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The benefits and challenges of integrating ERP and Business Intelligence

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ABSTRACT:
Organizations have invested a significant amount of resources in the implementation of Business Intelligence (BI) and Enterprise Resource Planning (ERP) systems. In today's competitive business environment, ERP and BI have become vital strategic tools, which impact directly on the success of any project implementation. The benefit of combining ERP and BI is that BI systems add intelligence into ERP data. The IT performance and decision-making capability inside the organization can be significantly improved by integrating ERP and BI systems. There has been given little attention to the integration of Enterprise Resource Planning and Business Intelligence (BIERP). Even though there have been studies which explain the integration of these systems, the literature is still classified as diversified and fragmented. This study attempts to review and evaluate articles which are related to the integration of BI and ERP. This study aims to examine how does the integration between ERP and BI systems affects businesses performance and what are the benefits and challenges of integrating these systems.

The thesis was carried out as an empirical, qualitative case study, and semi-structured interviews were used to collect data. Five interviews were conducted, four different companies and six people were interviewed from relevant departments for this topic. Observations and interviews indicate that the concept of direct integration between ERP and BI is quite outdated. In order to ensure that data is transferred and stored between the two programs effectively, different software has been introduced between ERP and BI today as a result of technological advancements. In the studied companies, the integration of ERP and BI does not always go smoothly, and companies have run into various issues in this area. For instance, maintaining the increased data volume, problems with data accuracy, and technical compatibility are challenges related to ERP BI integration. The empirical data also shows that ERP BI integration has many benefits. For example, it can enhance reporting, decision-making, and process efficiency because of its automation features. For instance, it can provide up-to-date reports on key performance indicators in real-time. Furthermore, because the company's figures now arrive automatically thanks to ERP BI integration, employees of the company now spend less time performing routine tasks, freeing them up to concentrate more on data analysis.

KEYWORDS: ERP, Business Intelligence, Integration, Data Vault

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Tiivistelmä:
Organisaatiot ovat investoineet huomattavan paljon resursseja Business Intelligence (BI) - ja Enterprise Resource Planning (ERP) -järjestelmien käyttöönottoon. Nykyisessä kilpailullisessa liiketoimintaympäristössä ERP- ja BI-järjestelmistä on tullut elintärkeitä strategisia välineitä, jotka vaikuttavat suoraan minkä tahansa hankkeen toteutuksen onnistumiseen. ERP- ja BI-järjestelmien yhdistämisen etuna on, että BI-järjestelmät lisäävät ERP-tietoihin älykkyyttä. Organisaation sisäistä tietoteknistä suorituskykyä ja päätöksentekokykyä voidaan parantaa merkittävästi integroimalla ERP- ja BI-järjestelmät. Kirjallisuudessa yritysresurssien suunnittelun ja Business Intelligence -järjestelmien integrointiin on kiinnitetty vain vähän huomiota. Vaikka näiden järjestelmien integrointia selittäviä tutkimuksia on tehty, kirjallisuus on edelleen luokiteltu hajanaiseksi. Tässä tutkimuksessa pyritään tarkastelemaan ja arvioimaan artikkeleita, jotka liittyvät BI:n ja ERP:n integrointiin. Tutkimuksessa pyritään selvittämään, miten ERP- ja BI-järjestelmien integrointi vaikuttaa yritysten suorituskykyyn ja mitkä ovat näiden järjestelmien integroinnin hyödyt ja haasteet.

Tutkielma toteutettiin empiirisenä, laadullisena case-tutkimuksena, ja aineiston keräämiseen käytettiin puolistrukturoituja haastatteluita. Haastatteluja tehtiin viisi, neljää eri yritystä ja kuutta henkilöä haastateltiin tämän aiheen kannalta merkityksellisiltä osastoilta. Havainnot ja haastattelut osoittavat, että käsite ERP:n ja BI:n välisestä suorasta integroinnista on melko vanhentunut. Sen varmistamiseksi, että tiedot siirretään ja tallennetaan tehokkaasti näiden kahden ohjelman välillä, ERP- ja BI-ohjelmien välille on nykyään otettu käyttöön erilaisia ohjelmistoja teknisen kehityksen ansiosta. Tutkituissa yrityksissä ERP:n ja BI:n integrointi ei aina suju ongelmitta, ja yritykset ovat törmänneet erilaisiin ongelmiin tällä alalla. Esimerkiksi lisääntyneen tietomäärän ylläpitäminen, tietojen tarkkuuteen liittyvät ongelmat ja tekninen yhteensopivuus ovat ERP BI -integraatioon liittyviä haasteita. Empiiriset havainnot osoittavat myös, että ERP BI -integraatiolla on monia etuja. Se voi esimerkiksi parantaa raportointia, päätöksentekoa ja prosessien tehokkuutta automaatio-ominaisuuksiensa ansiosta. Se voi esimerkiksi tarjota ajantasaisia raportteja keskeisistä suorituskykyindikaattoreista reaaliajassa. Koska yrityksen luvut tulevat nyt automaattisesti ERP BI -integraation ansiosta, yrityksen työntekijät käyttävät vähemmän aikaa rutiinitehtävien suorittamiseen, jolloin he voivat keskittyä enemmän tietojen analysointiin.

Avainsanat: ERP, Business Intelligence, Integraatio, Data Vault

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1 Introduction

In today's competitive economy, business intelligence (BI) and enterprise resource planning (ERP) have emerged as critical strategic tools that directly affect the success of any project. ERP software has recently altered organizations by improving financial visibility, supply chain operations, and reducing the burden and overhead associated with human resource management (Chou, Tripumallu, & Chou, 2005). In today's challenging business environment, business intelligence is a technique and a solution that aids managers in understanding the business situation (Nofal & Yusof, 2013).

The most up-to-date information technology gathers all necessary data from the ERP system, loads it into a data warehouse, and then connects the data to BI tools like data mining, OLAP, reporting, and query. In order to share information and data for control and decision-making, ERP integrated into BI is anticipated to be more flexible and competitive (Umble, Haft & Umble, 2003). This study focuses on examining how ERP and BI systems are integrated and how they cooperate to enhance organizational performance.

According to Chou et al. (2005), ERP is a software-driven business management system that integrates all aspects of the company's operations, including manufacturing, sales, planning, and marketing. Business intelligence, according to Habul and Pilav-Velic (2010), is a concept that employs information technology as a tool for increasing businesses' competitiveness, the perception of risk that exists in a firm's environment, and the potential for action. Unfortunately, many executives underestimate the level of dedication required of them and their company to ensure the effective use and implementation of BIERP (Muscatello & Chen, 2008). The success or failure of the project typically depends on how the businesses use the software, not the tool's maker or vendor (Nofal & Yusof, 2013).

Businesses are aware of the extensive information contained in ERP systems. How to extract data from these systems presents challenges for businesses. The entire system is unable to facilitate the decision support function because ERP systems were not initially

intended to provide real-time reports to large user bases (Chou et al., 2005). Using specific customer behavior data to manage relationships for the highest levels of customer satisfaction, retention, loyalty, and profitability is known as business intelligence (BI) in the context of enterprise resource planning (ERP) (Hall, 2004). Consequently, a data management infrastructure is essential to this BI strategy because it enables businesses to identify changes in real-time in customer behavior that indicate when there is a strong likelihood that the customer will accept an offer. (Gessner & Volonino, 2005).

The majority of businesses have strong market research capabilities that enable them to comprehend the needs and expectations of their clients. To be successful, businesses must understand their competitive environment as well as their customers (Thomas, 2001). All business sectors use application packages from the market, and ERP and BI systems in particular are experiencing rapid growth. This growth occurs for packaged solutions that support business BI and data warehousing as well as application packages that handle business transaction processes (White, 2004).

1.1 Research objectives

This study aims to investigate how does the integration between ERP and BI systems affect businesses performance. This study examines what is an ERP system, BI system and what are the benefits and challenges of using BI and ERP simultaneously. The research questions for the study are:

1. How does the integration of ERP and BI systems impact on businesses?
2. What are the benefits and possibilities of the integration?
3. What are the challenges of the integration?
4. How will the ERP BI integration develop in the future?

1.2 Research methods

Qualitative research is the method used for this thesis. Semi-structured interviews are used to gather data; while the general themes are the same across all of the interviews, the specific questions may vary. This type of study, where a deeper understanding of the subject is sought, is appropriate for this research methodology. According to Eskola et al. A grounded theory methodology is employed in the study. It was first mentioned by Glaser and Strauss in their 1967 book, "The discovery of grounded theory: Strategies for qualitative approach." The strategy has changed in many ways since then. The qualitative collection, analysis, and emphasis on empiric methods of data gathering, as well as the development of the theory from the data, are the common elements. According to Saaranen-Kauppinen et al. (2006), it is an inductive study method based on the material. Research using grounded theory usually begins with a question, like this: how has ERP BI integration affected the performance in the company? The theories that were used in the thesis didn't begin to take shape until after more research and data collection.

Five interviews with six respondents were used to gather the data. Email was used to reach out to each respondent, and the interview was conducted through Microsoft Teams. This method was chosen to ensure relaxed and open discussion between the interviewer and interviewees but at the same time to keep focus on the broader themes derived from the research questions.

1.3 Structure of the study

This study has ten chapters. This study will first introduce what the subject of the study is, what is the objective of the study and what are the research questions. The Second chapter defines what ERP is, what are the main characteristics of ERP, how has the ERP system evolved and what are the benefits and risks of using an ERP system in a business. This study continues by defining what Business Intelligence in general is, what are the benefits of the system, how does the Big Data effect on Business Intelligence and why should companies utilize Business Intelligence in their businesses. The fourth chapter

describes what is data vault methodology. The fifth chapter examines what kind of impact has an integration between ERP and BI systems. The sixth chapter topic is how the integration of ERP and BI will be developed in the future. The seventh and eight chapter include the empirical part, the ninth chapter includes the discussions of the empirical results and the final tenth chapter is the summery of this study.

2 Enterprise Resource Planning (ERP)

Examining what enterprise resource planning (ERP) is, is the goal of this chapter. The beginnings and development of the ERP system are covered in this chapter. The final section of this chapter looks at the advantages and challenges of adopting the ERP system in an organization while also examining the characteristics of the system and how it has changed over time.

2.1 What is ERP

There are numerous ways to look at the enterprise resource planning (ERP) system. ERP is first and foremost computer software. Second, ERP can be understood as a development goal that aims to organize all of an organization's data and processes into a comprehensive structure. Third, ERP is necessary for the infrastructure that provides business solutions. 2000 (Klaus, Rosemann, & Gable).

According to (Davenport, 1998), ERP systems are sizable commercial software packages that guarantee a seamless integration flow through an organization by combining various data sources into a single software application and a single data-base. They address the fragmentation issues of legacy systems by integrating the many facets of the enterprise and streamlining data flows (Davenport, 1998).

In order to present an integrated view of the business, ERP is a comprehensive piece of software that aims to integrate all of a company's processes and functions (Klaus et al., 2000). An organization's order management, human resources, manufacturing, financial systems, and distribution with external suppliers and customers are all linked into a tightly integrated system with shared data and visibility when ERP is successfully implemented (Chen, 2001). Currently, many large organizations use ERP, and small and medium-sized businesses are finding that adopting it is both competitively necessary and a cost-effective software solution (Klaus et al., 2000).

Due to competition, both small and large businesses are investing in ERP systems (Turbide, 1999). Information is now a valuable corporate resource, and businesses that manage and control their information have a significant advantage over rivals who lack the skills to effectively use it (Turbide, 1999). Manufacturing companies are discovering that management tools are the key to agility, reduced lead times, increased operating efficiency, responsiveness, and they can also greatly improve customer service and satisfaction as ERP related systems are constantly evolving (Turbide, 1999). The ability to manage and view the extended enterprise of suppliers, customers, and alliances as a single entity, as well as the ability to drastically reduce inventory and working capital, are additional potential benefits of ERP (Escalle, Cotteleer & Austin, 1999).

2.2 The characteristics of ERP

ERP software is provided by a number of vendors who are experts in this area of software as a standard commercial product. Leading ERP vendors, according to Klaus et al. (2000), include the American multinational computer technology corporation Oracle and the German multinational software corporation SAP. The ERP software can be easily customized to meet the varied needs of users in most economic sectors. There are currently three types of ERP software: installed, pre-configured, and generic. The generic software form, which is aimed at various industries, is the most complete. Prior to use, the generic form needs to be configured. Templates have been derived from the comprehensive software in pre-configured form. Pre-configured templates are designed for particular business sizes or industry sectors, like retail and the automotive industry. The third form is installed ERP software, which manifests as the operational installation following the customization of the generic or pre-configured package into a particular form. (Klaus et al., 2000.)

Since any configuration will result in unique instances of the product, ERP software can only be purposefully described in its generic form. ERP is a standard software package, and during the system deployment process, standard packages that are aimed at an anonymous market must be customized to the unique requirements of the individual

company. The implementation of ERP is supported by a number of tools, including project management tools, step-by-step instructions, remote checks, and generic presentation files. ERP stands out from other packages thanks to its extensive customization capabilities. Although some people might view the need to customize ERP as a negative, customization allows for a personalized configuration and distinct implementation of ERP. The rich potential of configuring ERP software derives from the range of pre-configured alternatives, for example, number and variety of chart of accounts and the number of alternative transactions and processes. (Klaus et al., 2000.)

Because ERP is packaged software, it was created with a "class" of organizations in mind and is said to include the best business practices. Standardization of data and business procedures across an organization is necessary for ERP systems to enable integration. (Gattiger & Goodhue, 2000) Although ERP systems can be modified, doing so is expensive and difficult depending on the particular organizational procedures. Typically, business procedures must be altered to fit the system. Reengineering current business processes is both a critical concern for system implementation and a key success factor of implementing an ERP system. (Holland & Light, 1999); (Bingi, Sharma, and Goodla, 1999); (Nah, Lau, and Kuang, 2001).

Application software, such as ERP, can be distinguished from other types of software, such as middleware, operating systems, and database management systems. The data involved and the supported functions are integrated across the various ERP application modules. The integrated database used by ERP software allows for the consistent and redundant storage of both master and transactional data. The primary benefits of ERP are the business solutions it offers to businesses, which support both administrative and commercial core processes. All business operations, including material management, procurement, logistics, production, upkeep, sales, financial accounting, distribution, asset management, cash management, controlling, quality management, and strategic planning, are supported by ERP software. Additionally, industry-specific tasks like patient

management in hospitals, university student administration, and high-volume warehouse transactions for retailers are supported by ERP. (Klaus et al., 2000.)

The primary elements of ERP solutions all adhere to a process-oriented view of the organization, even though they are at the highest level organized in various functional modules like sales or financial accounting. ERP functions seamlessly and supports common business processes, making it unlikely for users to be aware of which functional module they are using at any given time. (Klaus et al., 2000.)

According to Perkins (2022), (ERP) is used to manage daily business operations and processes in a variety of departments, including finance, human resources, procurement, distribution, and supply chain. Because they combine all the operations required to run a business into a single system that also makes resource planning easier, ERP systems are essential applications for the majority of organizations. ERP systems typically run on an integrated software platform with a single database and common data definitions.
ERPs were initially developed for manufacturing firms, but they now provide services to almost all industries, each of which may have unique ERP quirks and offerings. For instance, government ERP adheres to government accounting rules rather than GAAP and uses contract lifecycle management (CLM) in place of conventional purchasing.

ERP's extensive functionality necessitates corresponding documentation. ERP frequently describes the supported organizational structures, processes, and data structures in reference models, in addition to the usual software documentation. These reference models facilitate quick access to functionality and permit movement between various abstraction levels and viewpoints. (Klaus et al., 2000.)

Different industries with very different characteristics are targeted by ERP software. As a result, identifying ERP by simply listing functions is difficult. ERP supports a variety of industries, either by providing pre-configured individual solutions for businesses or by

supporting multiple industries within a single solution (for instance, the coexistence of manufacturing and retailing functionality). (Klaus et al., 2000.)

ERP software is made for businesses that operate internationally. ERP must be able to handle the distinct needs of various geographical areas, such as pre-configured country-specific delivery notes, invoices, quotes, or payroll-related HR regulations. The capability to handle multiple currencies in all transactions is a requirement for ERP software. Critical characteristics of ERP software include repetition and regular use. ERP supports recurring business operations like processing sales orders, purchasing, or payment procedures. It does not, however, concentrate on erratic, less structured processes like project management, marketing, or product development. (Klaus et al., 2000.)

Technical features are still important in distinguishing ERP from earlier identical software packages, such as integrated, but centralized software packages with strict platform requirements, even though ERP does not differentiate from other currently available applications by them. (Klaus et., 2000.)

2.3 The evolution of ERP

ERP can be traced back to its origins in Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRP II) (Turbide, 1999). MRP was initially developed in the 1950s and marked the first commercially available business application beyond General Ledger (Orlicky, 1975). Its primary purpose was to improve the efficiency of calculating essential materials (Klaus et al., 2000). MRP software facilitated the management of master data materials and bill-of-materials for all products and parts across one or multiple plants. It incorporated bill-of-materials processors for demand-based planning and forecasting algorithms for consumption-based planning. While MRP excelled at processing large volumes of data, its functionalities were limited in terms of process depth. To address this limitation, MRP packages were expanded in the 1970s to encompass

additional applications that comprehensively supported the production planning and control cycle (Klaus et al., 2000).

During the early 1980s, Material Requirements Planning (MRP) underwent a significant expansion, transforming from a material planning and control system into a comprehensive company-wide system (Chen, 2001). This expansion enabled MRP to effectively control and plan virtually all resources within the company (Chen, 2001). Subsequently, MRP evolved into MRP II, introducing new functionalities such as capacity management, sales planning, and scheduling (Klaus et al., 2000). The primary objective of MRP II was to integrate essential company functions, including marketing, production, finance, and other departments like personnel, engineering, and purchasing, into the planning process (Chen, 2001). One notable feature of MRP II was its built-in simulation capability, allowing enterprises to explore "what-if" scenarios (Chen, 2001).

In the 1990s, MRP II further evolved into Enterprise Resource Planning (ERP) (Chen, 2001). The term "ERP" was coined by the Gartner Group based in Stamford, Connecticut, USA (Chen, 2001). The main goal of ERP was to enhance resource planning by expanding the planning scope to encompass a more extensive portion of the supply chain compared to MRP II (Chen, 2001). The key distinction between ERP and MRP II lies in their focus: MRP II primarily concentrated on planning and scheduling internal resources, while ERP aimed to incorporate supplier resources as well, based on dynamic customer demands and schedules (Chen, 2001). The overview of the MRP II is illustrated in the Figure 1.

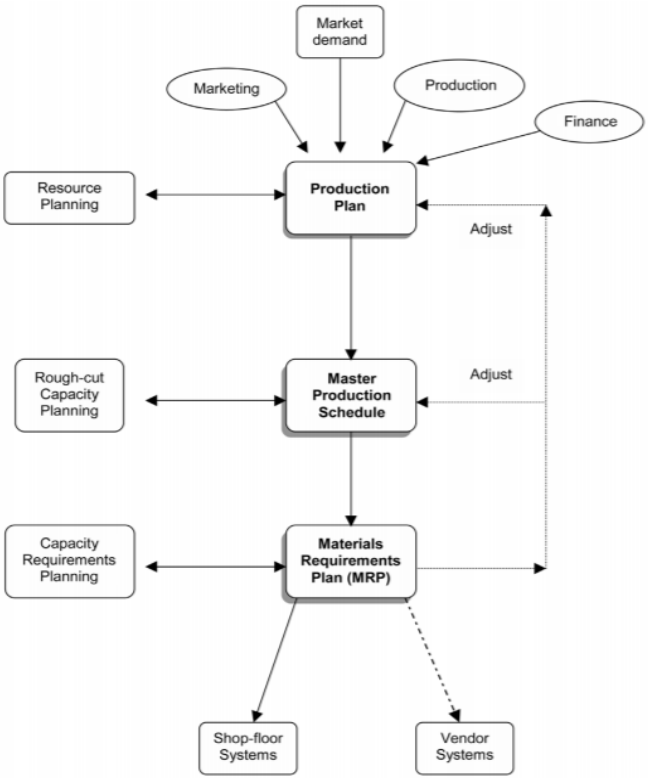

Figure 1. An overview of MRP II (Chen, 2011)

When the German company SAP released R/3, its next-generation software, the popularity of ERP systems began to rise. Businesses began pouring billions of dollars into the ERP systems provided by SAP and its top rivals, including Baan, Oracle, and J.D. Edwards, in the years that followed. By the end of the 1990s, industry analysts were predicting that the ERP market would grow at a rate of 30 to 40 percent and would reach $50 billion by 2002. An overview of ERP systems is shown in Figure 2, along with some of the most used features within each module (Chen, 2001). A typical ERP system integrates all these features by allowing its modules to freely transfer and share information and centralizing all data into a single database that is accessible by all modules, despite the fact that the names and numbers of modules in various ERP systems may vary (Chen, 2001).

According to (Chen, 2001), traditional MRP and MRP II applications might not be able to handle the challenges that manufacturers (who want to take advantage of the competitive advantage offered by an integrated supply chain) are presenting. As a result of its evolution from its predecessors, ERP is now an integrated piece of supporting software

for building value chains. (Chen, 2001.) The overview of the ERP systems is illustrated in the next figure.

Figure 2. An overview of ERP systems (Chen, 2011)

2.4 Benefits of ERP

What are the real-world advantages that businesses have reaped from using ERP systems, and what goals did the business have before introducing an ERP system to an organization? ERP systems integrate a company's operational processes, as was already mentioned. Information systems can more easily overlap and load when, for instance, a single software handles logistics, sales, procurement, marketing, control, metrics, and accounting. The goal of an ERP system is to consolidate everything under one piece of software in order to lower IT costs and workload. (Davenport, 2000).

Combining the activities has several goals, including reducing employee workloads, accelerating operations, and producing data and drivers that will aid businesses in making better decisions. Combining activities enables the company's financial monitoring (such as monthly reporting), which improves the effectiveness and quality of decision-making.

Additionally, the monitoring of the company's operations, cost accounting, bookkeeping, and inventory becomes effective. This enables the employees of the company's financial management department to focus more on analytical tasks than on producing manual reports. The company has constant access to real-time information, which will help it be more adept at managing changes and responsive to customer needs. (Shtub, 1999; Davenport, 1998.)

ERP systems establish a link between, for instance, sales and logistics, purchasing and logistics, as well as sales and management control systems. This connection makes it easier for different functions to communicate with one another. Information must only be entered into the system once before the change is apparent across the board in all departments of the business. Additionally, this continuous flow of information between the various departments allows the business operations to respond to changes more quickly. Budgets and material needs are always available and automatically updated. Delivery times are shortened, and inventory turnaround times are decreased as other functions, including the order-supply chain, become faster and more automated. (Davenport, 2000).

Large corporations today gather, produce, store, and analyze a lot of data, almost always. Having to store a lot of data presents difficulties. Corporate data is typically kept on electronic servers, either by the company's warehouses or by an outside service provider. Data warehouses are challenging to maintain and typically contain raw data that needs to be transformed into usable form. Additionally, in conventional systems, the data might be dispersed among numerous systems. Additionally, older systems frequently store the data mass in different data banks, which makes maintaining data banks and warehouses expensive. ERP systems centralize operational and data warehousing tasks so that the company's data system's data can be used in the decision-making process. It's not necessary to convert data into the same format after being collected using various pieces of software. (Davenport, 1998.)

In multinational corporations, data is shared among organizations in various nations, and terms specific to each nation are automatically updated. For instance, the Chinese government's purchases are made in renminbi while an Italian company's sales in the United States are reported in dollars. Additionally, the system can decide whether the accounting, income statement, and balance sheet comply with national standards. However, throughout the organization, the information is communicated in euros. Additionally, since the same system is used worldwide, the technical terms and functions are uniform, facilitating communication between various country units. This makes it quicker and simpler for different units to communicate with one another. (Davenport 2000).

By implementing an ERP system, businesses hope to gain business advantages. For instance, ERP systems are used to support business expansion, improve the company's various operations, and lower administrative and operational costs. An ERP system's main objective is typically to give the business access to the most complete cost accounting system possible. A company can more easily track and target operational costs with an ERP system, as well as cut back on activities that don't add value to the business. ERP improves the effectiveness of the company's value chain. (Velcu, 2007.)

ERP systems work to cut down on errors. It is crucial to enter data into the system accurately the first time, but after that, there is no need to re-enter the input data. Because each system must have the data entered again when using multiple systems, there is a greater chance of errors. (Velcu, 2007.) Automating warehousing and other logistical tasks is intended to significantly reduce costs in the company's logistics division. A company's current assets, for instance, can be continuously monitored and kept up to date by management thanks to automated inventory accounting. When the warehouse development can be monitored in real-time, inventory may no longer be necessary for tracking current assets. Additionally, it is simpler to avoid payment and shipping delays thanks to automated payment and the alert system. For instance, the ERP system might pay the purchase's invoice automatically on the last day and alert the user if the agreed-upon delivery has not yet been made or is not yet reflected in the system. The purpose

of automation is to reduce the lead time of the goods in the company and thus have a positive impact on efficiency. (Velcu, 2007.)

ERP systems are designed to simplify business operations and centralize information technology within organizations. The systems also hope to provide technical advantages while improving the performance of the company right away. Therefore, it is believed that an ERP system's successful implementation is a key element in raising a company's competitiveness. (Velcu, 2007.)

2.5 Challenges of using ERP

The risks associated with the ERP system must be considered when determining whether an investment in ERP will be profitable. The ERP system's implementation has a very high failure rate. The failure rate for implementations ranges from 66 to 70 percent. Davenport (2000). Complex systems demand effort, expertise, and financial resources. Despite the fact that ERP systems are a crucial component of contemporary IT and that their goal is to increase a company's competitiveness, a sizable portion of ERP implementations end in disappointment or worse. Failure to implement ERP effectively can lead to a company's demise. Due to the complexity of ERP systems, many businesses have discovered that implementing them is difficult. Also, measuring the impact of IT systems on a company’s profits is challenging. (Davenport, 2000; Poba-Nzaou, Raymond & Fabi, 2008; Tsai, Chen, Hwang & Hsu, 2010.)

Why does the ERP system's implementation go wrong so frequently? The increased revenue that an ERP system brings is not always as good as desired, and expectations for these systems are frequently too high. Additionally, not every requirement from a customer is always met by the system. The inability to accurately calculate costs is another issue. The ERP system implementation budget may have been exceeded, or the maintenance and training costs may have exceeded expectations. Each company's implementation procedure is unique. Determining a system project's schedule, such as the date of implementation and the deadline for implementation, is frequently challenging. The

new system presents difficulties for staff members as well. ERP system is effective as possible when employees have been trained on how to use an ERP system correctly. Inadequate training increases the implementation failure rate and the resistance to change. (Ghosh, 2012.)

Even though ERP systems are designed to enhance a company's financial performance, the immediate effects may vary. Companies frequently struggle to integrate new ERP systems into their current data warehouses and systems. Particularly when using outdated software alongside the ERP system, which frequently causes issues. When an ERP system is implemented, the business often adopts a significant number of new procedures and practices. As a result, the business may need to modify some of its core business processes to make them compatible with the complex ERP systems. The cost of purchasing an ERP system is high, but so are the costs of implementation and staff training. When external consulting is chosen, these services are typically expensive as well. In the long run, additional costs will be incurred because the systems' implementation typically takes three to five years. But the business should also be able to function normally at the same time. (Poston & Grabski, 2001.)

Processes for installing expensive ERP systems must be carefully thought out. The size of the business and the level of customization desired will determine how much the implementation will cost. ERP system costs frequently reach several million euros. Numerous businesses have incurred significant costs as a result of failed ERP projects. Hersey Foods and Nike are two examples of ERP projects that failed. Due to ERP systems, Hersey Foods was unable to deliver 100 million Kisses for Halloween in 1999, resulting in a 100 million dollar loss in revenue. Nike suffered a $1 billion loss in 2000 as a result of a botched ERP implementation. The cases caused Hersey Food's stock price to drop by 8% and Nike's stock price to drop by 20%. (Wailgum, 2009.) There are other instances where poorly designed and unsuccessful ERP implementations have led to multi-million dollar losses and a decline in stock prices, such as Hewlett & Packard, The University of Massachusetts, and Waste Management. Other businesses that have struggled greatly with the

implementation of an ERP system include Foxmeyer Drug Company, Dell, Whirlpool, and Apple. (Tsai et al., 2010; Ghosh, 2012.)

Because ERP systems are built on automated and pre-programmed processes, their implementation may have a negative impact on the growth of integrated operational activities. Because the functions are automatically deemed to be efficient, automation of the system could result in a situation where no innovations are created or focused on. Due to the automation of functions by ERP systems, the hierarchy within the organization is also raised. Generally speaking, a company should avoid increasing its hierarchies. (Poston & Grabski, 2001.)

To avoid errors brought on by multiple processes, data typically only needs to be entered into the ERP system once. However, if incorrect data is entered into the system, it becomes more challenging to detect and correct errors, and occasionally it becomes impossible to pinpoint the error because incorrect data is spread throughout the organization's system automatically. As a result, even minor numerical entry mistakes have the potential to significantly alter business data, such as key figures. (Poston & Grabski, 2001.)

Another issue is ensuring the ERP system's flexibility. Although ERP systems combine various organizational functions to facilitate business decision-making and make it more agile, they can be a very rigid tool for the core of the business. Changes to the company's structure and corporate culture are necessary to accommodate the systems' logic. Although ERP vendors make investments in flexibility, the reality is frequently different. The company's practices and requirements may not align with the new methods that the ERP system has introduced. Due to better specialization, software that was initially created to manage just one function, such as sales and marketing tools or separate accounting software, can be more effective and beneficial for a company. Software, which concentrates only on one aspect are generally more agile and customizable than heavy ERP systems. (Davenport, 1998; Al-Mashari, 2002.)

Instead of integrating the system with the company, businesses are attempting to adapt to it. Separate software frequently develops more quickly, and its update cycle might be shorter. Several businesses in the same industry might use standardized ERP systems. As a result, a business cannot use the implementation of an ERP system to differentiate itself from the competition and gain a significant competitive advantage. As a result, specialization may be a better competitive tool for a business than an ERP system. (Davenport, 1998; Al-Mashari, 2002.)

The most crucial and crucial process involved in deploying an ERP system is, by far, successfully implementing the system. Every business must determine the best and most appropriate method for putting an ERP system in place. There are numerous "best practice" models for implementing ERP systems, but they might not be the best for your business and industry. Models also become outdated as businesses and industries develop. (Poston & Grabski, 2001.)

3 Business Intelligence

This chapter examines what Business Intelligence is, what is Big Data, and how does it relate to Business Intelligence and lastly, what are the benefits and risks of using Business Intelligence in an organization.

Because ERP systems collect a lot of data but do not offer quick access to the relevant information that could be used in decision making, they have increased the need for business intelligence systems (Ranjan, 2008; Williams & Williams, 2007). Business intelligence has the advantage of efficiently and methodically searching data from ERP systems. (Brignall & Ballantine, 2004; Williams, 2008).

The benefit of making a business intelligence investment is that it enables proactive data use rather than reactive data use. Automation and integration of as many processes and steps as possible is the primary goal of BI. Providing information for analytics that is as tool independent as possible is another goal of BI (Biere, 2003). Business intelligence is used proactively to transform data from internal and external sources into information that can be used to protect a company's advantage over competitors in the market. Contrarily, the reactive use of data enables a business to make use of the findings and outcomes of operational processes. The transformation of a company's strategy and operational procedures can be supported by operational processes. (Ranjan, 2008.)

Businesses today operate in a volatile environment. As a result, businesses are starting to recognize the strategic advantages of information systems. By offering support for decision-making, BI systems enhance the company's overall performance. Companies rely on information to strengthen and maintain their competitive advantage when they learn that their profits are declining. (Gibson, Arnott, & Jagielska, 2004, p. 295-296.) A company can increase its sales and efficiency by implementing a BI system, which allows it to use information differently than before (Williams & Williams, 2007).

3.1 Conceptualization of Business Intelligence

Howard Dressner, an analyst at the esteemed research company Gartner, is credited with originating the term "Business Intelligence" in the early 1990s. Initially, its purpose was to describe analytical applications, and over time, it has become a widely recognized and ubiquitous term (Watson & Wixom, 2007, p.96). However, due to its versatile nature, there is no universally agreed-upon definition for Business Intelligence (Wixom & Watson, 2010). The lack of a consensus on the definition of Business Intelligence is highlighted by Williams (2011), who argues that its scope encompasses a wide range of components, such as technology, data integration approaches, customized software applications, and information analysis. This breadth contributes to the ambiguity surrounding the term (Williams, 2011, p. 27-28). Nevertheless, leveraging Business Intelligence within an enterprise can yield significant value by driving revenue growth and cost reduction. (Williams 2011, p. 27–28.)

In his work, Williams (2008) provides an alternative definition of Business Intelligence (BI). He portrays BI as a structured and business-driven approach aimed at enhancing a company's performance and profitability. By integrating business-related information, analytical tools, and decision support into the company's core value chain functions, the efficiency of its processes can be significantly improved (Williams, 2008:28).

Furthermore, Williams and Williams (2007) emphasize that Business Intelligence is not confined to a singular product, technology, or methodology. Rather, it encompasses a combination of products, technology, and methods that facilitate the organization of information management needs, foster business growth, and enhance overall company performance. BI involves the strategic utilization of business information and analysis within the framework of key business processes, leading to informed decisions and actions that drive improved performance. Moreover, BI entails harnessing information assets within essential business processes to achieve heightened business performance. The primary objective of businesses is to boost revenues, reduce costs, and ultimately enhance performance and profitability (Williams & Williams, 2007, pp. 2-3).

From a technical standpoint, Watson and Wixom (2010) offer a definition of Business Intelligence (BI) that encompasses various technologies, applications, and processes. They refer to BI as an umbrella term commonly used to describe the storage, gathering, access, and analysis of data, all aimed at facilitating better decision-making in a business context. The utilization of BI is considered essential for remaining competitive in the market (Watson & Wixom, 2010, p. 13).

Similarly, Davenport (2006, p. 106-107) shares a comparable definition of Business Intelligence to that of Watson and Wixom (2010). According to Davenport, Business Intelligence represents a comprehensive entity comprising numerous processes and programs designed to collect, analyze, and share data in order to support effective decision-making.

Elbashir, Collier, and Davern (2008, p. 138) contribute a more technology-oriented perspective to the definition of Business Intelligence (BI). They assert that BI encompasses specialized tools used for data analysis and reporting. Moreover, a BI system typically relies on a specialized IT infrastructure that includes data storage capabilities and various data editing tools.

Sabherwal and Becerra-Fernandez (2011, p. 6) present two distinct ways in which the term Business Intelligence can be interpreted. Firstly, it can be viewed as a process that empowers companies to acquire, analyze, and share vital information and knowledge within the organization. In this context, BI serves as a means to facilitate efficient internal information flow and decision-making. Secondly, BI can also be regarded as an end product, consisting of valuable information that holds significance for the company's operations and decision-making processes. Additionally, BI can be understood as a technology, functioning as a tool for gathering data from various sources, performing data analysis, and converting and sharing the resulting insights with different users within the organization.

BI systems serve as comprehensive platforms that integrate data collection, storage, management, and analytical tools. They empower enterprises to effectively capture, describe, and present their intricate internal and competitive information, providing valuable support for decision-making processes. The essence of Business Intelligence lies in its ability to deliver information to the company's senior management in the right time, place, and format, facilitating informed decision-making (Negash, 2004, p. 178).

Hannula and Pirttimäki (2003) assert that Business Intelligence encompasses a set of systematic processes geared towards acquiring, analyzing, and sharing critical information necessary for business operations. This information is instrumental in supporting both operational and strategic decisions within the company (Hannula & Pirttimäki, 2003, p. 593). Therefore, according to Hannula and Pirttimäki (2003), the primary role of Business Intelligence lies in the analysis and reporting of data.

Elbashir et al. (2008) highlight the expansive role of Business Intelligence (BI) in facilitating decision-making across different levels of the company, ranging from operational management to top-level management. However, Arnott and Pervan (2005) criticize the lack of a precise and universally accepted definition for the term Business Intelligence. They point out that each company offering BI solutions tends to define their software according to individual needs and perspectives. Consequently, the meaning of Business Intelligence can vary, with some interpretations emphasizing its role as a decision support system, while others encompass a broader scope of information management (Popovič, Turk & Jacklic, 2010).

In line with these discussions, the research company Gartner defines Business Intelligence as an umbrella term encompassing a wide range of applications, infrastructure, tools, and practices. Its primary objective is to enable access to and analysis of information in order to enhance and optimize decision-making processes and overall performance (Gartner, 2012).

3.2 Different levels of information

It is wise to highlight the various informational tiers and big data before delving further into the definition of business intelligence. The purpose of business intelligence is to transform the data into information that can be used to support and grow a company's operations. It is also helpful to emphasize what Big Data is and how it should be used. First, various informational levels are discussed.

Thierauf (2001) provides a hierarchical framework for understanding levels of information, which includes data, information, knowledge, intelligence, wisdom, and truth. Data is classified as the lowest level of information, characterized by its unstructured, rudimentary, and fragmented nature. It requires modification to transform into meaningful information. Data can be objective and provide contextual answers to questions of who, what, where, and when (Thierauf, 2001, p. 8).

According to Thierauf (2001), data evolves into business information when management utilizes it for decision-making purposes (Thierauf, 2001, p. 3–4). However, Clinton and White (2012) discovered that controllers in the business realm were hesitant to adopt analytical tools like Business Intelligence. Instead, they continued relying on spreadsheet software for their daily tasks, even though more advanced tools were available. Implementing Business Intelligence would empower controllers to leverage the organization's comprehensive data and analytics for optimization and forecasting purposes (Clinton & White, 2012).

As data is processed, it transforms into information. Information represents structured data that can be utilized for analysis and problem-solving. It comprises a set of related data that adds value for the recipient. Knowledge, on the other hand, is formed when information is further processed. It represents a combination of different pieces of information and can provide answers to questions of how and why (Thierauf, 2001, p. 2-8). For the purpose of this study, the focus is primarily on data, information, and knowledge,

as the higher levels of intelligence, wisdom, and truth are deemed less significant in this context.

3.3 Big Data

Over the past two decades, the volume of data has experienced a significant increase across various fields, leading to the emergence of the term "big data." The continuous generation of vast amounts of data from diverse sources in this digital era is expected to drive a substantial rise in data volume in the coming years (Addo-Tenkorang & Helo, 2016). According to a report by Gantz and Reinsel (2011), the total volume of created and copied data worldwide reached 1.8ZB (=1021 B), which grew nearly ninefold within a five-year period. In 2010 alone, the world generated over 1ZB of data, and by 2014, this amount escalated to 74ZB annually (Richard, Matthew & Carl, 2011). The majority of this data surge can be attributed to various devices utilized within industrial enterprise supply chain networks, including smartphones, embedded sensors, computer systems, and computerized devices. This influx of data presents new opportunities to extract value, yet also poses challenges for industrial organizations in terms of data utilization, analysis, and storage. Therefore, big data can be defined as a rapidly expanding collection of data from multiple sources, which increasingly presents complex challenges and valuable-use analysis issues for industrial organizations. The four primary factors associated with big data are its diverse development sources (Variety - V1), rapid acquisition (Velocity - V2), large-scale storage (Volume - V3), and comprehensive analysis (Veracity - V4). Furthermore, the study of big data has evolved and expanded, driven by its implementation and application processes in specific industries to create value (Value adding - V5). As a result, the original four Vs of big data have now expanded to encompass five Vs (Addo-Tenkorang & Helo, 2016).

The business landscape is undergoing rapid changes, accompanied by a substantial increase in the number of data sources. The significance of analyzing Big Data has grown exponentially in recent times, and the ability to connect with diverse data sources and effectively handle various data formats has become a crucial competitive factor for

enterprises. Presently, databases exhibit impressive speed, and their development is expected to further enhance their performance. Big Data, as defined, refers to an immense volume of data that surpasses the capabilities of spreadsheet programs like Microsoft Excel for analysis (Syed, Gillela & Venu-gopal, 2013, p. 2446). It encompasses a wide range of data sources, including social media, internet-related information, and data associated with enterprise resource planning (ERP) systems. The data derived from these sources are vast, unstructured, and prolific, hence the term "Big Data" (Gray & Alles, 2015, p. 23; ACCA, 2013, p. 10).

ACCA (2013) studies indicate that Big Data has the potential to enhance overall company performance through the application of Business Intelligence. Big Data enables the collection, storage, and analysis of extensive data sets (ACCA, 2013). Consequently, Big Data plays a crucial role in describing an organization's large data warehouse, which can be effectively analyzed using Business Intelligence tools.

3.4 Benefits of Business Intelligence

The decision to implement a Business Intelligence (BI) system over an Enterprise Resource Planning (ERP) system is not always straightforward for companies, and it is crucial to understand its benefits (Elbashir et al., 2008). Some researchers argue that measuring the value or benefits generated by BI can be challenging, as many of these benefits are non-economic and intangible, such as improved data quality and timeliness (Hannula & Pirttimäki, 2003; Gibson et al., 2004; Williams & Williams, 2007; Popovic et al., 2010). However, non-economic benefits should eventually translate into economic benefits, such as cost reductions, operational efficiency, and improved profitability. It is also necessary to consider the time delay associated with the effects of BI when evaluating its benefits (Lönnqvist & Pirttimäki, 2006).

Nevertheless, some researchers contend that the benefits of BI extend throughout the organization and across different levels. In the future, BI is expected to be utilized even

for routine-based decisions involving customer interface workers, experts, vendors, and factory workers. Data will continue to play a crucial role in the functioning of companies (Williams & Williams, 2007; Stiroh, 2001).

It is important to note that BI is not merely an Information Technology solution, although technology plays a significant role in its implementation (Venter & Tustin, 2006; Pirttimäki, 2007). The value of BI is realized only when it is effectively implemented and actively utilized in the organization's planning and optimization processes. Therefore, BI does not have an immediate impact on the company's performance (Lönnqvist & Pirttimäki, 2006). The next Figure illustrates how Business Intelligence works in practice.

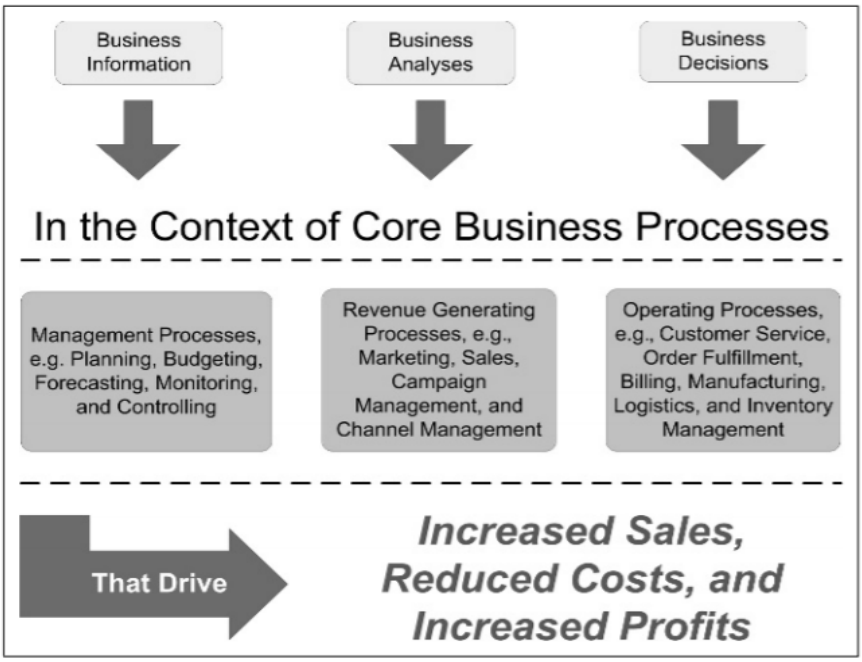

Figure 3. Business Intelligence in practice. (Williams & Williams, 2007)

The value generated by Business Intelligence is realized in the way as from the other Information technology solutions. It is based on how the resources and opportunities are utilized. The value generated by Business Intelligence depends on the processes being used in management. Also, it depends on the skills of the user, as information must be able to be utilized effectively in the company. (Williams & Williams, 2007). The return-on-investment increases, when getting higher quality data, which enables enhance the

processes. The more efficient processes enable a company to increase turnover while reducing the company's costs. (Ranjan, 2008). Bringing data closer to functions will support the growth of increased job satisfaction and the possibility to influence in the organization.

According to Nykänen, Järvenpää & Teittinen (2016), the survey's findings, improved business knowledge, increased operational effectiveness and better decision-making, are the main justifications for utilizing business intelligence. Approximately half of the BI users utilized BI systems because it reduced costs. However, it appears that operational effectiveness, which can also include lower costs, is a more compelling factor than lower costs alone. Competitive advantage was also viewed as a somewhat common reason for using business Intelligence. Almost half of the survey participants also used BI for frequent or very frequent purposes of continuous process monitoring. Even predictive analytics or forecasting was used by 41% at least regularly, and when those who use it occasionally are included, the percentage jumps to 75%. It indicates once more that BI is more than just historical reporting.

Among the respondents of the survey Nykänen, Järvenpää & Teittinen (2016), 78% said they at least somewhat agreed that BI sped up their decision-making, and 93% said the same about the quality of their decisions. These are significant numbers, indicating that business intelligence can significantly enhance the decision-making process. Surprisingly, "only" 78% of respondents thought BI was helpful for their daily tasks in general. Perhaps the increased decision-making quality alone is insufficient for BI to be useful overall, or BI usage is so infrequent that some respondents felt it was not offering value on a daily basis. Nevertheless, BI is generally regarded as valuable by the respondents as it was estimated to be somewhat valuable on average.

Business Intelligence is an entity, which consists of business information and business analysis. It impacts decision making through critical business processes (Williams & Williams, 2007, p. 2). BI systems provide indirect benefits to companies, and the most

significant ones are better quality of information and, as a result of that, improves business performance (Popovic et al., 2010). According to Elbashir et al. (2008), the benefits of Business Intelligence are strongly linked to the company's business processes and their efficiency. However, according to them, one of the most significant benefits of BI systems is that they allow a company to take advantage of the diverse data, which are stored in its systems. The benefits of Business intelligence can be categorized into three different groups that are tied to a company's business processes:

1. The first category is the benefits of business partnership relationship. It includes the benefits, which company derives from relationships with various business partners as well as suppliers. They are manifested, for example, in the reduction of transaction costs, better coordination and better inventory management.
2. The second category is the benefits of the efficiency of internal processes. They are reflected in the company's internal processes as a better, quicker and more reliable function. These benefits may also include the improved productivity of the staff and reduced costs of the operations.
3. The third category is the benefits of customer-related data, which means understanding customer buying behaviour, forecasting customer needs, and improved allocation between new products and services. For instance, a company can divide customers into better segments with using a BI system, which may lead to, for example, to reduced marketing costs and increased sales.

These business process-related benefits contribute to a company's overall performance through revenue and competitive advantage. The benefits which are strongly correlated to an organization are increased revenue, reduced lost in sales, improved regional sales distribution, improved profit margin, higher return on investment and improved competitive advantage. (Elbashir et al., 2008, p. 135, 144-145.) The benefits of Business Intelligence are also related to various aspects of information. According to Tyson (1986), Business Intelligence includes information related to customers, competitors, markets, products, and the corporate environment. Business Intelligence provides a different type of benefits to different organizations, as each

organization has different business information. BI, however, can create a unique competitive advantage for the company. (Moss & Atre, 2003, p. 31.)

4 Data Vault

The empirical part of this study revealed that Data Vault plays a major role in the integration of ERP and BI. In this chapter, we will go deeper into what Data Vault is to help the reader understand better the results of the empirical part. It is not recommended to have direct integration between ERP and BI and therefore Data Vault has been introduced. Data Vault works between ERP and BI to ensure that information flows and stores from ERP to Business Intelligence system efficiently.

4.1 Introduction to Data Vault

In an era of digitalization, the majority of societal and business functions rely on data, which can take many different forms. Applying data analytics on top of the data is necessary to gain a sizable competitive advantage and some insights from it. (Margulies (2015). Because of this, the amount, speed, and variety of data have been growing quickly over the past few decades. It became necessary to use a cutting-edge approach to get around all the potential drawbacks of traditional data warehouse solutions.
Traditional data modelling techniques, for instance, may become challenging to maintain to store all the data given the volume that keeps growing or changing. The classical data warehouse model is quite robust, but it can't handle all business requirements. (Vines & Samoila, 2023). Additionally, there are numerous problems with the traditional systems, including the absence of source keys, data problems, poor data quality, performance gaps, and a lack of database tuning or partitioning, and therefore Data Vault has been introduced. (Linstedt & Graziano, 2009 & 2011)

Data Vault 2.0 (DV2) is a business intelligence system that includes modelling, methodology, architecture, and best practices for implementation (Inmon & Linstedt,2015). The DV2 consists of the following components:

- DV2 Modelling (changes to the model for performance and scalability)
- DV2 Methodology (following Scrum and agile best practices)
- DV2 Architecture (including NoSQL systems and Big Data systems)

- DV2 Implementation (pattern-based, automation, generation Capability Maturity Model Integration)

The term “Data Vault” was invented in 2001 purely as a marketing term to represent the system to the market (Inmon & Lindstedt, 2015). "Common foundational warehouse architecture" is the true name for the Data Vault System of business intelligence (BI). The system covers several aspects that relate to the business of designing, implementing, and managing a data warehouse, which is shown in Figure 4.

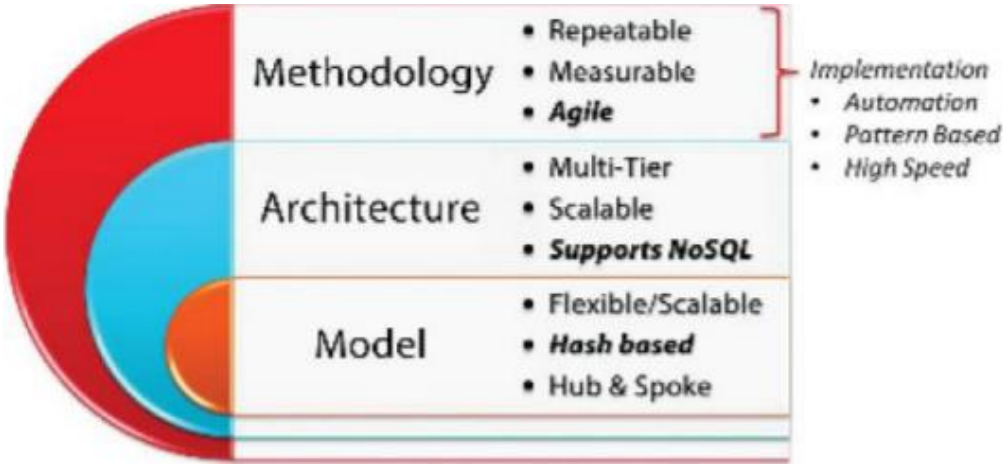

Figure 4. Data Vault System of business intelligence (Inmon & Lindstedt, 2015)

According to Inmon & Lindstedt (2015), Data Vault has several unique features, including a modelling style for enterprise data warehouses. The methodology applies concepts from software development best practices such as CMMI, Six Sigma, total quality management (TQM), Lean initiatives, and cycle-time reduction to ensure repeatability, consistency, automation, and error reduction. Each of these elements is critical to an enterprise data warehousing project's overall success. These elements are combined with industry-recognized and time-tested best practices such as CMMI, Six Sigma, TQM (total quality management), and Project Management Professional (PMP).

Data Vault 1.0 mainly focuses on data modelling, whereas Data Vault 2 encompasses the entire business intelligence effort (Inmon & Lindstedt, 2015) Data Vault has evolved

beyond the data model to allow teams to work in parallel while adhering to Scrum agile best practices. The Data Vault 2 architecture is designed to include NoSQL (think: Big Data, unstructured, multistructured, and structured data sets). The model's seamless integration points and well-defined implementation standards provide project teams with direction. They can delegate the responsibilities to any of the setups shown in Figure 5.

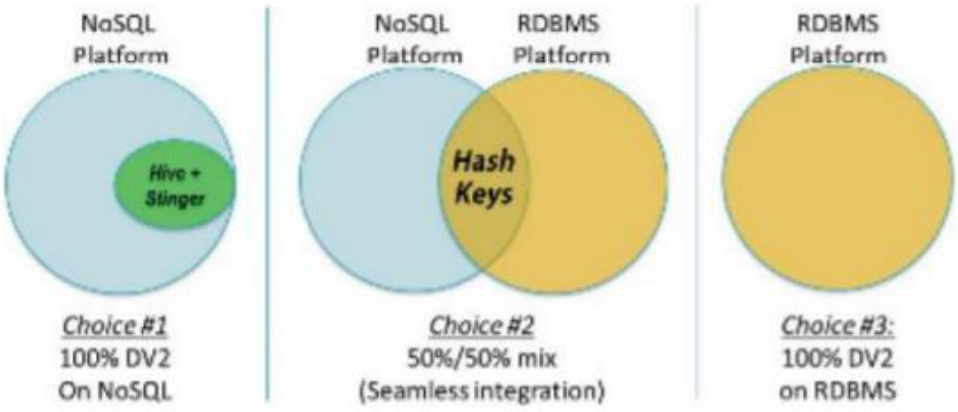

Figure 5. Data Vault Architecture (Inmon & Lindstedt, 2015)

4.1.1 Business Benefits of Data Vault 2.0

There are several advantages in utilizing Data Vault 2.0 systems, and there are far too many to list all of them, all of which are derived from the established best practices of CMMI, Six Sigma, TQM, PMP, Scrum agile, automation, and other similar concepts. (Inmon & Lindstedt, 2015). However, maturity is a good way to sum up the reason for using Data Vault 2.0 Business Intelligence systems.

Business intelligence and data warehousing systems must have the following essential components to be mature: repeating patterns, redundant design, fault-tolerant systems, great flexibility, high scalability, maintained constant costs for absorbing changes, Key process areas with measurable outcomes, gap analysis, and integration of unstructured and big data (Inmon & Lindstedt, 2015).

Data Vault 2.0 fulfills the business requirements of Big Data, unstructured data, multi-structured data, NoSQL, and managed self-service Business Intelligence (Inmon & Lindstedt, 2015). Data Vault 2.0 is specifically designed to support the development of business intelligence (BI) and enterprise data warehousing (EDW). The objective of Data Vault 2 is to develop repeatable, consistent, and scalable business intelligence system building procedures while enabling seamless interface with emerging technologies (i.e., NoSQL environments).

The following are some examples of the business advantages that emerge from using data vault systems: Reducing total cost of ownership (TCO) for EDW/BI programs, Improving team agility (including delivery), and Enhancing transparency throughout the program (Inmon & Lindstedt, 2015). The resulting advantages of using Data Vault is demonstrated in the Figure 6.

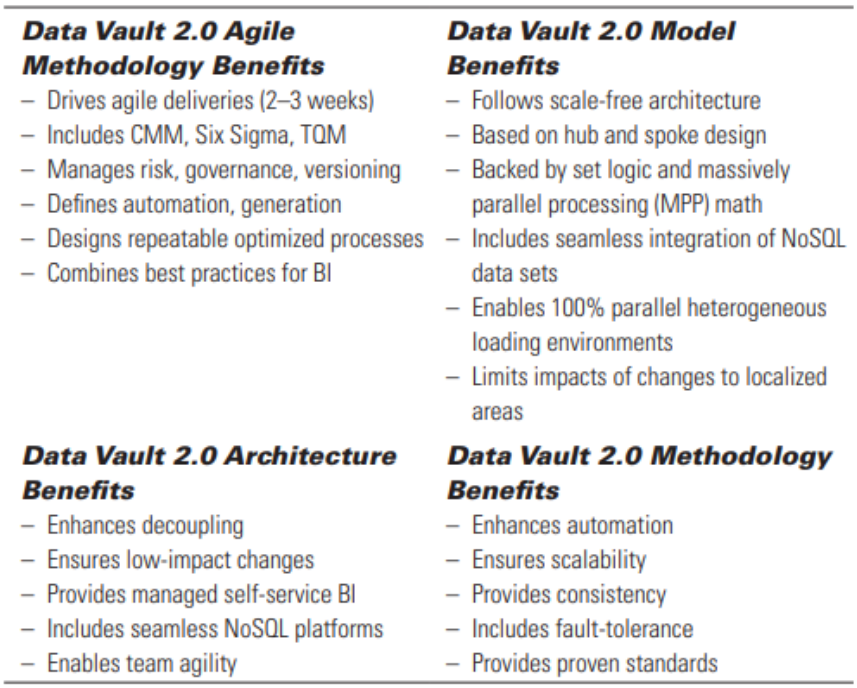

Figure 6. Business benefits of using Data Vault 2.0 (Inmon & Lindstedt, 2015)

4.2 Data Vault 2.0 Modelling

The objective of Data Vault 2.0 Modelling is to provide flexible, scalable patterns that work together to integrate raw data for the enterprise data warehouse by business key (Inmon & Lindstedt, 2015). Minor changes have been made to the modelling paradigms in Data Vault 2 to ensure that they can work with Big Data, unstructured data, multi-structured data, and NoSQL. The sequence numbers for hash keys are changed by Data Vault Modelling. Stability, parallel loading methods, and decoupled computing of parent key values for records are all provided by hash keys.

4.2.1 A Data Vault Model Concept

On a conceptual level, the Data Vault model is a hub-and-spoke based model, which is designed to target its integration patterns centered on business keys (Inmon & Lindstedt, 2015). These business keys are used to locate and uniquely identify records or data that are stored across multiple systems. These business keys are conceptually self-contained, which means they don't rely on other data to function. These business keys are used to locate and uniquely identify records or data that are stored across multiple systems. These business keys are conceptually self-contained, which means they don't rely on other information to exist.

Business context (or business ontologies) are elements that make sense to a business from a master data perspective, such as customer, product, service, etc. (Inmon & Lindstedt, 2015). These concepts are business drivers at the lowest level of grain. Unless the source systems provide data in this manner, the Data Vault model does not subscribe to the concept of supertype and subtype.

4.2.2 Data Vault Model Defined

A Data Vault model is a collection of normalized tables that supports one or more functional business areas and is detail-oriented, historically tracked, and uniquely linked. The model entities in Data Vault 2.0 are keyed by hashes, as opposed to the model entities

in Data Vault 1.0, which are keyed by sequences (Inmon & Lindstedt, 2015). The modeling approach is a unique mixture of dimensional modeling and third normal form methods, tailored to the enterprise's requirements. The hub-and-spoke diagramming technique, also known as "scale-free network" design, is a foundation for the Data Vault model.

4.2.3 Data Vault Model Components

Hub, link, and satellite are the three fundamental components of a data vault model (Inmon & Lindstedt, 2015). In terms of business, the hubs stand in for the actual business keys or master key sets that are distributed horizontally throughout the enterprise. The associations and relationships between the enterprise's business keys are represented by the links. The satellites, which continuously store non-volatile data, are the actual data warehousing components.

The normalization and division of data classes are the foundations of the Data Vault model. In this instance, the business keys (hubs) are considered to be different class than the relationships (links) (Inmon & Lindstedt, 2015). The context or descriptive data (satellites), which is subject to change over time, distinguishes between the two types.

4.2.4 Data Vault and Data Warehousing

The goal of Data Vault is to decrease the total cost of ownership in the organization (Inmon & Lindstedt, 2015). For instance, this means lowering overhead costs, decreasing delivery time for products and services and increasing quality of the deliverable. Correctly implemented and designed Data Vault data warehouse can be beneficial to these tasks. Data vault data warehouse can also discover and trace activities which are needed to identify critical paths. The ability to track and trace the data set across multiple lines of business creates great value, since without data traceability data can become quite valueless.

The ability to identify critical path and eliminate business processes that add no value and only serve to slow down the production and delivery of the product or service is provided by critical path analysis in the workplace and the establishment of the trace across multiple lines of business (Inmon & Lindstedt, 2015). This enables the business to engage in cycle-time reduction (or Lean enterprise initiatives). The crucial path and enduring business processes that need to be addressed in cycle-time reduction efforts may really be seen by understanding the journey of the data (identified by business keys) across the various lines of business.

It is simpler to assign value and understand the discrepancies between what multiple source systems are actually capturing and executing on and what the business perceives (i.e., the requirements they provide to the enterprise data warehouse (EDW) team) by tracking the business processes to the data through business keys (Inmon & Lindstedt, 2015). Helping to understand where the company may be losing money is one of the processes' outcomes (ideally). By bridging the gap using total quality management (TQM) best practices, they can potentially boost sales and improve the product or service's quality while also stopping the money loss.

4.2.5 Basic Rules of Data Vault Modeling

Data Vault model has some important rules that have to be followed, or the model itself can’t be classified to be a Data Vault model (Inmon & Lindstedt, 2015). Following rules are for example:

- Business keys are divided based on semantics and grain. The keys customer corporation and customer individual must be present or recorded in two different hub structures for this to be true.
- Link structures are used to organize relationships, occasions, and intersections between two or more business keys.
- Link structures are only a reflection of the relationship at the moment the data entered the warehouse; they do not have beginning or end dates.

- Satellites are divided into groups based on the data's classification, kind, and rate of change. One source system is frequently used for data of this kind.

  Supertypes and conformance are not addressed in Raw Data Vault Modeling, nor is it permitted or supported by it. These obligations are covered by the business vault models. (another form of Data Vault Modeling that is used as an information delivery layer).

4.3 Data Vault 2.0 Architecture

Data Vault's main goal is to guarantee quick adaptation to changes in the event that a new business object is defined or some new sources are ingested (Linstedt,2016, Three-tier data warehouse architecture is the foundation of the Data Vault 2.0 Architecture. The staging or landing zone, data warehouse, and information delivery layer are typical names for the tiers (or data marts). The numerous layers enable implementers and designers to isolate the enterprise data warehouse from information sourcing and acquisition as well as information delivery and data provisioning tasks. As a result, the team is more agile, and the architecture is more fault-tolerant and adaptable to change. (Inmon & Lindstedt, 2015),

Enterprise data warehouse (EDW), information marts, and information delivery layer are the sections (Inmon & Lindstedt, 2015). These layers will endure regardless of the platforms and technology utilized for execution. However, the demand for and dependence on the staging area will diminish as the system gets closer to complete real-time enablement. The EDW layer will receive data that is truly real-time.

In addition to the three layers, the architecture of Data Vault 2.0 dictates various components:

- Hadoop or NoSQL handles Big Data
- As real-time data moves in and out of the business intelligence (BI) ecosystem, the EDW gradually transforms into an operational data warehouse.

- Utilizing write-back and master data capabilities, managed self-service business intelligence (SSBI) (SSBI) enables overall quality management. (TQM).
- The enterprise data warehouse serves as a system of record for raw facts that are loaded over time by separating hard and soft business rules.

4.4 Data Vault 2.0 Implementation

Business intelligence (BI)'s Data Vault solution offers standards for implementation in the form of implementation guidelines, rules, and suggestions (Inmon & Lindstedt, 2015) . As mentioned in earlier sections of this chapter, the success of agile, Capability Maturity Model Integration (CMMI), Six Sigma, and total quality management (TQM) principles depends on having clearly defined standards and patterns. These guidelines direct the application of:

- The data model, identifying strategic imperatives, creating entities, and implementing important structures.
- ETL/ELT load operations.
- The feeds for real-time messaging.
- Information warehouse virtualization.
- Best automation practices.
- processes for delivering information marts.
- Hard and soft business rules.
- Capabilities for writing back in managed self-service BI.

Meeting TQM requirements, adopting master data, and assisting in alignment across business, source systems, and the enterprise data warehouse are a few of the goals of managing implementation through working practices (Inmon & Lindstedt, 2015).
Before continuing, it is important to realize that pattern-based and data-driven processes, designs, and implementations are the only way to achieve the highest level of optimization.

4.4.1 The Importance of Patterns

Patterns simplify life in the corporate world (Inmon & Lindstedt, 2015). Patterns in corporate BI enable automation and creation while lowering errors and the possibility of errors. The base of the Data Vault 2.0 BI system is patterns. It is possible to extend this idea to pattern driven design if the team has agreed that creating a data warehouse or BI system is similar to creating software.

A pattern that only functions in a particular situation, frequently based on an if statement, is referred to as conditional architecture (Inmon, Lindstedt, 2015). The architecture must alter when the case's boundaries (such as volume, velocity, or variety) change. Conditional architecture is the result. Constructing or designing an enterprise BI solution using conditional architecture is terrible. Reengineering is necessary to repair or adjust a design when volume increases and deadlines (velocity changes) shorten. This results in a solution that keeps getting more expensive and takes longer and longer to change. In other words, it eventually results in a brittle architecture. This is a terrible construct, especially for a Big Data solution.

The business will eventually be unable to cover the costs of reengineering (Inmon, Lindstedt, 2015). This usually occurs when the problem is completely dismantled and reconstructed (greenfield technique). For 98% of the instances where volume expands, velocity changes, and diversity increases, re-architecture and reengineering are avoided with the patterns of Data Vault 2.0 (both architecture and implementation). When the team uses the appropriate pattern or design that is founded on mathematical principles, reengineering due to changing needs is no longer a problem.

5 The integration between ERP and Business Intelligence

The purpose of this chapter is to examine how does the integration between ERP and Business Intelligence affect a company's performance. There has not been much research on how does the integration between these system affect company's performance. It is difficult to prove how the use of an ERP and a BI system will improve a company's performance, for example, by lowering the company's costs or enhancing revenue.

5.1 Business Intelligence integrated into an ERP system

Company data, especially from ERP systems, is one of the company's resources, and it can help build a competitive advantage over other companies and thereby achieve success. Data is often fragmented, incomplete, and usually not in a correct form, and for that reason, it cannot be used effectively. Data must be converted into information so that it can be utilized in industry and business departments. That is the reason why Business Intelligence system is necessary, as it allows data to be harmonized and thus, it provides a full image of the company. Harmonizing data will lead to an enhanced performance of the company. Especially ERP systems generate a lot of operational data, which is processed by using Business Intelligence to utilize data for decision making. (Ranjan, 2008, p. 467, 470.)

More and more companies, on the other hand, have switched to use BI tools, so that companies can efficiently utilize ERP system's data. BI systems are capable of extracting data from an ERP system, performing various analyses and generating reports which enable timely and accurate decisions to be made. (Chou et al., 2005, p.343.) One advantage of the BI system is that it allows information to be retrieved from the ERP system (Brignall & Ballantine, 2004; Williams, 2008). Convergence between the ERP system and BI is essential to highlight, as BI is often part of an ERP system (Elbashir et al., 2008). BI-system can be often found in companies which have already implemented an ERP system (Foster, Hawking & Stein, 2005).

ERP systems were not initially designed to produce real-time reports for a large number of users, so, therefore it is not suitable for analyzing data or decision-making process (Chou, Tripuramallu & Chou, 2005, p. 341 – 343). However, most of today's midsized and large companies have implemented an ERP system, as previous studies show (Laudon & Laudon, 2000; Sedera, Gable & Chan, 2003). At present, a competitive, uncertain environment and the quality of an organization's Business Intelligence and up-to-dateness can lead to differences between profits and losses, but also differences between company's survival and bankruptcy (Ranjan 2008, p. 461, 468).

However, there must be a rational reason to implement a BI system, so companies must analyze and evaluate how functions and processes can be enhanced by using Business Intelligence (Elbashir & Williams, 2007). Nonetheless, finding new competitive advantages is a constant struggle for companies. If the companies are not able to adapt to changes and challenges in the business environment, likely, they will not survive in their market. (Popovič et al., 2010.)

The BI system includes several technological features for reporting, analysis and information sharing, so it can be integrated into an ERP system to maximize the return on investment in the ERP system. The operational data of an organization is often very scattered throughout the organization's data systems. The BI system presents an overall picture of the organization's financial activities. Also, the BI system enables that the BI tools can be used throughout the organization. (Chou et al., 2005, p. 344; Agostino, 2004.)

The BI system can be used to inquire about financial outlooks, for example, sales figures (by location, customer or employee), sales receivables, bank account reconciliations (bank account opening and closing balances) and general ledger (budgets, forecasts, sales, revenues and variations by unit) (Rasmussen, Goldi & Solli, 2002, p. 304). Due to the BI solution, controllers can detect changes in cash flows in real-time, minimize overdue in sales receivables during the current month and increase the use of data imported

from the ERP system. Also, BI improve the company's profitability by analyzing and reacting to the trends and also reducing the time, which takes to process the reports. (Agostino, 2004.) In order to understand BI as part of a broader information system combination, it is vital to illustrate the relationship between its various components by this following figure (Vakalfotis, Ballantine & Wall, 2011, p. 2).

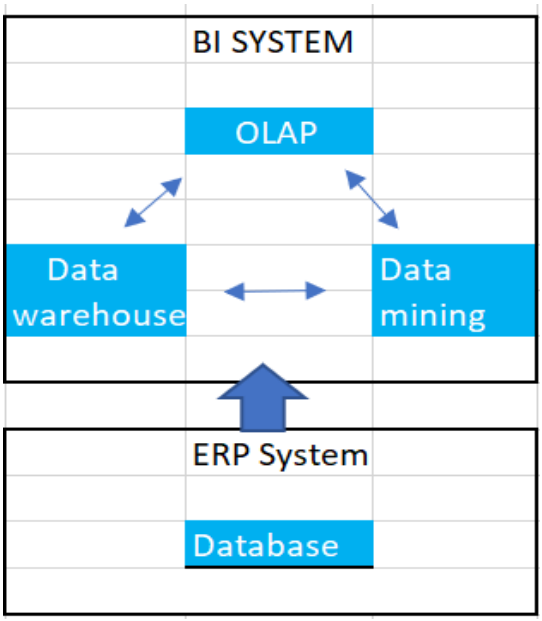

Figure 7. BI System's relationship with ERP system (Vakalfotis et al., 2011, p.2)

In general, Business Intelligence systems consists of three complementary and interconnected tools: data warehouse, OLAP (online analytical processing), and data mining. According to Teorey, Lightstone, and Nadeau (2006), OLAP is intended for rapid ad hoc surveys, and data mining is a combination of algorithms, which is used to get relevant things from data, such as trends. The data warehouse is for storage, maintenance and retrieval of data. The company's objective may include, for instance, reorganizing and enhancing internal processes, reducing costs, or increasing revenue. Achieving these goals is possible through using BI tools, which can bring together different sources into a unified set of existing data, which allows management to make analyses and decisions based on it. (Olszak & Ziemba, 2003.) Business Intelligence utilizes financial and non-financial metrics to assist in analysis and evaluation, and it seeks to lead the company with these features.

BI tools support decision making, analysis, monitoring, and it controls the operational functions of an ERP system. (Koupaei, Mohammadi & Naderi, 2016; Chaudhur et al., 2011.)

5.2 Benefits of integrating ERP and BI

The integration between a BI system and an ERP system offers a wide range of benefits. The integration between the two systems allows data for better data analysis. The BI system provides the ability to find and view a variety of trends and patterns, as well as the creation of different scenarios. Thus, the BI system performs various analyses using the operational data of the ERP system. Also, by integrating ERP and BI systems, a company is capable of enhancing its competitive edge continually. For instance, a BI system can find a specific type of model in pricing, allowing a company to modify its pricing. At the same time, these findings can be used for improving the ERP system's functionality. (Chou et al., 2005, p. 343; Nofal & Yusof, 2013, p. 658.)

The integration of these two systems has several benefits. For example, it allows to control the recognition of corporate cash flow in real-time, facilitates a company to implement cooperation between departments, improves profitability by transaction data analysis and forecasting business trends and reduces the time which is required to generate regular reports. Also, it enables finance staff to create financial revenue reports rapidly, improves accounts payable and vendor relationship management, it provides online access to the data, which will save access time, enables the management of the sales force, improves relations with customers through sales of in-depth data mining. Lastly, it will improve sharing information with the sales department, and this will allow making better decisions based on a macro view of the business. (Agostino, 2004.)

BI performs several operations, for example, facilitating the means of modifying, creating and distributing standard reports, data relationships, exploring the data, and trends through relevant methodologies to summarize conclusions, and BI can enhance organization's revenue and improve its operational efficiency (Thompson, 2006).

5.3 Concerns to ERPBI integration

Even though the integration of ERP and BI systems offer several benefits, there are still some concerns which are related to integrating these systems. These concerns are technological innovation, reliability and availability, system flexibility and scale efficiency. (Chou et al., 2005).

- Technological innovation: Customer's needs are continually changing. BI solutions should continuously adhere to the changing requirements and provide information infrastructures which suites well them rather than sticking with the same old technologies which do not satisfy the community of the users.
- Reliability and availability: As a Business Intelligence system scales up to the changing needs of the business, it should ensure a constant service with reliable performance. A BI system should have tools which provide load balancing, backup, and automated disaster recovery in times of need.
- Scale efficiency: Even though ERP system supports the enterprise-wide transactions, an integrated BI system is crucial for scale efficiency. When a company grows, it must provide proven infrastructure to schedule, manage, and deliver information to the right destination at the correct time.
- System flexibility: ERP systems are usually inflexible, and for that reason, BI systems have a responsibility to support all major web standards and integrate seamlessly with existing applications and infrastructures without much complexity. (Chou et al., 2005.)

6 How the integration of ERP and BI will be developed in the future

Integration of ERP and BI systems is at the cutting edge of innovation in the rapidly changing world of enterprise technology. The potential for this integration in the future is enormous, especially as organizations look to use data-driven insights for strategic decision-making, especially in the areas of machine learning and predictive analytics. This discussion explores upcoming trends that are expected to change how businesses use ERP and BI systems. Here is a brief overview of how this integration might develop in the future:

- **Advanced Predictive Analytics:** The field of advanced predictive analytics has made one of the biggest advancements. Forecasting techniques will be transformed by machine learning algorithms, which can find complex patterns within enormous datasets. These algorithms will enable businesses to predict market trends, consumer behavior, and resource requirements with accuracy. Predictive analytics, for instance, will help companies in the retail industry anticipate customer preferences, optimize inventory levels, and develop dynamic pricing strategies. In an environment where competition in business is on the rise, this transformative capability promises to improve agility and responsiveness. (Provost & Fawcett, 2013)
- **Natural Language Processing (NLP):** Within ERP and BI systems, the incorporation of Natural Language Processing (NLP) is expected to democratize data access. Users will be able to communicate with these systems using natural language queries thanks to NLP capabilities, eliminating the need for technical expertise. This innovation enables a broader range of stakeholders to gain insightful knowledge from the wealth of data at hand. NLP-driven interfaces will accelerate information retrieval and analysis, fostering a more inclusive data-driven culture within organizations, whether it be for creating custom reports or looking for specific KPIs. (Jurafsky & Martin, 2019)

- **AI-Driven Automation:** The development of automation powered by artificial intelligence (AI) is inseparably linked to the future of ERP and BI integration. Routine tasks like data integration, report generation, and data cleansing will be handled by AI algorithms. Human resources are freed up as a result of this transition, allowing them to refocus their efforts on more valuable strategic activities. For instance, AI-powered automation in financial operations will accelerate decision-making cycles and streamline procedures like invoice handling and reconciliation. (Chui & Miremadi, 2016)
- **Real-time Analytics:** Real-time analytics capabilities will be delivered by the integration of ERP and BI systems, bringing in a paradigm shift in decision-making. Businesses will be able to track their operations in real-time, enabling them to react quickly to changing conditions. Real-time data insights enable the optimization of routes, inventory levels, and resource allocation, which will have a significant positive impact on sectors like logistics and supply chain management. In an era where responsiveness is crucial, this newfound agility promises to increase competitiveness and customer satisfaction. (Davenport & Harris, 2007)
- **Personalized Insights:** Within ERP and BI systems, a new era of personalized insights is expected to be brought in by machine learning algorithms. These systems will pick up on user preferences and behavior trends, customizing dashboards and reports for different stakeholders. For instance, in marketing, personalized insights will make it possible to target customers with greater accuracy, improve ad campaigns, and increase conversion rates. This degree of individualization enhances the effectiveness of data-driven decision-making by coordinating organizational strategies with individual objectives. (Hastie & Friedman, 2009)
- **Enhanced Data Security:** Data security will become a top priority as AI and machine learning are incorporated into ERP and BI systems. Advanced security measures, such as AI-driven threat detection and automated response systems, will be incorporated in future integrations. These measures will defend organizations from evolving cyberthreats, protect sensitive data, and increase

stakeholder trust. Businesses can confidently utilize the full potential of ERP and BI integration by proactively addressing security concerns. (Schneier, 2015)

- **IoT Integration:** A significant step forward has been made with the integration of ERP and BI systems with the Internet of Things (IoT). Companies will be able to collect and analyze data from a variety of connected devices with ease thanks to this integration. This synergy will benefit a variety of industries, from manufacturing to healthcare, as IoT-enabled sensors offer a wealth of real-time data for analysis. This increase in data will lead to advancements in process optimization, proactive maintenance, and customer-focused product design. (Vermesan, Friess, Guillemin, Gusmeroli, Sundmaeker & Bassi, 2014)

In conclusion, cutting-edge technologies will converge in the future of ERP and BI integration, with machine learning and predictive analytics at the forefront of innovation. These developments promise to fundamentally alter how businesses use data to inform strategic choices and boost operational excellence and competitiveness. Businesses can position themselves at the forefront of data-driven excellence in a constantly changing global market by embracing these trends.

7 Empirical research methods

7.1 Qualitative research method

The qualitative research method is primarily used in this thesis. While being more subjective, qualitative research offers greater understanding and insight into the topic under study (Barnham 2015). It is frequently inductive. The study investigates the subject in-depth and in detail without using predefined categories and is not predicated on any preexisting hypotheses or formulas. Instead of measuring a single variable or making statistical generalizations, its aim is to make a thorough description of the phenomena that occur in the real world. Instead of breaking the case up into separate parts, a well-executed qualitative study considers all of its different facets (Eskola et al. 2005).

A grounded theory methodology was used in the study. The first time it is mentioned is in Glaser and Strauss' 1967 book, "The discovery of grounded theory: Strategies for qualitative approach." Following that, the strategy underwent numerous changes. These approaches have in common the collection and analysis of qualitative data using empirical techniques and the development of the theory based on the data. According to Saaranen-Kauppinen et al. (2006), it is a material-based inductive study method. What are the benefits and challenges of integrating ERP and Business Intelligence? is the typical opening question for grounded theory studies like this one. Later subject research and data collection allowed the theories that were used in the thesis to start to take shape.

7.2 Data Collection

Field research is used in this thesis to collect data. Semi-structured theme interviews were used to collect the primary data for this thesis. The interviewees are asked the same questions using this method, allowing them to respond in their own words (Eskola et al. 2005). The researcher wants to concentrate on particular issues for this thesis, so a semi-structured approach is preferable to an open interview.

To collect the data, five interviews with six respondents were conducted. One interview included two persons at the same time, while the rest were one-on-one interviews. All interviewees were contacted by phone or email, and meetings were set up after brief introductions of the thesis' main themes to each party. One of the interviewees was chosen based on the information gained from the previous interview. Interviews were held via Microsoft Teams meetings during 2022-2023.

Table 1. Interview summary

Title	***Date***	***Length of the interview***
Finance Data and Analytics Lead A	5.9.2022	43 min
Head of Enterprise Architecture & Enterprise Architect A	14.11.2022	48 min
Business Controller B	6.3.2023	35 min
Business Controller C	7.8.2023	50 min
Chief Information Officer D	22.8.2023	35 min

8 Empirical results

The results from the interviews are presented in this chapter. The purpose of the interviews is to learn more about the integration of ERP and BI-related research questions. Each interview question covers different themes about the integration of ERP and BI. Although some sections might have partial overlap with one another, all areas are important to understand to answer the research questions properly. The analysis tried to find commonalities from the interviews and gain reliable insights to the research questions.

8.1 Interviewee information

Each interview started by asking the interviewee job title and role in the company. The aim was to get insight from participants, who are involved and have an in-depth understanding of ERP and BI systems integration. In this chapter is the introduction of the respondents of the interviews.

"*My job title is Finance Data and Analytics Lead. My Responsibilities include the finance development department, which develop our company's Data Eco system, which aims to think about not just doing reports on top of ERP but thinking about coherence, synergy and harmonization of data between programs. I also act as a supervisor for our team and have a wide range of responsibilities." (*Finance *Data and Analytics Lead A)*

Also, there was another interview with Head of Enterprise Architect & Enter-prise Architect from the Company A. The other interviewees were two business controllers from companies B and C and one Chief Information Officer from company D.

"My job title is Business Controller. I am responsible for overseeing the financial performance of the company, analyzing data, providing insights for strategic decisions, and ensuring efficient resource allocation." (Business Controller B)

8.2 ERP and BI software in the studied companies

The companies interviewed have many different types of ERP and BI software in use, but many of them use the same software. The most popular ERP software occurred to be SAP and the most popular BI software occurred to be Microsoft Power BI. Company D was a standout company in this study because it is the only company with a custom-built ERP.

"Our most used ERP software is SAP, but SAP is linked to several different software. The main BI software are Microsoft Power BI, SAP BO, Qlik Sense, Tableau and Excel. In addition, our Data Scientists use R-code to create various graphs using Jupiter Notebook." (Finance Data and Analytics Lead A)

"We use SAP, Microsoft Dynamics 365, Oracle Finance, SAP Business Object, Microsoft Power BI and Qlik sense. SAP business warehouse is our official data source. Also, we have other various cloud data warehouses and data lakes, and SAP BW is used to integrate data from ERP to business intelligence software." (Head of Enterprise Architecture & Enterprise Architect A)

"We use SAP ERP for managing various business processes such as procurement, inventory, and finance. For Business Intelligence, we utilize Microsoft Power BI to create interactive reports and dashboards for data analysis." (Business Controller B)

"We utilize Microsoft Dynamics 365 for our ERP needs, managing processes such as procurement, finance, and inventory. For Business Intelligence, we rely on Tableau to create interactive visualizations and reports." (Business Controller C)

"We have a custom-built ERP system, which is not an off-the-shelf product, but a system that we have developed ourselves from scratch. Our BI software is Microsoft Power BI for reporting, our data warehouse is Snowflake, and our data is transferred by using

Microsoft Azure cloud native tools such as Azure Data Factory, Integration Runtime, Blob Storage and Power BI Gateway." (Chief Information Officer D)

8.3 The integration between ERP and BI

One of the main questions of this study is that are ERP and BI related to each other in organizations, which means that do companies use them together at the same time, and does the companies utilize data from ERP for their BI reports.

It turned out from these interviews that, direct integration between ERP and BI is a bit old-fashioned concept. Nowadays, as technology has evolved, different software has been introduced between ERP and BI to ensure that data is transferred as smoothly as possible between the software.

"There should not be direct integration between ERP and BI, because ERPs are the most productive systems in our company. If, for example, Power BI software was used for reporting and if it were directly linked to the ERP system, it would overload the ERP system. In such a situation, the operational work that is done from the ERP, which is not only related to reporting, would be compromised because the ERP system would be overloaded. This is why something should be put between ERP and BI to ensure that information flows from ERP to Business Intelligence systems smoothly." (Finance Data and Analytics Lead A)

"Perhaps in the past, the direct integration between ERP and BI has played a bigger role. Today, ERP and BI are somewhat distanced from each other." (Head of Enterprise Architecture A)

For ERP and BI integration, a wide range of software has been developed to improve the transfer of data between the software. ERP systems would easily become overloaded if there were direct integration between ERP and BI.

“Currently, when we retrieve data from Sap, we have a specific tool for that. It's called Aecorsoft, which is a tool specialized for SAP software that allows to manage data integration from different SAP software. With Aecorsoft you can connect to all SAP products. Then once Aecorsoft has retrieved the data it needs from SAP, it transfers that data to a cloud environment called Azure. In Azure, the data is first moved to a data lake storage called BLOB storage. The data is then moved to an enterprise data warehouse. Then the Enterprise Data Warehouse layer is modeled using the Data Vault Methodology.” (Finance Data and Analytics Lead A)

Also, Enterprise Architect Department from company A utilizes Aecorsoft software for ERP and BI integration.

“We use Aecorsoft and it allows us to transfer from SAP spreadsheets to data lakes and it allows us to make changes in the cloud and to edit the data as we want. In the past we have also used Informatica software, but we have found Aecorsoft to work better for this integration.” (Enterprise Architect A)

Company C also utilizes Data Vault methodology in the ERP BI integration.

“The integration between ERP and BI is accomplished through a data vault methodology. We extract relevant data from our Microsoft Dynamics 365 ERP system and use the data vault model to store and organize this information. This approach ensures data accuracy and consistency for reporting and analysis purposes.” (Business Controller C)

Company D, which has custom-built ERP, has its data exported to the BI tool in a processed format.

“In our company, ERP and BI are integrated with each other in such a way that the relevant and necessary data found in ERP is exported to the reporting layer (Power BI) via the data warehouse. And our integration technologies consist of the previously

mentioned software, which are: Microsoft Azure cloud native tools such as Azure Data Factory, Integration Runtime, Blob Storage and Power BI Gateway" (Chief Information Officer D)

The studied companies utilize various software for the ERP BI integration such as Aecorsoft, Microsoft Azure and Power BI Gateaway. These results indicate that there is no direct integration between ERP and BI and the Data Vault methodology is an important tool in this integration process.

8.4 Challenges of the ERP BI integration

In the studied companies the integration of ERP and BI does not always go smoothly and most of the case companies have faced various challenges in this regard. For instance, Company A no longer faces significant challenges from a technical point of view but has been more challenged from a resourcing point of view internally.

"There have been many challenges related to the integration of ERP and BI. For example, we have had challenges with resourcing in-house. Technically, integration is not that difficult anymore because the infrastructure is in place. The problem comes in the fact that we are now able to produce more data and bring in more data, but our business processes and staff are challenged to keep up with this increased data. The challenges have shifted from technical implementation to business. In the past, employees didn't have the data decoded ready to go, instead they used to model the data themselves in Excel. Now that this process has been reversed, when the data comes to them with ready-made parameters and KPIs, they have to check and analyse their old Excel sheets to see if the figures match. Because of this big change, we have had to slow down a bit so that we are not bringing in so much new data all the time." (Finance Data and Analytics Lead A)

Some companies have also had difficulties with licensing issues, which has made integration of ERP and BI more difficult.

“The reason why we switched from Informatica to Aecorsoft is that first of all, with Informatica we had to be careful with licensing issues. There are certain things you have to take into account when integrating data from SAP. In addition, there were certain technical challenges with Informatica, which fortunately have been resolved with Aecorsoft. With Aecorsoft, you can handle really big data much better. So Aecorsoft has been able to solve the licensing problems and the technical challenges.” (Head of Enterprise Architecture A)

Company A's other challenges are as follows: “*We have been using SAP BW but it is not a very user-friendly system and it is not up to modern standards, so it is quite outdated. In addition, we have had challenges on how to connect external products to our ecosystem.”(Enterprise Architect A)*

Company B’s challenges of the ERP BI integration are related to data complexity, technical compatibility and data accuracy.

“Integrating data from various ERP modules and sources can be complex and time-consuming. Also, ensuring compatibility between the ERP and BI systems, especially during software updates, can pose challenges, and maintaining data accuracy and consistency between the ERP and BI systems requires continuous monitoring and validation.” (Business Controller B)

According to Business Controller C Company C’s challenges have been related to data transformation, resource allocation and data governance.

“Adapting the data from the ERP system to fit the data vault model can sometimes be complex”,

“Implementing the data vault methodology requires skilled personnel and resources”.

"Maintaining data quality and adhering to data governance principles is an ongoing effort."

Company D has not faced any significant challenges regarding to ERP and BI integration since it has a custom-built ERP which has reduced issues substantially.

"*No major challenges have been encountered because the technologies have been chosen correctly. Potential challenges are reduced by the fact that our ERP system is custom built software. This makes it much easier to make changes." (Chief Information Officer D)*

8.5 Benefits of the ERP BI integration

According to the empirical material, ERP BI integration has several benefits. For instance, it enhances the decision-making, process efficiency and reporting due to its automation features.

"The benefits we have achieved are for instance Improved Decision Making, since Integrated ERP and BI provide comprehensive insights, enabling better-informed decisions. Also, due to ERP BI integration we can generate real-time reports, giving us up-to-date information on key performance indicators. It has also improved our process efficiency, since streamlining data extraction and analysis processes has increased operational efficiency." (Business Controller B)

"Data reliability has improved, and traceability of data has increased. In addition, data can be better exploited and visualized, which also allows for better analysis of the data. The integration of these programmes supports decision-making. So, the benefit is that we can combine data from many different sources, some from ERP and some from other systems. This gives us a holistic picture of our business and what we are doing, and we can then make better decisions about our business." (Head of Enterprise Architecture A)

“The use of data in ERP has become much easier, especially when combined with data from other systems.” (Chief Information Officer D)

This integration has also reduced the routine work of company employees, allowing them to focus more on analyzing data.

“ERP BI integration has enabled that figures now come automatically (sales figures only for the moment). Before, sales figures came overnight once a night, so they were always 24 hours late. Nowadays the sales figures come 4 times during the day, so every 2 hours new figures come in, if there are happened any transactions in Sap. Thanks to automation, the reporting user does not have to do the report/modeling himself but now the user can analyze the reports. Before, "bulk work", i.e. routine work, played a big role in our organization and data analysis was very limited, because bulk work used to take up so much of our resources. Luckily, we have turned this situation around with automation and now there is more time for analysis.” (Finance Data and Analytics Lead A)

Company C’s Business controller described their benefits of the integration as follows:” The joint use of ERP and BI, along with the data vault methodology, has provided us with several benefits. For instance, it has unified our data. The data vault approach ensures consistent and standardized data, enabling accurate analysis. Also, it has improved the data scalability. We can easily expand the data vault to incorporate new data sources beyond ERP, supporting our evolving business needs. And lastly, The Data Vault allows us to track historical changes in the data, aiding in trend analysis.”

8.6 How will the integration of ERP and BI be developed in the future?

According to the empirical results, directly integrating ERP and Business Intelligence is an old-fashioned concept. As a result, different software and methods have been and will be developed to make the integration of ERP and BI as efficient as possible. Many companies have started to utilize the Data Vault methodology, which allows them to use the data collected from ERP with BI software.

"The direct integration of ERP and Business Intelligence is an outdated idea. For example, if something in the business changes and you want to add new parameters to the existing business models. To make this change in ERP would require an absurd amount of time and resources. That is why we use the Data Vault methodology, because it is much more convenient to change models, because the Data Vault methodology stores the old models there and it is easier to change new parameters to the model. The Data Vault methodology also allows you to compare the current model with the previous one, and to determine whether it was worth making the business model change in the first place. With Data Vault, these changes are made much more quickly than in ERP. If you were to do it the old way, where you have an ERP and a data warehouse solution with an OLAP system on top of it and reporting system on top of that. If you start to change the ERP system in such a situation, everything else falls apart along the way. Especially at the end, i.e. the reporting has to be redone. That's why we use the Data Vault methodology, so that this kind of damage doesn't happen. We use the Data Vault methodology so that we always have certain business fundamentals in place, so that the reporting doesn't break down even if we change the model below. So, we have protected this process with the Data Vault methodology." (Finance Data and Analytics Lead A)

Company B aims in the future to develop advanced analytics techniques for enhancing the ERP and BI integration and reducing manual work in the company.

"In the future, we plan to further enhance the integration between ERP and BI by exploring advanced analytics techniques. This might involve predictive analytics to anticipate future trends and outcomes, enabling proactive decision-making. Additionally, we aim to automate more data extraction processes to reduce manual efforts." (Business Controller B)

Company C's future goals for developing ERP BI integration also include adding predictive analytics to their processes for gaining deeper understanding of future trends.

“Looking ahead, we plan to further optimize our data extraction processes from Microsoft Dynamics 365 to enhance efficiency. Additionally, we are exploring the possibility of incorporating machine learning and predictive analytics to gain deeper insights into future trends.” (Business Controller C)

So, in the studied companies, the advanced analytics techniques, predictive analysis and machine learning were seen as ways to enhance the ERP and BI integration and benefits received from it.

9 Discussion

9.1 The integration between ERP and BI

Based on interviews and observations, the idea of direct integration between ERP and BI is a little outdated. Different software has been introduced between ERP and BI today as a result of technological advancements to ensure that data is transferred and stored efficiently between the two programs. If BI is directly connected to the ERP system, the ERP system will become overloaded. For this reason, something should be placed between ERP and BI to guarantee that data is effectively transferred from ERP to business intelligence systems. Many software tools have been developed to support this integration. For example, Company A uses Aecorsoft software, which allows them to move data from ERP to BI software efficiently. Once Company A has collected data using Aecorsoft, it moves that data to a cloud environment called Azure to keep the data safe and to make efficient use of that data. The data is then moved to a data lake storage called BLOB and then moved to the Enterprise Data Warehouse. In the final stage of this process the Enterprise Data Warehouse layer is modeled using the Data Vault Methodology.

Company D, which is the only studied company with a custom-built ERP, has similar type of process with company A in the ERP and BI integration. The ERP and BI systems of Company D are integrated in a way that allows the relevant and essential data found in the ERP to be exported to the reporting layer (Power BI) via the data warehouse. Company D's integration technologies consist of Microsoft Azure cloud native tools such as Azure Data Factory, Integration Runtime, Blob Storage and Power BI Gateway. So, the process is quite complex and there is many steps and software utilized in this integration process.

As it can be observed here, the integration of ERP and BI is not very simple process. The data collected from the ERP is not directly transferred to the Business Intelligence software, but instead, there are several different steps in this process. Firstly, to get the data

in the right format, secondly to store it easily and thirdly to make efficient use of the data collected from the ERP, there should be different software in between ERP and BI.

9.2 Challenges of the ERP BI integration

The integration of ERP and BI does not always go smoothly in the studied companies, and in the majority of cases, companies have encountered various difficulties in this area. For instance, Company A has experienced greater internal resource challenges than technical challenges, despite no longer facing significant technical challenges. The issue arises from the fact that Company A is now able to produce and import more data, but their staff and business procedures struggle to keep up with the increased data.

The challenges that Company B faces with the ERP BI integration are centered around data accuracy, technical compatibility, and complexity. Data integration can be difficult and time-consuming when using different ERP modules and sources. Furthermore, maintaining data accuracy and consistency between the ERP and BI systems requires ongoing monitoring and validation. Ensuring compatibility between the ERP and BI systems can be difficult, particularly during software updates. The difficulties faced by Company C have been related to resource allocation, data governance, and data transformation.

Since Company D has a custom-built ERP, which has greatly decreased issues, it has not encountered any significant problems integrating its ERP and business intelligence.
Since the technologies were properly chosen, there have been no significant difficulties. The fact that Company D's ERP system is a custom-built software reduces potential issues.

9.3 Benefits of the ERP BI integration

The empirical data shows that ERP BI integration has many benefits. Due to its automation features, it can improve decision-making, process efficiency, and reporting. For example, it can offer real-time reports with the most recent data on key performance indicators. Data traceability and reliability can both be enhanced by integration. Additionally, data can be more effectively used and visualized, which enables better data analysis. These programs' integration therefore supports decision-making. Hence, the advantage is that data from numerous sources can be combined with the EP BI integration. This provides businesses with an in-depth analysis of their operations, enabling them to make wiser business decisions. In addition, one of the benefits is that the information from the ERP is much easier to use and the availability of that information is also more accessible.

Employees of the company now spend less time performing routine tasks, freeing them up to concentrate more on data analysis. The company's figures now arrive automatically thanks to ERP BI integration. For instance, whereas previously Company A's sales figures arrived once at night, they now do so four times throughout the day. Because of automation, Company A's reporting user no longer has to create reports or model data; instead, the user can now analyze reports. Because routine work used to consume so much of Company A's resources, routine work used to play a bigger role and data analysis was very limited. With the help of automation today, Company A has changed the situation so that there is more time for analysis.

Also, Data Vault methodology has brought some benefits in the ERP BI integration. According to Company C's Business Controller, Data Vault methodology's benefits are: unified data, scalability of data and historical tracking of the data.

10 Summary

10.1 Conclusions

ERP systems are acknowledged as being reliable tools for managing supply chain management and corporate resource planning. The ERP system's capacity to manage and integrate transactional data from across the entire organization is a significant contribution. The vast majority of ERP systems on the market are capable of effectively utilizing this feature. They lack, however, the ability to report and analyze data. To bridge the gap for corporate decision-making, BI tools can be used to align the direction of this information technology innovation (Chou et al., 2005).

As more users at all organizational levels become aware of the benefits of BI software's decision support capabilities, its acceptance grows. Business intelligence software is now being used by organizations that previously struggled to demonstrate the ROI of ERP implementation (Chou et al., 2005).

Because ERP systems are so complex, it can be challenging to extract data for business intelligence in a way that is separate from the extract supported by the ERP system. Data from enterprise transactions is streamlined by ERP systems. Combining these systems has the advantage of giving ERP data more intelligence thanks to BI systems. Integrating ERP and BI systems can significantly increase the IT performance and decision-making capacity within the organization (Chou et al., 2005).

Previous literature has focused on the direct integration between ERP and BI and less attention has been paid to things that work between ERP and BI. This study initially started by focusing on the direct integration between ERP and BI, but eventually this study expanded into a more extensive study, which examined, for instance, the Data Vault methodology and other factors that are part of this software integration.

Interviews from the empirical part have revealed that direct integration between ERP and BI is a somewhat outdated idea. Different software has been introduced between ERP and BI today as a result of technological advancements to ensure that data is transferred as easily as possible between the two programs. If BI were directly connected to the ERP system, the ERP system would become overloaded. The ERP system would be overloaded in such a scenario, which would compromise the operational work that is performed using the ERP. To ensure that data flows smoothly from enterprise resource planning systems to business intelligence systems, something should be placed between them. Many businesses have begun to use the Data Vault methodology in order to use the data gathered from ERP with BI software. Maybe in the past, the integration between ERP and BI has been more important. Currently, ERP and BI are somewhat separated from each other.

The results of the empirical part increased the understanding of the topic, but the results cannot be generalized, as only a few interviews and companies were interviewed.

The future of ERP and BI integration will involve the merging of modern technologies, with machine learning and predictive analytics at the forefront of innovation. These innovations aim to fundamentally change how companies use data to support strategic decisions, improve operational excellence, and increase competitiveness. By embracing these trends, businesses can position themselves at the forefront of data-driven excellence in a constantly shifting global market.

10.2 Suggestions for future research

Future research on this subject could involve the impact of modern technologies on the integration of ERP and BI. Also, this research could potentially be expanded using advanced analytics methods, machine learning, and predictive analytics.

References

ACCA (2013). Big data: its power and perils. [online] [cited: 3.3.2020] available from internet: http//:www.accaglobal.com/bigdata

Addo- Tenkorang, R & P.T. Helo. (2016) Big data applications in operations/supply-chain management: A literature review. doi: https://doi.org/10.1016/j.cie.2016.09.023

Agostino, R. (2004). Business Intelligence: solving the ERP overload. [online] [cited: 1.6.2020] Available from internet: http//:mthink.com/legacy/www.cfoproject.com/content/pdf/CFO1_wp_agostino.pdf

Al-Mashari, M. (2002). Enterprise resource planning (ERP) systems: A research agenda. Industrial Management + Data Systems. 102(3), 165-170.

Arnott, D. & G. Pervan (2005). A critical analysis of decision support systems research. Journal of Information Technology 20:2. 67–87.

Biere, M. (2003), Business Intelligence for the Enterprise. Prentice-Hall PTR, Indianapolis, IN.

Bingi P, Sharma MK, Godla JK. (1999). Critical issues affecting an ERP implementation. Information Systems Management. 16(3):7–14.

Brignall, S. & J. Ballantine (2004). Strategic Enterprise Management Systems: new directions for research. Management Accounting Research. 15:2, 225–240.

Chaudhuri, S., U. Dayal & V. Narasayya (2011). An Overview of Business Intelligence Technology. Communications of the ACM. 54:8, 88–98.

Chen, I. (2001). Planning for ERP systems: analysis and future trend. Business Process Management Journal. 7:5, 374-386.

Chou, D. C., H. B. Tripuramallu & A. Y. Chou (2005). BI and ERP Integration. Information Management & Computer Security. 13:5, 340–349.

Chui, M., Manyika, J., & Miremadi, M. (2016). Where machines could replace humans—and where they can't (yet). McKinsey Quarterly.

Clinton, B. & R. White (2012). The Role of the Management Accountant: 2003-2012. Management Accounting Quarterly Fall. 2012, 40–74.

Davenport TH. (1998). Putting the enterprise into the enterprise system. Harvard Business Review. 1998;76(4):121–131.

Davenport TH. (2000). Mission Critical: Realizing the Promise of Enterprise Systems. Boston, MA, Harvard Business School Press.

Davenport, T. H. (2006). Competing on Analytics. Harvard Business Review. 84:1, 98– 107.

Davenport, T. H., & Harris, J. (2007). Competing on Analytics: The New Science of Winning. Harvard Business Review Press.

Elbashir, M. Z., P. A. Collier & M. J. Davern (2008). Measuring the effects of business intelligence systems: The relationship between business process and organizational performance. International Journal of Accounting Information Systems. 9:3, 135– 153.

Escalle, C.X, Cotteleer, M.J. & Austin, R.D. (1999), Enterprise Resource Planning (ERP): Technology Note, Harvard Business School Publishing Boston, MA.

Eskola, J. & Suoranta, J. (2005) Johdatus laadulliseen tutkimukseen. Osuuskunta Vastapaino, Tampere.

Foster, S. & P. Hawking & A. Stein (2005). Business Intelligence Solution Evolution: Adoption and Use. Business Intelligence Journal. ABI/INFORM Collection 10:4, 44–54.

Fui-Hoon Nah. F., S. Faja & T. Cata. Characteristics of ERP software maintenance: a multiple casestudy. Available from internet: https://onlinelibrary-wiley-com.proxy.uwasa.fi/doi/epdf/10.1002/smr.239

Gantz, J., & Reinsel, D. (2011). Extracting value from chaos. IDC, 1-12.
Gartner (2012). IT Glossary [online]. [cited 18.3.2020] available from the internet: http://www.gartner.com/it-glossary/business-intelligence-bi/

Gattiger TF, Goodhue DL. (2000) Understanding the plant level costs and benefits of ERP: Will the ugly duckling always turn into a swan? Proceedings 33rd Hawaii International Conference on Systems Science. IEEE Computer Society Press: Los Alamitos CA. 2000; 10 pp. (on CD).

Gessner, G.H. and L. Volonino (2005). Quick response improves returns on business intelligence investments. Information systems management. 22(3): p. 66-74.

Ghosh R. (2012). A Comprehensive Study on ERP Failures Stressing on Reluctance to Change as a Cause of Failure. Journal of Marketing and Management. 3:1. 123-134.

Gibson, M., D. Arnott, I. Jagielska & A. Melbourne (2004). Evaluating the intangible benefits of business intelligence: Review & research agenda. Proceedings of the 2004 IFIP International Conference on Decision Support Systems: Decision Support in an Uncertain and Complex World. Prato, Italy. 295–305.

Glaser, B., & Strauss, A. (1967). The Discovery of Grounded Theory: Strategies for Qualitative Research. Mill Valley, CA: Sociology Press.

Gray, G. L. & M. Alles (2015). Data Fracking Strategy: Why Management Accountants Need It. Management Accounting Quarterly. 16:3, 22–33.

Habul, A. and A. Pilav-Velic (2010). Business intelligence and customer relationship management. in Information Technology Interfaces (ITI), 2010 32nd International Conference on.IEEE.

Hall, J. (2004). Business Intelligence: The Missing Link in Your CRM Strategy. DM REVIEW. 14: p. 36-40.

Hannula, M. & V. Pirttimäki (2003), Business Intelligence — Empirical Study on the Top 50 Finnish Companies. Journal of American Academy of Business. 2:2, 593–599.

Hastie, T., Tibshirani, R., & Friedman, J. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer.

Holland CP, Light B. (1999). A critical success factors model for ERP implementation. IEEE Software. 1999; 16(3):30–35.

Inmon W.H & D. Linstedt (2015) Data Architecture: a Primer for the Data Scientist : Big Data, Data Warehouse and Data Vault. Elsevier Science & Technology.

Jurafsky, D., & Martin, J. H. (2019). Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Pearson.

Klaus, H., M. Rosemann & G. What is ERP? Gable Information Systems Management Research Center, Queensland University of Technology, Brisbane, Australia.

Koupaei, M., M. Mohammadi & B. Naderi (2016). An Integrated Enterprise Resources Planning (ERP) Framework for Flexible Manufacturing Systems Using Business Intelligence (BI) Tools. International Journal Of Supply & Operations Management. 3:1, 1112-1125.

Laudon, K. & J. Laudon (2000). Management Information Systems: Organization and Technology in the Networked Enterprise. 6. edition. New Jersey: Prentice Hall Inc. 588 s. ISBN 978-0-13-015682-2.

Linstedt D., "Building a Scalable Data Warehouse with Data Vault 2.0," Morgan Kaufmann, 1st ed., Boston, MA, USA, 2016.

Linstedt D., & K. Graziano, and H. Hultgreen, "The business of data vault modeling, 2nd edition," in Proceedings of the 2009 International Conference on Information and Knowledge Engineering (IKE), Las Vegas, NV, USA, July 2009, pp. 232-238.

Linstedt D., & K. Graziano, "Super Charge your Data Warehouse," Createspace Independent Pub, Scotts Valley, CA, USA, 1st ed., 2011.

Lönnqvist, A. & V. Pirttimäki (2006). The measurement of business intelligence. Information Systems management. 23:1, 32–40.

Margulies J. C., "Data as competitive advantage," Winterberry Group, Oct.
2015, Tech. Rep. 2015-02, pp. 1-28.

Moss, T. L. & S. Atre (2003). Business Intelligence Roadmap: The Complete Project Lifecycle for Decision Support Applications. Addison Wesley Longman, Boston, MA. 576s. ISBN: 978-0-201-78420-6.

Muscatello, J.R. and I.J. Chen (2008). Enterprise resource planning (ERP) implementations: theory and practice. International Journal of Enterprise Information Systems (IJEIS). 4(1): p. 63-83.

Nah F, Lau J, Kuang J. (2001). Critical factors for successful implementation of enterprise systems. Business Process Management journal. 2001; 7(3):285–296.

Negash, S. (2004). Business Intelligence. Communications of the Association for Information Systems. 13, 177–195.

Nofal, M. I. & Z. M. Yusof (2013) Integration of Business Intelligence and Enterprise Resource Planning within Organizations. Procedia Technology. 11, 658–665.

Nykänen E., M. Järvenpää & H. Teittinen (2016). Business intelligence in decision making in Finnish enterprises.

Olszak, C. M. & E. Ziemba (2003). Business Intelligence as a Key to Management of an Enterprise. In Proceedings of Informing Science and IT Education Conference. 855–863.

Orlicky J. (1975). Material Requirements Planning: The New Way of Life in Production and Inventory Management. New York: McGraw Hill. 1975.

Perkins B. (2022) What is ERP? Enterprise resource planning systems explained.

Poba-Nzaou P., L. Raymond & B. Fabi (2008). Adoption and risk of ERP systems in manufacturing SMEs: a positivist case study. Business Process Management Journal. 14:1. 530 – 550.

Popovič A., T. Turk & J. Jaklic (2010) Conceptual model of business value of business intelligence systems. Journal of Contemporary Management Issues. 15:1, 5–29.

Poston, R & S. Grabski (2001). Financial impacts of enterprise resource planning implementations. International Journal of Accounting Information Systems. 2. 271 – 294.

Provost, F., & Fawcett, T. (2013). Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking. O'Reilly Media.

Ranjan, J. (2008). Business justification with business intelligence. The journal of information and knowledge management systems. 38:4, 461–475.

Rasmussen, N., P. S. Goldy & P. O. Solli (2002). Financial business intelligence: Trends, technology, software selection, and implementation. John Wiley & Sons. 304p. ISBN: 978-0-471-26785-0.

Richard, L. V., Matthew, E., & Carl, W.O. (2011). Big data: What it is and why you should care. IDC.

Saaranen-Kauppinen, A. & Puusniekka, A. (2006) KvaliMOTV - Menetelmäopetuksen tietovaranto. Tampere: Yhteiskuntatieteellinen tietoarkisto. <http://www.fsd.uta.fi/menetelmaopetus/>

Sabherwal, R. & I, Becerra-Fernandez (2011). Business Intelligence. Practices, Technologies, and Management. ISBN:978-0470461709.

Schneier, B. (2015). Data and Goliath: The Hidden Battles to Collect Your Data and Control Your World. W. W. Norton & Company.

Sedera, D., G. Gable & T. Chan (2003). ERP success: Does organisation Size Matter? Pacific Asia Conference on Information Systems. 10:13, 1075–1088.

Shtub, A (1999). Enterprise Resource Planning (ERP). The Dynamics of Operations Management. Kluwer Academic Publishers. 7.12.2014.

Stiroh, K. (2001). Investing in Information Technology: Productivity Payoffs for U.S. Industries. Current Issues in Economics and Finance. 7:6, 1–6.

Syed, A., K. Gillela & C. Venugopal (2013). The future revolution on Big Data. International Journal of Advanced Research in Computer and Communication Engineering. 2:6, 2446–2451.

Teorey, T., S. Lightstone & T. Nadeau (2006). Database Modeling & Design: Logical Design. 4. edit. Morgan Kaufmann, San Francisco. 275s. ISBN: 978-0-12685352-0.

Thierauf, R.J. (2001). Effective Business Intelligence Systems. Greenwood Publishing Group, CT, U.S.A. 392s. ISBN: 978-1-56720-370-7.

Thomas Jr, J.H. (2001). Business Intelligence–Why. eAI Journal. p. 47-49.

Thompson, O. (2006) Business Intelligence Success, Lessons Learned. Process ERP Partners, LLC.

Tsai, W., Chen, S., Hwang, E. T. Y., & Hsu, J. (2010). A study of the impact of business process on the ERP system effectiveness. International Journal of Business and Management. 5(9), 26-37.

Turbide, D. (1999). What is ERP? 33 Metal Producing; Aug 1999; 37, 8; ABI/INFORM Collection p. 40.

Tyson, K. (1986). Business Intelligence – Putting It All Together. Leading Edge Publications, Illinois- Teoksessa Hannula, M. & V. Pirttimäki (2003), Business Intelligence — Empirical Study on the Top 50 Finnish Companies. Journal of American Academy of Business. 2:2, 593–599.

Umble, E.J., R.R. Haft, and M.M. Umble. (2003). Enterprise resource planning: Implementation procedures and critical success factors. European journal of operational research. 146(2): p. 241-257.

Vakalfotis, N., J. Ballantine & A. Wall (2011). A research model to understand the impact of enterprise systems on management accounting. MCIS 2011 Proceedings. 10, 1– 22.

Velcu, O. (2007). Exploring the effects of ERPsystems on organizational performance: Evidence from Finnish companies. Industrial Managemanent & Data Systems. 107:9. 1316 – 1334.

Venter, P. & D.H. Tustin (2006). Business Intelligence in South Africa. Pretoria: Bureau of Market research. Southern African Business Review. 13:2.

Vermesan, O., Friess, P., Guillemin, P., Gusmeroli, S., Sundmaeker, H., & Bassi, A. (2014). Internet of Things Strategic Research and Innovation Agenda. River Publishers.

Wailgum T (2009). 10 Famous ERP Disasters, Dustups and Disappointments. CIO.

Watson, H.J. & B. H. Wixom (2007). The Current state of Business Intelligence. Computer 40:9, 94–99.

Watson, H.J. & B. H. Wixom (2010). The BI-based Organization. International Journal of Business Intelligence Research. 1:1, 13–28.

White, C. (2004). Developing a BI Strategy for CRM/ERP Data. TDWI report series. p. 2-31.

Williams, S. & N. Williams (2007). The profit Impact of Business Intelligence. Morgan Kaufmann Publishers. 218s. ISBN: 978–0-12–372499–1.

Williams, S. (2008). Power combination. Strategic Finance. 89:11, 1–8.

Williams, S. (2011). 5 Barries to BI success and how to overcome them. Strategic Finance. 93:1, 27–33.

Williams, S. and D.P. Consulting (2004). Delivering strategic business value. DM REVIEW. p. 1.

11 Appendix

Interview structure

1. Interviewee information, what is your job title and role.

2. What software do you use for ERP and BI?

3. Are ERP and BI related to each other in your organization (do you use them together at the same time)?

4. How are ERP and BI related to each other in your organization, i.e. how are they integrated?

5. What challenges have you encountered in the joint use of these software?

6. What benefits have been achieved by the joint use of these software?

7. How will the integration of ERP and BI be developed in the future?

8. Is there anything else you'd like to bring up or that I haven't asked yet?