its focus from systems to networks as organizations shifted from single applications to internet-based interconnected systems. Second, they observed that these infrastructures were not designed as traditional systems but grew organically from attracting more users. This redefined the object of study; what we are trying to understand is not the implementation of technology but the growth of socio-technical networks over time. A socio-technical network consists of technology as well as the users, developers, and the work practices (Hanseth and Monteiro 1997).

### **2.2 Knowledge Management**

The growth of such structures implies the development of knowledge. In 1995, Nonaka and Takeuchi published their book *The Knowledge-Creating Company* (Nonaka and Takeuchi 1995). They argue that the success of Japanese companies is not only due to lifetime employment, excellent manufacturing skills, or close relationships with customers, suppliers and government agencies. Instead, they claim that Japanese companies are successful because of their *organizational knowledge creation*. By organizational knowledge creation they mean “...the capability of a company as a whole to create new knowledge, disseminate it throughout the organization, and embody it in products, services, and systems.” (p. 3). Despite the Western common view of Japanese companies as inefficient and cumbersome, the Japanese organizations have proven to be excellent innovators due to the cultivation of their knowledge. Nonaka and Takeuchi focus on knowledge *creation* (and not knowledge per se), as they argue that knowledge creation leads to continuous innovation, which again leads to competitive advantage.

In their book *Working Knowledge* Davenport and Prusak attempt to define what knowledge *is* within an organization and how to manage it. Creating knowledge requires an on-going process of self-renewal at both individual and organizational level. Knowledge can be acquired from outside, but it must also be built on its own, involving every actor in the organization. Traditionally, the company was viewed as a “black box” whereas interest was focused on ingoing resources and outgoing products, as well as the market and customers (Davenport and Prusak 1998). What went on inside the firm was beyond the interest of the economists. Suddenly, partly due to global competitiveness and more demanding

consumers, the focus shifted and *knowledge in organizations* became a buzzword. Some organizations assumed that technology alone would replace the skilled worker, which proved false. However, technology used in the right way may actually facilitate collection, storing, and distributing knowledge within an organization. Going from seeing the company as a black box, Davenport and Prusak define it as a collection of people organized to produce goods or services, and their ability to produce depends on their knowledge. People, technology, products, and business environment change over time, and so does knowledge, albeit at a slower pace. Intellectual capital can be less fragile than physical capital provided that the knowledge is continuously generated and shared.

In line with Nonaka and Takeuchi, Davenport and Prusak state that “*Knowledge is neither data nor information, though it is related to both...*” (p. 1). Their definition of knowledge is therefore: “*Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information*” (p. 5). In sum, “*knowledge derives from minds at work*” but it is not simple. It exists within people, and in order to be developed and shared, smart people must talk to each other. The problem is that organizations often put their smart people in isolated cubicles. Nonetheless, Davenport and Prusak assure us that knowledge will be transferred, regardless of how the organization manages the process.

### **2.3 Knowledge Infrastructure**

In 2004, Hanseth combined the theory of Information Infrastructure with the concept of knowledge management (Hanseth 2004). The key insights from his chapter “Knowledge as Infrastructure” are:

#### **Knowledge as a network**

Regarding knowledge as a network means that it is both structure and action. For example, a hospital has procedures and medical equipment as shared resources (structure). Each doctor will use these elements in his or her way (action).

#### **Network externality and increasing returns**

Network externality means that the value of the network increases with the number of participants it has (Shapiro and Varian 1999). They suggest the fax machine as a good example: it was considered a niche product until 1982. During five years, the demand and supply for the fax machine exploded, and after 1987, the majority of the companies owned one. When it comes to knowledge, a similar example can be when a doctor achieves new knowledge and shares this with colleagues; the value of the knowledge will increase. Other well-known examples are social media networks such as Wikipedia, YouTube, and LinkedIn. Increased use will attract more users, which again will increase the value of the network.

#### **Knowledge as infrastructure**

In addition to the features described above, Hanseth (2004) describes knowledge as being “*big, heavy and rigid – and not light and flexible as it is often wrongly assumed*” (p. 8). This implies that building a knowledge infrastructure is a substantial task which takes resources and time.

Summing up these perspectives, I conclude that it is useful to perceive knowledge not as a black box (Davenport and Prusak 1998), but as being embedded in the complex web of relationships between various actors and elements such as human beings, organizations, technology, and information systems.

### **2.4 Dynamics of Knowledge Infrastructures**

Hanseth did not elaborate on the inner dynamics of the knowledge infrastructures. In order to do so, I will draw on the contributions of Anthony Giddens and Olga Volkoff et al.

My underlying theory is Giddens’ structuration theory (Giddens 1984). Giddens theorises society as an interaction of macro and micro dimensions where social structure enables and constrains individual action, and action reproduces or transforms structures. In other words, they are mutually constitutive, meaning that one cannot exist without the other. Moreover, this mutual dependency requires that the cycle is reproduced continuously. An example from the Information Systems (IS) world could be that an organisational structure and IT systems enables individuals to perform certain tasks, such as entering an order and an invoice into an ERP system. In doing these tasks, the individual will also reproduce the



structure of the organisation with its ERP system; although this was not the intention of the action. On the other hand, if the individual decides to do a workaround, to use the system in a way that was not intended, one consequence can be a small change of the whole structure (both the organisation and the IT system).

Giddens was not particularly interested in technology, but many IS researchers have tried to use Giddens' framework in an IS context (Desanctis and Poole 1994). The interaction between micro and macro levels, including technology at both levels, was described by Volkoff et al (Volkoff et al. 2007). They describe technology-mediated organisational change in three phases. The first phase is "Structural Conditioning", which enables and constrains the possible actions through routines and technology. In the second phase, "Social Interaction", individuals are using the technology to accomplish tasks. Finally, the third phase "Structural Elaboration/Reproduction" reflects the fact that action may either reproduce the routines and/or technology or elaborate them.

Building on Giddens and Volkoff, Lessard proposes a model for knowledge infrastructure (Lessard 2013). Lessard directs focus on the relationship between structure and agency. In her view, these two *objects* mutually shape and imply each other but can still be analysed separately.

Drawing on the concepts and perspectives reviewed above, I propose my own framework, named "knowledge infrastructure in action", as shown in figure 1:

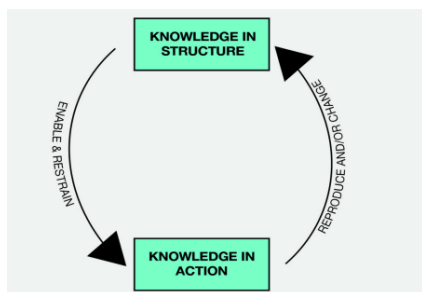


Figure 1: The proposed framework "knowledge infrastructure in action"

The framework (figure 1) has a strong focus on action, hence the name. If you want to create a rock-and-roll band or travel around the world with your friends, you cannot only make abstract plans; at some point you have to rehearse with the band or save money to buy the plane tickets.

It is also worth drawing attention to the arrows in figure 1. From "knowledge in structure" the actors will both enable *and* restrain the action. The "knowledge in action" has two potential impacts: It may *either* reproduce *or* change the "knowledge in structure", or it may do *both*. Having presented the theoretical perspective and the framework, the next section will describe the chosen method.

### 3. METHOD

The chosen research approach was a case study. A case study allows for an in-depth study of a contemporary, real-life phenomenon where boundaries are unclear (Yin 1994). As mentioned in the introduction, there are several business systems courses in higher education: Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Business Intelligence (BI). The latter discipline was chosen for three main reasons. The first was that BI is a rather new discipline; it was introduced into higher education in the 2000s (Power 2007). Second, less attention has been given to BI compared to for example ERP (Sircar 2009). Finally, the industry is currently in desperate need of "Data Scientists" (Davenport and Patil 2012).

#### 3.1 Data collection

The case study took place at a university college in Norway where I have been responsible for lecturing in business systems (ERP and BI) at the Bachelor level for six years and a Master's module in BI since 2011. I acknowledge that this double role (researcher and lecturer) may influence my observations and assessment. To ensure reliability, all evidence is carefully documented below. The data consisted of teaching materials, students' grades, student surveys, e-mail correspondence, contracts, and publications (an overview can be found in appendix 1).

The teaching materials were comprised at detailed lecture plans with learning outcomes, curricula, themes, and tools, which were official and collected from the school's web-site. "How-to's" (meaning Word or PDF documents with several screen shots of the technology and step-by-step instructions for the students. See appendix 2 for example) and lecture presentations, as well as exercises for the students to solve, were collected from the school's intranet. Finally, the students' grades were calculated.

Feedback from the students was collected each semester in form of online, anonymous surveys. They were asked to rate the course content, lecturer, exercises, and their own learning in the course from a scale from 1 (unsatisfied) to 6 (very satisfied). They also had the opportunity to write comments.

Companies, either from retailers using Business Intelligence or large consultant houses, gave guest lecturers. Evidence of this exists in form of e-mail correspondence. Memberships with SAP's and QlikTech's academic alliances are documented in legal binding contracts.

Finally, publications on how to teach BI, for example by using real-life puzzles, were a result of writing conference papers and journal articles. Most of these publications can be found online.

### **3.2 Data analysis**

Once data were collected as described above, they were treated from the perspective of process research (Pettigrew 1990). Process research (as opposed to variance research) is less concerned about causal variables and more about identifying the processes of a phenomenon. In my case, this meant searching for successful patterns. Patterns can be traced back to Christopher Alexander: *Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over* (Alexander et al. 1977) (p. x). Furthermore, Alexander et al write: "...when you build a thing you cannot merely build that thing in isolation, but must also repair the world around it, an within it, so that the larger world at that one place becomes more coherent, and more whole; and the thing which you make takes its place in the web of nature, as you make it." (p. xiii).

Summing up, a pattern is "a solution to a problem in a context". Although the original "Pattern" is mainly about communities and towns, it is also widely used in Information Systems, for example Software Engineering patterns by Craig Larman (Larman 2005). He explains, "...a good pattern is a named and well-known problem/solution pair that can be applied in new contexts..." (p. 279). Larman suggested a quadrinomial structure of pattern description: pattern name → problem → solution → context. The name of a pattern name should be based on existing concepts, research, or ideas. Finally, a pattern should be reusable, as quoted from The Gang of Four (Gamma, Helm, Johnson & Vlissides, cited in Larman, 2005, p. 280), "*One person's pattern is another person's primitive building block*".

Throughout careful analysis of the data, I identified four patterns. They were identified in two steps. 1) using the "knowledge infrastructure in action" framework, I analysed each main event (table 2 below) through the enabling/constraints and change/reproduce dynamics. 2) This produced a number of candidate patterns. These were then assessed, and the most successful ones were selected and described in more detail. Finally, the applicable context for the pattern to work appropriately was evaluated by drawing on previous research.

## **4. THE CASE OF ESTABLISHING BI AS AN ACADEMIC DISCIPLINE AT A UNIVERSITY COLLEGE**

The private university college specialises in IT and currently hosts about 600 students at both Bachelor and Master levels. One of the Bachelor programmes is called "E-business" where BI is taught during the fifth semester, from August to December. The learning outcomes of the BI course consist of both theory on decision making and hands-on experience with state-of-the-art technology such as SAP and QlikView. The Master's course has very similar content but is taught in block-mode over two weeks. (Describing BI an industrial discipline and its history is beyond the scope of this study, but a comprehensive description can be found in Power (2007). Also, MISQ had a special issue on BI in 2012.)

The development of the BI course started in 2008, and table 2 below illustrates the timeline of the main events. In the following, I describe how this infrastructure grew from only a course description in the “knowledge in structure” into a complex knowledge base consisting of several actors (lecturers, students, lab assistants, university alliances, and industry partners) and technology components (“How-to’s”, SAP Business Warehouse, Excel, and QlikView). I also explain how this knowledge base enabled and constrained new forms of teaching and learning, which again contributed to an increased knowledge base.

<i>Year</i>	<i>Main events</i>	<i>Description</i>
2008	First course, using SAP, member of SAP	The first course was conducted during the fall semester, using SAP technology as part of the curriculum. Member of SAP University Alliances
2009	More SAP, company visit	SAP was given a larger part of the course, and the students enjoyed a company visit from a large Norwegian retailer
2010	Updated curriculum, first publication	The book by Turban et al was updated (from 2007 to 2011). First conference article was published
2011	Additional publications, first Master’s course	2 more conference articles on BI were published, and a Master’s course was conducted
2012	More publications, member of QlikTech	Two more conference papers and one journal article were published. The school became a member of QlikView Academic Program
2013	Sponsoring “Gurus Of Business Intelligence”	The school sponsored and attended the conference “Gurus of Business Intelligence” (GOBI) in Oslo as the only academic representative

*Table 2: Summing up the main events of Business Intelligence*

### **2008: First course, using SAP; Member of SAP**

Business Intelligence had been run the year before which meant that I, the new lecturer, had access to the curriculum and previous lecturer presentations from 2007 at the school’s Intranet. Before starting, the faculty decided that the course should include SAP technology. Thus, the knowledge base “knowledge in structure” consisted of one book and the tools from SAP, which an external lecturer from Haaga-Helia in Finland briefly introduced. Thirty Bachelor students signed up this year. The “knowledge in action” consisted of teaching in the classroom, observing the students while doing the exercises, and working with the technology. At the end of the semester, the students gave their feedback through an anonymous survey. The results of the survey were, to some surprise, quite positive. On the scale from 1 to 6, the course landed on a total sum of 4,6. Typical comments on the positive side were: *Relevant assignments; Good book, I have learned a lot; Thumbs up ☺* while the less satisfied students would comment: *Would like more SAP exercises; The teacher lacks experience with the technology.*

As a result, this action reproduced the focus on SAP technology, and it changed the “knowledge in structure”, with the result that the “How-to’s” became part of the curriculum.

### **2009: More SAP; Company visit**

By the start of the second year, the knowledge base “knowledge in structure” had grown. In the previous year 27 of the 30 students had received a passing grade. The “How-to’s” of the technology became a substantial part of the knowledge base. Based on the feedback from the students, SAP was given more attention, and the teacher also practised more with the technology. A SAP consultant from Bouvet was hired for one day, working through and evaluating the exercises which the external lecturer from Haaga-Helia had provided. Another new actor in “knowledge in structure” was a company visit from a large and well known retailer in Norway.

In the “knowledge in action” that year, the same procedures were copied from the previous year. Theory was taught in the classroom; the students downloaded the technology on their laptops and went through the SAP exercises. It is hard to assess whether spending one day with the SAP consultant was worth the money. What *did* engage the students, however, was being told that the consultant could charge NOK 1600,- for one hour. Although they understood that this money did not go straight in the SAP consultant’s pocket, this fact seemed to motivate them.

The one-hour presentation from the visiting company gave the students the opportunity to verify that the curriculum they were learning in class also was in demand by the industry.

The results of the student survey were similar to the first year. The majority found SAP cumbersome to work with but still wanted more time spent on the software. *“I am satisfied with everything! It has been a pleasure to follow this course and I think it is quite relevant for working life. Not enough SAP and a lot of theory, but still fun ☺”*. Contradictory, there were less satisfied students, typically complaining about lack of relevance to working life and too much theory: *“There should be more exercises related to practice. I am left with a feeling of not quite knowing where to relate my competence to the working life”*.

Having spent so much time and money on SAP, this both enabled but also restrained the action. SAP was now a firm part of the knowledge base. It was more articulated on the curriculum and learning outcomes than in the first year. Also, the “How-to’s” were expanded in content with more functions.

### **2010: Updated curriculum; first publication**

For two years, the book by Turban et al (2007) had been used as the main theoretical curriculum. This was the eighth edition. In 2010, the ninth edition was launched and replaced the old version as curriculum. Having used the previous edition also enabled and constrained this replacement. Both editions are about 900 pages long, and it had taken the lecturer two whole months to work through the eighth edition. This effort enabled the examination of the new edition but also constrained the action of finding an entire new book. The first conference publication on BI was presented at NOKOBIT, Gjøvik (Presthus and Bygstad 2010). This paper received encouraging comments from the audience.

Typical feedback from the students this year was that they mastered the theory and liked working with SAP technology, but they requested more training: *“Very very exciting subject”, “I would have liked to learn more about SAP BW”*.

### **2011: Additional publications; Master’s course**

In 2011, there were two main events. First, a second publication about BI was published and presented at UKAIS, held in Oxford, UK (Presthus and Bygstad 2011). Second, I became responsible for teaching the Master’s course called “Data management and Business Intelligence”.

When studying the feedback from the students, the majority of the responses were positive: *“If I could choose, then I would like to have one more semester with Business Intelligence”*.

### **2012: More publications, Member of QlikView**

Publications on BI continued, both in journals and at conferences. One paper was awarded “Best teaching paper” at the third BI Congress in Orlando, Florida in December (Presthus and Bygstad 2012b).

The school also engaged with one more industry partner, QlikTech. In 2012, QlikTech started an Academic Program, free of charge, as opposed to SAP which charges an annual fee. By signing up as a member, the school received free licences for their application as well as two instructors working at the school for an entire day. This was of course a huge enabler for the students’ learning outcome. Engaging with one more industry partner may protect against lock-in, meaning that once substantial resources have been invested in the technology, the “switching cost” becomes so high that one continues make investments (Shapiro and Varian 1999) rather than to scrap the technology (Hanseth and Lyytinen 2010).

The students’ overall feedback was positive, but their comments were divergent: *“I am very pleased with the **theoretical** part”* versus *“I am very pleased with the **practical** part”*. A trend seemed to emerge; they were less eager about SAP: *“I am less satisfied with the SAP application; I think it is a cumbersome application, and difficult to learn with limited time”*.

### **2013: Sponsoring Gurus of Business Intelligence (GOBI)**

GOBI was initiated by the Norwegian consultant company NextBridge, located in Oslo. The goal was to initiate a large seminar with all main BI actors worldwide. Well-known BI experts, such as Cindy Howson and Wayne Eckerson, accepted the invitation and flew in from the US. Sponsors were large companies such as SAP, Microsoft, IBM, as well as this university college. All speakers had to be approved by a committee. I presented a journal article at the Research and Development-track.

After six years, the “knowledge infrastructure in action” can be illustrated as in figure 2 below.

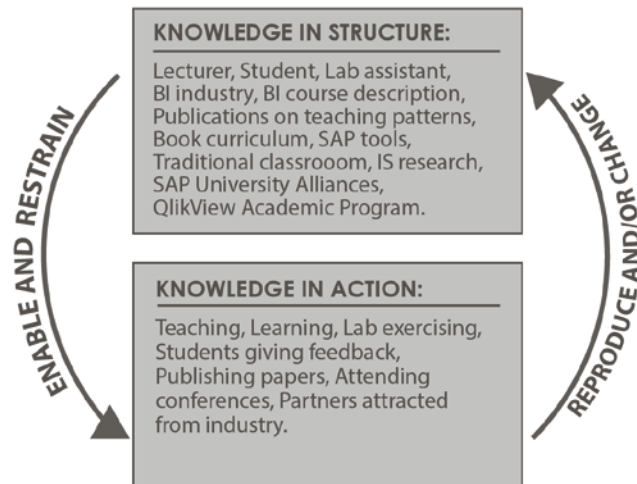


Figure 2: The knowledge infrastructure in action in 2013

Figure 2 shows how the “knowledge in structure” has grown from its small start in 2008. Going from only BI curriculum and SAP technology the initial year, the knowledge base now constitutes permanent actors such as lecturer, students, assistants, industry partners, academic alliances, and research. At the same time, the knowledge in action has also expanded. More details of the evolution are found in appendix 1.

## 5. DISCUSSION

This section discusses the two research questions from the introduction.

### 5.1 What are the dynamics of the knowledge infrastructure in business systems studies?

My point of departure is that it is useful to conceptualise a business system course as a dynamic knowledge infrastructure instead of a set of theories and isolated variables. Furthermore, this study illustrates the richness of resources for developing business systems studies in addition to the traditional books and constructed tasks. Drawing on Giddens, Hanseth, Volkoff, and Lessard, I propose a theoretical reframing of business systems studies: a dynamic “knowledge infrastructure in action”. It also draws on elements from the case study, such as course description, the students (current and previous), academic alliances, and more, as shown in figure 2.

The top object “knowledge in structure” corresponds to what Giddens calls the *structural dimension*. In my study, the *structural dimension* refers to the *knowledge base* (Hanseth 2004). This object will enable and restrain the lower box “knowledge in action”. Readers familiar with Volkoff et al’s (2007) work will recognise this object as the *performative dimension*, where knowledge transformation happens, which again will reproduce and/or change the top object. This cycle is repeated at least once every semester. What we need to know more about, is the following:

- a) How is the “knowledge in action” enabled and constrained?
- b) How is the “knowledge in structure” reproduced and/or changed?

The dynamic model starts with a few resources in the structural object. This installed base (Hanseth and Lyytinen 2010) is never completely blank (Ramilier and Pentland 2009). The initial resources will influence the performance (i.e. action).

#### How the “knowledge in action” is enabled and constrained:

The fact that SAP was a well-known technology by the students, as well as being a part of the curriculum, *enabled* the action of lecturing and conducting the exercises. Also, an external lecturer provided the first “How-to’s”, which the students used and commented on. Working through the exercises and the “How-to’s” thus improved the SAP knowledge for the school. However, once the technology has gained a

foothold, it also *restrains* the action. The students had to relate to SAP terminology and methods, which are not necessarily representative for other data warehouse vendors. Another *restraint* was that this iterative way of teaching building on gained knowledge required that each student had performed previous exercises. For the school, it became more difficult to exchange the technology as many resources were invested in the SAP technology. Also, access to SAP technology requires membership with the SAP University Alliance, along with an annual contract and fee. Over time, this situation may lead to a lock-in (Hanseth and Lyytinen 2010). Another dynamic is found between the “How-to’s” and the role of the technical assistant; these two depend on each other. Having only the step-by-step documents on how to use the application is not sufficient because the students will go through it rather mechanically, not understanding what they just did, or why they did it, as one student commented in the survey:

*“The How-to’s are well constructed, they describe well what we are going to do, but I would like more text on what is actually happening. Now it is like that we are following the How-to’s and think: ‘yes, now I have done it, but what did I actually do???’ and this does not make us any wiser”.*

This also implies that business systems courses would be difficult to teach as pure online-courses without a classroom presence. Likewise, having a technical assistant without “How-to’s” has also proven to be chaotic because some students will learn faster than others. Also, the “How-to’s” allowed students to repeat the exercises several times at their own convenience.

#### **How the “knowledge in structure” is reproduced and/or changed:**

During the semester, the students learned as they went through the exercises, and their positive feedback led to the teaching materials and practises being *reproduced*. Although the students experienced frustrations with the technology, they wanted more SAP on the curriculum, and they did not give up on their assignments. In addition to being *reproduced*, this feedback and observation of the students in action and their performance in class led to *improvement* of the teaching materials and technology. Another action (the student’s feedback) requested SAP as a larger part of the course. This also *expanded* the “knowledge in structure” to include more SAP for the successive class of 2009.

The model in figure 2 can be used to analyse whether something works or not when developing new business studies. As an example we can take a guest lecturer from a consultant company. This consultant was brought in as part of the “knowledge in action” and enabled new insights for the students, such as some real-life examples. The problem was that very little is added to the “knowledge in structure”, because the consultant takes her knowledge back with her. Fortunately, the majority of the evidence collected in this study is mainly positive. The next section discusses successful patterns.

## **5.2 How should universities develop these studies in order to become a stable part of an academic knowledge base?**

If you want to build a knowledge infrastructure at your school (or at your workplace), how can you exploit these dynamics? To frame this investigation, I draw on the concepts of patterns. From section 3.2 we recall that a pattern was defined as “a solution of a problem in a context” based on Larman (2005). Having analysed the evolution of the case of Business Intelligence by using my model from figure 2, four patterns were identified (table 4). These patterns address key problems in establishing the knowledge infrastructure of BI. They are briefly summarised in table 4. Each pattern follow Larman’s principles for a good pattern: an instructive name, the problem and solution, as well as contexts (prerequisites and comments for using the patterns in other situations and/or by other people).

<i>Pattern</i>	<i>Problem</i>	<i>Solution</i>	<i>Context (use pattern when...)</i>
Boot-strapping	Starting the new course, attracting students	Motivate students with state-of-the-art technology	... a course contains hands-on technology
Scaffolding learning	Managing student expectations, difficult technology	Create “How-to’s”, learning through achievement	... a technical assistant can be present in the classroom/lab
Industry partner	Implementing new technology	Choose technology with academic alliances	... you want to use the latest technology, and need support
Real-life puzzles	Teaching new concepts and theory	Use existing BI curriculum and research	... discipline contains abstract concepts

*Table 4: Overview of identified patterns*

**Pattern: Bootstrapping**

**Problem:** How to start a new course, and ensure that it will attract enough students?

**Solution:** The key attractor (Hanseth and Lyytinen 2010) is the obvious business relevance of the course and the hands-on profile. Expose the students to hands-on experience with the technology as quickly as possible, while gradually introducing small and tangible parts of the curriculum. Less is more when it comes to technology; it is better to master a few functions well rather than trying to teach the whole BI suite. As shown in the case, making thorough “How-to’s”, which also mapped theory against practise, was demanded by the students.

**Context:** Use this pattern when the course is business-oriented with a focus on practical use of technology. Theory should support practice and not the other way around.

**Pattern: Scaffolding learning**

**Problem:** The students had unrealistic expectations about what they should learn about SAP. They wanted to become “SAP experts” and learn the entire Business Warehouse application, only to meet frustration when they started to use the technology. SAP Business Warehouse does not have an intuitive interface and forces the students to model and have a plan before they start. The students who failed to acknowledge this soon became stuck and completely lost in the application.

**Solution:** Simple parts of the curriculum should be presented to the students, and they should manage these parts before releasing the next section. This technique is called *scaffolding* which has been shown to work well in similar courses (Bygstad et al 2009). In my study, scaffolding was accomplished by approximately ten “How-to’s” with a technical assistant who would assure that each student could manage the exercises. There must be no loopholes or short-cuts in the making of the “How-to’s”. The students will not understand if there are missing links. The lecturer (or technical assistant in charge) should also be the one making the “How-to’s” him/herself. Using other people’s material, or even the one from SAP or QlikView, has proven to work poorly. Material from others can constitute a useful fundament but must be personalised by the technical assistant.

**Context:** In order for this pattern to work in similar context, each “How-to” must build logically on one another, and the technical assistant must be present.

**Pattern: Industry partner**

**Problem:** Business systems technology is often complex and difficult to manage; it is difficult to install and difficult to solve the various error situations which may occur. Common problems that students have when downloading and installing are that all types of operating systems may not be compatible with the application, there are new versions of the software, and the students will need licenses, user-IDs, and passwords. Having such problems during lecturing will quickly discourage the students. Most lecturers in business schools do not have the knowledge and skills to deal with these complexities.

**Solution:** Engage with an industry academic program. Almost all of the leading vendors of BI technology now offer an academic alliance (SAP, Microsoft, SAS Institute, QlikTech – the list is not complete). The academic programs will differ in terms. Some are free, and some require an annual fee for the licenses of their technology. Some will even provide an instructor who visits the school for a few hours, helping the students to get started. If engaging with an academic program sounds too restraining, it is possible to make an agreement with a consultancy house, which uses technology from several vendors.

**Context:** Use this pattern to ensure that you are using the latest technology as well as for stability and support. Will this lead to a lock-in situation? While the knowledge base benefits directly from having an industry partner, it may also constrain other technology choices. You may solve this problem by having multiple industry partners.

**Pattern: Real-life puzzles**

**Problem:** There are many new concepts for the students to master, and in BI there are many abbreviations, techniques, and theories. Examples include KMS, DSS, the ETL-process, data mining (Turban et al. 2011), sense & respond (Overby et al. 2006), and decision making (Davenport 2010). Modern BI is regarded as a process, technology and product, and it is difficult for new students to understand and differentiate between all this.

**Solution:** Use game-based learning (Moursund 2007) and real-life puzzles (Highley and Marianno 2001). In order to make the students curious and motivated, the real-life puzzle must contain a known problem as well as a known solution (Presthus and Bygstad 2012a)

**Context:** This pattern can be used when introducing a course with many concepts and abbreviations to new students.

### **5.3 Limitations to this research and suggestions for further research**

As with any case study, there are limitations. This paper has only studied one discipline at one school. The data studied in this case span multiple formats (documents, surveys, e-mails, and contracts), but the study could benefit from additional interviews with previous students who now have Business Intelligence jobs. Other knowledge infrastructures of data warehousing and BI, such as Teradata University Network (<http://www.teradatauniversitynetwork.com/tun/>), would constitute an interesting case for exploring the theoretical framework “knowledge infrastructure in action”. Such a study would probably reveal other patterns in addition to the four identified in this study.

## **6. CONCLUSION**

This paper proposes to conceptualise business systems studies as a growing knowledge infrastructure. It has investigated the following research questions:

- 1) What are the dynamics of the knowledge infrastructure in business systems studies?
- 2) Which successful patterns can be identified to help universities develop these studies to be a stable part of an academic knowledge base?

This study offers one theoretical and one practical contribution. The answer to the first question is the suggestion of an alternative, theoretical reframing of business systems studies. They should be regarded as a dynamic knowledge infrastructure which is continuously enabled, restrained, changed and/or reproduced. The proposed “knowledge infrastructure in action” model highlights the dynamics of the interplay between the structural level and the actionable level. The BI case illustrates the accumulative growth of the knowledge infrastructure over six years, going from only a course description at the beginning of the first year to a full knowledge base of actors, partners and technology. On the practical side, four patterns for educational and industrial purposes are suggested. The Bootstrapping pattern explains how to start a new business systems course. The Scaffolding pattern helps students to learn challenging technology. The Industry partner pattern helps to establish and maintain a sound technology base. Finally, the Real-life puzzle pattern teaches the students to learn new concepts and theories in a fun and motivating way. Further research should explore the opportunities offered by the theoretical perspective described in this paper in other contexts, such as studies within ERP and CRM. Further research should also aim at identifying additional patterns within this field.

## **ACKNOWLEDGEMENTS**

Gratitude goes to the anonymous reviewers at NOKOBIT 2013 and my colleagues at NITH: Bendik Bygstad, Stig Magnus Halvorsen, Kjetil Raaen, and Fiona Jansson whose feedback improved this study.

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## APPENDIX 1

### Evolution of Business Intelligence at Bachelor level.

My role was lecturer all years.

“No of students” refer to the amount which actually received a grade at the end of the course.

<i>Year</i> →	<i>2008</i>	<i>2009</i>	<i>2010</i>	<i>2011</i>	<i>2012</i>
No of students	27	23	28	33	18
Curriculum (Book)	Turban et al, 2007	Turban et al, 2007	Turban et al, 2011	Turban et al, 2011	Turban et al, 2011
Tools	SAP	Excel, SAP	Excel, SAP, QlikView	Excel, SAP, QlikView	Excel, SAP, QlikView
Academic program	SAP	SAP	SAP	SAP, QlikTech	SAP, QlikTech
Technical assistant	None	None	Assistant A, Assistant B	Assistant B	Assistant B
Company visit	None	Elkjøp (electronic retailer)	Inmeta (consulting), Affecto (consulting)	IBM (vendor of BI solutions)	Tine (dairy producer), CapGemini (consulting)
External lecturer	Haga-Helia, Finland	None	None	None	None
Assessment/ Assignment	3 essays (all aid), 1 oral presentation	3 essays (all aid), 1 oral presentation	2 essays (all aid), 1 multiple choice (no aid), 1 oral presentation	2 essays (all aid), 1 multiple choice (no aid), 1 oral presentation	2 essays (all aid), 1 multiple choice/short answer (no aid)
Research and publication			NOKOBIT	UKAIS, NOKOBIT	JITE, IJBIR, IRIS, BI congress, NOKOBIT

### Evolution of Business Intelligence at Master level.

My role was technical assistant in 2009 and 2010. In 2011 and 2012, I taught in Brunel’s regime. Finally, in 2013 I was fully in charge because my university college was accredited with its own Master’s programme from the Norwegian government.

<i>Year</i> →	<i>2009</i>	<i>2010</i>	<i>2011</i>	<i>2012</i>	<i>2013</i>
No of students	Not available	Not available	15	8	5
Tools	Excel, SAP	Excel, SAP	Excel, SAP	Excel, SAP	SAP, QlikView
Technical assistant	None	Assistant A	Assistant B, Assistant C	Assistant B	Assistant B
Company visit	None	CapGemini (consulting)	Affecto (consulting)	Evry (consulting)	Evry (consulting)
Guest lecturer	None	None	None	None	None
Assessment/ Assignment	1 essay (all aid)	1 essay (all aid)	1 multiple choice (no aid) 1 exam (no aid)	1 multiple choice (no aid) 1 exam (no aid)	1 multiple choice (no aid) 1 essay (all aid)

## APPENDIX 2

Below is an example of a typical “How-to”. Each artefact builds on existing documents available through SAP, but they are nonetheless developed by the technical assistant and published one-by-one for the students. “Developed by the technical assistant” means that all steps are actually conducted by the assistant, while at the same time using the personalised print screens.


### SAP NetWeaver 7.10 - Module 5


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## DataStore Object & InfoCube Data modeling

### 1. Create DataStore Object

To create a DataStore Object (DSO) we need to go to the InfoProvider view.

1. Select  InfoProvider on the Navigation Window to open the InfoProvider view.
2. Select the InfoArea you created in chapter 1: “WX00\_FRUITCO”.  
*Replace the double zeroes (00) with your user number.*

You may need to refresh the view window by clicking the  refresh button in the View Menu to update and view the latest changes.

3. Right click your InfoArea “WX00\_FRUITCO”.  
*Replace the double zeroes (00) with your user number.*
4. Select “Create DataStore Object”.
5. Type in the values as shown in Figure 1.  
*Replace the double zeroes (00) with your user number.*

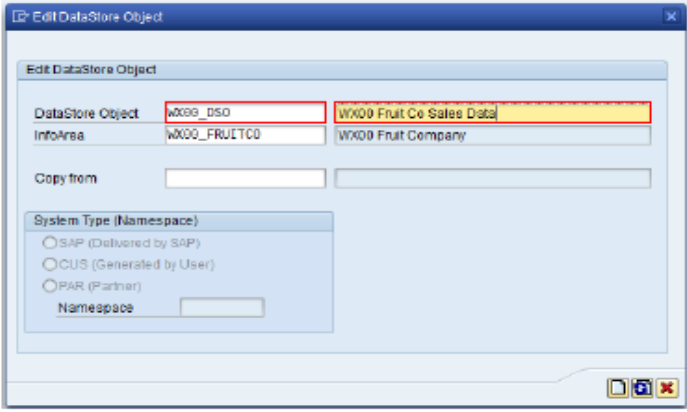





Figure 1 - Create DataStore Object window

6. Click the  create button to create the DataStore Object.

Click the  Show/Hide Tree Display button on the top sub menu to hide the tree display on the left if you have screen space issues.

#### Add Characteristics

7. Click the  InfoObject Catalog button in the top of the DSO view to open the select window as shown in Figure 2.

A valuable “best practise” from SAP was making each step numerical. This simple but powerful procedure proved extremely useful for the students as well as the lecturer when going through the exercises. Typically, a student would raise his/her hand and say “I am stuck at number 16”, and if others had the same problem, they could either help each other or maybe even receive help from other students who had mastered it.

The first sets of “How-to’s” started out in Norwegian, but it soon proved useful to write them in English because it was easier to communicate with the SAP University Alliance when problems were encountered. The students did not express any disapproval with documents in English.

# BREAKFAST AT TIFFANY'S: THE STUDY OF A SUCCESSFUL BUSINESS INTELLIGENCE SOLUTION AS AN INFORMATION INFRASTRUCTURE

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Wanda Presthus, 2014, "BREAKFAST AT TIFFANY'S: THE STUDY OF A SUCCESSFUL BUSINESS INTELLIGENCE SOLUTION AS AN INFORMATION INFRASTRUCTURE", Proceedings of the European Conference on Information Systems (ECIS) 2014, Tel Aviv, Israel, June 9-11, 2014, ISBN 978-0-9915567-0-0  
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# **BREAKFAST AT TIFFANY'S: THE STUDY OF A SUCCESSFUL BUSINESS INTELLIGENCE SOLUTION AS AN INFORMATION INFRASTRUCTURE**

*Complete Research*

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## **Abstract**

*Business Intelligence (BI) solutions are complex and abstract. "You can build the solution, but users will not come," Cindi Howson writes in her famous BI book, indicating that even if it is successfully implemented, a BI solution may not be used to its full intention. Guided by the research question, "How do we bootstrap and adapt a BI solution?" this study investigates a successful BI solution at a large Norwegian company. Based on a case study, this paper argues that it is fruitful to regard a successful BI solution as the growth of an Information Infrastructure rather than the implementation of a certain technology alone. Drawing on the definition by Hanseth and Lyytinen, an Information Infrastructure is a shared, open, heterogeneous, and evolving socio-technical system (which they call an installed base) consisting of users, a set of IT capabilities, operations, and design communities. This paper attempts to describe how the case company is sustaining their successful BI solution and what we can learn. As a practical contribution, it offers three guidelines for BI practitioners. This study should be of interest to both users and managers of Business Intelligence solutions in the industry.*

*Key words: Business Intelligence, Information Infrastructure, QlikView, Case study*

## **1. Introduction**

In the current business world the competitor is only a click away; the customers frequently change their preferences; new products enter the market, as described in Michael Porter's model *Five Forces* (Porter 2001). To stay competitive, it is important for businesses to *sense and respond* (Overby et al. 2006) both quickly and accurately. While technology empowers the customer to browse the Internet for the cheapest goods and services, technology also enables the company to collect huge amounts of data from sales transactions and Internet user behaviour. Such data can be turned into information and provide decision support (Davenport 2006; Davenport 2010). The process and tools for this data exploration go under the umbrella term "Business Intelligence" (Turban et al. 2014).

The problem is that Business Intelligence (BI) systems are not always used as intended. In line with other information systems, BI systems have traditionally been complex, consisting of various types of source data, data warehouse components, and BI products like reports and graphs. "*You can build it, and users won't come*" (Howson 2014) (p. 261). Even more simply put: "*If the users do not like the technology, they will just not use it*" (Hanseth 2001) (p. 87). Research has been conducted on both successful and unsuccessful BI projects. Examples include the types of data warehouse architectures that are most successful (Ariyachandra and Watson 2006) and on Critical Success Factors for BI projects (Presthus et al. 2012). While the conclusions are valuable, a common denominator is that these studies tend to focus on isolated variables and usually from a technical perspective. Examples include type of architecture and programming language. Another study found that most research of BI focused

more on turning data into information, and less on how to make decisions and act on the information (Shollo and Kautz 2010). Making decisions and acting involves people to a higher degree than turning data into information. However, information is wasted if people do not use it (Davenport et al. 2001).

I will illustrate that by framing BI as an Information Infrastructure, we can gain a better understanding on how to get people to both bootstrap (start to use) the BI solution and adapt it (continue to use it in their own manner and while doing so, adding value to the infrastructure). The research question reads: *How do we bootstrap and adapt a Business Intelligence solution?*

The rest of this paper is structured as follows. First I present BI and Hanseth's Information Infrastructure Theory (Hanseth and Lyytinen 2010) and the concepts of bootstrapping and adaptation. Then the case company is described, followed by an analysis and discussion of the case company's BI solution as an Information Infrastructure and what we can learn from their success. I briefly point to limitations of the study in this section. Finally, a set of three practical guidelines is offered for successful employment and evolution of Business Intelligence.

## 2. Theoretical background

This section briefly presents the industry discipline of Business Intelligence and the theory of Information Infrastructure. These two fields play an important role in the case company.

### 2.1 Business Intelligence

The term *Business Intelligence* appeared for the first time in 1958 in an IBM article *A Business Intelligence System* by Hans Peter Luhn. He discussed the possibilities and benefits of automatic textual analysis of a company's many written documents such as letters and manuals (this was before e-mail). Perhaps Luhn was ahead of his time. Nonetheless, Business Intelligence as a term lay dormant until the end of the 1980s when Gartner Group revived the term and made it popular. BI tools had been used in organisations since the 1960s, but under the name Decision Support Systems or Executive Information Systems (Power 2007). As the names indicate, these systems were intended for management, and the systems were stand-alone databases with restricted access. It could take days, or even weeks, for the decision maker to get a report. Significant progress was made in the 1980s and 1990s as the data warehouse technology matured. A data warehouse will allow for multidimensional analysis by means of Online Analytical Process (OLAP) cubes. OLAP is one example of end-user BI tools like reporting, data mining and dashboards, as illustrated on the right hand side in figure 1.

According to Garner Group the largest vendors of BI technology include SAP, IBM, Microsoft, and SAS Institute (Schlegel et al. 2013). Of these four, SAP is German, and the rest are all from the US. Their solutions are known to be trustworthy but rigid. In 1993, something interesting happened. In a rather small town in Sweden called Lund, a new company was founded: QlikTech. The two founders, Björn Berg and Staffan Gestrelus, wanted to create user-friendly BI software, which they called QlikView. They wanted the tool to be intuitive; allowing the user to click and then see the results (<http://www.qlikview.com/us/company/history>). Today the company counts more than 29000 customers and over 1500 employees worldwide. QlikView does not use OLAP cubes but relies on "in-memory" processing, making the technology more agile than the traditional solutions from SAP, IBM, Microsoft, and SAS Institute.

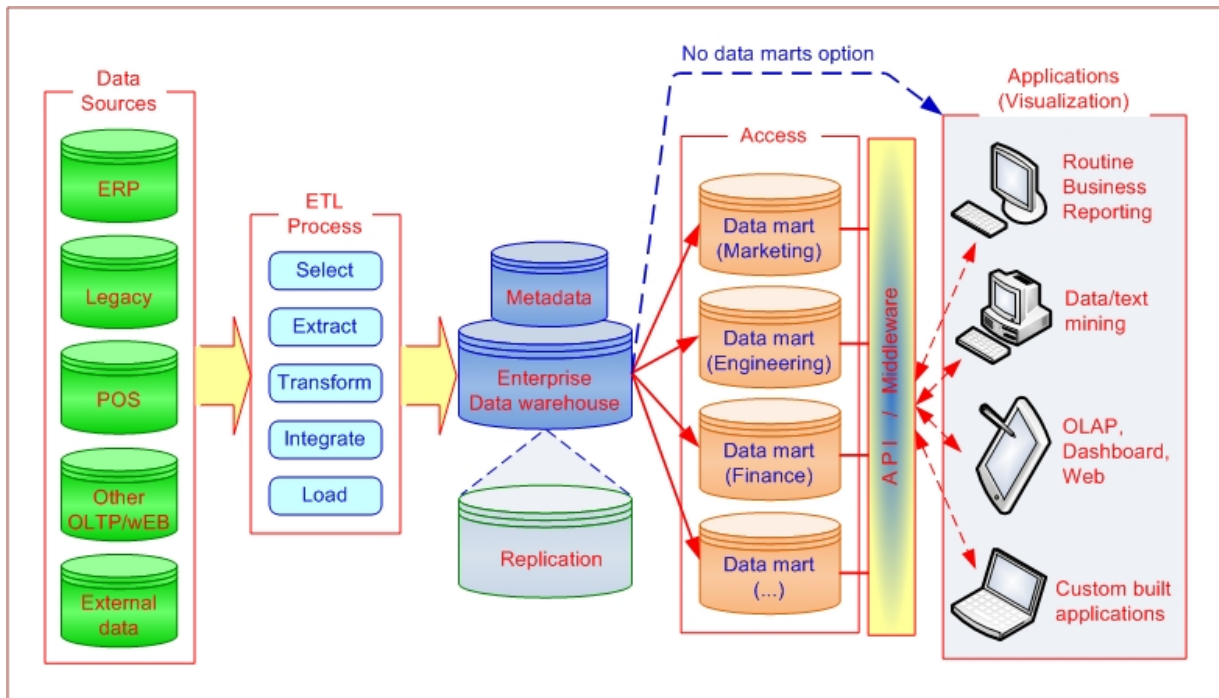


Figure 1: A data warehouse framework and front-end BI applications (Turban et al. 2014), p. 296

The evolution of BI is illustrated in figure 2. It goes from fragmented in-house systems which could only handle highly structured data (BI 1.0) to today’s BI (called 3.0) which includes mobile and sensor-based content (Chen et al. 2012). It now has applications for virtually any industry.

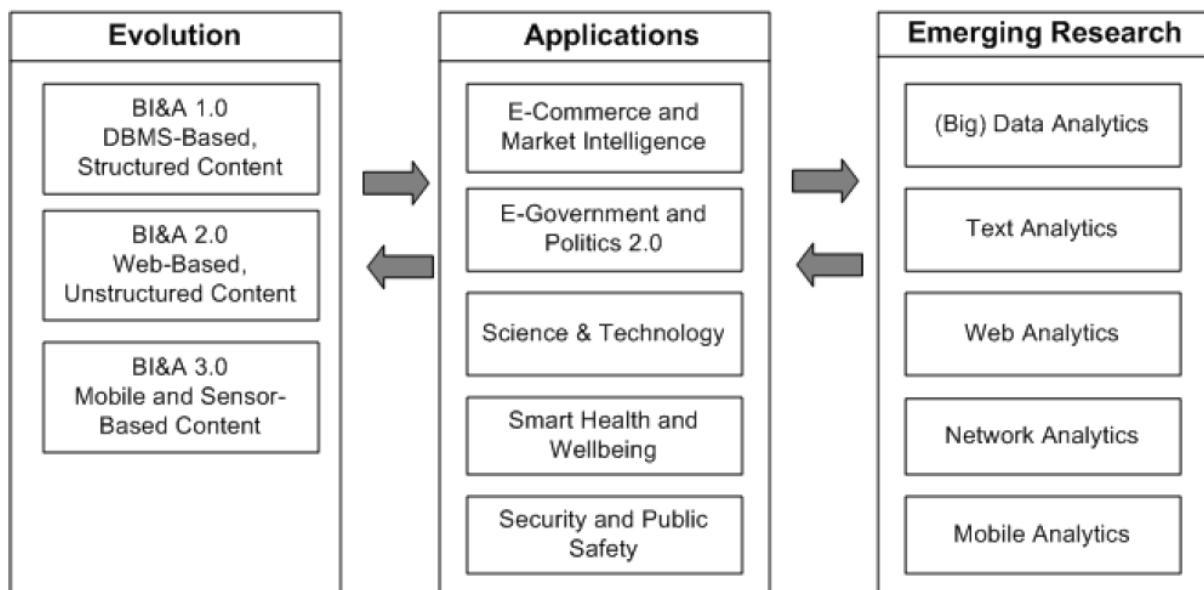


Figure 2: Business Intelligence and Analytics Overview (Chen et al. 2012) p. 1167

Summing up, BI is defined as a process (make decisions based on facts), a technology (for example SAP or QlikView) and architecture (data warehouse or in-memory) with a front-end product (OLAP cube, report, or dashboard). The benefits of the correct use of BI include cost and time savings, more and better information, better decisions, and improved business processes (Turban et al. 2014; Watson and Wixom 2007).

## 2.2 Limitations of the traditional view of BI

From the above section, we note that the focus is mainly on (1) implementing technology and (2) regarding the BI process as stepwise and linear with rational stakeholders.

Readers of traditional BI literature might be tempted to ask “what is BI *not*?” This question has not been frequently addressed. However Cindi Howson includes a few claims in her book, for example having a data warehouse in itself is not BI. Front-end tools are also needed. More interesting for this study is Howson’s belief that BI will fail if the *people* disregard the information and make decisions based on intuition and previous experience. Based on the brief review in section 2.1, one will note that this socio-technical view is missing from most of the BI literature, with some exceptions like Davenport’s book *Information Ecology* (Davenport 1997). Also, in a recent study, Henfridsson and Bygstad found that successful Information Infrastructures need to have self-reinforcing processes (Henfridsson and Bygstad 2013). These perspectives will be highlighted in the next section.

## 2.3 Alternative conceptualisation: BI as Information Infrastructure

An Information Infrastructure is defined as “...a *shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities*” (Hanseth and Lyytinen 2010) p. 4. **Shared, open (unbounded)** means that several actors can access the system and (possibly) make changes. A change made by one actor will influence the work of the other actors, usually in the sense of adding value. Wikipedia is a good example; the value of its infrastructure increases with the number of contributors. **Heterogeneous** represent that the system has various types of technology and user groups, which are constantly evolving. The final characteristic, the **evolving socio-technical system (the installed base)**, indicates that an Information Infrastructure does not have a clear start. It emerges from something: like the Internet builds on telecommunication, and Harvard’s internal student network (Facebook) turned into a global social media platform for individuals and companies. The installed base consists of technology, people, processes, communities and more. I return to the concept of installed base shortly.

Information Infrastructures face two challenges: bootstrapping and adaptation. **Bootstrapping**, as defined by Hanseth and Aanestad, is about getting the technology started by no external means; “*bootstrapping yourself to the top*”, or “*lifting yourself by your own hair*” (Hanseth and Aanestad 2003). Besides defining what bootstrapping means, perhaps the most interesting contribution of Hanseth and Aanestad’s paper is the focus on individual behaviour. They describe how some people might start to use a technology at an early stage, while others want to wait until a large group has started to use it. They also list aspects of technology which may influence a person’s willingness to use it (p. 390):

*Availability*: the users should have close contacts with designers

*Simplicity*: the solutions should only provide essential functions and should be easy to learn

*Costs*: the solutions should be cheap

*Flexibility*: improvement should be possible without changing the whole solution

*Future oriented*: low risk of lock-in

**Adaption** is explained by Hanseth and Lyytinen (2010): *When the bandwagon starts rolling, the designers need to guarantee that the Information Infrastructure will grow adaptively and re-organize constantly with new connections between the components* (p. 13). As a solution they propose a set of design principles for Information Infrastructure. The first three are for the bootstrap problem, and the last two for the adaptation problem (p. 6):

1. *Design initially for usefulness*

2. *Draw upon existing installed base*

3. *Expand installed base by persuasive tactics*

4. *Make each IT capability simple*

5. *Modularize the Information Infrastructure by building separately its principal functions and sub-infrastructures using layering and gateways*



Simply put; the installed base consists of a number of people using a certain technology (Shapiro and Varian 1999). The *installed base* from Hanseth's Information Infrastructure theory builds on Complexity Science, which again has its roots from natural sciences and economics. Key concepts of Complexity Science are the **self-reinforcing installed base** and the **lock-in effect**. The self-reinforcing installed base is a cycle driven by positive feedback, as illustrated in figure 3. The figure illustrates standards but I find that it also illustrates the interplay between users and technology: when people use the technology, more functions will be produced, which will provide value to users, causing additional people to use the technology.

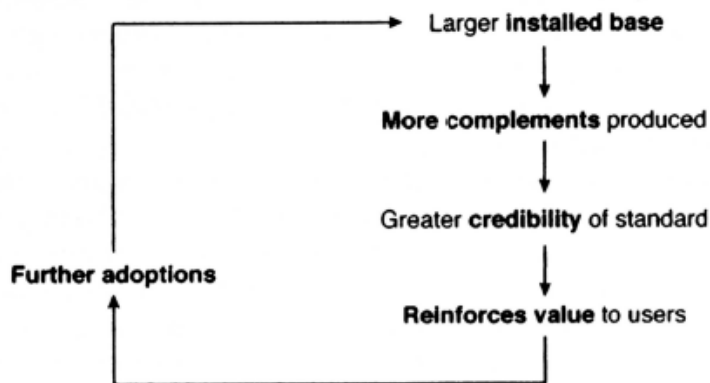


Figure 3: Standards reinforcement mechanism (Grindley, 1995, cited in Ciborra et al. (2000), p. 62)

The reinforcement mechanism illustrated in figure 3 above has a positive outcome. When the installed base of users grows, more and more users will want to use the technology. However, such a reinforcement of a technology may lead to a side-effect called lock-in. According to Shapiro and Varian's book *Information Rules*, lock-in means that it would cost too much effort or money to change the current technology. The classic example of lock-in is the layout of our computer keyboard. The QWERTY style does not result in faster typing; this is inherited from the typewriter and was originally designed to actually slow the typist down to prevent the typebars from tangling. However, when computers took over for the typewriter, the users were already familiar with QWERTY. It made the switch to a PC easier, but also resulted in lock-in. The QWERTY keyboard is hard to get rid of today; it would result in a high *switching cost* (Shapiro and Varian 1999).

A loosely coupled architecture (Hanseth et al. 2012) may prevent lock-in. The Internet is an example of a loosely coupled architecture. In Zittrain's book *The Future of the Internet* he focuses on how the layered architecture can be extensible by allowing new innovations and add-ons by a large community. By this approach, contradictory of a top-down management driven approach, "*Good applications can then be adopted widely while bad ones are ignored*" (Zittrain 2008) (p. 67). We can also call a layered architecture for an *end-to-end architecture* which may entail that "*intelligence is in the fringes*" (Hanseth and Nielsen 2013).

Summing up this review, I will view a BI solution as (1) an installed base, which must (2) be bootstrapped and (3) endure a continuous adaptation.

### 3. Method

The overall approach is a case study (Yin 1994). Following Yin's definition, I chose a case study because I have a "how question"; as a researcher I have little control over the events; and my focus is on contemporary phenomenon within a real-life context.

TINE (spelled with capital letters) was chosen as case company due to its relatively large (by Norwegian standards) BI department of six people, and because TINE benefits from successful

employment of its BI solution. As an example, TINE was a nominee for the BI award by the Norwegian Computer Society (however a Norwegian bank won the first prize) in 2010. See logo in picture 4.



Figure 4: Picture and logo from <http://www.jarlsberg.com/about-tine>

The case company is 132 years old and is the largest producer, distributor, and exporter of dairy products (TINE SA, 2013). As found on their website ([www.jarlsberg.com/about-tine](http://www.jarlsberg.com/about-tine)):

*TINE SA is organised as a cooperative owned by more than 15.000 Norwegian dairy farmers. Each member is a shareholder in the cooperative to which they deliver 1.4 billion litres of cow's milk and about 19 million litres of goat's milk every year. The milk is processed into more than 200 different products which are sold under the TINE trademark. The TINE Group also consists of several wholly owned and partially owned subsidiaries. Outside dairy products the group manufactures products ranging from ice cream, juice to marine products. The dairy cooperative is Norway's largest food manufacturer with a total of 5.485 employees and an annual turnover of NOK 19.7 billion for 2012.*

Building on section 2, an interview guide was created which consisted of eight semi-structured questions. Questions 2 and 3 investigated the successful outcome. Key Information Infrastructure terms such as “installed base” were, however, modified into more descriptive, generic questions (please see appendix). Ten interviews were conducted on TINE’s premises, each lasting about thirty minutes (table 1). An assistant was present to type the answers in real-time. After the interview, this transcript was e-mailed to the participant for approval, additional comments, and quality assurance.

Participant#	Title	Years worked with BI
1	Manager (BI department) (BICC member)	10 in TINE, 15 in total
2	Systems engineer (BI department)	30
3	Systems engineer (BI department)	25
4	Systems engineer (BI department)	25
5	Business controller (end-user)	7
6	Manager of branding (end-user)	9 months
7	Market analyst (end-user)	4
8	Business controller (end-user)	1
9	Team leader, Business Analytics (BICC member)	5 in TINE, 9 in total
10	Manager, Analytics (BICC member)	1 in TINE, 8 in total

Table 1: Overview of participants in chronological order of interviews

In addition to interviews, some of the participants demonstrated QlikView. I was also allowed to study internal documents of TINE’s architecture and business processes including a presentation of their BI solutions from 2005 to this day.

The collected data were analysed by building on the *Ladder of Analytical Abstraction* framework by Carney, 1990, cited in (Miles and Huberman 1994) p. 92. The *Ladder of Analytical Abstraction* has three levels. In the first level, I summarized my data (accumulated transcripts, print screens and documents). Level two consisted of arranging the interviews into a matrix, which constitutes a sound base for aggregating data (searching for themes and trends). In the third and final level, I synthesised the findings into explanations and lessons learned from studying TINE’s BI solution as an Information Infrastructure. Table 2 summarises this method section.

Step	Action	Outcome
1	Conduct literature review of BI and Information Infrastructure	Basics for semi-structured questions (appendix)
2	Collect data	Documentation from TINE (processes, architecture) Interviews and observation at TINE's premises
3	Analyse data	Quotes, illustrations of TINE's processes and BI architecture
4	Discuss findings	Section 4 (How TINE's BI successful solution can be understood as an Information Infrastructure)
5	Conclude	Section 5 (Lessons from TINE: three guidelines)

Table 2: Summary of method

## 4. Findings and discussion

Guided by the research question: *How do we bootstrap and adapt a BI solution?* this section describes the findings from the documentation and interviews. It also discusses how the findings relate to existing literature within Information Infrastructure and Business Intelligence.

### 4.1 TINE's BI architecture

The documentation from TINE includes a model of their current BI architecture. Figure 5 visualises TINE's data sources (ERP system, external and internal data), their data warehouse (grey box in the middle with dimensions and fact tables) and the front-end tools (QlikView, Cognos, and Excel).

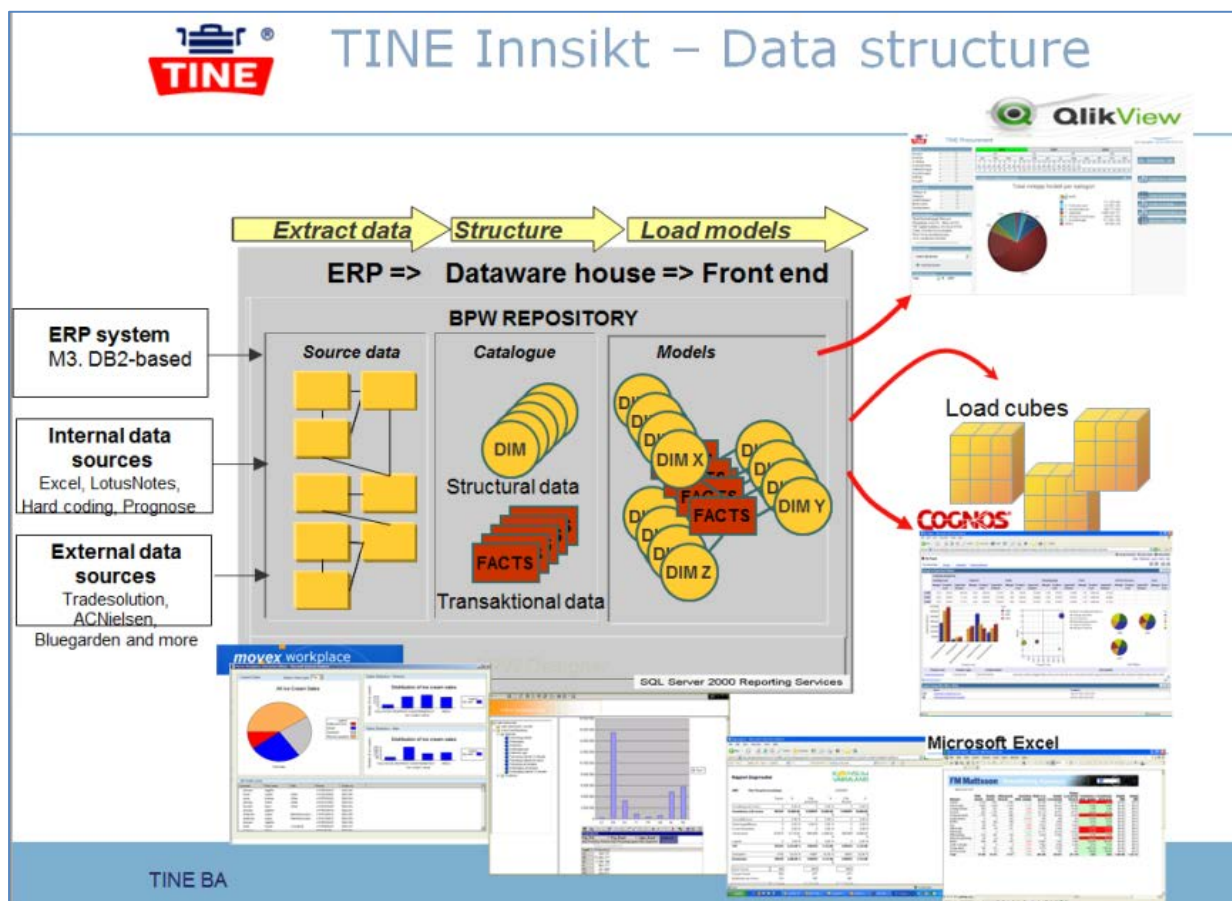


Figure 5: TINE's Business Intelligence architecture

This loosely coupled architecture allows for flexible replacement of the components, especially the front-end tools. TINE previously used Cognos as front-end tool but is in the process of replacing it with QlikView. The documentation provided by TINE reveals that before their current BI solution, the

technologies were slow and delivered uneven data quality. The previous technologies also required extensive skills and competence with a high entry level for the end-users. Figure 6 illustrates a dashboard made in QlikView. A participant demonstrated how the sales numbers for a popular product (called *Go' Morgen Joghurt* – translates to “Good Morning Yoghurt”) are visualised with a graph, along with four Key Performance Indicators visualised with four gauges.

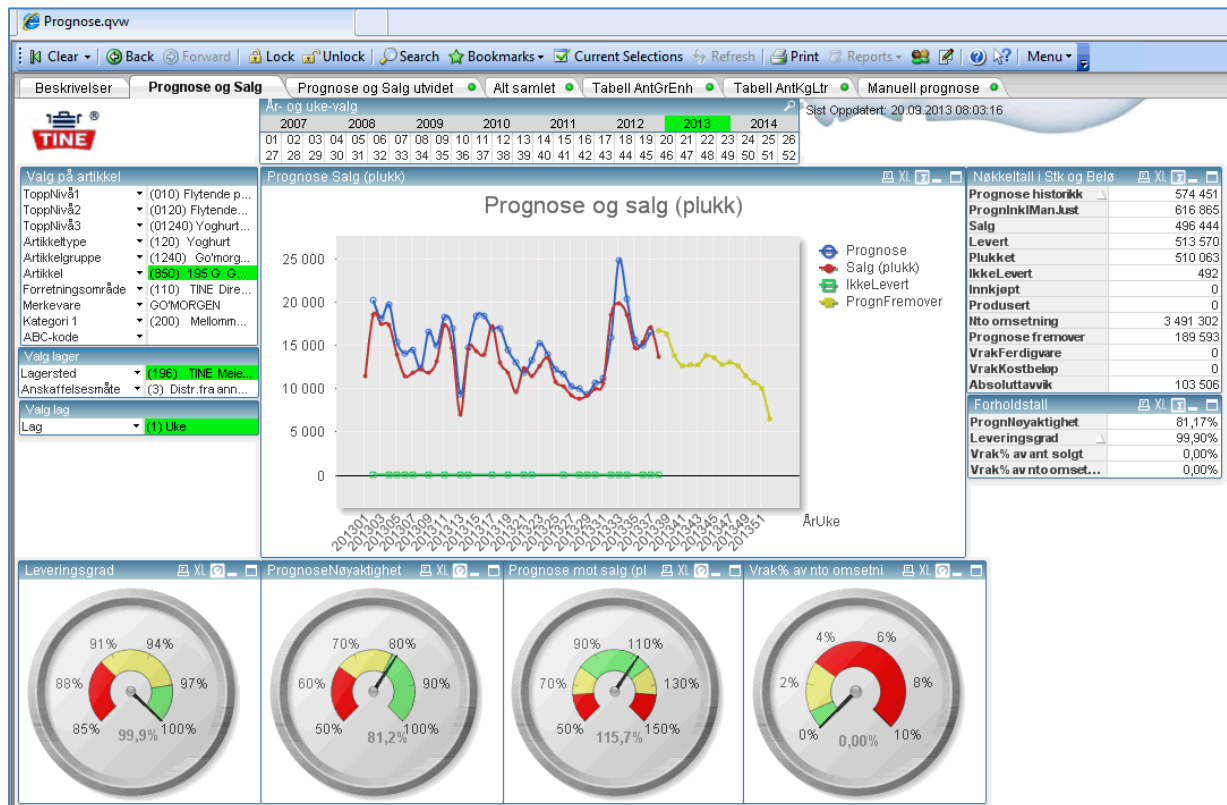


Figure 6: A dashboard made in QlikView – sales numbers of a certain type of yoghurt

Other documents reveal that QlikView delivers information to a total amount of 14 business processes within TINE. At management level QlikView supports planning, management, and evaluation. Primary activities include purchase of dairy raw material, producing, marketing, distributing, and sales. Finally, QlikView supports secondary activities such as accounting and personnel. The next section discusses the findings while mapping TINEs solution against the Information Infrastructure theory.

## 4.2 TINE's BI solution as Information Infrastructure

An Information Infrastructure is **shared** and **open**, which means that several actors can access the system and make changes. This seems to be partly true at TINE. First, only people working at TINE or subsidiary companies may use the BI system. The rest of the supply chain (farmers, grocery stores) are not granted access. On the other hand, as all participants point out, once employed by TINE, virtually everyone can be granted access to the system regardless of which department the employee is a part of. For example; production, distribution, accounting, or marketing groups can use the system to their departments' benefit. The procedure of receiving access happens through licensing. Second, making changes in products typically shown in figure 6 above can only be done by the BI department. The BI department controls all BI products and this rule is clear to the majority of the respondents. One participant explains that each ready-made BI product (report, dashboard) is tagged with the name of the creator, making it easy for the user to request changes. The majority of the participants agree that requests for changes are an easy procedure and that they usually receive their tailored solution quickly, typically between 1 and 4 working days. Two participants show concern about the workload placed on the BI department. The number of users of QlikView and the number of BI products are increasing. In

September 2013, the number of BI products counted 231. Changes in these 231 BI products have to be handled by one among the six persons in the BI department.

**Heterogeneous** means that the system has various types of technology and various types of user groups. These characteristics are present at TINE. We recall from figure 5 that the BI technology consists of ERP-systems and other source data, as well as a data warehouse, and end-user tools like QlikView and Excel. Participant 1 informs that the ERP-system has been replaced three times during his/her working time. QlikView is currently replacing Cognos in a seamless manner. The reason for this successful evolvement is probably due to loosely coupled architecture and is further discussed below. Getting rid of Excel (another end-user BI tool) seems to be a more difficult task. This issue will also be discussed below. All participants mention that QlikView is used at all levels and for various business processes in TINE. Participant 10 highlights this fact as one of the reasons for the success in addition to QlikView delivering useful information tailored to various user groups. No official training courses are necessary for any user groups because *QlikView is an intuitive tool*. Participant 7 explains that the colleagues provide training for new employees and that the problem is more that some users are lazy, meaning that they are quick to ask their colleagues rather than exploring the system themselves. All participants agree that the users group have very different requests. For example, Participant 4 says; *the controllers want to see "everything" in one report, so they can choose later. People in sales want only what they need.*

The final characteristic of an Information Infrastructure, the **evolving socio-technical (the installed base)**, indicates that an infrastructure will always build on existing technology, peoples' competence, prior experience, and more. From the interviews at TINE, all participants at the BI department unanimously explain that the existing BI solution is built on Cognos and that their current ERP-system affects the BI solution. When asked whether this was positive or not, the participants have a somewhat different opinion. Participant 1 informs: *Our ERP system affected the present solution. We could skip a few steps, but this did not affect us too much. We have replaced the ERP three times since I started*, while Participant 2 sees it as an advantage; *Cognos was the foundation for our current solution, but QlikView has new opportunities. Best of breed*. Finally, Participant 3 from the BI department focuses on the user's satisfaction: *The users were rather satisfied with QlikView from the beginning. It is an intuitive tool*. When asking the end-users, they also agree that QlikView is fast and easy to use and that they do not miss Cognos. It is worth mentioning that QlikView is not the only in-memory, intuitive tool on the market. Would TINE endure the same success with another technology with similar characteristics and functionalities as QlikView offers? This study does not answer this question and I briefly return to this in the limitations and further research section.

The fact that the number of users, along with the number of BI products, are increasing also indicates that the installed base is evolving. Participant 9 is concerned about the capacity of the BI department: *we should have a stronger regime on important and less important products*. Consequently, a Business Intelligence Competence Centre (BICC) was established in the beginning of 2013. The aim is to support the BI department. Currently, BICC counts 9 members from the BI department and managers of other departments. A BICC also constitutes a part of the installed base. Finally, one interesting fact emerged from the collected data: Each interviewed member of BI department has minimum 15 years of BI experience, and some up to 30 years. Unfortunately, my collected data does not reveal whether this is a strategy or a coincidence.

Summing up this section, TINE's BI solution maps the Information Infrastructure theory as heterogeneous, evolving, socio-technical installed base. It is considered a huge success by all participants. However, TINE's solution is less open and shared because only users employed TINE can use it, and they also need a licence. Once given a licence, they can only drill down into the reports and graphs; they cannot make changes to QlikView. On the other hand, requests are handled professionally and (usually) quickly by the BI department. According to Participant 2; *QlikView is the best that has happened to TINE since the low-fat milk*. The next section will investigate this success in more detail using underlying Information Infrastructure literature.

### 4.3 Bootstrapping

The Complexity Science Theory is comprehensive, but I focus on the concept of *Self-reinforcing Installed Base*. As illustrated in figure 3 above, this is not a linear process with a clear start and end, but a perpetual cycle which constantly adds value for the users, which again results in more users. Each new user of the technology will contribute to the value for the existing users (Hanseth and Aanestad 2003). This brings us to the issue of *bootstrapping*. If the value of the technology depends of the number of users, how do we get the snowball running? It is like a chicken-egg problem. You need users to increase the value of the technology but it may be hard to recruit users if only a few is using it.

From the BI literature, Howson (2014) argues that you may create your BI system, but this does not automate success or value. In other words: people need to use the BI system in order for it to be a success. And when people use the system, more functions and resources will be put back into the system, which again will result in more value for the end-user.

At TINE, this installed base consists of (amongst other) all employees of TINE, who can be granted access to QlikView upon request. In addition to QlikView, there are other technologies such as ERP, Lotus Notes, Excel and more (recall figure 5). The knowledge and skills of each employee is also part of the installed base. My data indicate no trace of bootstrapping problems. The participants all agree that they do not miss Cognos, and that the users like QlikView and were happy to use it from the very beginning. The explanations from the participants are also in unison: the users experienced easy and fast access to data. Another reason could also be that the end-users were already familiar with BI technology such as Cognos.

### 4.4 Adaptation

Zittrain explains that the network of the Internet can be carved into three levels: the physical at the bottom, the protocol in the middle and the application layer at the top. If we tip Zittrain’s figure over, we see that it resembles the framework from Turban et al (2014). Also, the IT architecture at TINE is loosely coupled and follows the common BI three-tier pattern, as illustrated in table 3 below.

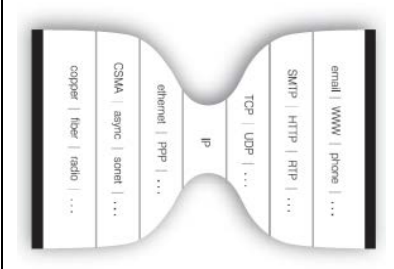
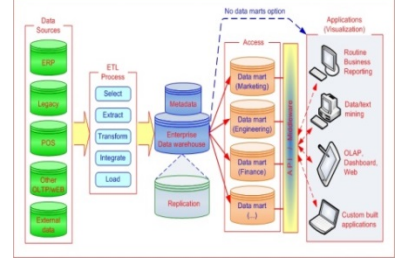
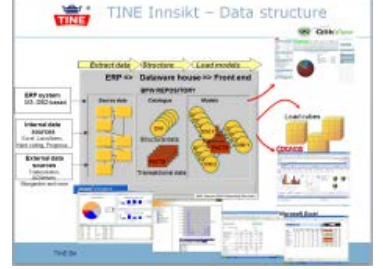
Information Infrastructure literature (Zittrain, 2008) (Author’s modification)	BI literature (Turban et al. 2014)	TINE’s BI architecture
		

Table 3: A comparison of the architecture from the literature and the case company

According to the core Information Infrastructure literature, a loosely coupled architecture is preferred to a tightly coupled one (Hanseth et al. 2012). This theory proved true at TINE’s case. The participants explain that replacing Cognos with QlikView was a smooth and problem-free process. It is also interesting to point out how the BI department chose to carry out this change. Instead of a *big bang* implementation (Bygstad et al. 2010), which could be shutting down Cognos from one day to another, they are letting Cognos *die quietly*, allowing for a smooth overlap between the old and the new BI tool.

Zittrain makes an interesting point when describing that intelligence is created at the end-nodes of a network. Can the same be said about TINE’s architecture? Participant 5 mentions the obvious; *Non-sense into the system will result in non-sense out of the system*. In other words; it is not TINE’s data warehouse that creates value. Rather, it is the people who create value. Yes, a data warehouse and BI tools will ensure the Extract, Transform, and Load (ETL)-process and safe storage of data. (We can say

that the ETL-process in BI in a way corresponds with standardisation issue in Information Infrastructure). But it is the people who are the ones providing the information in the source data at the very right of figure 5 as well as making use of the reports and dashboards coming out of the other end.

The Information Infrastructure literature reads that there is a tension between control and innovations. The management needs to control the technology in order to avoid lock-ins and other unwanted consequences such as digital piracy on the Internet. On the other hand, *intelligence is found in the fringes* of an architecture (Hanseth and Nielsen 2007) meaning that people must be allowed to contribute to create value.

I was curious about the extensive use of Excel when I first started this study. We recall that it is the most common BI end-user tool (Watson 2009). My point of departure was that this was an example of *lock-in* in the negative sense; in that it would slow down the BI process (like the QWERTY keyboard slows down the typist). The employees at TINE are already experienced with Excel, and the participants also inform that their customers prefer to get reports in the Excel format. Participant simply 9 states; *It is impossible to remove Excel*. The extensive use of Excel troubles the BI department more than the end-users who “cannot live without it” and “I would miss it if it was taken away from me”.

Having completed this study, I have a new perspective on Excel. Yes, Excel is probably an example of lock-in at TINE. The good news is that it is possible to benefit from a lock-in (Shapiro and Varian 1999). Several researchers (for example Hanseth and Lyytinen, 2010) believe that it is the simple end-to-end architecture of the Internet which has proven critical for its adaptive growth. This is because the “intelligence” is being placed into the end nodes, a point also shared by Zittrain. The end-user participants (5-8) of this study explain that they prefer to transport their data into Excel in order to perform further analysis. This analysis is in fact a type of intelligence, which BI is all about. The drawback is that this individual work does not necessarily contribute to the *installed base* of TINE. Each user guards her/his own spreadsheet, and it is difficult for others to benefit. The BI department at TINE does have a plan: if they observe employees using Excel, they try to demonstrate that the same tasks can be done in QlikView. One participant tells that one boss in TINE has the mission of becoming *the Excel-killer*. This plan can be wise, provided that the employees can perform their same data analysis in QlikView. If not, it may be wiser to let the end-users work with Excel and then make sure that they upload it in their shared database called *TINE Finn* (translates to TINE Find), where all employees may store and share their spread-sheets and other documents.

#### 4.5 Summing up

The collected data from this study illustrates that TINE’s current BI solution is a success. The evidence is shaped in the sense that the solution is both bootstrapped and adapted. Tables 4 and 5 below explain in more detail, comparing TINE’s BI solution to each design principle from Hanseth and Lyytinen’s study (Hanseth and Lyytinen 2010):

The bootstrap problem (p.6)	TINE’s successful BI solution
1. Design initially for usefulness	TINE’s users immediately found the new solution useful, mainly because they could access data faster and thus work more effectively.
2. Draw upon existing installed base	TINE had an installed base consisting of technology (Cognos and ERP-system) as well as a highly competent BI department and end-users who were accustomed with Cognos.
3. Expand installed base by persuasive tactics	There was a training session, and online guidelines which can be accessed by any TINE employee. If a user is spotted using Excel, the BI team demonstrates what QlikView can do.

Table 4: *Bootstrapping in Information Infrastructure compared to findings at TINE*

TINE experienced a positive feed-back loop: the **installed base** lead to new **BI solution** which again led to **useful** information for the users. This positive feed-back loop enabled the bootstrapping of the current BI solution.

The adaptation concept means that even though TINE managed to implement QlikView and are experiencing a demand from end-users, the BI department cannot rest on their laurels. Indeed, at TINE they do not, and TINE has taken action to promote an adaptive growth, as shown in table 5:

The adaptation problem (p. 6)	TINE's successful BI solution
4. Make each IT capability simple	Each BI product is marked with the owner's name. If an end-user needs additional information, it is easy to contact this person. TINE also keeps their BI and QlikView competence in-house, making the interaction easier and quicker between the BI department and the end-user.
5. Modularize the Information Infrastructure by building separately its principal functions and sub-infrastructures using layering and gateways	TINE's BI solution is loosely coupled, consisting of several, independent elements. This made the exchange from Cognos to QlikView easier: it could be changed without affecting the other technology such as their ERP-system, or even the beloved Excel-sheets from the end-users. (This study has not investigated gateways.)

Table 5: *Adaptation in Information Infrastructure compared to findings at TINE*

TINE is experiencing another positive feed-back loop: the **loosely-coupled BI architecture** leads to **adaptation** of new functions, which again leads to **new BI products** in QlikView.

#### 4.6 Limitations and suggested further research

As with any piece of research, this study has limitations. I have studied only one case company. Further research could investigate other companies, for example of a smaller size, or a company with a less successful BI solution in order to make a comparative study. Finally, it would be interesting to study a company using a technology different than QlikView to find out how important role this type of technology plays in a successful BI solution.

### 5. Conclusion

This study has investigated *how do we bootstrap and adapt a BI solution?* Through a case study of TINE's successful BI solution, I argue that is useful to regard it as an Information Infrastructure. This view has three implications. First, we need to regard a company's BI solution as an Information Infrastructure rather than the implementation of a certain technology alone. Second, we need to understand and exploit the dynamics of bootstrapping. Third, we need to understand adaptation over time.

As practical contribution, this research offers three guidelines:

- 1) **The Bootstrapping guideline:** demonstrate usefulness of the solution to end-users.
- 2) **The Adaptation guideline:** keep as much of the BI competence in-house as possible.
- 3) **The Loose-coupled Architecture guideline:** choose a technology which can be exchanged without affecting the whole architecture and other tools which are in use.

These three guidelines are all dynamic parts of TINE's BI solution. We see that they are far from the traditional, isolated Critical Success Factors such as "Get Management's Support" and "Involve the Users". Rather, these guidelines are not to be executed once but to be constantly present and evolving, bringing more value to TINE as they are being used over time.



## Acknowledgements

Gratitude goes to the associate editor and the two anonymous reviewers at ECIS for providing thorough and useful reviews. Professor Bendik Bygstad at the University of Oslo contributed throughout the study and I am forever grateful. I thank my two assistants, Bjørnar Mæland and Andreas Biørn-Hansen, who eased the data collection by “typing faster than their own shadows” during the interviews at TINE. Last, but not least, I thank the participants at TINE for granting me time to visit, observe, and interview at their premises.

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## Appendix: semi-structured interview at TINE

### **For the BI department:**

1. How do you define BI?
2. To what extent do you think that your BI solution is successful? (Ex: provides reliable data, saves costs, more satisfied customers)
3. Why do you think it is a success (or less successful)?
4. Who uses the BI solution? (Can anyone use it? Can the user tailor the solution to her/his needs?)
5. Who can make changes in the BI solution?
6. The users from question 6: how do they differ?
7. Was the solution built from scratch? (What kind of training did the users get? What solutions did you have prior to your current BI solution? Are there any old habits/procedures you do not get rid of?)
8. Do you still use Excel in TINE?

### **For the end-users of BI products question 7 was changed:**

7. What kind of training did you receive for the current BI solution (Do you miss the old solution)?

### **For the members of BICC question 9 was added:**

9. You are a member of BICC. Why was it established? What is the role of BICC?



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**ISSN 1400-741X (print), ISSN 1651-8225 (online)**

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