The Connection Between the Relational Model and ERP Systems: a Financial Approach

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Abstract

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This qualitative literature review aims to discover and present the connection between the relational data model and enterprise resource planning systems through a financial viewpoint, discussing to which extent finance professionals are also data professionals. In the ever-evolving world of information technology and data, roles and business operations are constantly changing and expanding. The expanding growth of data and need for data-analytics also affects the roles of finance professionals, and their contributions to companies.

The theoretical framework aims to explain theories and concepts like information technology (IT), data, the relational data model, relational data base management systems (RDBMS), enterprise resource planning (ERP) systems and SQL as simply as possible and in connection to the functional business process of accounting and finance. The majority of the theoretical framework is built based on peer-reviewed journal articles. In addition, some books and web sources are used. The sources were gathered from several different journals and databases. Information technology, system architecture, relational theory and programming languages can be difficult and highly technical subjects for beginners. This review aims to simplify these subjects so that even people perhaps learning about the relational model for the first time, could understand them easily.

ERP systems are integrated information technology systems that are crucial for the data integration and performance of a thriving business. But what is their role in financial transactions, and how much does the database in the system actually matter and affect the work or finance professionals? Business operations include a lot of financial transactions, that revolve around transactional data. Relational databases, based on the relational model dating back to 1970, are still a prevalent database choice for ERP systems today. A computer language SQL can be used to query and modify those databases. All of these subjects have a closer connection than what might seem obvious at first glance. By exploring and explaining this connection, the author aims to provide deeper insight for people already working with a relational database, as well as starting finance professionals simply interested in the growing world of data and computer sciences.

Key words
Data, Relational data model, ERP, Finance, Information technology

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1 Introduction

This bachelor's thesis is an independent literature review on the connection of the relational data model and ERP systems. With my (words my and I in this thesis refer to the author) business administration degree in mind, the viewpoint is finance: data in finance, financial business processes, transactional data and so on. I want to discuss data, information systems and ERP in the world of finance, and why finance professionals should have or need more data and analytical skills. ERP systems in general, as well as the current market and vendors will be part of the theoretical framework, but the focus is on the financial aspects of ERP and the connection to the relational model. Different databases and systems (and their vendors) will be briefly discussed, as well as a notion of which of these systems are relational and which are not. The analysis itself focuses on the relational data model and ERP systems that operate on relational databases. Regarding relational database management systems, the structured query language SQL is also discussed.

The review does not argue whether the relational data model is the best option for ERP systems or not. It simply aims to explain the connection of the relational data model and ERP systems, while discovering how understanding this connection could benefit individuals working in finance, who handle and access data from ERP systems daily. To simplify the context of the theoretical framework, ERP systems and their architecture in detail is not discussed, but simply presented as an information technology system that includes a database, of which a relational data model is one option.

According to my research for sources from multiple databases no similar research has previously been conducted on the subject. Most of the research on ERP and relational theory are quite technical and studied independently from each other. Research on ERP mainly focuses on differences between systems, technology advancement strategies and central success factors. Similarly, research on relational theory and or relational databases and SQL is often highly technical and or more directed towards computer and software professionals. Or at least this is what I came across during my search for sources. I aim to, when applicable and appropriate, simplify these subjects in a way that is understandable also for someone perhaps learning about the relational model and the concepts related to it for the first time. I want to build a firm theoretical foundation through which I discuss how finance professionals, especially students and people starting out their careers could benefit from deeper data related and analytical skills; not just using an ERP system, but truly understanding how it works. Therefore, I consequently argue, that diving deeper into understanding the data and the systems is not just for software developers or IT professionals.

Acronyms appearing in the text are as follows:

- AI (Artificial Intelligence)
- AIS (Accounting Information Systems)
- DBM (Database Management)
- DBMS (Database Management System)
- ERP (Enterprise Resource Planning)
- IT (Information Technology)
- RDBMS (Relational Database Management System)
- SQL (Structure Query Language)

1.1 Strategy and methodology

Through qualitative analysis of textual data, mainly peer-reviewed journal articles and other relevant sources, I will build a theoretical framework divided into three sections: ERP systems and business processes (chapter two), data in general and data in finance (chapter three) and the relational model and SQL (chapter four). By first exploring the semantics of these three different areas I aim to answer the main research question and sub questions presented later in this chapter. This thesis is an independent literature review, so the research is purely based on the analysis of textual data I have sourced from different databases and academic journals, as well as some book and web sources. Using an inductive approach, the aim is to build a new theory grounded in the data I analyse (Saunders, Lewis and Thornhill, 2019, p. 624).

The qualitative analysis of the data was executed through thematic analysis. The purpose of thematic analysis is to search for re-occurring themes or patterns across the data being analysed. Thematic analysis usually involves coding of the qualitative data. (Saunders, Lewis and Thornhill, 2019, p. 651.) My coding was relatively loose, based mainly on the keywords I used to look for relevant sources. The financial viewpoint of the review in mind, the keywords used to narrow down the subject and search for relevant sources in order of importance are ERP, Data, Finance, Relational data model, RDBMS, Database management systems, SQL, Information technology and Big data.

I divided the sources into three categories: books, peer-reviewed articles and web sources. Amongst these categories I had three themes:

1. Relational theory and relational databases
2. ERP, financial analysis and big data
3. SQL as a programming language.

I used the iOS FreeForm app for planning the review and visualising different aspects of it, like gathering and coding the sources. See appendix 2 for a visual presentation of the themes and categories mentioned above. Appendix 3 is a visualisation of the amount of planning I did for this review, including the subject, strategy, sources, analysis methods and structure of the report.

The structure of this literature review imitates the structure of Haaga-Helia's (2022b) guidelines for research-based theses, apart from the empirical part. Discussion is divided into two chapters: results (chapter five) and discussion (chapter six). The theoretical framework consists of three chapters (chapters two to four). The review therefore naturally includes all the parts of a literature review presented by Monash University (2023), the abstract, the introduction, the body, and the conclusion. The in-text references and the reference list in this thesis has been formed via Mendeley reference manager. The citation style is the recommended Harvard Cite Them Right 12th edition.

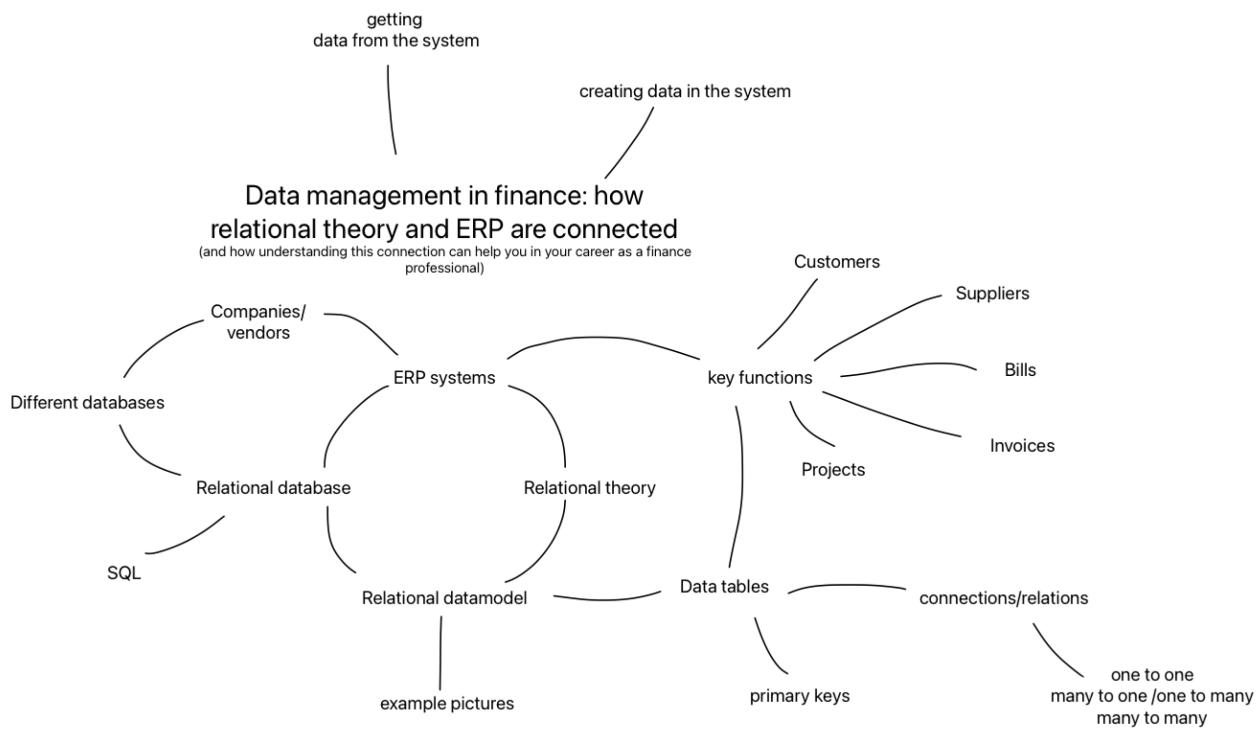

Figure 1. Theoretical framework of the thesis

Figure 1 demonstrates my plan for the theoretical framework of this review. The subject of this thesis was inspired by Metropolia UAS (2023) course "SQL Basics" as well as the Haaga-Helia (2022) course "Financial Information Systems and SQL". Both of these courses discussed the basics of relational databases, relational theory and SQL. The courses presented an example relational database, through which the use of SQL was practiced. Without these courses I would not know what a relational database, or SQL is. The term "key financial functions" (later key financial activities) leads back to my experience as a financial assistant, working with the Oracle NetSuite ERP system daily (see chapter 1.2), as well as my Business Administration (Finance Specialist) studies at Haaga-Helia, and the sources used in this thesis. (Figure 1.)

The goal of this literature review is to clearly showcase the connection between the relational data model and ERP systems from a financial perspective, while analysing (the presumably positive) effect understanding this connection can have on the work performance of individuals in the field of finance. **The main research question, that builds the core of the theoretical framework, therefore is: What is the connection between the relational data model and enterprise resource planning (ERP) systems?** The ERP systems in the main research question naturally refer to ERP systems that use a relational database. With the term “finance professional” I refer to anyone with a degree in finance, working in the financial sector.

In addition to the main research question I will try to also answer the related sub questions:

1. Can understanding this connection (the main research question) be of value to finance professionals?
2. To what extent are finance professionals also data professionals?
3. Should you learn SQL as a finance professional?

The overlay matrix below (table 1), presents the key concepts and terminology used in this review and the chapters they are presented in, as well as the research question and or sub question they relate to the most. Concepts and chapters bolded in the matrix are the ones that provide the most insight regarding the main research question. A more comprehensive list of all the essential terminology used in this review (**bolded** in the text), can be seen in appendix 1.

Table 1. The overlay matrix (adapted from Haaga-Helia, 2022b)

Concept	Theoretical frame-work (chapter)	Research question (main and or sub 1-4), most applicable
Enterprise resource planning (ERP) systems	**2, 2.1,** 2.2	Main research question and sub question 1
Financial business processes	**2**, 4.3	Main research question and sub question 1
Accounting information systems (AIS)	2.3	Sub question 2
Data	**3**	Main research question and sub question 2
Information systems (IS)	1.2, 2	Sub question 2
Information technology (IT)	2.1, 4.1,	Sub question 2
Relational data model	**4.1, 4.2, 4.3**	Main research question and sub question 1
Database management systems (DBMS)	3.4	Sub question 2
Relational database management systems (RDBMS)	**4.3**	Main research question
Structured query language (SQL)	4.4	Sub question 4

1.2 Reasons for conducting the research

My interest in data-analysis was piqued through my first position in the field as a finance assistant, as well as my studies. I first stumbled upon relational theory through a course on financial information systems and SQL. Through this course I realized that the ERP system I had used daily for nearly two years at work, was a relational database. I couldn’t help but wonder, if knowing this sooner would have helped with my work. Considering I used the same system every day for most of my work, I was relatively familiar with it and comfortable using it. But after learning about relational databases and SQL, I quickly realized that having a deeper understanding of the data and the system I work with, would be of immense value in the future.

My responsibilities as a financial assistant in a global technology firm were vast. Lots of daily financial and administrative tasks, updating records and inserting new data into the ERP system, supporting tasks in other areas such as budgeting, cost centre calculations, EBITDA calculations, monthly accounting, managerial accounting and more. In hindsight I can see how useful it would have been to understand the system and the data in it better. I knew enough to be good at my job, but I don’t want to be just good at what I do. I want to be great. I want to be efficient.

Through the evolution and development of the (financial) information systems, related technologies and the world of modern data, the careers in the industry (accounting profession) must also evolve and keep up with the change (Grabski, Leech and Schmidt, 2011, p. 40). Already in 2013, Monk and Wagner (p. 5), state that the world is information driven, highlighting the importance of integrated information systems. Gartner (2020, pp. 10, 14) showcase in their report on financial trends, that things like embedded machine learning, AI- and automation-enabled ERP systems, and the revolution of AI will fundamentally change the work of finance professionals in the future.

I will graduate as a finance professional during spring summer of 2023 and will soon start a full-time position in a different company as a financial assistant. The personal goal of this literature review is to gain an even further understanding of database management, data and relational databases, and to discover how other finance professionals could use this understanding as an advantage in their careers. Whether you directly work with data or software development or not, a career in finance in general, requires (in my opinion) knowledge about data; how it works, where it's stored and how to access it. Especially if in your career as a finance professional you oversee activities like financial reporting, managerial accounting, or financial analysis.

Romney et al. (2021, p. 163), emphasize using examples like corporate accountants, tax professionals and investment advisors that finance professionals (accountants) "need to understand data and how it is changing business". Through my own work experience, studies and the research conducted for this review it has become increasingly obvious that the role of data, integrated information systems and the need of more advanced analytical skills in the world of finance are continuously increasing. Therefore, I argue that finance professionals should also continuously improve their data and analytical skills. Gartner (2020), presents the Future of Finance in trends (see chapter 3.3). The importance of digital and analytical skills in the financial sector (especially for CFO's) seems apparent through the lens of this report.

2 ERP systems and finance

Before exploring **enterprise resource planning (ERP)** in more detail, I will discuss common business processes, and why the data and information related to these processes needs to be integrated, and how integrated information systems will benefit the business. This chapter includes research on enterprise resource planning systems, how they work and what their purpose is (especially in finance). The connection to the relational data model is presented in chapter four. In connection to ERP we also discuss different vendors, their products, and the current market situation.

Monk and Wagner (2013, p. 1), explain business processes as a collection of activities. These activities produce a specific outcome with value, usually for the customer, or internally for the business, through different sources of input. Business processes are related to one or more business areas of Marketing and Sales (M/S), Supply Chain Management (SCM), Accounting and Finance (AF/), and or Human Resources (HR). These are the four main functional areas of operation. (Monk and Wagner (2013, p. 2.)

According to Romney et al. (2021, p. 31), effective decision-making itself requires lots of decisions. Before decision-making a company must decide what decisions are being made, what related information is required for the decision-making, and how the data will be gathered and processed, to produce the needed information. This decision process is essentially needed for every business process. (Romney et al., 2021, p. 31.)

In the Journal of Information Systems Grabski, Leech and Schmidt (2011, p. 40) explain that accounting is becoming more and more connected to other functional areas of businesses. The more companies rely on ERP and integrated technologies, the more the profession of accounting is changing, and accountants are required to broaden their contributions to the company. (Grabski, Leech and Schmidt, 2011, p. 40.)

2.1 ERP systems and their business benefits

ERP systems are **IT (information technology)** systems that provide value and benefits for the company. The value can be monetary or immaterial, and the benefits can be categorised into strategic, operational, managerial, and organizational benefits. Examples of strategic benefits are business growth and competitive advantage. Operational benefits can be things like reduced costs in different departments and business areas and better support for customers, employees and or suppliers. Managerial benefits can include better monitoring and performance, and organizational benefits include organizational aspects like automation, improved communication, and a flatter organization with less management layers. (Bansal, 2013, chap. 3.1.)

ERP systems are integrated information technology systems, with the purpose of integrating the data between different functional areas. These functional areas (M/S, SCM, A/F and HR as mentioned before) are interdependent when it comes to data. They all require data from the others. For example, Supply Chain Management and Accounting and Finance both require information from Sales and vice versa. To produce more efficient business processes, **data integration** is crucial, i.e., the data between these functional areas needs to be shared "effectively and efficiently". (Monk and Wagner, 2013, pp. 3–4.) See chapter 3.4 for more advantages of data integration from the perspective of database management systems.

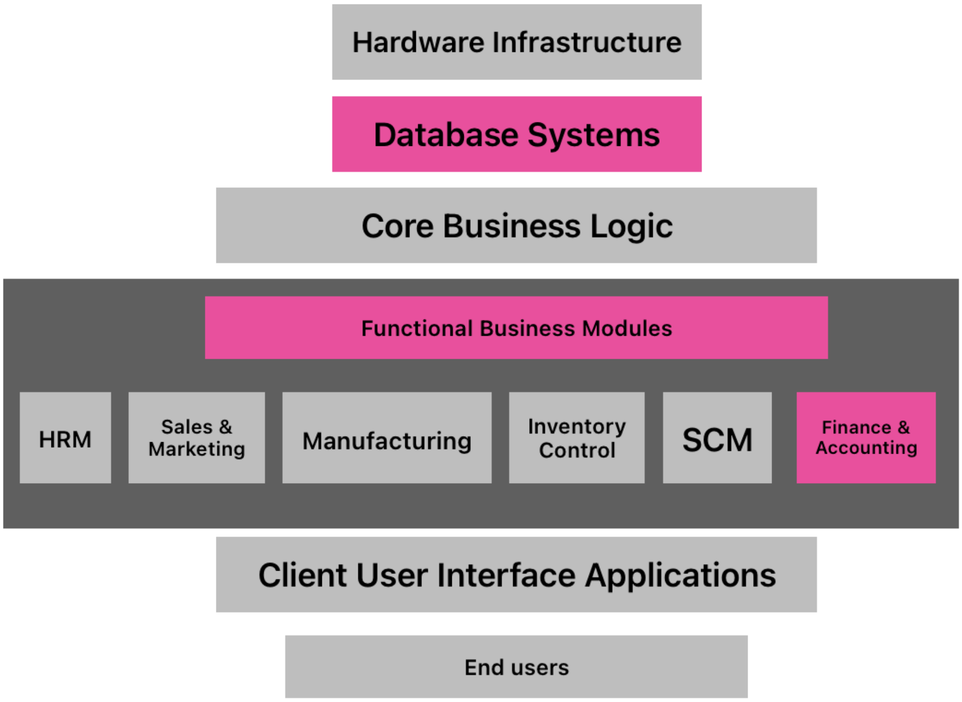

Figure 2. Architecture of an ERP system (adapted from Valashani and Abukari, 2020, p. 74)

The logical architecture of an ERP system in figure 2 showcases the different application layers needed for an ERP system. Lowest layer (reverse order, lowest to highest in the figure), is the hardware infrastructure and database. Core Business Logic simply describes the business decisions that are needed for the Functional Business Applications or Modules. Client user interface is the "highest" logical level, in which user interactions take place. (Valashani and Abukari, 2020, p. 74.) The integrated backend database is the access to data of the ERP system. The module, or unit, of finance and accounting is described to be a "functional unit that collects, generates and stores vast quantities of data". (Bansal, 2013, chap. 1.1, 1.3.) According to Bender et al. (2022, p. 477) "**databases** serve as the foundation for data storage and retrieval". (Figure 2.)

The **system** now known as ERP, evolved over time from previous IT systems mainly designed for manufacturing. First from Transaction Processing Systems (TPS) to Material Resource Planning (MRP), to Manufacturing Recourse Planning (MRP II) to Enterprise Resource Planning (ERP). (Bansal, 2013, chap. 1.1.) These manufacturing systems were created for functions like calculating materials, planning sales, and managing capacity. Because of objectives like profitability and customer satisfaction, these systems were extended from just manufacturing to the whole enterprise. This meant adding functions like finance, distribution, and human resources. According to Helmut, Rosemann, and Gabble, this extension of the manufacturing planning systems happened during the 1970's. (Helmut, Rosemann and Gabble, 2000, p. 144.) However, Sánchez-Rodríguez and Spraakman (2000, p. 400), state that "ERP systems have only existed since the 1990's". Regardless, the time frame presented in research in general implies that ERP systems are a relatively new technology.

2.2 ERP vendors, products and the current market

Bansal (2013, chap. 1.1), named SAP, Oracle, and Microsoft as the top three major ERP vendors. These vendors are repeatedly in the top 10 also in recent studies. The Top 10 ERP Solutions by ERP Research (2023), Top 10 ERP Systems for 2022 by Third Stage Consulting Group, written by Erik Kimberling (2021), Top ERP software vendors for 2023 by Tech Republic, written by Megan Crouse (2023), and Top 10 ERP Software Vendors, Market Size and Market Forecast 2021-2026 by Apps Run The World, written by Pang, Markovski and Ristik (2022), all list SAP, Oracle, and Microsoft in the top 10 (often in top 3 or 4). Other vendors mentioned by the sources above are, for example Infor, Sage, Intuit, Acumatica, and Epicor.

Pang, Markovski and Ristik (2022), write that the ERP applications market was nearly 104.1 billion dollars in 2021 and estimated that the worldwide ERP applications market is headed to reach 112.3 billion by 2026. Globe Newswire wrote in March 2023, that the global ERP software market in 2022 was 51.4 billion and expected to reach 136.1 billion by 2023. The ERP Software Global Market Report (Research and Markets, 2023) expects the global ERP market to grow from 167.3 billion in 2022 to 187.9 billion in 2023. Clearly these numbers are not all aligned, but it is safe to say that the estimated market in 2023 is well over 100 billion USD globally.

As previously mentioned, not all ERP systems have a relational database. Databases are often referred to as either relational or non-relational (also known as NOSQL, meaning Not Only or Not SQL). Relational databases are tabular databases, formed with tables. The most important difference in non-relational databases, compared to relational, is that they do not use relations (tables) as a storage structure for the data in the database. The relational database is a predominant choice because it can be easily accessed, easily created and easily extended, as in changed and modified. (Jatana et al., 2012, pp. 1, 3.)

According to Jatana et al. (2012, pp. 2-3), the two most widely used relational databases are Oracle and MySQL. MySQL is more popular in websites and Oracle in sectors with large database requirements. They also list 10 primary classifications of non-relational databases as follows: key value and document stores, as well as graph, column oriented, object oriented, grid and cloud, XML, multidimensional, multivalue and multimodel databases. (Jatana et al., 2012, pp. 1, 3.)

Yu and Meng (1994, p. 8), mention that in addition to the relational database (RDB) model, there are several others, such as object-oriented, deductive, scientific, temporal, distributed and heterogeneous multidatabase systems. Bender et al. (2022, p. 444), list column-based, object-oriented, graph, key-value, and document-based databases as other database styles. These other database models and styles are not discussed in detail in this review, but are worth mentioning, since there are several different data models of which the relational is just one.

2.3 Accounting information systems

As I am discussing ERP systems from a financial perspective, I think it is important to create distinction between ERP systems and accounting information systems (AIS). According to Romney et al. (2021, p. 36), “accounting is the systematic and comprehensive recording of an organization’s financial transactions”. Accounting also includes summarizing, analysing and reporting these transactions. Accounting is a process of identifying, collecting and storing data, as well as developing, measuring and communicating information. An **accounting information system (AIS)** is a system with the purpose to collect, record, store and process the data to produce information. The six key components of an AIS are listed as people, procedures, data, software, information, and internal controls and security. (Romney et al., 2021, p. 36.)

Accounting software (AIS) differs from ERP in its range and functionality. Where ERP according to its name encompasses all areas of the enterprise, AIS according to its name is focused on the financial aspects and accounting transactions of the organisation. Typically AIS offers features like financial management, planning and budgeting. Most of the ERP products offered already include accounting software, that can later be improved and increased with more specific components. (Folio3 Microsoft Dynamics Partner, 2023). Accounting information systems can also be considered as subsystems of ERP systems (Lata and Lata, 2021).

3 Financial data and data in general

Discussing ERP systems and the relational data model without also discussing what data is and what it means from a financial perspective would not hold much value. Understanding data in the financial sector will also support the theoretical framework in chapter four. To start off I will build a framework for data and the value and purpose it has in the corporate world. See appendix 1 for key terminology used in this review.

According to Monk and Wagner, the functional business area of Accounting and Finance is responsible for financial and managerial accounting, and other tasks like planning and budgeting, control of accounts and cash-flow management. To perform these tasks Accounting and Finance record raw data about different transactions like sales, purchases and payroll. Raw data is numerical data collected from other operations that have not been modified in any way. (Monk and Wagner, 2013, pp. 7-8.) More on financial data in chapter 3.2.

3.1 What is data and where does it come from?

The concept of data seems in a way almost self-explanatory and is something we all are faced with daily in the modern world. We all consume, create, handle and analyse data to some extent. But what is data, and what does it mean in the world of finance? Sherman (2014, chap. 1), creates a distinction for the term data by separating it from information in his Business Intelligence Guidebook. Sherman describes data with words like “raw”, “random” and “unorganized”. Whereas **information** in Sherman’s words is data that has been handled in some way (such as organization, structurisation or some form of processing). Romney et al. (2021, p. 29), also explain information as data that has been organized and processed. The organization and processing of data is meant to provide meaning for the business and help with decision-making. When the quantity and quality of the information improves, better decisions can be made. (Romney et al., 2021, p. 29.)

With the **Five C’s of Data**, Sherman explains what good quality data is; clean, consistent, conformed, current and comprehensive. Clean meaning no incorrect or missing information, consistent meaning a unified view, no different versions or number being upheld, and conformed company-wide and common dimensions. Current accounts for valid currencies as well as up to date data time wise. Comprehensive means that the company has all the relevant data it needs to make business decisions based on said data. Quality data helps enterprises understand different business operations and areas like customers, competitors, suppliers, partners, employees etc. “In the business world, knowledge is not just power. It is the lifeblood of a thriving enterprise. Knowledge comes from information, and that, in turn, comes from data.” (Sherman, 2014, chap. 1.)

Compared to data, **big data** is defined as datasets with a size beyond what a typical database can capture. Big data is essentially large pools of data. From a business perspective data has immense value and has, according to a report on big data, now “reached every sector in the global economy”. In the same report, “Big data: The next frontier for innovation, competition, and productivity”, it is stated that data creates significant value for the world economy. (Manyika et al., 2011, pp. 1, 4.). Economist Intelligence Unit (2012, p. 2), even describes data as the “fourth factor of production”; meaning that data has become as essential to business as factors like land, workforce (labour) and assets (capital).

In addition to what data means, it is important to discuss where it comes from, as there are a lot of different sources. Data can come from physical devices such as phones, laptops, cars, industrial devices and different media (multimedia, social media). Companies constantly create a lot of transactional data and information about customers, suppliers, operations etc. Companies also produce a lot of data as a by-product of different business activities like interacting with customers. Especially digital data is spreading quite literally everywhere, through different sectors, economies, organizations and individuals. Already a decade ago, data was expected to have “exponential growth for the foreseeable future”. (Manyika et al., 2011, pp. 1-2.)

3.2 Data in the world of finance

Especially in finance (when it comes to activities like reporting) data needs to have value. Data has no value, unless it can be understood and analysed in a way that makes it possible to act on and make decisions based on that data (Sherman, 2014, chap. 1). The world of finance naturally revolves around numerical data, but I believe that gaining a deeper understanding of data, and the system it is stored in, will help finance professionals develop more analytical skills and excel in routine financial tasks like reporting, month end closing and presenting financial information to stakeholders.

A report commissioned from the Economist Intelligence Unit by Capgemini studied big data and decision-making, and 69% of all survey respondents (607 global executives) “agreed that business activity data adds the greatest value to their organization”. Business activity data, similarly, to transactional data, describes data related to business actions like sales, purchases, and costs. A whopping 85% of the same respondents say that the biggest issue with data is not the volume, but the missing ability to analyse all the data to be able to act on it in real time. (Economist Intelligence Unit, 2012, pp. 3, 10, 18). It was brought up several times in research that the lack of analytical skills is a major issue in today’s data driven corporate world. More data is being produced than ever, and it is repeatedly recognized how much value all the data brings and could bring to companies. (Manyika et al., 2011, pp. 13, 15.) But without the skills and ability to utilize the data to their advantage, companies cannot benefit from that value.

It is increasingly obvious how big a part data plays in today's corporate world, and especially in the financial sector. A career in finance in general requires knowledge about data and basic analytical skills to perform routine financial tasks like reporting and accounting. Even if one's current role does not specifically ask for deep analytical skills, it is often naturally part of the job as a finance professional. Increasing amounts of data added with the value it can possibly (and provenly) provide for companies naturally means increasing job opportunities in the field of data-analytics. The lack of expertise in areas like statistics, machine learning and analysis is even described as a "significant constraint" for companies (Manyika et al., 2011, p. 10). This was the reality already in the previous decade, and even more so now.

3.3 Data trends in finance

Gartner's report discusses the future of finance in terms of rising trends. Gartner's Senior Director Craig Wilton is quoted to say that taking swift action on these trends means developing the skills and characteristics of the company required by the future of finance, in addition to just basic financial strategic planning. (Gartner, 2020, pp. 1-2.)

The first six of these trends by Gartner (2020, p. 2) are listed as:
1. Digital is creating a skill disconnect.
2. Demand for decision-ready data.
3. (Re)centralization of finance analytics.
4. Reporting goes on-demand.
5. An emerging fourth era for ERP.
6. The AI revolution has begun.

The digital transformation (in systems and roles) in the financial sector requires competencies that may previously have been outlooked. Digital transformation and digital competencies are obviously multi-faceted subjects, but data and data skills are a natural part of the digital transformation. Gartner gives an example of a "digital translation" skill: an ability to understand digital technologies in the corporate world (Gartner, 2020, p. 4). The demand for decision-ready data encompasses the speed of global organizational growth, which requires a "greater use of corporate-approved performance data". The (re)centralization of finance analytics highlights the importance of improving analytical insights to reduce costs. Advanced reporting is more and more in demand when stakeholders have more and more data accessible to them in real-time. In an emerging fourth era of ERP, ERP vendors are offering more financial applications in the cloud, advanced with systems like automation, **AI (Artificial Intelligence)** and ML (Machine Learning). The AI revolution suggests that nearly every activity in finance will be optimized or transformed by Artificial Intelligence. (Gartner, 2020, pp. 4–14.) Straight away the data trend is visible from terms like digital, decision-ready data, finance analytics, reporting, ERP, and AI revolution. The report offers insight on future trends, what is happening right now, and what actionable steps CFO's (Chief Financial Officers) should or could make based on the trends, to improve the successfulness of their business processes.

3.4 Data management and database management systems

A **database system (DBS)** is a computer system with the purpose of storing data, as well as keeping it available for the users when required. A **database management system (DBMS)** is a program or programs that allow for the management of the database system. DBS is composed of different components such as hardware, DBMS, database, related systems and applications, as well as end users (see also chapter 4). (Foster and Godbole, 2014, chap. 1.1.)

Foster and Godbole (2014, chap. 1.1) list the critical functions of database management systems as follows:

- Data definition.
- Data manipulation.
- Data security and integrity checks.
- Programming language support.

Of these this review focuses especially on data definition (relations and views of data), and data manipulation (such as editing, adding, deleting, organizing and accessing data) (Foster and Godbole, 2014, chap. 1.1). In addition, the computer language SQL is also discussed. In chapter four relational database management systems are discussed in more detail.

The goal of the database approach is to create organization-wide databases to store all the needed data for different business operations. The advantages of database systems are data aspects like data integration, data sharing, minimal data redundancy, minimal data inconsistencies, data independence and cross-functional data-analysis. Data integration allows the consolidation of large amounts of data in a one database and data "pool". The integration of data allows the sharing of data from a centralized data storage to different users. Minimizing data redundancy and inconsistency attempts to keep a unified storage of data, so that each item appears only once. Data independence refers to the separation of data and the systems it is used in, both need to be able to change without affecting the other. (Romney et al., 2021, pp. 119, 121.)

4 The relational data model and SQL

In this chapter the basic concept and history of relational theory and SQL are discussed. The theory of the relational model will be linked to ERP in chapters 4.3 and 4.4. Date describes the relational model as a principle that endures. In his words products (like different RDBMS's) and technologies (like SQL) change all the time – but principles don't. Date emphasises, that by understanding the principle of the relational model you will have "transferable knowledge", instead of product specific knowledge, that might not take you very far or be applicable in different environments. (Date, 2006, chap. 1.2.) The theoretical framework in this chapter is therefore focused on the concept of the relational model, instead of specific products or companies. Companies and technologies are just briefly mentioned regarding the history of relational databases. In the last subchapter 4.4 SQL and its use is discussed.

Yu and Meng describe the database technology as "a special are of interest" that started with simple file systems in the late 50's and early 60's. They refer to Codd's introduction of the relational data model as the biggest breakthrough of the industry. Previous database systems (such as hierarchical. and network-based data systems) lacked in certain areas like data control and usability. (Yu and Meng, 1994, p. 7.)

4.1 History of the relational model

Codd's (1970) paper "A Relational Model of Data for Large Shared Data Banks" started a revolution in the information technology industry regrading databases. He presented a relational data model based on relational algebra. Codd didn't develop an actual relational database, but his model was the start of several different products later to be marketed as relational database systems (RDBMS). (Grier, 2012, p. 9)

Based on Codd's research IBM started to develop a relational database prototype, System R (Codd was excluded from the development team, even though he worked at IBM at the time). The query language SQL that is used to update and query data form a relational database was originally created through the IBM prototype. After reading Codd's paper, Michael Stonebraker started to build a practical relational database system called Ingres. Microsoft's system now called SQL Server was originally Sybase, based on Stonebraker's Ingres. An entrepreneur Larry Ellison continued the development of relational databases by founding the organization now called the Oracle Corporation. Oracle's first RDBMS was released in 1979. (Strawn and Strawn, 2016, pp. 64-65.)

In approximately 30 years since Codd's seminal paper, the theory of a relational data model had grown into an industry, with companies like Oracle, IBM and Microsoft providing actual working relational database systems. According to Strawn and Strawn relational database management systems “are used to store and process the primary information of an organization”. (Strawn and Strawn, 2016, p. 65.). For my presentation of primary financial/transactional information see chapter 4.3, figures 4 and 5.

4.2 The relational data model

Codd (1970, p. 377), explained that his relational model for databases “provides a means of describing data with its natural structure only”. Due to this natural structure, relational databases were meant to be more user friendly (Yu and Meng, 1994, p. 7), because users didn’t need to know the physical structure of the system, but just the logical structure of the relations (tables) and the data in them (tuples). Codd (1970, pp. 377, 379), also commented on the data dependencies of the current database systems and argued that the relational model would provide a structure where changes to data would be easier to implement.

The relational data model is often explained as tables like spreadsheets, where rows and columns make up tables of data. Distinct entities (data values) are described as rows and the different attributes of those data rows as columns. The database is made up of several tables in relation to each other. (Strawn and Strawn, 2016, p. 63.) This vocabulary is not in line with the model Codd presented, and some argue it is misleading. In my opinion the name of the definitions is purely semantics. Having read multiple sources on relational databases, if you understand the underlying theory of the relational model, you will understand why relations are referred to as tables, domains as columns and tuples as rows (figure 3).

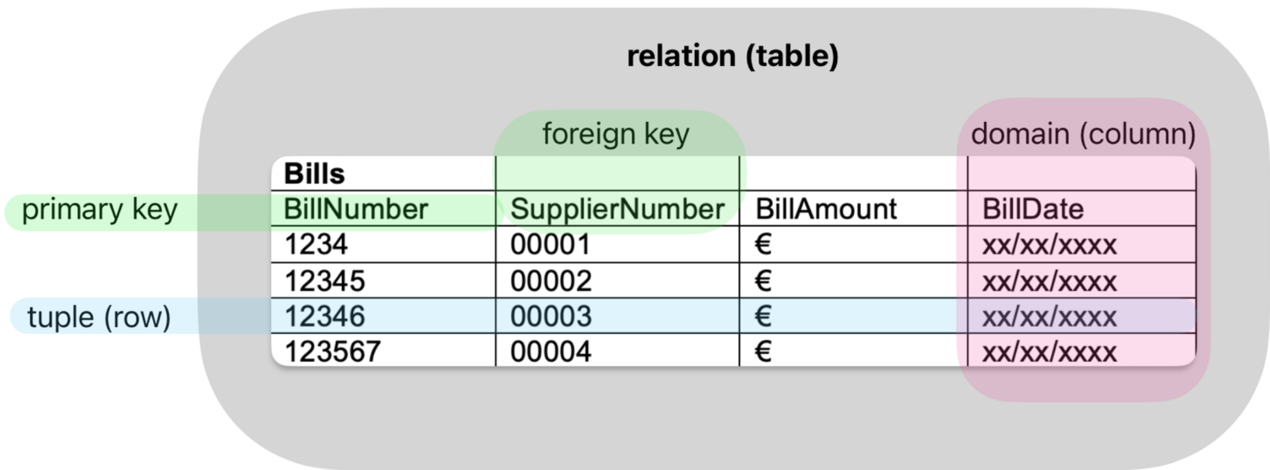

Figure 3. The relational model: Codd’s theory vs. SQL terms (inspired by Codd, 1970; Date, 2005; Strawn and Strawn, 2016)

Figure 3 above is my illustration of the relational model as explained by Codd and as explained by a lot of SQL sources. (Note that the figure is not an adaption of an existing picture, but rather my illustration based on the theory it is inspired by.) Similar terms are primary keys and foreign. Codd explains that normally one domain of the relation (in this case Bills), has a unique identifier, meaning that the values in that domain are unique identifiers of each element (in this case Bill number). This identifier is called the primary key. Foreign keys on the other hand are used to cross reference other elements of a different relation (table). SupplierNumber is the primary key of the relation Suppliers, and a foreign key of the relation Bills (see figure 5). This foreign key connects the relations Bills and Suppliers (figure 5). The difference in terminology is presented in blue, grey and purple. (Figure 2.)

Codd (1970, p. 380), uses the terms tuple, domain, and relation. Other sources like (Strawn and Strawn, 2016, p. 63) use the terms table, row, and column. Date (2005), discusses the differences in terminology in depth in his book Database in Depth: The Relational Model for Practitioners in chapter 1.1 A Remark in Terminology.

As this thesis is not extensive in its theoretical framework, for more detailed and or further theory on the subject I recommend sources used in this thesis (see reference list for full references):

- Codd, E.F. (1970) A Relational Model of Data for Large Shared Data Banks
- Darwen, H. (2012) The Relational Model: Beginning of an Era
- Date, C.J. (2005) Database in Depth: The Relational Model for Practitioners
- Grier, D.A. (2012) The Relational Database and the Concept of the Information System
- Mateosian, R. (2005) Going through the database
- Strawn, G. and Strawn, C. (2016) Relational Databases: Codd, Stonebraker, and Ellison

4.3 Relational databases in connection to ERP systems

Key financial activities in ERP systems and data tables in a relational database can be quite simply explained in connection to each other (see chapter 2 for business processes and chapter 4.2. for data tables). Generalising, with a financial viewpoint in mind, most companies have transactional activities related to accounting and finance, such as customers, suppliers, bills, invoices, and projects.

According to Monk and Wagner (2013, p. 13), the business process of Accounting and Finance (A/F), includes data (inputs and outputs) from functions such as payments, accounts receivable (AR), accounts payable (AP), sales, production and inventory, payroll and expenses, payments to suppliers, financial reports and customer credits. In the figure 4 below is my visualisation of the aforementioned financial functions of AP, AR, suppliers and customers, with the internal addition of projects. In addition the figure showcases examples of data related to those functions. This is a simplified example with less data than what could be related to customers, suppliers, bills, invoices, and projects. Examples of data related to customers and suppliers are identifiers like name, VAT code, address, and the system generated customer and supplier numbers. Bills and invoices have information like dates, amounts, and the sender of the bill and recipient of the invoice. Bills and invoices also have system generated identifying numbers. Projects have identifiers like project name and number, all other information is related data (so called foreign keys). (Figure 4.)

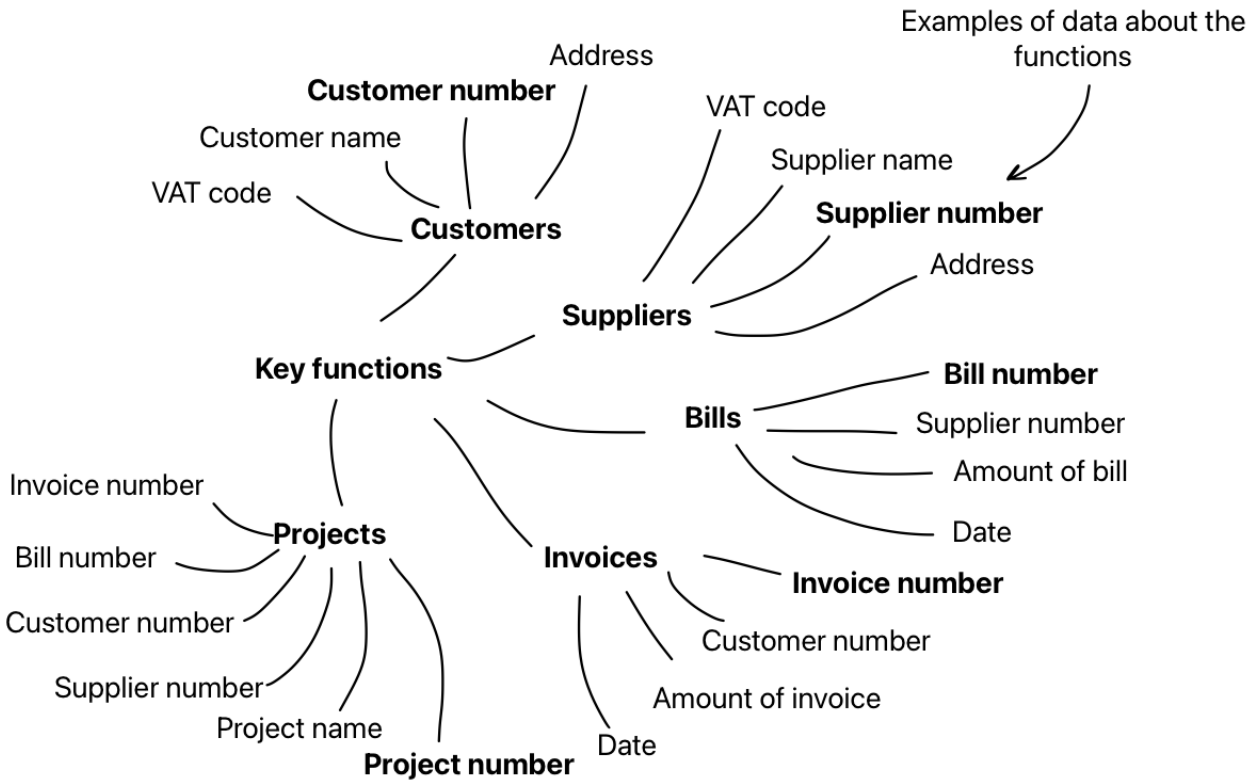

Figure 4. Key financial activities

Romney et al., explain that businesses need to collect several different kinds of data regarding different business activities, as well as the resources and people affected by these activities. Transactional example is that a business needs to collect data about their sales (date, amounts etc.), the resource or goods sold (quantity, unit price etc.) as well as the people who participated in the transaction. (Romney et al., 2021, p. 29.) According to Romney et al. (2021, p. 31), “a business process is a set of related, coordinated, and structured activities and tasks that are performed by a person, a computer, or a machine, and that help accomplish a specific organizational goal”. In my examples (figures 4 and 5), I focus on the transactional business activities of sales (invoices and customers) and purchases (bills and suppliers) as well as the people and other relevant data related to these transactions (projects). (Figures 4 and 5.)

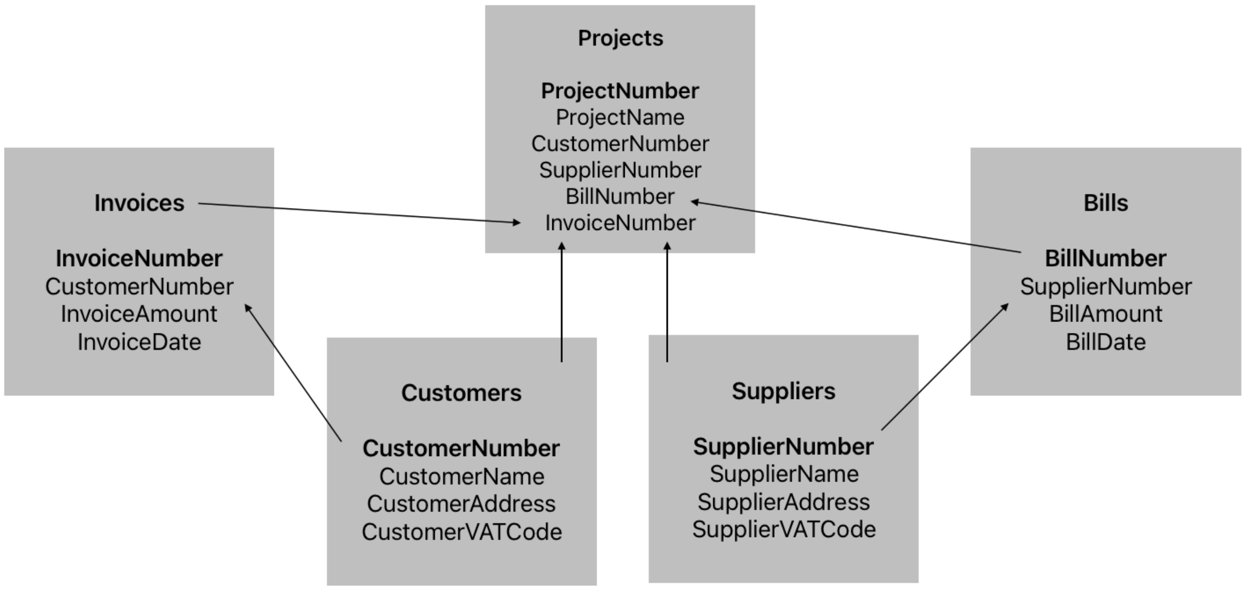

Figure 5. Key financial activities as data tables in a relational data model

In figure 5 the same transactional activities and data items related to those activities presented in figure 4, are presented in a relational data model. Invoices, Bills, Customer, Suppliers and Projects are now data tables in relation to each other. In bold are the names of the tables, and their primary keys. Arrows reflect the relations between the tables. Notice how the same data is related to multiple functions. Invoices are related to Customers through the Customers table, where the primary key is CustomerNumber. Bills are related to Suppliers through the Suppliers table, where the primary key is SupplierNumber. All four tables are related to the Project table through their primary keys. (An example assuming that suppliers, customers, bills, and invoices can all be connected to a specific project). The primary key of Projects is the ProjectNumber. Foreign keys, primary keys and the relational model is explained in previous chapter 4.2. (Figure 5.)

Valashani and Abukari clearly describe the function of ERP systems as follows: “ERP systems tie together a multitude of business processes and enable the flow of data between them”. This flow of data is possible through a central database. The central database of an ERP system records, processes, monitors and reports all business transactions. (Valashani and Abukari, 2020, p. 71.)

Bender et al., explain that relational databases are the primary choice for ERP systems today. The data in relational databases is presented in tables in relation to each other. **Database management systems with relational databases are called (RDBMS)**, relational database management systems. (Bender et al., 2022, pp. 442-444.) These tabular databases are great for storing and processing similar and reoccurring datasets. This applies especially to transactional data often used for financial functions. **Transactional data** is used to describe data related to financial transactions like orders, invoices, payments etc. (Bender et al., 2022, pp. 472- 474.)

Date (2006, chap. 1) states philosophically in his Database in Depth book that:

> "Professionals in any discipline need to know the foundations of their field. So if you're a database professional, you need to know the relational model, because that model is the foundation (or a huge part of the foundation, anyway) of the database field in particular."

One might of course argue that finance professionals are not the same as "database professionals" that Date is referring to (Date, 2006, chap. 1). But if you use a database every day for majority of the work you do, are you not practically a database professional? Or at least someone who could benefit from having the skills/some skills of a database professional? Shouldn't the theory/knowledge of the product you use to do your job be a core priority? Can one truly say they are proficient (or efficient) at their job, if they are unfamiliar with the product (system) that essentially does their job?

4.4 SQL (structured query language)

Structured query language (known as **SQL**) is a computer language that allows data query from relational database management systems (RDBMS) (Rao, 2000, p. 4).According to Manyika et al., 2011, p. 33), SQL is originally an acronym from the words structured query language but is nowadays just a three-letter word: S-Q-L. Bender et al. (2022, p. 471), argue that basic knowledge of SQL is essential for understanding relational databases. Date describes that in contrast to principles (such as relational theory) products and technologies (such as SQL) change all the time. Implying that understanding the underlying principles of the products would be a more beneficial long-term skill, than just understanding one individual product. Date also emphasises strongly that "SQL and the relational model aren't the same thing". (Date, 2015, chap. 1.)

Therefore, opposite to Bender et al. (2022, p. 471), I would argue, that understanding the relational model is essential for understanding SQL, not the other way around. Without truly understanding how the relational model works, trying to query the data from it using SQL is nearly impossible. To be able to query the data from the database, you need to understand the structure (as in relations between the tables) of the database (RDBMS). At least from my own experience studying relational theory and SQL. In addition, it is important to note that there are several different SQL languages, but just one theory (the relational data model) underlying the relational databases, for which SQL is used (Date, 2015, chap.1).

In addition to just querying the database, you can also update and delete data in the database using SQL. To add and update data SQL uses operators like INSERT, UPDATE, CREATE, ALTER, DROP, and DELETE. SQL is not a full programming language, but a so called “data sub language” for relational databases. (Melton, 1996, p. 142.)

I was intrigued on what others think of SQL as a skill, and whether you should learn it or not. Therefore, I looked at a few web sources such as Noble Desktop that offers learning and career development and SQL courses. They say that SQL is one of the most popular programming languages. They also point out that it is used in a lot of different fields including business analytics, data science, software engineering, database administration and even journalism. SQL is widely used across different sectors and lot of popular RDBMS support SQL such as Microsoft SQL Server, Ingres, Access and Oracle. Noble Desktop even state on their Learn Hub page, “Why learn SQL?”, that SQL knowledge is a must for anyone who works with data. Regarding financial analysis, SQL can be a time saving tool, as it enables the user to sort through large volumes of financial data from a relational database. (Noble Desktop, 2023.) In line with my argument of finance professionals being also data professionals, or at least able to benefit from more in-depth data skills, Noble Desktop states that SQL can help in understanding the way a company structures it data, therefore possibly even helping with communicating with other teams (such as tech and data analysts). They also note that SQL is being used by a multitude of large international companies such as Google, Amazon and Netflix. (Noble Desktop, 2023.)

Contradictory to other programming languages, SQL is often described as relatively easy and user-friendly. According to Thorndyke (2021), “learning SQL isn’t a big task, even for a beginner”. Tying SQL skills directly into financial tasks Thorndyke (2021), also explains that “if you work in finance, you’ll be able to use SQL to gather the details you need for any monthly or quarterly reporting”.

Lefevre (2021), writes in a Toward Data Science blogpost “3 Reasons Why You Should Learn SQL Even if You Are Not Part of a Tech Team”, that learning SQL could:

1. Help you to become more autonomous in data analysis.
2. Help you structure your thoughts (by understanding how you company’s data is structured).
3. Help you develop new professional skills (SQL was ranked as the third highest commonly used programming language by Stack Overflow in 2020).

Thorndyke (2021), writes in a Code Academy blogpost that even if you are not considering a role in fields like data science, back-end engineering or programming, SQL can be useful for non-technical professionals who want to learn more about data. Thorndyke also highlights that since SQL has many potential uses, “different types of professionals (can) use it for data extraction and data analysis”. She continues about non-technical roles, saying that if you work for a company that already uses a relational database, learning SQL might enable you to look for data more efficiently on your own. (Thorndyke, 2021.) This perfectly describes the thought process I had after my role as a financial assistant without the previous knowledge of relational databases and SQL. I kept thinking there must be a better and faster way to do this, when it came to data-analysis or reporting of any sort.

5 Results

This chapter will present the results of the study in detail, and the conclusion. We will look at the research questions and discuss whether the literature review managed to assess and answer these questions as planned. Key points from all chapter will be raised, summarising the research conducted through the literature review.

It became clear quite early on that the results would be very subjective. Nevertheless, I continued with the plan and the research because the main goal for me was to deepen my knowledge of the subject in question, and that I have done to a degree that I feel will be beneficial to me in the future. I also hope that this thesis would be an interesting read for students (or working finance professionals) that are curious about data and the systems they work with. But purely from a research perspective I recognize that this thesis did not really provide as much new ideas or theories as I hoped it would.

5.1 Answers to research questions

The main research question was: What is the connection between the relational data model and enterprise resource planning (ERP) systems (with a relational database)? Through discussing business processes and financial transactions, and the role of ERP (see chapter 2), I connected the data related to those transactions to the logical presentation of a relational data model (see chapter 4.3). Codd started a revolution in 1970 in the field of integrated information systems and databases. Relational databases based on Codd's theory are still the prevalent choice for ERP systems today. The simplicity of the relational model, compared to others, is the fact that the user does not need to know the specific details or architecture of the database. It is sufficient to "just" understand the logical architecture of the relations (tables) and the data (tuples) in them. (See chapters 4.1 and 4.2.) The comparison of the relational model to tables like spreadsheets makes the theory of the database quite simple, and therefore easy to understand for non-technical professionals. As ERP systems and integrated technologies evolve, so does the work of the professionals using these systems. Especially accountants are required to broaden their contributions to the company, as accounting is becoming more connected to other functional areas of businesses (see chapters 1.2. and 2).

The sub questions as presented in chapter 1.1 were:

1. Can understanding this connection (the main research question) be of value to finance professionals?
2. To what extent are finance professionals also data professionals?
3. Should you learn SQL as a finance professional?

Databases serve as the foundation for data storage and retrieval. Understanding the database in the system provides deeper insight into ways the data can be accessed. (See chapters 2.1, 3.4 and 4.3.) The ERP market is a billion-dollar industry and is expected to continue its growth (see chapter 2.2). Improving the quality and quantity of information is a prerequisite for decision-making in business. Knowledge (information derived from data) is in the core of every thriving business. However, data only holds value if it can be understood and analysed. Especially the world of finance revolves around data, and naturally understanding the data and the system it is stored in better, would improve analytical skills required for different financial tasks, reporting and financial analytics. A major issue with the growth of big data and improving technologies, is not the data or technologies itself, but the lack of skills (professionals) in companies to actually benefit from this growth and evolution. The digital transformation requires more and more digital skills in order to understand the digital technologies in the corporate world. (See chapters 3 to 3.2)

From a financial perspective, data is largely numerical and transactional. Finance professionals (depending on the field, but generalised) deal with financial data like bills, invoices, sales figures, balance sheets, profit and loss, VAT's, currencies etc. Everything from daily and monthly financial activities like AR (accounts receivables), AP (accounts payables), month end closing, tax reporting, accounting and so on, revolves around numerical and transactional data. (See chapters 2 and 3.2.) This is why, I personally, wanted to learn more about data and study how finance professionals could benefit from more specific data-driven skills like understanding data models, databases like RDBMS, relational theory, computer languages (like SQL) and financial data-analytics.

Using a system (ERP) with a database, essentially also makes you a data professional, or at least someone who can benefit from a deeper understanding of data. In comparison to singular products or computer language, relational theory as a whole is a principle that has remained the same over a long period of time. Understanding underlying principles, therefore, is more beneficial in the long-term. Applying knowledge from a theory to a product is more straightforward than vice versa. Products have different qualities that cannot always be applied to other products, but knowledge of principles and theories can more often than not be applied to majority of the products produced from said theories. (See chapters 4 and 4.4.)

SQL is one of the most popular programming languages, even though it is not actually a full programming language, but a computer language, meant to query data from a database. SQL is used in a lot of different fields, not just finance. Most popular RDBMS support SQL. SQL can help understand the way company structures its data. More specifically, it can help with gathering details needed for reporting, being more autonomous in data-analysis, and simply just help you develop new professional skills. As most companies use some kind of integrated information system (often

ERP) that includes a database (not always, but often RDBMS), there is a chance you already work for a company that uses a relational database. If that is the case, you can benefit from SQL, as it can enable you to look at, and analyse data more efficiently. (See chapter 4.4.)

5.2 Conclusion

The main research question was more theoretical, to which the answer was built via the theoretical framework about ERP systems and the relational model. The sub questions were more hypothetical, under the assumption that the subjects discussed play a major role in the career of finance professionals. As pointed out before, the field of information technology is continuously growing, and the use and integration of ERP systems is expected to grow as well. RDBMS still being the prevalent database choice for said systems (see chapter 4.3) emphasises the role they play in using the system (ERP) and understanding the data in it better. Therefore, at least if you work with a system using a relational database, understanding their connection will be beneficial (see chapter 4.4). Up to what degree, is up to the user.

Considering the growing role data plays in the decision-making of businesses, and the growing need for skilled data and analytical professionals, especially in the financial sector, it seems apparent that finance professionals are essentially also data professionals. Again, up to what degree, relies on the career path and career development one wishes to acquire. The implied benefits of SQL enforce the answers to sub questions 1 and 2 (see chapter 1.2). If learning SQL is truly as beneficial as research suggests (see chapter 4.4), I would argue that understanding the relational data model, ERP systems on a deeper level, and data management in general, are almost prerequisites for the use of SQL. If this sounds like a bold statement, consider the opposite; what would be the be benefits of learning a query language, without also learning about the system it is used in, and the data in the system being queried.

5.3 Further comments

Whether or not actual relational theory and SQL come into play in one's career, is up to them. But it seems that in the ever-evolving world of data, IT (information technology) and AI (artificial intelligence) understanding data and having strong analytical skills (for example visualizing, reporting, and analysing data), is no longer a nice extra skill but a requirement in the workforce. Especially when numerous routine tasks are increasingly automated. The role of finance professionals is gearing more towards understanding and presenting the data, than just simply handling it in routine repetitive tasks.

It seems apparent that the future (and current) trends of finance majorly revolve around data. The amount of data gathered and created by companies proceeds to grow, but without insightful analytics, the data holds no value. Due to the AI revolution, the work of finance professionals will fundamentally change in the future (see chapter 3.3). Professionals needs to adapt to new environments, systems, and ways of working. Therefore, understanding the systems and the data in the systems, is a necessity for finance professionals. Proficient data integration is crucial for efficient business processes, especially now when data continuously plays a bigger role in the corporate world (see chapter 2.1 and 3.4).

In my opinion it would be interesting to research this topic using a quantitative method as well. As an example, a group of finance professionals, of which half would study relational theory and SQL and the control group would not, would be studied through questionnaires and or interviews. After and during the training period the participants would continue their work and be surveyed on their experience and how they feel it has affected their work performance. Studies like this would perhaps provide more reliable research and deeper insight into the amount of data skills finance professionals could truly benefit from.

6 Discussion

I feel as though I cannot explicitly prove that understanding relational databases is beneficial for finance professionals, since ones career is obviously largely in their own hands. However, it seems obvious (maybe even without research) that data skills in general and at least having an interest in the systems and the databases one uses in their work, would be beneficial, at least for general work performance. When you understand the system and the data in it, navigating it becomes quicker and easier. Through this understanding one could easily gain more responsibilities at work, in areas like IT and or system support, implementations, as well as reporting and analysing data.

6.1 The research and learning process

I feel like a had a solid start to the process and spent a lot of time planning the subject (appendix 3) of the thesis. I ended up changing the subject quite a bit (from a very technical project type thesis to a literature review more focused on finance and ERP), but I feel that the careful planning I had done allowed me to really look at the subject objectively and discuss it critically with my supervisor. I had a very carefully planned schedule, but I must admit I did not follow through on it. The start to my process was very hands on and focused, and I did finish close to my original schedule. However, the actual writing process was more focused on the last month, and not consistent throughout the whole process like I had planned.

I overestimated my prior knowledge on the subject lightly, coming across a lot of sources that were not appropriate for use and or too technical for me. However, I am content with the process of updating my key words and searches and I managed to get a good number of sources, most of which are peer-reviewed articles from reliable databases and publications. I ended up using maybe 60-70% percent of the original sources I had sourced and found a lot more during the process of writing. I had anticipated this and on purpose gathered a lot of sources in the beginning, to count for the fact that most likely not all of them would end up being suitable for my work.

In general, I feel like I learned a lot through the seminar course and the process of planning for and writing this thesis. From the start of the process (in January 2023) the subject, the keywords, the viewpoint, and even the research questions where redefined several times. Things like searching for sources, navigating databases, building a report with specific format expectations, and using a reference manager like Mendeley, have made me more proficient in my research, documentation, and IT skills. I have also learned a lot from research and literature reviews in general, and different approaches, strategies and analysis methods that can be used. Building the theoretical framework for this thesis taught me a lot about subjects like ERP, relational theory, SQL, AIS, data and databases. I feel as though I gained a deeper insight into these subjects, like I had wished to.

6.2 Reliability and validity of the study

Peer-reviewed articles from the study where from publications like Journal of Business Research, Journal of Applied Intelligent Systems & Information Sciences, IT Professional, Information Systems Frontiers, Industrial Management and Data Systems, IEEE Software Year, IEEE Micro, IEEE Internet Computing, IEEE Annals of the History of Computing, and Communications of the ACM. For the search of peer-reviewed articles I used Google Scholar and different databases such as IEEE Xplore, ProQuest, EBSCO and ScienceDirect. I am satisfied with the quality and number of sources used. In hindsight, I could have paid more attention to the years of publication of the sources. The underlying theory regarding relational databases has stayed somewhat the same throughout, but in other aspects of the study I could have used more recent publications.

In the era of continuous information technology development, big data, and AI, I feel that the subject is very relevant (see appendix 1 for terminology). The roles of different professionals are constantly changing, and especially in finance, the roles seem to grow more diverse through automation, and not diminish, as maybe expected. What constitutes a finance professional is a very open-ended question and probably up for debate. This is something I could have looked at more critically at the start of the research process.

Personally, I enjoy different computer systems and am fascinated by business areas like software development and IT implementations, and I hope to build a career not only as a finance professional, but a data professional as well. The research I did is obviously only a miniscule part of what could be researched regarding information technology (specifically ERP) and finance (specifically data and data management), but nevertheless, I hope it was an interesting read for anyone interested in the subjects discussed.

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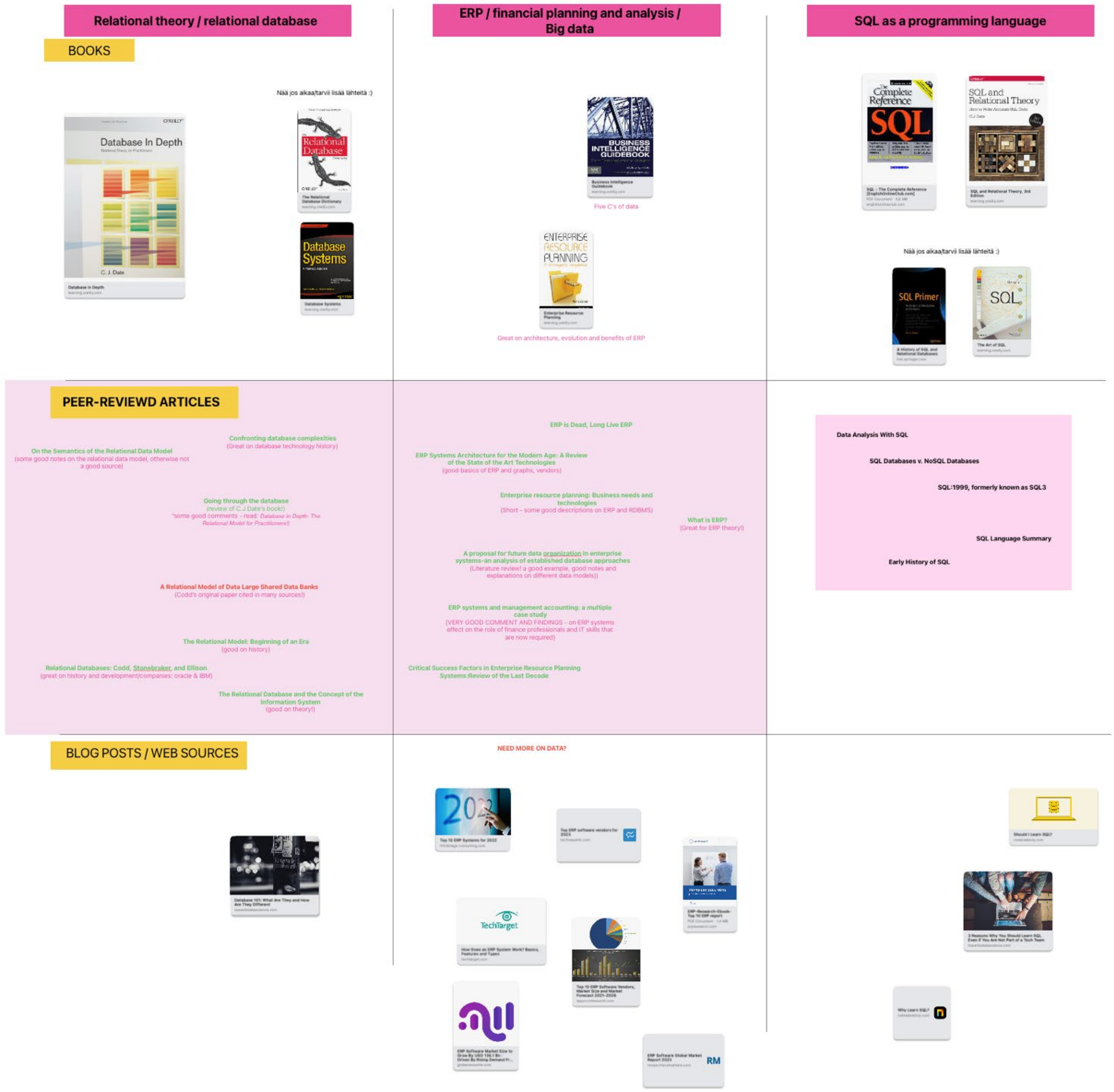
Appendices

Appendix 1. Key concepts and terminology

Concept	Description	Reference
ERP	Enterprise Resource Planning systems: integrated information technology systems, with the purpose of integrating the data between different functional areas.	Monk and Wagner, 2013, pp. 3-4
Data	“Facts collected, recorded, stored and processed by an information system”. Data that has been handled (organized, structured, or processed).	Romney et al., 2021, p. 29 Sherman, 2014, chap. 1.
Information	Organized and processed data.	Romney et al., 2021, p. 29
System	“A set of detailed methods, procedures, and routines” designed to “carry out specific activities”.	Romney et al., 2021, p. 29
IS	Information system: the “people, procedures, software and computers that store, organize, analyse and deliver information”.	Monk and Wagner, 2013, p. 3
AIS	Accounting Information System: “A system that collects, records, stores, and processes data to produce information for decision makers”. Includes multiple aspects such as people, procedures, instructions, data, software, IT infrastructure, and internal controls and security measures.	Romney et al., 2021, p. 812
IT	Information technology: “computer and other electronic devices used to store, retrieve, transmit and manipulate data”.	Romney et al., 2021, p. 309
Database	A collection of large volumes of data. Component of a database system.	Jatana et al., 2012, p. 1 Foster and Godbole, 2014, chap. 1.1.
DBS	Database System: a computer system with the purpose of storing data and keeping it available upon request, composed of different components such as hardware, DBMS, database, related systems and applications, as well as end users.	Foster and Godbole, 2014, chap. 1.1.
DBMS	Database Management System: a program or programs that allow for the management of the database system (DBS).	Foster and Godbole, 2014, chap. 1.1.
RDBMS	Relational Database Management System: A database management system with a relational database component.	Bender et al., 2022, p. 444

Concept	Description	Reference
SQL	Structured query language: a computer language that allows data query from relational database management systems (RDBMS).	Rao, 2000, p. 4
AI	Artificial Intelligence: Gartner Senior Principal Clement Christensen states that the AI revolution has the possibility to “fundamentally change how you work” in the upcoming years.	Gartner, 2020, p. 14
Five C’s of data	Clean, consistent, conformed, current and comprehensive data.	Sherman, 2014, chap. 1
Big data	“Large pools of data that can be captured, communicated, aggregated, stored and analysed”. Size beyond what can typically capture in a database. Definition can vary by sector.	Manyika et al., 2011, p. 1
Transactional data	Data about transactions, e.g., process data, billing data, sales data, etc., business activity data.	Bender et al., 2022, p. 472 - 473
Data integration	Combining data from different sources to one comprehensive and unified view.	Sherman, 2014, chap. 1

Appendix 2. Categories and themes of textual data (coding)



Appendix 3. Planning of the review