ERP 3.0 Requirements

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Submitted to Marta Sabou

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AFFIDAVIT

I hereby affirm that this Master's Thesis represents my own written work and that I have used no sources and aids other than those indicated. All passages quoted from publications or paraphrased from these sources are properly cited and attributed.

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ABSTRACT

This research provides a deeper understanding of business needs of a modern enterprise, their fulfillment by current ERP systems, and necessary requirements for future ERP systems. In the current rapidly changing business environment, enterprises need to adapt quickly and efficiently. Just as the technology is driving the change, at the same time it helps enterprises adapt to the change. Even though ERP systems are currently the best technological support for enterprise's operation, current ERP systems are not providing what modern enterprises need, causing many problems for the adopting enterprises. This research first defines general business requirements of an enterprise, relating them to the literature review of current ERP benefits and problems, and finally deriving the requirements for ERP 3.0 (label used for the next generation of ERP systems) from the adopting enterprise's perspective. Methodology primarily used in this thesis is integrative review, bringing together previously unrelated published research to create new connections in support of the research topic. Final results of this research provide ERP 3.0 problem domain requirements on three levels. First, general requirements (integration, agility, simplicity, reuse, and automation) are the essential requirements underlying the architecture of the future ERP systems, which enable the other more specific requirements. Second, administrative requirements (upgradeability, security, templates, simulation, and cost-efficency) are the requirements that support setup, implementation, maintenance, and change of ERP systems. Third, end users' requirements (responsiveness, accessibility, availability, planning, collaboration, and business functionality) include requirements that are needed by the end users performing the actual enterprise's processes within the ERP system, with the goal of optimizing enterprise's effectiveness.

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LIST OF ABBREVIATIONS

GENERAL ABBREVIATIONS

ERP	Enterprise Resource Planning
ERP 3.0	The next generation ERP system
SaaS	Software-as-a-Service
BI	Business Intelligence
MRP	Manufacturing Resource Planning
R&D	Research & Development
VE	Virtual Enterprise

THESIS-SPECIFIC ABBREVIATIONS

SMM	Strategy & Marketing Management
ORM	Organizational Resources Management
FSM	Fixed Assets Management
FAM	Finance & Accounting Management
CCM	Compliance & Control Management
RPM	Research & Production Management
SCM	Supply Chain Management

1 INTRODUCTION

1.1 Context and Previous Research

> ***The two primary drivers in the evolution [of] Enterprise Systems were business need and technological change. Technological change made possible the development of systems to meet changing business needs. The needs may exist for a while before the technology can help meet them, and the technology can exists for a while before someone recognizes its usefulness in meeting a current or evolving business need. In either case, the focus should be on monitoring business needs and monitoring technological change. Research that does both and is geared towards bringing the two together could make significant contributions to business. The ERP system of the future, whatever it may be called, will be found at the convergence of business need and technological change. (McGaughey & Gunasekaran, 2010)***
>
> ***Current ERP technology provides an information rich environment that is ripe for very intelligent planning and execution logic, yet little has changed since the late 1970s in the logic associated with such applications as forecasting, reorder point logic, MRP, production scheduling, etc. The current systems are now just executing the old logic much faster and in real-time. The area is ripe for innovative new approaches to these old problems. (Jacobs & Weston, 2007)***
>
> ***The main objective of the third generation ERP (3gERP) project is too produce the research breakthroughs that will enable the development of a much more comprehensive ERP-system, which can be localized to the different countries/industries/enterprises with a minimum of efforts like the MS Office Package. (Johansson & Bjorn-Andersen, 2007)***
>
> ***While it is widely agreed that current enterprise resource planning (ERP) systems cannot evolve much further, it is the question how future enterprise systems will look like. (Frank, 2009)***

These four quotes represent the best previous research found on the topic of future ERP requirements. They set the context perfectly. ERP (Enterprise Resource Planning) systems are at the intersection of business needs and the technological change (McGaughey & Gunasekaran, 2010). Current ERP systems are built on obsolete technology dating 20+ years back (Jacobs & Weston, 2007). Business needs have changed requiring globally flexible ERP systems

(Johansson & Bjorn-Andersen, 2007). Current ERP systems cannot evolve much further due to technology limitations, so a new generation of ERP systems is needed (Frank, 2009). This new generation will could be called ERP 3.0, continuing the ERP to ERP II naming convention. It will also technologically merge with the upcoming Web 3.0, so instead of ERP III, ERP 3.0 has been chosen as a more appropriate name in the context of this thesis.

Current Enterprise Resource Planning (ERP) systems are very limited in their ability to support modern business practices. There exists a substantial gap between modern management theory in literature and MBA programs and the capabilities of today's ERP software. It is evidenced in research literature and experienced by managers all over the world. Most common problems include lack of flexibility limiting business agility and responsiveness, lack of supported customization limiting innovation and competitive advantage, lack of real time reporting and analysis limiting managerial decision making, complex user interfaces limiting efficiency, difficulty of component integration limiting supplier and customer interoperability, and missing support for specific business functions limiting ERP usability.

1.2 Research Aims and Objectives

The primary aim of this research is to define the user requirements of future ERP systems (labeled as ERP 3.0 in this thesis). If satisfied, future ERP systems will be able to fulfill the needs of modern enterprises fully, as opposed to the current ERP systems, which have many problems. In order to achieve this aim, several secondary objectives need to be accomplished. First, full understanding of enterprise's business needs is necessary, as they are the inputs into ERP system requirements. Second, the benefits that current ERP systems provide need to preserved in future ERP requirements. Third, the problems that current ERP systems cause need to be resolved by future ERP requirements. Finally, a general direction of relevant technological trends that can make the requirements come to life is needed for plausibility of the final requirements (that they are not impossible to satisfy within the next decade).

1.3 Selection of Methodology

Approaches from previous ERP research include questionnaires, observations, interviews, system interactions, inspections of internal functioning, and literature reviews. The primary source of this thesis has been the literature review from peer-reviewed sources, supplemented by observations, systems interactions and inspections of internal functioning. Questionnaires and interviews were not used, as a quantitative data was already available in previous literature. This choice of methodology was due to the qualitative nature of this research.

1.4 Research Instrument

The secondary data was collected in a systematic literature review (SLR) approach, SLR being defined as a "methodical way of identifying, assessing and analyzing published primary studies in order to investigate a specific research question" (Saeed, Juell-Skielse, & Uppstrom, 2011). Search functionalities in the following literature sources were used: Elsevier, Emerald, ACM, Springer, and Google Scholar. Search terms were "ERP" and "Enterprise Resource Planning" in combination with different specific topics (example for ERP benefits: benefits, advantage, improvement, quality, and so on). Information from the practitioners' side was taken from the leading ERP vendors (SAP, Oracle, and Microsoft). For business related literature, primary source were books and articles encountered in the MBA program, complemented by the same research literature search engines already listed. Finally, for primary data, firsthand interactions with the current ERP systems were used. This included SAP Business One and several smaller ERP systems, not globally known.

1.5 Terminology

There are many terms that can be found in the literature referring to the software that is used to run an enterprise, such as Enterprise Resource Planning (ERP), Enterprise Information System (EIS) and Management Information System (MIS). Based on the meaning of the words comprising the term, EIS would be the most appropriate name for such a system (McGaughey & Gunasekaran, 2010; Tabatabaie, Paige, & Kimble, 2010). Unfortunately for historical reasons ERP is the term that is overwhelmingly used in almost all commercial literature and most research literature (Klaus, Rosemann, & Gable, 2000). A quick search on Google shows a difference of 256:1 in favor of ERP over EIS. That is the main reason why the title of this thesis is ERP and not EIS. It is also the term that will be used throughout this thesis to refer to a single unified software system that is used to run the entire enterprise across all its functions and processes. The word "run" as in "run the entire enterprise" has a vague meaning (manage, operate, plan, control, organize, etc.). It is chosen on purpose to encompass everything that is needed for an enterprise to exist successfully.

According to the literature (Laudon & Laudon, 2012; Baltzan & Phillips, 2008) ERP can be subdivided into Transaction Processing Systems (TPS), Management Information Systems (MIS), Decision Support Systems (DSS), and Executive Support Systems (ESS) which are also called Executive Information Systems (EIS). All these types of information systems used to be completely separate software systems, but through time they are increasingly coming together into one system (but are still not there). Nowadays, ERP is usually associated with Online Transaction Processing (OLTP) dealing with operational information, while Online Analytical Processing (OLAP) is separated into Business Intelligence (BI) systems dealing with analysis and reporting. This is mostly due to historical technical challenges of building a single system that will at the same time support quick, short and frequent OLTP transactions and long, complex and infrequent OLAP transactions. Additionally, talking of Customer Relationship Management (CRM), Supply Chain Management (SCM), Supplier Relationship Management (SRM), Product Lifecycle Management (PLM), Knowledge Management (KM), Workflow Management (WM) or Electronic Commerce (E-Commerce) systems as separate systems that interact with the ERP system, is contradictory to the definition of ERP used in this thesis. As defined above, the term ERP here refers to the single unified software system, encompassing all of the systems mentioned above, which can be modules or components in the ERP system.

To compare to other definitions in existing research literature, a non-exhaustive summary of definitions is given in Table 1-1. From this list of definitions one can see that the term has evolved over time. Every time a refinement of technical and/or ideological capabilities happens, the term ERP gets redefined to reflect the changes. In its essential meaning, it represents the idea of a software system used to run an enterprise, regardless of its current implementation and literal meaning, as discussed in (Klaus, Rosemann, & Gable, 2000). That is why term ERP is used here to define the next step, combined with 3.0 indication which conveniently suits both the historical numbering (currently ERP II) and the basis of the refinement (parallel to Web 3.0 – the semantic web). The only recent definition that does not fit is from (Laudon & Laudon, 2012) which should be ignored (CRM, SCM and KMS are not separate from ERP as defined by ERP II term).

One more term that needs to be defined globally is – Enterprise – which is for most current commercial systems defined too narrowly (Klaus, Rosemann, & Gable, 2000). It is contained in the term ERP and is the basis of requirements analysis for ERP 3.0. Enterprise as a noun can mean an organization, a business, a corporation, a group, a firm, a venture and so on. In this thesis term enterprise will be referring to a formal legal organization that takes inputs from the environment and processes them (adds value), producing outputs to the environment (Laudon & Laudon, 2012; Dunn, Cherrington, & Hollander, 2004; Worthington & Britton, 2009; Monk & Wagner, 2008). It can be a commercial organization (business firm), a not-for-profit organization (Non-Governmental Organization – NGO) or a government organization (governmental entities). For-profit organizations want to maximize their margins (difference between the value of inputs and outputs), while not-for-profit and governmental organizations want to optimize their services while matching inputs to outputs (Dunn, Cherrington, & Hollander, 2004). We can label both as a search for efficiency (or productivity as in (Leon, 2007)) in bureaucracies with division of labor and specialization. Efficiency is achieved through efficient business processes, which are a series of routine activities for adding value to inputs (Dunn, Cherrington, & Hollander, 2004). This gives us a common framework for all types of enterprises and our term ERP applies to all of them. This is also true for current commercial ERP systems which usually have versions for all of those enterprises with a common core.

Definition of ERP	Source
The business software systems that evolved as an extension of MRPII-type systems to include integrated modules for accounting, finance, sales and distribution, HRM, material anagement, and other business functions based on a common architecture that linked the enterprise to both customers and suppliers.	(Wylie, 1990) for Gartner, Inc. cited in (Jacobs & Weston, 2007)
A commercial software package that promises the seamless integration of all the information flowing through the company–financial, accounting, human resources, supply chain and customer information.	(Davenport, 1998)
Integrated, enterprise-wide, packaged software applications that impound deep knowledge of business practices accumulated from vendor implementations in many organizations. ERP systems are evolving to incorporate new technologies, such as E-commerce, data warehousing, and customer relationship management. ERP software is a semi-finished product with tables and parameters that user organizations and their implementation partners configure to their business needs.	(Shang & Seddon, 2000)
First, and most obviously, ERP is a commodity, a product in the form of computer software. Second, and fundamentally, ERP can be seen as a development objective of mapping all processes and data of an enterprise into a comprehensive integrative structure. Third, ERP can be seen as the key element of an infrastructure that delivers a solution to business.	(Klaus, Rosemann, & Gable, 2000)
The implementation of standard software modules for core business processes, usually combined with bespoke customization for competitive differentiation.	(Skok & Legge, 2002)
A collection of applications that can be used to manage the whole business. ERP Systems integrate sales, manufacturing, human resources, logistics, accounting, and other enterprise functions. ERP allows all functions to share a common database and business analysis tools.	Gartner, Inc. cited in (Yen, Chou, & Chang, 2002)
A packaged software system that enables a company to manage the efficient and effective use of resources (materials, human resources, finance, etc.) by providing a total, integrated solution for its information- processing needs. An ERP system supports a process-oriented view of an enterprise and standardizes business processes across the enterprise.	(Nah, Zuckweiler, & Lau, 2003)
An IT solution to provide a centralised IT application for business processes and functions within a company or group of companies. It is a software solution that integrates information and business processes to enable information entered once into the system to be shared throughout an organisation. It covers manufacturing and production planning, order management, financial management, asset management, human resources management, marketing automation, electronic commerce, sales and supply chain systems.	(McAdam & Galloway, 2005)
Computer-based technologies that integrate data across an organisation and impose standardised procedures on the data's input, use and dissemination.	(Grant, Hall, Wailes, & Wright, 2006)
Packaged software, which is pre-built by a vendor with the intention of licensing it to consumers in a mass market. Through the standardisation of work activities, via software configuration, ERP packages aim to provide integrated support for organisational practices such as sales, distribution, manufacturing, human resources and finance.	(Light & Wagner, 2006)
A new breed of Information Technology (IT) solutions that promise to effectively integrate islands of information and structure systems to reflect best practices ensuring total transparency and real-time information sharing across the intra-organizational processes (major functional areas) as well as inter-organizational processes (suppliers and customers).	(Gupta & Kohli, 2006)
Integrated business processes and information technologies into a synchronized suite of procedures, applications and metrics that span intra and inter-firm boundaries.	(Wier, Hunton, & HassabElnaby, 2007)
Integrates all departments and functions throughout an organization into a single IT system (or integrated set of IT systems) so that employees can make decisions by viewing enterprisewide information on all business operations. An ERP system provides a method for effective planning and controlling of all the resources required to take, make, ship, and account for customer orders in a manufacturing, distribution, or service organization.	(Baltzan & Phillips, 2008)
Enterprise applications are systems that span functional areas, focus on executing business processes across the business firm, and include all levels of management. There are four major enterprise applications: enterprise systems, supply chain management systems, customer relationship management systems, and knowledge management systems. ERP systems, to integrate business processes in manufacturing and production, finance and accounting, sales and marketing, and human resources into a single software system.	(Laudon & Laudon, 2012)
Ability to deliver an integrated suite of business applications. These tools share a common process and data model, covering broad and deep operational end-to-end processes, such as those found in finance, HR, distribution, manufacturing, service and the supply chain.	(Gartner, Inc., 2012)

TABLE 1-1 DEFINITIONS OF ERP IN RESEARCH LITERATURE

1.6 History of ERP

ERP has a long history dating back to the beginning of computing, evolving with the enabling technology. Progression of computing technology has been quite constant since the invention of computing, following a so-called Moore's law which states that computer hardware capabilities are doubling every 18 months (Monk & Wagner, 2008; Kurzweil, 2005). ERP seems to be following its own law of progression, changing in complexity and thus definition roughly every decade as summarized in Table 1-2. This evolution of ERP is actually following the capabilities of the technology, as not so long ago it was not as powerful and widespread as it is today. Few decades ago only the richest enterprises could have afforded computers and those computers could have done only limited operations. This indicates that the desire to automate the operation of an enterprise has been present ever since it first became possible.

The application of computing in enterprises started in the manufacturing and accounting departments separately. Given the limited computing power and user interfaces of the first computers in 1960s, first processes to be automated were repetitive number crunching processes, such as accounting and manufacturing inventory control (Jacobs & Weston, 2007; Rashid, Hossain, & Patrick, 2002; Klaus, Rosemann, & Gable, 2000; Gil Gomez, A., M., O., & R., 2010; Moller, 2005; Gupta & Kohli, 2006; Chung & Snyder, 2000). They were called Inventory Control Systems (ICS) or Reorder Point Systems (ROP) and General Ledger, Invoicing, Paying and Collecting Systems.

Decade	Definition of ERP
1960s	Inventory Control Systems (ICS) a.k.a. Reorder Point Systems (ROP) General Ledger, Invoicing, Paying and Collecting Systems
1970s	Material Requirements Planning (MRP)
1980s	Manufacturing Resource Planning (MRP II)
1990s	Enterprise Resource Planning (ERP)
2000s	Extended ERP (ERP II)
2010s	ERP 3.0 ?

TABLE 1-2 OVERVIEW OF ERP EVOLUTION

In 1970s, Material Requirements Planning (MRP) evolved from ICS. They consisted of Master Production Schedule (MPS) with Bill Of Materials (BOM) and Inventory Database (IDB) (Chung & Snyder, 2000; Gil Gomez, A., M., O., & R., 2010; Klaus, Rosemann, & Gable, 2000; McGaughey & Gunasekaran, 2010). In this period current major ERP software companies were founded (SAP, J.D. Edwards, Oracle and Baan) and IBM was dominating with integrated manufacturing and accounting systems (Jacobs & Weston, 2007) on their mainframes.

In 1980s, Manufacturing Resource Planning (MRP II) evolved further from MRP, by extension to the shop floor and distribution management, and focusing on quality, efficiency and integration (Gupta & Kohli, 2006; Jacobs & Weston, 2007; Chung & Snyder, 2000; McGaughey & Gunasekaran, 2010). In this period the first servers appeared (again by IBM) and IBM continued its software dominance, reaching more and more enterprises due to significant difference in price between mainframes and servers. Also, PeopleSoft was founded.

In 1990s, Enterprise Resource Planning (ERP) has evolved from MRP II. The term ERP was coined by the Gartner Group (Wylie, 1990) as cited in (Jacobs & Weston, 2007; Gupta & Kohli, 2006). ERP integrates both across and within the various functional silos, enabled by the technological evolution of client-server systems, Database Management Systems (DBMS), Graphical User Interface (GUI) and fourth generation languages (Jacobs & Weston, 2007; Monk & Wagner, 2008; Gupta & Kohli, 2006; McGaughey & Gunasekaran, 2010). It enables the enterprises to speed up their operations and to focus on cross-enterprise processes instead of functions. In this decade IBM lost its leading position, with the majority of world ERP market being controlled by SAP, J.D. Edwards, Oracle, Baan and PeopleSoft (Jacobs & Weston, 2007).

In 2000s and still holding on, Extended ERP (ERP II) has evolved from the ERP. Term ERP II was again coined by Gartner Group (Bond, Genovese, Miklovic, Wood, Zrimsek, & Rayner, 2000) with focus on inter-company communication and collaboration enabled by the evolution of Internet. This is best illustrated by the original figure from the creators of the term in Figure 1-1. ERP II extends the ERP by assimilating SCM, CRM, SCM, SRM, BI, PLM and E-Commerce (also called Extended ERP components) (Baltzan & Phillips, 2008; Gil Gomez, A., M., O., & R., 2010; Moller, 2005; McGaughey & Gunasekaran, 2010). This assimilation of functionality has caused significant vendor consolidations worth billions of dollars: PeopleSoft acquired J.D. Edwards, and was in turn acquired by Oracle (Jacobs & Weston, 2007). This left only 2 big players, SAP and Oracle, with Microsoft slowly sneaking up on their market share.

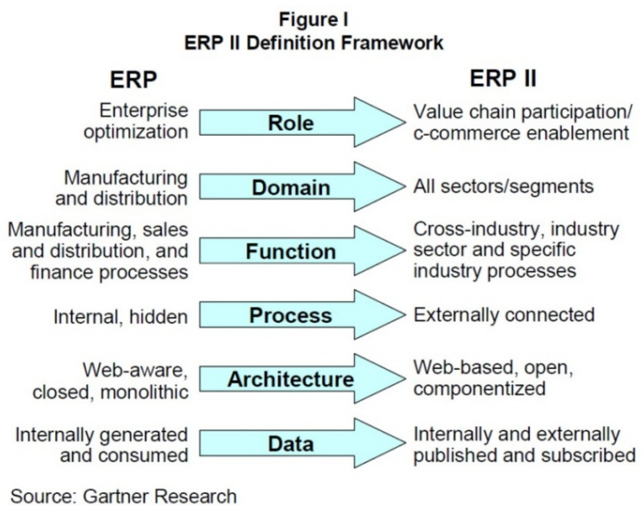

FIGURE 1-1 CHANGES FROM ERP TO ERP II (BOND, GENOVESE, MIKLOVIC, WOOD, ZRIMSEK, & RAYNER, 2000)

In 2010s, we can assume that by the end of the decade there will be a new shift. Based on the historical line of events, the state of technology and business requirements of the global economy, this thesis tries to give an answer to what will be the next step in the evolution of ERP. Due to its expected characteristics, the proposed name is ERP 3.0.

1.7 Structure of Thesis

This thesis has 7 chapters, including this introductory chapter (chapter 1) and the summary chapter (chapter 7). Out of the remaining 5 chapters, chapter 2 presents the necessary business background, context and terminology needed for better understanding of the main research question domain. The other 4 chapters represent the contributions of this thesis. Chapter 3 defines the functional requirements of a modern enterprise, which need to be supported by an ideal ERP system. Chapter 4 reviews and classifies ERP benefits from previous research, which should be preserved in ERP 3.0. Chapter 5 reviews and classifies ERP problems from previous research, which should be removed from ERP 3.0. Finally, chapter 6 defines the problem domain requirements of ERP 3.0., building upon the previous chapters, and answering the main research question. Chapter 7, besides the summary, provides directions for future research into the solution domain requirements of ERP 3.0.

2 BUSINESS BACKGROUND

This chapter covers the business background needed to understand the functioning of a modern enterprise, which is in turn needed to understand the ERP system that support the enterprise's functioning. The goal of ERP systems (by their definition from previous chapter) is to support the enterprise's operation on all levels and across all functions and processes. Before going into the detailed requirements of modern enterprises and ERP systems in the later chapters, background in business context and terminology is provided here. This chapter starts with the business evolution of enterprises (section 2.1), as a historical line that can be extended into the future to understand the current and evolving needs of modern enterprises. Then, necessary terminology of functions and processes is defined (section 2.2), followed by previous attempts to define functional areas of an enterprise supported by ERP systems (section 2.3). This chapter answers the question: *what needs to be taken into consideration before defining the functional requirements of a modern enterprise?*

2.1 Evolution of Business

Looking at the evolution of ERP, covered earlier, one can see a clear trend of integration and consolidation. It is no surprise that the management literature and MBA programs are showing the same trends. What used to be strategy only (with prominent authors such as Porter, Mintzberg, and Barney), now has become intertwined with marketing and labeled as strategic marketing (lead by Kotler). Different measures of performance across different functions (such as financial, customer satisfaction, process efficiency and innovation rate) are being combined to better align strategy, operation and agency in approaches like Balanced Scorecard (Kaplan & Norton, 1992). ISO quality certifications are becoming common among enterprises, based on international adoption of best process practices such as the PDCA cycle (Plan, Do, Check, Act) by Deming. Regardless of which book you take or which MBA program you look at, these topics are prevalent. In ERP literature these concepts are covered as a background for understanding the ERP requirements, however they are neither well integrated nor up-to-date (Laudon & Laudon, 2012; Baltzan & Phillips, 2008; Hinton, 2006; Dunn, Cherrington, & Hollander, 2004). These books by scientific authors are still ahead of any commercial literature, where functions, processes, and buzzwords are mixed up, reflecting the patchwork evolution of their ERP systems.

In its very essence, every enterprise (as discussed under section 1.5 Terminology) converts inputs from suppliers into outputs to customers (Figure 2-1). The primary goal of an enterprise is to optimize the efficiency and differentiation of this process (Porter, 1998). For operation an enterprise needs resources and activities combined in an optimal way (strategy) and exchanged for money (finance and accounting) with the external environment (compliance) (Barney, 1991; Porter, 1998). If an enterprise does this better than its competitors, then it has a competitive advantage. If it can maintain that advantage over an extended period of time, it has a sustained competitive advantage, which is ultimately what all enterprises are looking for.

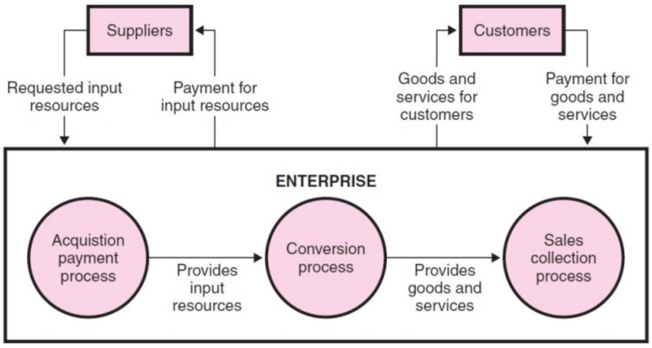

FIGURE 2-1 VALUE SYSTEM AND VALUE CHAIN (DUNN, CHERRINGTON, & HOLLANDER, 2004)

2.1.1 History of Business

Most of the theory about competitiveness was developed in the 80's and the 90's (Porter, 1998; Barney, 1991), when the world was a different place from now. The single greatest contributor to the evolution of business environment is technology. Starting from the very beginning, before there were enterprises, business organizations were small independent units geographically disconnected due to high latency and low throughput of information (people carrying physical letters). With the industrial revolution came improved transportation (replacing horses and sailboats with railroads and steamboats) and predecessors of electronic communication (telegraph starting from mid-19th century). This allowed the formation of the first large enterprises which started assimilating small independent businesses that existed before. Further improvements in technology increased the speed and efficiency of physical and information transportation, increasing the complexity of the business environment. In order to cope with increased complexity of such large organizations, people turned to division of labor between different functions and units. One person cannot be an expert in all areas because of the information overload and the time needed to learn each, as well as the time needed to perform each function. Creation of departments around functionality and business units around geographical areas and/or product groups, led to highly hierarchical and rigid governing structures. With too many different units, managers could not deal with each individually, but were seeking to standardize the system.

Prior to the invention and diffusion of computers, some information was able to flow between units at a higher rate than humans could process it. For example, double-entry accounting systems kept by hand were slow, aggregated and inaccurate, even though the revenues and expenditures were provided in detail (but also with questionable accuracy). For other information, such as marketing, design and engineering, copying of information from one unit to another by hand was slow and problematic. With the invention of computing, from the section 1.6 on history of ERP one can see that the process of integration began. As technology progressed, integration started from inter-process integration (within departments), going to inter-departmental integration (within business units), then inter-unit (within the enterprise) and coming to present day of inter-enterprise integration (within the supply chain). Each of those shifts was the result of changes in the market due to technology advancements and enabled by the technology supporting the transformation.

2.1.2 Current State of Business

Today we are in living in the age of information overload. As every little bit of information is recorded about each and every transaction (product, customer, vendor, employee and everything else), it is not possible for a human to make sense of the vast quantities of data. However, computers can process and transmit amounts of data that the humans cannot even imagine. At first, they were able to do it in a rather simple way with basic math of accounting and manufacturing planning, but over time, with improvements in hardware and software, their abilities have been improving. Besides the repetitive and rule-based transactions that the early computer systems were used for, modern enterprises increasingly rely on the so called Business Intelligence for computer analysis and forecasting. In certain industries, computers have already taken over even the decision making process, such as the stock market electronic trading systems which "offer considerable advantages over human brokers, including speed, reduced cost, and more liquid markets" (Laudon & Laudon, 2012).

Nowadays we live in a global environment. This is something that most people notice on their own (most of every day products such as electronic devices and clothing items are currently manufactured in China or nearby countries). Accordingly, most of the articles published in the last decade on the topic of ERP acknowledge this change. This process of globalization can be defined as a "shift towards a more integrated and interdependent world" in economic, political, technological, and cultural dimensions (Mudambi, 2008). As discussed earlier, the main driving force behind globalization is technology such as improved transportation, media, and communication (one thing in particular – the Internet). Some of the resulting trends that modern enterprises need to deal with include deregulation, disintermediation, industry convergence, service-based economy, customer experience, information availability, outsourcing, offshoring, shorter product life-cycles, and mass-customization (Kotler & Keller, 2012; Kindstrom, 2010; Kirchmer, 2008; Bernardes & Hanna, 2009). As a response to these trends, there is an increasing need for innovation, speed and responsiveness from enterprises (Kirchmer, 2008; Bernardes & Hanna, 2009; Ireland & Webb, 2007).

Innovation can help enterprises by exciting the customers with new products and services, staying ahead of the competition and creating new business models for current or new market segments (Bowonder, Dambal, Kumar, & Shirodkar, 2010). Innovations with iPod, iPhone and iPad have for example enabled Apple to become the most valuable company in the world (Laugesen & Yuan, 2010). Speed is closely related to innovation, as the next step after innovation is the speed to market and the speed of market share capture. This is known as the first-mover advantage due to cycle time reduction (Bowonder, Dambal, Kumar, & Shirodkar, 2010). Responsiveness (including similar terms such as agility and flexibility) on the other hand it the ability to purposefully and rapidly change in response to changes in the environment (Bernardes & Hanna, 2009). Just as one can attribute the success of Apple to their innovation and speed, so can Nokia be attributed with lack of responsiveness which allowed Apple to completely take over their market. In particular Nokia failed to respond to changes in technology and customer needs resulting in an incredible loss for the enterprise.

2.1.3 Virtual Enterprise

The need for improved innovation, speed, and responsiveness is causing a change in the way supply chains and markets are evolving. The traditional horizontal and vertical integrations (buy-outs of competitors in the same market to gain market share and suppliers or distributors to increase supply chain efficiency) result in huge enterprises with complex management structures and strong standardizations. The main problem is that rigid governing structures do not support innovation, speed, and responsiveness. Automation of management processes with current ERP systems has proven to be inflexible and difficult to evolve (discussed in chapter 5). As a response to this problem, there is an increasing trend of disaggregation of the supply chain and formation of virtual enterprises. Virtual enterprise (VE) brings together separate enterprises as nodes in a dynamic network in a global supply chain, each specializing in its core competence and cooperating as a single unit to serve the final customer (Martinez, Fouletier, Park, & Favrel, 2001). In the literature, the term virtual enterprise usually refers to the short term cooperation dealing with a project or a product, while the long term virtual enterprise is commonly referred to as an extended enterprise (Browne & Zhang, 1999; Martinez, Fouletier, Park, & Favrel, 2001). For readability purposes, the term virtual enterprise will be used as the category label, which consists of the short-term virtual enterprise and the long-term virtual enterprise (the extended enterprise).

Long-term virtual enterprises have a longer history, usually built around a manufacturer with just-in-time (JIT) system in place (automotive manufacturers for an example). An example of an extended enterprise is given in Figure 2-2 which shows the value chain of Apple's iPhone. From the figure it can be seen that Apple as an enterprise does R&D, marketing and customer service, while everything else is given to other partner enterprises. The end customer usually only knows of one enterprise which hides the other enterprises in the long-term VE. The current short-term VE is usually put together by a broker and involves smaller enterprises and the end customer is usually aware of all the enterprises. An example would be a tourist agency offering a full service vacation by combining lodging, transportation, and entertainment, in a dynamic way using ICT. A modern short-term VE could even be one-man contractors hired separately, for an example one to design website content, one to design it graphically, and one to write the code. This is enabled on a global scale by contractor portals like Freelancer.com.

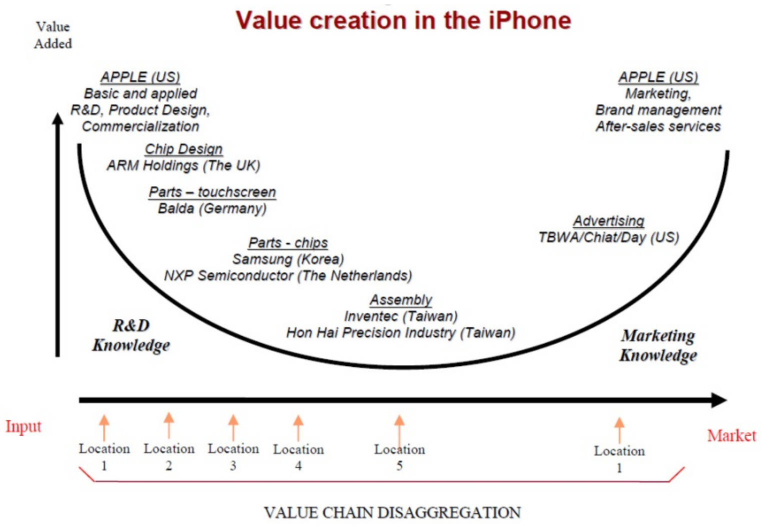

FIGURE 2-2 VALUE CHAIN FOR THE IPHONE (MUDAMBI, 2008)

2.2 Business Functions and Business Processes

Before going into the analysis of business requirements, it is important to define and separate two important terms that will be used extensively in the rest of the thesis – business functions and business processes. Without them, understanding of functioning of modern enterprises would be impossible.

2.2.1 Business Functions

As mentioned in section 2.1.1, business functions are built around distinct areas of business expertise. They include business activities grouped into departments such as marketing, accounting, human resources, and so on. The main driver of function-driven business procedures is the human capability. These functional areas of expertise are very different amongst each other and each is very complex in its own way. A single person is unlikely to be a true expert in more than one area and in companies but the smallest, it is almost impossible for a single person to perform all the required activities on a daily basis. So historically, dating back to 19th century, enterprises have formed departments around functions, each with its internal flow of information (Targowski, 2010). Similarly, education is organized in the same way, with separate course for each function (Kirchmer, 2008). Within the functional departments there is usually further specialization which defines the job that a person performs. For example, within the human resources department, there are people in charge of recruitment, people in charge of payroll, and so on. All the people in the department eventually report to the department head which is responsible for their performance. Some functions are closely related and many enterprises (especially smaller ones) tend to combine them in a single department, such as marketing and sales or finance and accounting.

This bureaucratic function-based approach is suitable from a single person's view (as expertise improves efficiency) and from a control point of view (the expert manager knows best how to manage people in his area of expertise). However, as defined in section 1.5, the operation of an enterprise is based on converting inputs into outputs. The two basic enterprise's processes include exchanging products or services for money with the customers, and exchanging money for materials and services with the suppliers. Traditionally, departments and functions were kept in isolation, one not aware of what is happening in the other. This separation, also referred to as the "silo effect", resulted in conflicts of interest (Leon, 2007; Baltzan & Phillips, 2008). Local optimum does not necessarily result in global optimum in complex environments. In other words, what is best for the department is not necessarily best for the enterprise. The functional areas are in fact interdependent, as one requires information from the others for the enterprise to work (Monk & Wagner, 2008). The better the integration between departments, the better the enterprise can serve its customers, outperforming its competitors.

2.2.2 Business Processes

A simple order fulfillment process spans sales, billing, warehousing and transportation business functions. If one enterprise can complete this process in a single day while the other needs two weeks, it is clear which one the customer will choose. That is why managers are increasingly paying attention to processes as a way of efficiently linking functions to deliver goods and services. A business process can be defined as a set of cross-functional activities, tasks or procedures that take inputs and create outputs of value to the customer, defining roles and relationships (Baltzan & Phillips, 2008; Bititci, et al., 2011; Chinosi & Trombetta, 2012; Monk & Wagner, 2008). Processes can be private (business-facing) where the customer is internal (another department) or public (customer-facing) where the customer is external (customer/ supplier) (Ko, 2009; Baltzan & Phillips, 2008). Processes can also be subdivided into managerial (future oriented like planning and controlling), operational (present-oriented delivering performance like order fulfillment), and supporting processes (enabling the other two types like HR and IT) (Leon, 2007; Bititci, et al., 2011; Baltzan & Phillips, 2008). A good business process should have a defined input and output, be ordered, have a customer, be value adding, be embedded in the organizational structure, and have a process owner (responsible person) (Leon, 2007; Leung & Bockstedt, 2008). A role can be defined as a logical group of activities, tasks or procedures in a process that a single person takes part in (Johansson B. , 2009).

There are two business process related terms that are common nowadays – BPM and BPR. Business process management (BPM) refers to the management of the business process environment (including humans, software and organizations) to improve operational performance, in a systematic and iterative way (Chinosi & Trombetta, 2012; Ko, 2009). Business process reengineering (BPR) is a radical one-off analysis and redesign of business processes. BPR was popular in the 90's, when computerization became widespread, as a way to make the big change from human-only to computer-assisted processes. Now it is more common to use BPM as a continual improvement technique, instead of radical changes of BPR. BPM can also sometimes mean business process modeling, which is the activity of creating a process map showing process inputs, tasks, and activities, in a structured sequence. Business process model "is a graphic description of a process, showing the sequence of process tasks, which is developed for a specific purpose and from a selected viewpoint" (Baltzan & Phillips, 2008). Business process modeling has an internationally standardized graphical notation called Business Process Modeling Notation (BPMN) (Chinosi & Trombetta, 2012).

2.2.3 Virtual Enterprise Processes

In the case of virtual and extended enterprises, processes get further complicated. There are process paths that not only cut across different functions, combining the work of different people in different departments within an enterprise, but also across different enterprises. In the Figure 2-2 which illustrates an example of such a value chain, it can be seen that the top-level process of providing an iPhone to the customers has been split up across different enterprises. Apple as the top enterprise performs the marketing, R&D, customer service, and also management of the strategic alliances (the overall SCM organization and control). In this value chain, the other enterprises (except for the advertising enterprise) do not engage in the marketing function. However they connect to Apple's marketing function, by taking inputs from it, like sales forecasts for production planning and production requirements through R&D specifications. On the other hand, each enterprise engages in its own functions like CRM and SRM (customer and supplier relationship management), as each enterprise in the value chain is the customer to its supplier and vice-versa. Furthermore, all the enterprises contribute to the production efficiency and R&D processes of the value chain. As the overall process consists of many well-defined sub-processes, it results in a complex network of processes spanning functional departments and enterprises in the value chain. This can be depicted in a 3D cube in Figure 2-3 with a sample processes path illustrated with the red line. These inter-enterprise processes require advanced composition models across the boundaries. The BMPN standard defines two composition approaches: orchestration and choreography. Orchestration involves centralized control across the entire process, while the choreography sets individual rules for each participant, and the overall behavior emerges from interaction (Chinosi & Trombetta, 2012).

FIGURE 2-3 PROCESSES, FUNCTIONS AND ENTERPRISES (OWN ILLUSTRATION)

2.3 Previous ERP Functionality Classifications

To start with functional requirements of an ERP from a business point of view, one needs to look at the diagrams of current and proposed ERP systems from research and commercial literature. Starting from the research side, Figure 2-4 shows an ERP diagram consisting of Supply Chain Management (SCM), Customer Relationship Management (CRM), Supplier Relationship Management (SRM), Corporate Performance Management (CPM), Product Lifecycle Management (PLM) and Human Resources Management (HRM). This is a process-based approach which focuses on the operation of an enterprise. PLM for example involves marketing, sales, R&D, production, and so on. From this list there is a number of supporting and strategic processes missing (dealing with fixed assets, financing, compliance, organization, and strategy).

Another attempt is shown in Figure 2-5, which is function-based. It divides business information systems in five functional categories: marketing, production/operations, HRM, accounting, and finance. Compared to the first one, it includes accounting and finance separated, while at the same time combing sales and marketing under marketing, which is a bit unusual. However, this one is still missing compliance management (quite mandatory since Sarbanes-Oxley in the US and on the rise world-wide), asset and organizational resources management, strategy management, and SCM entirely (CRM, SRM, logistics and procurement). It is interesting to note that even though both diagrams were chosen as the most advanced found in the reviewed research literature, they are treating ERP systems as pure operations software, leaving out the resource, strategy and compliance management completely out of the picture. On the other hand they do focus on functions or processes exclusively without mixing up the two and adding buzzwords, unlike the commercial diagrams.

First commercial diagram, shown in Figure 2-6, depicts Microsoft Dynamics AX, as the most recent and most advanced release among the top 3 world-wide ERP vendors. It includes the relevant functional areas of finance (including accounting and fixed asset management), sales and marketing, HRM, SCM, manufacturing, service production and compliance. It also includes project accounting as a separate area, which is in fact a combination of accounting and organizational resources management (which is missing from the picture). It also includes collaboration and mobility, which are nothing more than technological ways of supporting other functional areas and currently popular buzzwords that help increase sales. And finally, there is the BI and reporting, which should not be shown as a functional area as it has no meaning on its own. BI is more of an ERP feature which should be integrated within each functional area, allowing the users to perform their jobs in an informed way. Integrated BI is something that is important and will be discussed further in chapter 4, as even the SAP's president acknowledges that (Plattner, 2009).

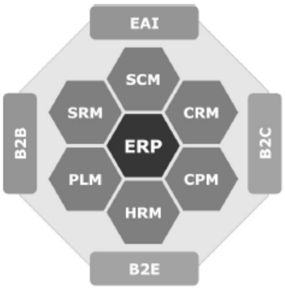

FIGURE 2-4 CONCEPTUAL FRAMEWORK FOR ERP II (MOLLER, 2005)

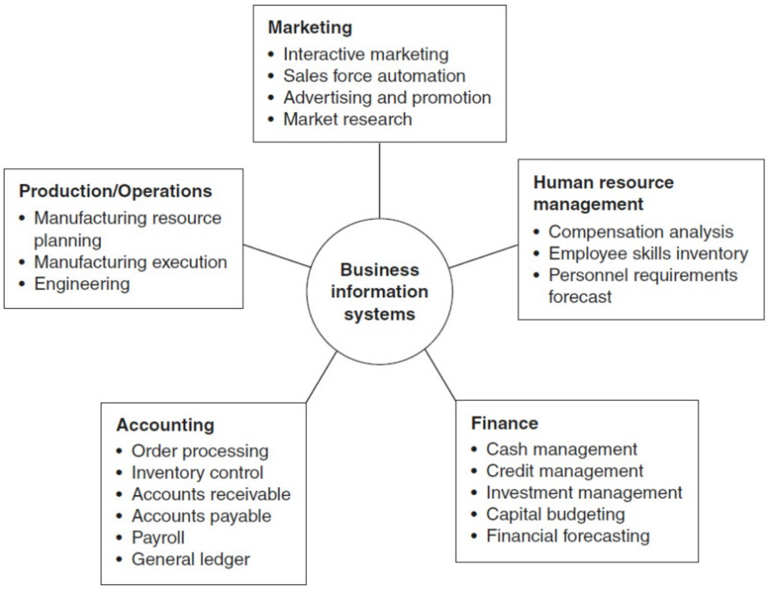

FIGURE 2-5 BUSINESS INFORMATION SYSTEMS (HINTON, 2006)

FIGURE 2-6 MICROSOFT DYNAMICS AX SOLUTION AREAS (HTTP://WWW.IGNIFY.COM/IMAGES/MICROSOFTDYNAMICSAX_SOLUTIONAREAS.JPG)

As the second commercial diagram, SAP's Netweaver functionality diagram is shown in Figure 2-7. The functional areas are listed in the leftmost column, followed by a more detailed list of contained sub-areas. It includes logical functional areas of financials (including accounting), human capital management (HRM), procurement and logistics, product development and manufacturing, and sales and services. It also has separate analytics, which is nothing more than BI discussed in the previous paragraph. The last functional area depicted is corporate services, which includes sub-areas from fixed asset management (real estate), compliance (environment, health and safety), organizational resources (project management), and so on. From this list are still missing marketing and strategy completely, and many important sub-areas. Overall it is a valid functional division, except perhaps for "Global Trade Services" which is nothing more than a buzzword and Life-Cycle Data Management which is a process, not a functional sub-area.

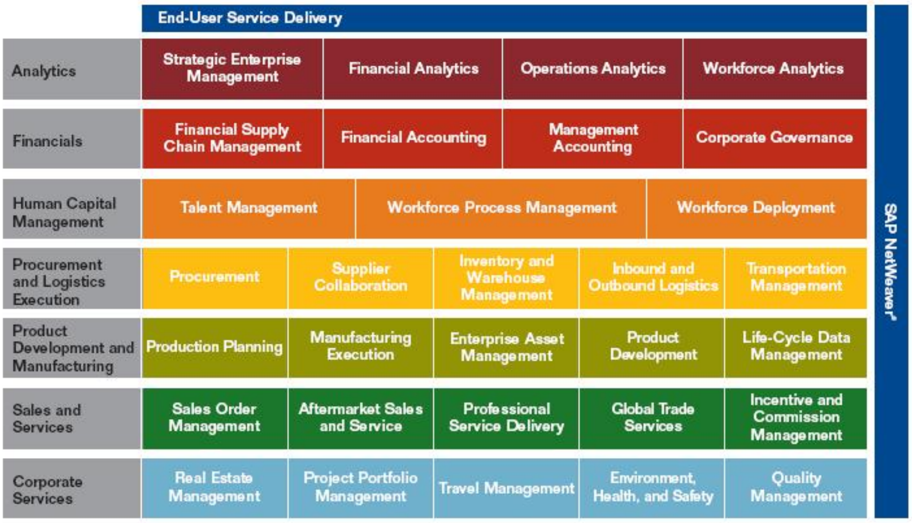

Figure 2-7 SAP Netweaver ERP Functionality (http://www.brainart.hu/images/mySAP_ERP_Operations.gif)

As all of the currently relevant ERP systems have been around for some time (for decades).They have been merged from many different ERP systems and sub-systems, each developed by a different company (see section 1.6 for history of buyouts). Since none of the leading companies want to rewrite their complex code, as the technology and business changed over time they added layer upon layer on top of the original architecture. This can be comically illustrated as a concrete block (the core of the ERP) with add-ons like bricks and screws stuck onto it, shown in Figure 2-8. Compliance and compensation came from changes in business needs, while BI and security were results of changes in underlying technology. Common thing is that none of those add-ons existed when the original ERP architecture and its core were created. Instead of rewriting the core they were added as bolt-ons. This need for a new core (perhaps an integrated carbon-fiber block in the terminology of the illustration) will be accentuated with the next step in the evolution form client-server model to the pure cloud Software-as-a-Service (SaaS).

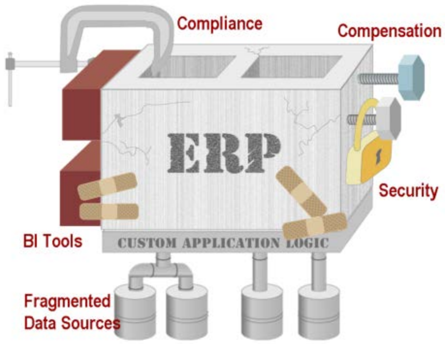

FIGURE 2-8 ERP SOFTWARE COMICAL MOCK UP (WAINEWRIGHT, 2007)

2.4 Conclusion

This chapter provided the business background needed to understand the functioning of a modern enterprise. It provided a quick overview of business evolution of enterprises (section 2.1), as a way to understand the current and future needs of modern enterprises, through extrapolation from the past. Then, necessary terminology of functions and processes is defined (section 2.2) in the context of past, present, and future enterprise interactions. Finally, it provides an overview of ERP-related enterprise functional classification literature, as a context for the next chapter.

3 FUNCTIONAL REQUIREMENTS OF A MODERN ENTERPRISE

As already mentioned, the goal of ERP systems is to support the enterprise's operation on all levels and across all functions and processes. Before going into the detailed characteristics of ERP systems in the following chapters, a thorough understanding of functional requirements of a modern enterprise is needed, with outlook into the future. This chapter answers the question: *what are the functional areas that each enterprise needs to provide across its processes for optimal short and long-term effectiveness?* It is these business requirements that define the ERP requirements, as the ERP system's requirements need to support the enterprise's requirements. When ERP systems fail to support a certain functional area, those activities need to be performed outside the ERP system, manually or on separate software. In a logically categorized overview, each functional area is discussed separately in the following sections.

Based on the reviewed business and ERP-related literature, as well as current commercial ERP systems, and personal experience in business management and an international MBA program, the business requirements taken into account in this thesis include 8 main functional areas illustrated in Figure 3-1. They are strategy & marketing management (SMM), organizational resources management (ORM), human resources management (HRM), fixed asset management (FSM), finance & accounting management (FAM), compliance & control management (CCM), research & production management (RPM) and supply chain management (SCM). The top three functions in the figure (ORM, HRM and FSM) deal with enterprise's resources, which are used in operational activities of conversion of inputs into outputs (RPM and SCM), according to the enterprise's strategy (SMM), in compliance with enterprise's environment (CCM), and exchanged and accounted for in monetary terms (FAM). Each functional area is used by all the other areas in the process of running an enterprise. Process-wise, all areas should be perfectly integrated, but function-wise they represent completely separate areas of expertise defining separate roles and jobs. In the following sections, each functional area is briefly discussed in the order indicated in the Figure 3-1 (starting from customer's needs and ending with delivery to the customer).

It is also important to note that for each distinct market, there will be multiple functional departments dealing with each of the functional areas separately, but again in an integrated way on the enterprise level. The simplest example would be an enterprise offering a custom-made product in one market and a mass-produced product in another market. In this example the enterprise is likely to have different strategies in each market, and manufacturing the products in two different factories in completely different ways with different SCM approaches. However, these two top-level processes (which could be seen almost as two sub-enterprises within the overall enterprise) will still both be using the 8 functional areas. For this enterprise to function efficiently, the processes should be sharing resources (organizational, human and fixed), aligning their strategies for synergy, and using the shared FAM and CCM enterprise functions.

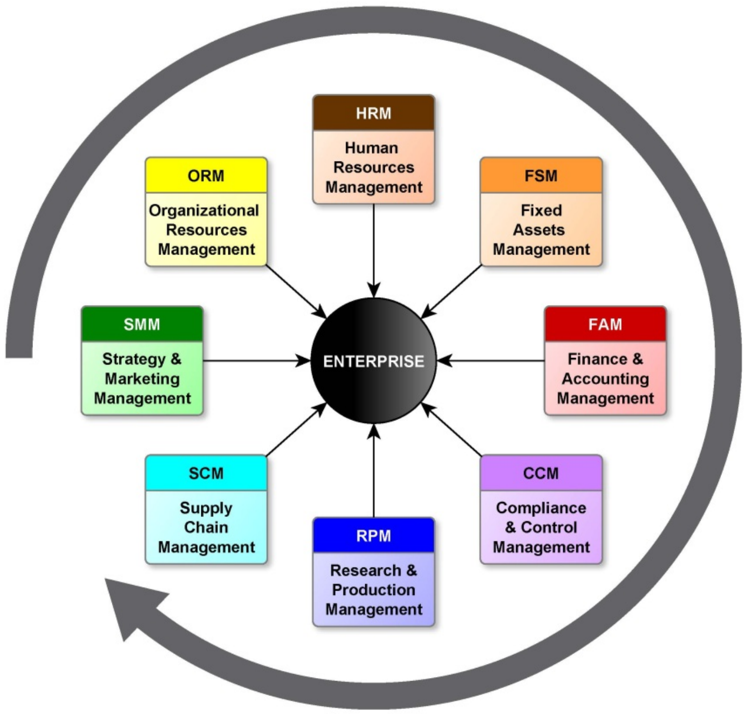

FIGURE 3-1 SUMMARY OF BUSINESS REQUIREMENTS OF AN ENTERPRISE (OWN ILLUSTRATION)

3.1 Strategy & Marketing Management (SMM)

The strategy and marketing management (SMM) function deals with the enterprise's overall goals and the ways those goals are achieved.

Strategy in the business requirements context can be defined as the intended plan and the realized behavior of enterprises (Mintzberg, 1987). It is important to note that the more dynamic the business environment, the more likely it is that the planned strategy will not be realized as intended and will contain more elements that emerge unplanned. This does not mean that the strategic planning should be skipped, but that it should be a dynamic and flexible process with continuous improvement, rather than a plan set in stone. Enterprises should still do the Porter's five forces analysis (buyers, suppliers, substitutes, competitors, and potential entrants) and plan their competitive strategies (differentiation, cost leadership, or focus) (Porter, 1998). They should plan their strategic positioning (serving few needs of many customers, broad needs of few customers, or broad needs of many customers in a narrow market), required trade-offs and the fit between activities (Porter, 1996). They should do the SWOT analysis (strengths, weaknesses, opportunities, and threats) and define their marketing mixes (4P – product, price, placement, and promotion) (Kotler & Keller, 2012). However, enterprises should do all those things continuously, instead of doing it once and sticking to their original strategies till death. It is very unlikely that 10 years ago Apple planned to become the world's most valuable company through mobile phones sales. At some point the market opportunity emerged, Apple saw it fit with their enterprise, and adjusted their strategy and marketing accordingly.

3.1.1 Strategic Marketing Management

The strategic marketing activities need to be done for each product/service group and market segment, keeping in mind that marketing strategy for services is different from products. For each market segment, activities should be performed first separately to define the individual profitability, then as a whole to define the overall fit. Enterprises should first perform market research, and then define the market positioning and competitive strategies. Strategic alliances should be defined (outsourcing, JIT materials or joint ventures), if needed. Next come the 4 Ps – product/service design (customer requirements not R&D), pricing policy, promotion strategy, and placement (distribution channels). For services, it is recommended to also plan another 3 Ps – customer-facing processes, customer-facing people, and physical evidence (physical environment where services are performed). Services are increasingly important as the degree of service content in the developed world is rising (Kindstrom, 2010). At the end, all of these activities should define the branding strategy.

But from the definition of strategy, plans are not enough. This functional area also includes the implementation and market performance measurements, followed by adjustments to each of the activities. It lays the master plan that other functional areas use and follow, and takes care of the fit between them (Porter, 1996). It defines what resources are needed, what activities should be performed, how it should all be accounted for, and what needs to be complied with. Another term used for this set of fitting activities is the business model. Business model consists of the value proposition to customers (combination of product/service marketing mix and the market segment needs), set of linked activities to provide this value proposition in a cost-effective way, and a way that value is captured (revenue model) (Teece, 2010).

3.1.2 Enterprise Strategy management

Strategically, three more areas on the enterprise level are important. Strategic technology management is crucial in the modern business environment, whether it is own R&D or sourced (patents, licensing and strategic partnerships). Technology improves efficiency of processes and quality of products and services. In current volatile business environment, strategic risk management is also important. Predicting potential risks and planning prevention and contingency are the best way to ensure enterprise's long-term survival. Finally, strategic KPI (key performance indicators) definition should be used as a way to ensure fit and performance of the planned activities. Strategic KPIs define the feedback loop to continuous improvement for the entire enterprise.

3.2 Organizational Resources Management (ORM)

According to the resource-based view, organizational resources include organizational structure, business process management (planning, controlling, and coordinating systems), and organizational culture (Barney, 1991). From the capability-based view, it is the dynamic capabilities in terms of management innovation and organizational routines that are key organizational resources (Gebauer, 2011). Management innovation is the creation and implementation of new management processes and structures. For a modern enterprise, organizational culture, structure and process management can be supplemented by innovation, knowledge, goal, and project management. These organizational resources are used by all other functional areas as a backbone for their activities, providing enterprise-wide integration framework. These areas have been grouped here into four major functions – culture management, innovation management, knowledge management, and organization management.

3.2.1 Business Organization Management

The most basic functionality of organization management is the enterprise's organizational structure. Traditionally, most enterprises had, and SMEs (Small and Medium Enterprises) still have, a hierarchical structure. This means that each manager reports to exactly one manager at a higher level, up to the top manager of the enterprise (CEO, president, mayor, minister, etc.). In a functional hierarchy (also called U-form for unitary) departments are organized around functional areas, whereas in a divisional hierarchy (or M-form for multidivisional) departments are organized around products or regions (Harris & Raviv, 2002). A more recent organizational structure used by larger enterprises is the matrix structure, which combines the functional and divisional structures into dual-authority relations. Finally, the simplest structure is a flat structure where neither basis is used for grouping and all the middle managers report directly to the top manager (used by smaller enterprises). Changes in the business environment and technology (as discussed in section 2.1.2) have been driving enterprises towards flatter structures (Laudon & Laudon, 2012). Flatter structures are more responsive and more efficient, due to lower overhead and delay. They are enabled by information technology which timely, accurately, and specifically distributes information, empowering employees to make structured decisions more easily. Organizational structures usually reflect three types of decisions: unstructured, structured, and semistructured. Unstructured decisions are non-routine, important decisions usually associated with senior (top) management, structured decisions are repetitive and predefined decisions usually associated with operational (lower) management, and semistructured decisions contain parts of structured and unstructured at the same time, usually associated with middle management (Laudon & Laudon, 2012).

Within the organizational structure there are numerous processes performed by the employees, equipment, and partners. How these business processes are performed determines the quality, speed, efficiency and other important characteristics of the provided products and services. However, besides these operational processes that most BPM (business process management, aka workflow management) efforts focus on, it is the holistic view that distinguishes great enterprise from good ones. This means that BPM should be applied to all functional areas optimizing processes within and between functional areas. For enterprises taking part in virtual enterprises this goes even further to processes between enterprises as well (as discussed in section 2.2.2). The main goal of BPM is to optimize all enterprise activities within the chosen enterprise structure, following the requirements defined in the strategy and marketing function. There are many important characteristics of processes that can be influenced through BPM, like centralization of authority (autonomy of decision making), standardization of procedures (unification throughout the enterprise), and formalization (degree of written instructions to be followed) (Ireland & Webb, 2007). The current state-of-the-art process model to follow is the PDCA cycle, originally promoted by Deming, standardized in Japan, and currently adopted worldwide by the International Organization for Standardization (ISO; Moen & Clifford). PDCA principle takes a circular continuous improvement approach of Plan, Do (implement), Check (results) and Act (correct), that should be applied to all processes. As a starting point of BPM, goal management sets distinct individual goals for each process according to the strategic KPIs of the entire enterprise. It also feeds into HRM by clearly defining the purpose, measurements, and acceptable levels of performance for processes and roles (employee performance). After the goals and models of business processes have been defined, specific process execution and control aids can be used. Project management provides cooperation management, planning, progress tracking, and reminders to employees and partners working on project-based activities. Closely related to project management is task management, which deals with all activities that employees are involved with, in addition to project related tasks. Task management provides reminders, checklists, calendars, deadlines, resource scheduling, and accompanying details which help the employees perform better. Planning and implementing how the business processes will be managed and providing the supporting structure, improves enterprise effectiveness across all functions.

3.2.2 Organizational Culture Management

In modern enterprises, organizational culture is considered to be an important component of organizational resources and significant effort is put into its management. Organizational culture can be defined as common beliefs, values and norms, shared by the employees of an enterprise (Willcoxson & Millett, 2006; Laudon & Laudon, 2012). It defines what is considered acceptable and what is not. It forms attitudes towards customers, coworkers, partners, work, environment, change, technology, and so on. Organizational culture can be influenced through other functions, like recruitment (selecting new employees that are already closer to the desired organizational culture), training (explicitly stating what’s right and wrong), performance management (rewards and punishments), and organizational structure (centralization of decision making) (Willcoxson & Millett, 2006). There are also some direct ways that don’t involve other functions, such as social events (company picnics, parties, team-buildings, etc.), and leadership by example by the managers. Either way, organizational culture management is about knowing what kind of culture the enterprise wants and promoting it throughout the enterprise. In a way, it defines the “personality” of the enterprise.

3.2.3 Innovation Management

Innovation management is closely related to the organizational culture management, as it also works indirectly to influence other functions in order to improve the rate and magnitude of beneficial innovations. It takes innovation oriented culture, structure, goal, process, and knowledge management as a basis for a holistic cross-functional innovation approach for an enterprise to be innovative. It is the organizational resources that enable and reinforce innovation in all functional areas, carried out by the employees of all levels. Looking at the top performing enterprises, if we ignore the ones with physically scarce resources (oil being the most prominent one), one could say that the only true sustainable competitive advantage is the innovation capability. Every enterprise, no matter how big and strong at some point, will eventually lose its position, if it stops to innovate. Most recent examples of downfall of enterprises that used to be among the most valuable companies in the world include bankruptcy of Kodak (once leader in photography) and the market loss of Nokia (once the leader in mobile phones). Current opposite example would be Apple, which through constant innovation successfully brings new business models to crowded markets and dominates (iPod, iPhone, iPad). Certain studies show that top innovators have 2.5 times higher sales of new products and 10 times higher returns from their investments (Dobni, 2010). Most important innovation benefits for an enterprise include entering or creating new market segments, staying ahead of the competition, and exciting the customers with new offerings (Bowonder, Dambal, Kumar, & Shirodkar, 2010). This shows that innovation management is extremely important for an enterprise in the long run.

3.2.4 Knowledge Management

The last function of organizational resources management defined here is knowledge management. Knowledge management deals with recording, organizing, evaluating, and sharing of knowledge among employees of the enterprise and also between strategic partners. The primary objective of knowledge management is to ensure that the existing knowledge (facts, manuals, specifications, solutions, etc.) is readily available to all employees and partners when needed (Baltzan & Phillips, 2008). It represents a base for effective processes across all functions and levels. Without proper knowledge management, it is impossible to reach optimal levels of quality, efficiency, and innovation. Without it, it is also difficult to make good strategic decisions, acquire optimal resources, or perform any other activity efficiently. Additionally, knowledge management deals with development of new knowledge (in support of innovation management) and transfer of knowledge (in support of employee training under HRM) (Grant

R. , 2010). A specialized type of knowledge management automation is an expert system. Expert systems capture and apply tacit knowledge (know-how) in a specific domain of human expertise as rules in a software system (Laudon & Laudon, 2012). They provide speed and efficiency (cost effectiveness) over human resources (employees). An example would be the stock market electronic trading systems, mentioned in section 2.1.2.

3.3 Human Resources Management (HRM)

Overall, human resources management deals with individual employees who perform the roles in business processes, required by the enterprise's strategy and marketing management, and within the framework defined by organizational resources management (organizational structure, process design, and so on). Number of processes that are being automated has been increasing over time (as computers, software, electronic communication, and robotic technology improve), however people are still the base and building blocks of current enterprises. In the end, enterprise's process efficiency is bound by the quality of the people performing them. Even with the most technologically advanced companies which automate production with robotic factories and enterprise's processes (information flow, decisions and control) with software systems, all of those are still designed, setup and managed by people. Human resources of an enterprise are its employees at all levels, from lowest operational level to the top management level. Each employee has certain value through his/her skills (from experience or training) and relationships (with enterprise's customers, suppliers, government, public, other employees, competitors, etc.), and a certain cost to the enterprise (payroll, benefits and expenses).

3.3.1 Personnel Records Management

Human resource management deals with personnel records, personnel planning, and human capital management (Hinton, 2006). Personnel records management manages personnel information (job position, department, assigned roles, location, personal information, etc.) and personnel costs. Primary source of personnel costs is the payroll. It includes permanent employment, temporary employment, and contract employment. It can consist of fixed compensation (predetermined salary) and variable compensation (performance-based salary like commission or bonuses). Additional costs that can be considered as a part of payroll include employee benefits, such as housing, retirement benefits, and so on. Secondary source of personnel costs are travel and expenses costs, which include fare, rent-a-car, hotel, food, and similar costs incurred by employees while performing their roles in enterprise's processes.

3.3.2 Human Capital Management

Human capital management deals with the employee value side. For existing employees it is about performance and development management. Performance management takes goal management (from organizational resources management) as inputs, and determines each employee's performance within their assigned roles, which is in turn used as an input into variable compensation calculation. Development management and selection and recruitment management take current and expected needs as inputs, and then try to fill those needs as efficiently as possible. Sometimes current employees with additional training are the better approach, but other times it is the employment of new employees which already have the necessary skills and/or relationships, or better potential for developing them.

3.3.3 Personnel Planning Management

Expected needs of personnel are managed through personnel planning, which tries to optimize the enterprise's workforce based on overall needs of all functions, and in accordance to strategic and financial plans of the enterprise. Traditionally, two options available for obtaining human services have been permanent and temporary employment. Depending on the country and existence of unions, they differ more or less in term of ease of ending employment and changing salaries. A more modern arrangement is contract work, which is primarily used for hiring a person for a specific task. In the context of the virtual enterprises, as discussed in section 2.1.3, this relationship can go as far as partnering between different specialists and sharing revenues. Modern technology is enabling increasingly dynamic arrangements by providing skill registers, performance histories (feedback from previous partners), costing negotiations (bidding), contracting and so on. Current examples are internet portals like Freelancer.com and Elance.com.

3.4 Fixed Asset Management (FSM)

Fixed asset management deals with providing assets that are needed by the enterprise in order to perform activities. People (managed by HRM) performing their roles within the processes (defined by SMM) and according to the process structure (defined in ORM) need assets (provided by FSM). Traditionally, from the resource-based view, physical resources include physical technology, plants, equipment, and access to raw materials (Barney, 1991). From a modern point of view, assets can be grouped into tangible (physical objects), intangible (patents, licences and copyrights), and digital (information stored in computers – neither tangible, nor intangible) assets. For example, enterprise's IT system consists of all three types of assets: hardware which is a tangible asset, software which is usually licensed, and digital assets. IT systems are usually dealt with in a holistic approach called the Enterprise Architecture (EA) (Johansson, Holst, & Henningsson, 2009; Targowski, 2010; Kang, Lee, Choi, & Kim, 2010). It includes strong integration of IT assets management with BPM, knowledge management, structure management (ORM), and personnel records (HRM), but also taking into account the requirements of all other enterprise functions.

3.4.1 Tangible Asset Management

The oldest assets used in activities are tangible assets. They include all physical objects, such as buildings, equipment and land. Although common, the enterprise does not have to have ownership of the physical asset. It can have a financial or operating leasing, concession, easement, or other use agreements. Tangible assets need to be inventoried (kept track of and checked for presence), maintained (kept in operational state), and depreciated. Depreciation is distribution of purchase cost over the useful life of an asset, usually associated with accounting. For an enterprise that is providing raw materials to its own activities or other enterprises, ownership of the material-rich land and/or rights to exploitation is the key physical resource. The buildings provide the location where enterprise's processes are performed, using the required equipment. Either there are special employees that maintain the tangible assets, or the maintenance is outsourced to other specialized enterprises.

3.4.2 Intangible Assets Management

Intangible assets can be owned or "rented". They include patents, licences, copyrights, and trademarks. They are "intangible" because they cannot be touched – they represent ideas, processes, designs, formulas, rights, and other abstract objects. An enterprise can be the owner of the intangible asset, using it exclusively for its activities (usually an enterprise's name and logo) or renting its use to some other enterprise in exchange for money (like a patent used in a product). On the other hand, an enterprise can rent an intangible asset from another enterprise for use in its activities, product design, or even branding (like franchising). Intangible assets can be developed by the enterprise (through R&D and other activities) or purchased from another enterprise. The main difference between tangible and intangible assets is that physical assets can be used only in one place at one time, while intangible assets can be used simultaneously in many places and by many enterprises. However, the more an intangible asset is used, the more it loses its value because of a loss of uniqueness. For example, a machine can only be used in one place and by one enterprise at one time. A patent for a certain design included in a product can be used in many products by many enterprises at the same time. However, assuming it is a superior design, if only one enterprise uses it, its product will be better than all other products on the market. If every competitor used the same design, then all products would have the same quality in the particular area covered by the patent. Intangible assets do not have to be maintained, but portfolio of owned and rented intangible assets should be kept. This includes activities for protection of unauthorized use and contracted rights management. Finally, intangible assets also have certain costs that need to be accounted for. This is called amortization and is equivalent to depreciation for tangible assets.

3.4.3 Digital Assets Management

The last group of assets are digital assets, which should not be confused with digital products (such as music or movies). Digital assets include digital data in computers (which are physical assets) and used by software systems (which can be licensed or owned). Digital assets are all custom configurations, code, and data used by the enterprise in its processes. Most of it is usually stored in databases (for ease of retrieval and update) and configuration files. It can be internal, external, or the communication link between the two. Internal digital assets relate to software systems in use within the enterprise. These systems are configured and customized specifically for the enterprise using them. According to the definition of ERP used here, these assets would cover ERP's configurations, custom code, and all data stored in it. For external digital assets, there is a commonly used term EDI (Electronic Data Interchange) which defines all formats, configurations, and code customization for purpose of exchanging data with other enterprises. This can be B2B (customers and suppliers enterprises), B2G (governments), B2C (individual customers, for example web-shop), and B2E (employees). Finally, communication management deals with custom configurations, code, and data for communication equipment and software, usually associated with internet (web services, web sites, email, telephony and so on). Digital assets are different from digital products (movies, music, e-books, etc.) in terms of purpose and ease of copying. They are not made to be sold and cannot be just copied and used, as they are specific for the equipment, software, and organizational structure of the enterprise. They represent large quantities of important information which is crucial for the processes of a modern enterprise, physically stored and executed by the IT equipment. They cannot be sold or rented out to another enterprise. As such they are categorized separately, as something between tangible and intangible assets.

3.5 Finance & Accounting Management (FAM)

Finance and accounting management deals with monetary aspects of inputs and outputs. As discussed in section 1.5, enterprises convert inputs into outputs, and exchange them with the environment. In all modern human societies this is a monetary exchange process. Money is given by the enterprise to the suppliers in exchange for the inputs, and money is obtained from the customers in exchange for the outputs. Money is also given by owners to the enterprise, and taken by the owners from the enterprise (as profit pay-outs for for-profit enterprises). Additionally money is borrowed by the enterprise from the banks or other enterprises, and given back with interest, when owners don't want to or can't give their own money. In the opposite direction, money can be loaned by the enterprise to other enterprises for interest, or invested into ownership of other enterprises. Finally, money is given to the governments as tax and related payments. All of these money related functions are managed by accounting, budgeting & controlling, and financial management.

3.5.1 Financial Management

The exchange of money between owners and lenders on one side and the enterprise on the other is managed through financial management. Owner management deals with investments by the owners in owners' equity (issue of new shares or increase of capital for non-incorporated enterprises) and pay-outs of profits (dividends or profit distribution). Financing management manages lending and borrowing of money from other enterprises (usually banks). Most enterprises borrow money to speed up their growth and increase future profitability. Investment management deals with buying ownerships in other enterprises, when the enterprise has excess money that it does not want to give to the owners. This can be done strategically to gain a controlling share in related enterprises for the purpose of increasing the enterprise's own profitability, or financially on the stock market for the purpose of earning dividends or increasing the value of money through share price growth. A special type of investment is bonds, which are a hybrid between lending and buying shares.

3.5.2 Accounting Management

Accounting management's purpose is to record cost or value of enterprises processes. Costs are associated with inputs and value is associated with outputs. There are three levels of accounting management: managerial, financial, and tax accounting. Managerial accounting is internal accounting for the enterprise itself. It serves all functions equally by recording everything and providing historical records for later analysis. Complexity and configuration of managerial accounting depends on the strategic purpose and organizational structure of the enterprise. Ideally every single action should be recorded in as much detail and as close to real time as possible. Better information (detailed and timely) allows better decisions within all functions of the enterprise, eliminating guess-work and improving efficiency. Financial accounting usually deals with transforming the managerial accounting records to standard formats dictated by government, industry or market regulations. Financial reports are due several times per year (usually every 3 months) within a certain time after the accounting period has ended (30 to 90 days). They are used by owners, lenders, and governments to evaluate the efficiency of the enterprise in monetary terms. A similar set of accounting reports (sometimes even sharing reports with financial accounting) is tax accounting. Tax accounting is strictly for governments, specifying how much tax the enterprise needs to pay (or not, depending on laws, regulations and the enterprise's results).

3.5.3 Budgeting & Controlling Management

The so far described functions of finance and accounting management have been dealing with recording facts and reporting them historically. Budgeting and controlling deals with planning and monitoring of those plans. It tries to predict future so that actions can be taken now to increase or decrease the probability of something happening. It takes historical data from accounting management and then forecasts operating (expenses and revenues) and capital (fixed assets needs) budgets as to-be reports. A special subset of planning and control activities are accounts receivable management and accounts payable management. Accounts receivable management plans and controls payments by the customers, while accounts payable management plans and controls payments to the suppliers. Together with the operating and capital budgets, they determine lack or excess of cash, managed by cash flow management. This is in turn connected to financial management for raising or placing that cash. Although operating and capital budgeting relies heavily on historical accounting data, it is actually done by managers from other functions. Ideally they take detailed historical data and adjust it according to their plans and expectations for the future of the activities they are in charge of, which is then summed up under the operating and capital budgeting.

3.6 Compliance & Control Management (CCM)

Compliance and control management has been present in enterprises since their beginning. Laws allow creation of enterprises and their operation as long as they follow the laws. Over time the number of rules an enterprise has to comply with has been increasing. On top of the basic government laws, modern enterprises need to follow different rules and regulations depending on their industries and markets. In addition to the laws, rules and regulations, the cultural norms of the society within which the enterprise operates dictate ethical guidelines that the enterprise needs to respect. Finally, each enterprise needs to have a system of checks to make sure that its processes are implemented and executed as designed and intended. This is to prevent all the actors in enterprise's processes from damaging the enterprise from the inside.

3.6.1 Laws & Regulations Management

Laws and regulations management deals with mandatory laws and regulations imposed by governments, governmental agencies and regulatory bodies. Every enterprise needs to follow the general laws of the countries it operates in (like taxes, stealing, killing, and so on), called here legal environment compliance. Then there are specific industries regulations that only the enterprises engaged in those activities need to comply with (like medical or financial services). Next there are market regulations, which can be based on owner markets and/or customer markets. Owner markets refer to stock markets that the enterprise's shares are traded at (if it's incorporated and publicly traded). For example, non-US based enterprises that want their shares traded on a US stock exchange need to comply with the SEC rules, regardless of the country they are based in. Customer markets refer to the markets where the product is being sold, regardless of where it's produced. An example would be the automotive industry, where different adjustments are made to a car made in Japan depending on where it will be sold (Japan, Europe, USA, etc.) in order to comply with local regulations and be eligible for sale. All of these laws, rules and regulations cover certain common areas present internationally. Most prominent areas to mention include health and safety (of employees, customers, partners and general public), environmental protection, privacy protection, financial transfer laws (credit cards, money transfers, and electronic payments), intellectual property, bribery and corruption, antitrust and competition, and most recently internal control compliance. A specialized set of "cultural rules" that a modern enterprise needs to comply with are the ethical norms. They are not defined and enforced by any governmental entity, but if broken they can cause significant damage to the enterprise, such as loss of sales, employment problems, brand value devaluation, and so on.

3.6.2 Enterprise Control Management

Enterprise control management traditionally used to be left up to the enterprises to define on their own. However, over the last decade there has been increasing legislative definition of mandatory internal controls. Currently most prominent law is the Sarbanes-Oxley Act of US, which was triggered by the multibillion-dollar enterprise collapses, such as Enron and WorldCom (Targowski, 2010; Baltzan & Phillips, 2008; Kumar, Pollanen, & Maheshwari, 2008). Similar regulations are implemented also in EU and Canada, trying to protect the owners of the enterprises (usually shareholders) from the actors inside the enterprises (employees, machines, computers and partners). There are two key components to the enterprise control management – internal and external audit. Internal audit is performed by the specialized employees of the enterprise, trying to keep rules, procedures, and systems in place that will catch and correct any deviations in enterprise's activities (Kumar, Pollanen, & Maheshwari, 2008). External auditors (certified individuals not related to the enterprise) are mandated by law to inspect the internal auditors once per year, when yearly financial reports are issued. The two areas that enterprise control management focuses on are systems control and people control. They represent two sets of actors performing activities within the enterprise's processes. Systems control management deals with information security and correctness, and automated activities performed by machines. Modern enterprises do not operate on pieces of paper but on information in computers. Securing and verifying the digital and related tangible and intangible assets, as well as managing automated activities, is performed by IT personnel and verified by internal controls. There exist defined international guidelines for systems control management, such as Control Objectives for Information and Related Technologies (COBIT), and related ISO certifications like 27001 (Information Security Management) and 20000 (IT service management). People control management on the other hand deals with people performing roles in enterprise's processes. They include employees (including the top management), and also partners (customers, suppliers, lenders and owners). Purpose of people control management is to catch any person engaging in activities within the enterprise's processes that are against company culture or process definitions, or are illegal or immoral (like forgery, bribery, fraud, theft, embezzlement, defamation and so on). If CCM finds any problems in existing processes it will make necessary corrections through the ORM or FSM function.

3.7 Research & Production Management (RPM)

Research and production management covers the enterprise's activities transforming inputs into outputs. It includes research & development management, manufacturing management and service delivery management. Research & development function deals with the design of the exact specifications and procedures for production of enterprise's services and products. It takes input from the strategy & marketing function in the form of customer's requirements. There are three important areas that R&D, manufacturing, and service delivery management need to optimize: planning, efficiency and quality.

3.7.1 Manufacturing Management

Traditionally, manufacturing has long been dealing with planning, efficiency, and quality, and was one of the first activities to be automated with the MRP systems (see section 1.6). Manufacturing planning, efficiency, and quality management are basic requirements for enterprise's competitiveness, as there is a high standard set for everyone on the global level. As opposed to services, traditionally products can be mass produced or custom-made. Mass production means making the exact same product many times for maximum efficiency (cost reduction through standardization). A modern approach that requires significant technology support is mass customization. It is a way of producing products and services which falls between mass production and custom-made production. Mass customization is the ability of an enterprise to offer the customer to tailor its products or services to customer's specifications, while maintaining the cost efficiency near to mass production (Baltzan & Phillips, 2008). It requires flexible processes with high volumes at reasonably low costs, and allows differentiation in highly competitive and segmented markets (Da Silveira, Borenstein, & Fogliatto, 2001). In the background of all manufacturing types, there are details such as production schedules with material planning through bills of materials. All of those details in the end serve the three goals of planning, efficiency and quality. Depending on products and technology, details can vary widely.

3.7.2 Research & Development Management

Over time there has been increasing pressure to optimize R&D and service delivery as well. These two areas are not as mature as the manufacturing, with R&D being the most delicate one. R&D is where the need for product and service innovation puts the greatest pressure, so there is increasing experimentations with joint ventures and similar inter-enterprise cooperation to improve efficiency and reduce risks. R&D is by its characteristics somewhere between products and services. R&D outputs (designs and production procedures) are not immediately perishable but usually have a short lifespan, as they become obsolete very quickly.

3.7.3 Service Delivery Management

As opposed to most products, services are intangible, inseparable, variable, and perishable. It means that they mostly cannot be touched, seen, transported, stored or standardized (Kotler & Keller, 2012). Because of perishability and inseparability, service delivery management planning is in fact capacity management. A service can't be pre-produced in times of lower demand, or elsewhere, and used in times of higher demand. Resources needed for services (mostly employees) need to be carefully planned to be available at the right time in the right amount. For services, the customer usually needs to be present, so there are quite different aspects to take care of compared to products. The most famous service quality model SERVQUAL focuses on reliability, responsiveness, assurance, empathy, and tangibles (Kotler & Keller, 2012). In the end, even though products and services production and design management are both focused on the same three areas (planning, efficiency and quality), they mean different things and require very different approaches.

3.8 Supply Chain Management (SCM)

Supply chain management is a term that is often misused as a synonym for supplier relationship management. As the name itself suggest, supply chain consists of multiple links of customer and supplier relationships of multiple enterprises, starting from the raw materials suppliers and ending with the final customers. More specifically "a supply chain is a network of material, information and cash flows between suppliers (who provide raw material), manufacturers (who convert raw material to final products), distributors (who transport and deliver products to customers), and customers" (Arora, 2010). Supply network would be a better term because chain implies a single line of relationships, while in reality it is more of a many-to-many directed graph. However, "supply chain" term is too widely recognized to not to use it here. For example, a microchip manufacturer needs several basic ingredients (silicone, copper, and plastic) provided by several suppliers, which are converted into the chips and sold to customers. Chips customers in turn produce electronic components, which are used to produce computers, which are sold by (usually several layers of) distributors, until they are finally combined with software and sold to the final customers (the consumer of the product) by the retailers.

Supply chain management is "the management of information flows between and among stages in a supply chain to maximize total supply chain effectiveness and profitability" (Baltzan & Phillips, 2008). Ideally, the overall supply chain should be driven by the demand of the final customers. Supply chain management as a separate functional area defined here does not correspond to the supply chain management process as used elsewhere. It does not include the production or demand planning (defined in RPM and SMM functional areas). It deals only with the exchange of inputs with suppliers and outputs with customers. As such it consists of customer and supplier relationship management, corresponding sales and procurement functions, and the shared logistics function (transportation and storage).

3.8.1 Customer Relationship Management

The management of the customers in the enterprise's activities is called customer relations management (CRM). Currently CRM is a huge buzzword used by marketing & sales consultants and software vendors. Their primary focus is on sales – finding prospects and converting them into customers. It is usually based on the marketing push approach, where the enterprise actively reaches out to potential customers, and tries to convince them that they should buy the enterprise's products or services. A better approach is the pull approach, where the product or service is made to suitably satisfy a strong need of the customer through thorough understanding of the customer's needs, so that the customer will actively seek out the product or service (Bernoff, 2011). From the functional point of view, the decision of the marketing strategy is made under the SMM function, including the analysis, research, and design. Sales part is also separated under the sales management, so what is left here for the definition of CRM is the actual contact with and care of the customer. That consists of customer service management, customer performance management, and upstream supply chain management. Customer service includes all contacts with the customer before, during and after the purchase by sales people and customer support (assistance, complaints, warranty, maintenance, information, etc.) through face-to-face, call center, mail, email, or website contacts (Kotler & Keller, 2012). For each customer, information about their satisfaction, characteristics, revenues, and all associated costs should be recorded, providing the customer profile and customer lifetime value (Kotler & Keller, 2012). Managing satisfaction information and customer profitability (which specific customers are worth the enterprise's efforts) is performed under customer performance management.

In case when the customer is not the final consumer, there is a supply chain link present. Sharing of information about the consumer demand, sales patterns, stock, lead times, and so on across the supply chain, improves profitability for everyone involved. This sharing of information has been split here into upstream and downstream supply chain management functions, which connect between enterprises forming the first step towards the virtual enterprise. Upstream supply chain management is the connection to the enterprise which buys the product for further resale to the end consumer or other intermediary enterprises. For example, suppliers of the world's largest retailer Wal-Mart are obliged to connect to their EDI, where they can access real-time data about their products in each Wal-Mart store – shelf stock, sales patterns, and all other relevant data. This functionality is provided by the Wal-Mart as part of their downstream supply chain management, which is a part of supplier relationship management (SRM).

3.8.2 Supplier Relationship Management

SRM consists of supplier requirements management, supplier performance management, and the already mentioned downstream supply chain management. Supplier requirements management deals with planning and management of what is needed from suppliers for efficient functioning of the enterprise. This can include many different conditions from pricing, quality, lead times, and payment conditions to supplier's image, reputation, location, and other indirect characteristics. Just as the downstream and upstream supply chain management functions connect between two enterprises in a supplier-customer relationship within a supply chain, so does the supplier requirements management connect to the customer service management. In this requirements-service link, problems and information needs are resolved. Finally, supplier performance management is the equivalent to the customer performance management. It deals with recording and managing supplier's quality and all direct and indirect costs, deciding whether this supplier is worth keeping or should be replaced by another that satisfies the requirements.

3.8.3 Sales Management

Corresponding to the CRM and SRM functions, sales management and procurement management deal with the buy-sell agreement. They are again two connected links on the opposite sides of a supply chain link, but they deal with the legally regulated part of the invoicing and contracting. This is where the revenues are formally recognized, legal obligations are created, and usually sales tax is calculated. There are two main types of sales that are quite different, the retail and the wholesale sales. Retail sales are individual sales to the final consumer, a physical person. It can be done in a retail store or remotely (web-shop, telephone, or mail catalogue). They are mostly characterized by small quantities, immediate payments (or 3rd party financing), immediate delivery, and mixed buyer motivations with potential to be influenced. Wholesale sales are sales to other enterprises, for resale or to be used in enterprise's processes. They usually include higher quantities, many conditions, payment delays, delivery delays, and planning/approval requirements. Wholesale is a very different processes from retail as it usually does not require immediate stock (like retail stores), but it can take a long time for the sales to complete (from first enquiry to the final delivery and payment).

3.8.4 Procurement Management

Connecting to the wholesale sales management of the seller is the procurement management of the buyer. Enterprises can buy several different types of products or services for different purposes. Procurement can be for finished goods, materials/supplies, fixed assets, and outsourced services. Finished goods are purchased for further resale to customers, while materials and supplies are used in the production of products or services (RPM) or other enterprise's activities (like office supplies). Fixed assets are also normally procured from other specialized enterprises (as finished goods or contracted to be built as outsourced services). Finally, outsourced services are common for activities that are not core competencies of the enterprise (like cleaning, security, IT and so on). The procurement function finds, negotiates, and performs the formal purchase function based on requests from other functions, usually associated with internal plans, request, and approvals.

3.8.5 Logistics Management

Between all of the SCM functions described so far (CRM, SRM, sales, and procurement), there is a common function that serves all of them. It is the logistics management which deals with transport & packaging, warehouse & inventory, and import & export functions. Logistics management manages all movement and storage of any items sold or procured. It is not uncommon to have certain parts (like transportation or import/export management) or even the whole function outsourced to specialized companies (such as FedEx or UPS). It is a complex function which requires accuracy, planning, and extended assets (buildings, trucks, IT, etc.). It is also one of the first functions to be connected through EDI between enterprises, as a step towards the virtual enterprise. Overall, the SCM function is the top point of connection between enterprises and currently the most integrated part of the inter-enterprise cooperation. It is the point where enterprises exchange products and services among themselves, starting from materials suppliers up until the final consumer.

3.9 Conclusion

Figure 3-2 provides a graphical overview of the 8 functional areas described above. Its intention is to list, group, and relate all of the important functional sub-areas discussed in the previous sections, providing a clear and logical picture of everything in one place. Table 3-1 gives a quick meaning to each functional area. As we can see, we have defined the enterprise's purpose (why), structure (internal how), people (who), assets (with what), money (how much), rules (external how), product/service (what), and partners (with whom). It is a restatement of the sentence from introduction (section 0): "the top three functions in the figure (ORM, HRM and FSM) deal with enterprise's resources, which are used in operational activities of conversion of inputs into outputs (RPM and SCM), according to the enterprise's strategy (SMM), in compliance with enterprise's environment (CCM), and exchanged and accounted for in monetary terms (FAM)".

It is once again important to note that all of these functions will be required by any enterprise in an integrated way, which seamlessly connects all the required functions in enterprise-wide and inter-enterprise (virtual enterprise) processes. Each function will be executed by a qualified actor (human or machine expert), performing his or her role in the process. Together, they provide the basis for short and long-term efficiency of the enterprise. Each enterprise should provide all of the functions (unless it is integrated into a virtual enterprise and using some other enterprise's functions). As we have seen throughout this chapter, integration is the key to short-term efficiency and modern enterprises need to integrate within and between enterprises as much as possible. A complementary key to long-term efficiency is innovation, as history has shown that those enterprises that stop to innovate lose efficiency over time.

Function	**Abbr.**	**Defines**	**Answers**
Strategy & Marketing Management	SMM	Purpose	Why
Organizational Resources Management	ORM	Structure	Internal how
Human Resources Management	HRM	People	Who
Fixed Assets Management	FSM	Assets	With what
Finance & Accounting Management	FAM	Money	How much
Compliance & Control Management	CCM	Rules	External how
Research & Production Management	RPM	Product	What
Supply Chain Management	SCM	Partners	With whom

TABLE 3-1 FUNCTIONAL AREAS OVERVIEW

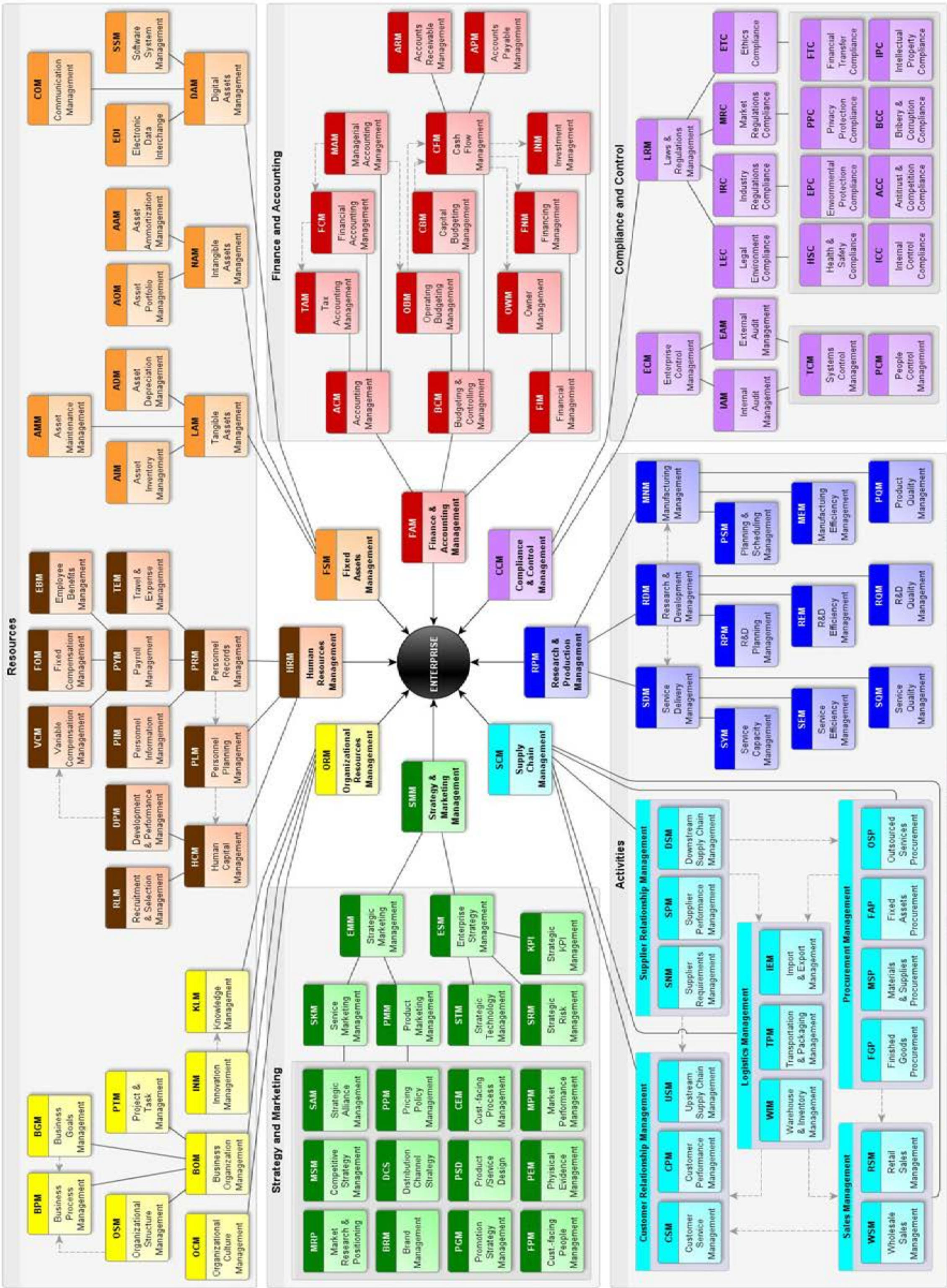

FIGURE 3-2 DETAILED BUSINESS REQUIREMENTS OF AN ENTERPRISE (OWN ILLUSTRATION)

4 BENEFITS OF ERP SYSTEMS

As defined in section 1.5, ERP system is a single software used to run the entire enterprise, supporting all processes across all functional requirements. This chapter analyzes the current state of ERP systems by looking into the achieved benefits of the enterprises using the ERP systems. The benefits of current ERP systems represent the base that future ERP systems can build upon. We shall see that the previous chapter of functional enterprise requirements connects neatly to the enterprise ERP benefits (specific functional benefits) from the published research. These enterprise ERP benefits can be extended by the documented intrinsic ERP benefits (general system benefits), which connect to the ERP 3.0 requirements in the chapter 6. First, financial indicators of ERP benefits will be discussed, followed by a classification of ERP benefits. Together, this section should provide the answer to the question: *what do enterprises gain from current ERP systems?*

Research literature on the topic of ERP benefits indicates that identifying and measuring ERP benefits in actual performance of an enterprise is difficult, even calling it a “key challenge for practitioners” (Williams & Schubert, 2010). Most of the ERP benefits are vaguely listed in ERP related research papers in a general form like operational benefits, financial benefits, benefits for investors and user satisfaction (Moon, 2007). A list of possible measurements can also be found, such as measurements by cost savings, return on investment, asset turnover, return on assets and perceptions by the market (Moon, 2007). Then, some list more specific benefits, like the ability to handle an increased volume of transactions with the same staff, easier linkages with customers and suppliers, less errors and reruns, better access to information, easier after-sales support, improved quality of business reporting, easier access to key performance indicators, better resource management, inventory reduction, productivity improvement, and cash flow and forecasts improvement (Adam & O'Doherty, 2000; Ferran & Salim, 2008; Botta-Genoulaz & Millet, 2006; Johansson & Newman, 2010). Some researchers mention general qualitative observations, in the form of speed, accuracy, flexibility and awareness (Adam & O'Doherty, 2000; Shang & Seddon, 2002). Finally, some list quantitative benefits. The literature overview in (Ehie & Madsen, 2005) lists the following: net improvement in operating margin from 2.4 to 3.3%, improved on-time delivery to 99%, delivery performance improvement from 60 to 95%, lead time to customers reduced from 6 to 2 days, repair parts reduced from 2 weeks to 2 days, and Work-In-Progress inventory dropped 60%, time to ship a replacement part reduced from 22 days to 3 days, and the time to perform credit check from 20 min to 3 seconds. Similar list of quantitative benefits in (Davenport, 1998) includes: reduced order delivery time from two weeks to within 24 hours, the time required to re-price all of its products from 5 days to 5 minutes, the time to ship a replacement part from 22 days to 3 days, the time to complete a credit check from 20 minutes to 3 seconds, the cycle time for filling orders from 18 days to a day and a half, and closing of financial books from 8 days to 4 days.

4.1 Financial Benefit Indicators

As we already noted that all enterprise's inputs and outputs are measured in monetary terms, so is enterprise's efficiency. For for-profit enterprises, it is reflected in the value of the enterprise, which if it is publically traded, is contained in its share price on the stock market. Changes in financial indicators of enterprises that can be traced back to ERP implementations are the only true ERP benefit indicators. Some researchers mention that the announcement of ERP implementation can cause increases in financial predictions by the investors (Hunton, Lippincott, & Reck, 2003). However, those are subjective expectations and not a real financial indicator of ERP benefits. It seems that no research could positively identify the improvement in financial indicators that the analysts were expecting, but instead it has been shown that those who did not adopt an ERP system have declined in comparison to those who did (Hunton, Lippincott, & Reck, 2003). So even though the ERP adopters stayed pretty much the same, their competitive position in comparison to their direct competitors improved. Study results show that return on assets (ROA), return on investment (ROI) and asset turn-over (ATO) were significantly higher for ERP adopters the third year after ERP implementation (Hunton, Lippincott, & Reck, 2003). This supports the expected competitive advantage from ERP systems compared to their rival enterprises (Johansson & Newman, 2010), but not as an improvement to where they were before, but as a way of staying where they were and staying competitive. Instead of providing a competitive advantage, it can provide the enterprise with a competitive disadvantage, if it does not use an ERP system when its competitors do. This situation could be compared to a website, which if an enterprise does not have is a significant disadvantage in today's business world (Johansson & Newman, 2010). If the enterprise only has an average website, it will not be an advantage. Only a great website which is better that the competitors' websites can be an advantage. Same could be said for ERP systems.

Another study found that it is not just the ERP system that determines the competitive advantage, but also the way it is used. Study results show that implementation or ERP in combination with managerial goals based on non-financial performance indicator (NFPI) resulted in significantly higher ROA and stock returns, than for ERP-only and NFPI-only adopters (Wier, Hunton, & HassabElnaby, 2007). This is proof that combining NFPI approach like the balanced score-card (Kaplan & Norton, 1992), with modern technology like ERP systems, does improve enterprise's efficiency. As a comment to their study they further elaborate:

> ***According to cybernetic control theory, if an organization is to adapt and survive in its environment, decision makers need to receive feedback on key performance indicators in sufficient time to notice unexpected deviations, take appropriate action and observe system responses... Consistent with this theory, ERP systems provide the means by which organizations can capture, process and deliver a wide array of key perfor-***

mance indicators in (near) real-time ..., and through which managers can coordinate and control their decisions across the enterprise... Agency theory suggests that when NFPI become part of the managerial reward system, managers have a motive to implement information processes, procedures, systems and metrics that are focused on non-financial performance indicators, and the opportunity to evoke goal-directed managerial actions. Thus, the combined benefits of adopting ERP and NFPI should boost corporate performance over firms that adopt ERP-only or NFPI-only, as the means, opportunities and motives are aligned with managers' interests and investors' objectives. (Wier, Hunton, & HassabElnaby, 2007)

4.2 Benefits Classifications

The underlying benefit related to our primary goal of all enterprises (as discussed in section 2.1) can be stated as: ERP is “improving efficiencies through computerization and enhanc[ing] decision making by providing accurate and timely enterprise-wide information” (Botta-Genoulaz & Millet, 2006). This encompasses both the short-term competitive advantage and the long-term sustainability of it. The way the ERP systems accomplish that is related to their characteristics, such as single system, single database, real-time accessibility, and in-depth reporting (Mishra, 2008; Botta-Genoulaz & Millet, 2006). However, most authors focus on the manifestation of those intrinsic benefits in the processes of the enterprises. Those manifestations will be called “enterprise ERP benefits” as opposed to “intrinsic ERP benefits” (as general benefits of ERP systems over other forms of enterprise operations management, both manual and computerized). There are a number of ERP benefits classifications present in the ERP research literature. For each one reviewed here, a summary table is given with indicated related area from this thesis.

Before we go into more elaborate classifications, most authors mention tangible vs. intangible benefits classification (O'Leary, 2004; Mishra, 2008; Shehab, Sharp, Supramaniam, & Spedding, 2004). This attempts to divide the benefits into those that can be easily measured and those that are hard to measure (implicitly measurable). Examples of tangible benefits include reduction of lead time, on-time shipments, increased business, increase of inventory turnover, reduction in cycle time, and work in progress reduced; while examples of intangible benefits include better customer satisfaction, improved vendor performance, increased flexibility, reduced quality costs, improved resource utility, improved information accuracy and improved decision-making capability (Mishra, 2008; O'Leary, 2004; Shehab, Sharp, Supramaniam, & Spedding, 2004; Mishra, 2008). However, there is no clear line between them and as technology progresses more of them are becoming measurable, so this classification is of no relevance here and will not be mentioned again.

4.2.1 Enterprise ERP Benefits

As noted in the introduction, enterprise ERP benefits are the specific manifestations of benefits within a specific functional area of an enterprise. It is the proof that the ERP system has at least partially satisfied a specific functional requirement of the enterprise that is using it. This section provides an overview of how different authors classified enterprise ERP benefits and their relation to the functional classification of enterprise's processes in section 3.

The first research presented here notes that "ERP systems uses are multidimensional, ranging from operational improvements through decision making enhancement to support for strategic goals" (Mishra, 2008). The classifications used in a comparison of two studies from US and Sweden are listed in TABLE 4-1. Some of them are generic and can be related to improvements in every functional area, while others are covering the functional sub-areas belonging to ORM, SCM, FAM, HRM and FSM. There is no mention of any improvements in the areas of RPM, CCM and SMM.

Area	United States	Sweden	Reference
Availability of information	3.77	3.74	ALL
Integration of business operations/process	3.61	3.42	ORM
Quality of information	3.37	3.31	ALL
Inventory management	3.18	2.99	SCM
Financial management	3.11	2.98	FAM
Supplier management/procurement	2.99	2.94	SCM
Customer responsiveness/flexibility	2.67	2.95	SCM
Decreased information technology costs	2.06	2.05	FSM
Personnel management	1.94	2.06	HRM

TABLE 4-1 AREAS BENEFITING FROM ERP SYSTEMS (Mishra, 2008)

A process-oriented classification of IT benefits referenced in the context of ERP benefits is listed in TABLE 4-2 (Hunton, Lippincott, & Reck, 2003). As indicated by its title it is mostly focused on the ORM functional area (more specifically Business Organization Management), leaving out pretty much all the rest (just barely touching the SMM function). It also mentions some generic qualities such as speed and accuracy in analysis and decision making, which apply to all functional areas.

	Benefit	Reference
1.	More accurate, comprehensive, timely, and available organizational intelligence from internal and external information sources at greatly reduced costs	ORM,SMM
2.	Greater speed and accuracy in identifying problems and opportunities	ALL
3.	Fewer intermediate human nodes within the organizational information-processing network	ORM
4.	Reduced number of organizational levels involved in authorizing and making decisions	ORM
5.	Less time being consumed in the decision-making process	ALL

TABLE 4-2 IT FACILITATION OF BUSINESS PROCESS IMPROVEMENTS (Hunton, Lippincott, & Reck, 2003)

4.2.2 Intrinsic ERP Benefits

As discussed in the introduction, the intrinsic ERP benefits are the general benefits of ERP systems over other forms of enterprise operation management, both manual and computerized. They do not include specific functionality from a functional area, but support all of the areas as an essential improvement in the capabilities of a management system.

From research that focuses on the general ERP requirements, we have a purely intrinsic ERP benefit classification in TABLE 4-3 (Yen, Chou, & Chang, 2002). The list can be grouped and summarized as integration, integrity, accessibility, agility, and reuse in terms of general intrinsic ERP characteristics. They don't fall under any single functional areas, but instead they benefit all of them. We will come back to these in chapter 6 on ERP user requirements.

Benefit	Description	Reference
Promotion of integration	ERP automatically update data among different business components and functions. Therefore, communication and integration among different business processes are improved, and the scope of improvement is business-wide.	Integration
Adaptation to globalization	ERP allows flexible use of language, currency, and accounting standards. It thus improves adaptation to multinational business environments.	Accessibility, Agility
Data integration	ERP performs real time filing and data analysis from a variety of sources. It then allows a more comprehensive and unified management of data.	Integration
Utilization of the latest information technology	ERP utilizes the latest information technology such as the Internet and e-commerce. It allows businesses to quickly adapt to the latest information technology and fit in the future business environment.	Agility
Enabling process improvement	ERP system needs to enter data only once. Therefore, operation efficiency can be increased and its operational cost will be decreased.	Integration, Reuse

TABLE 4-3 ERP BENEFITS (Yen, Chou, & Chang, 2002)

4.2.3 Combined ERP Benefits

Most authors discussing ERP benefits include both the enterprise and the intrinsic benefits in their research. They usually discuss the intrinsic ERP benefits in the context of the underlying IT infrastructure, and the enterprise ERP benefits in the context of improvements in the ERP-supported enterprise's processes.

A detailed and widely cited classification including both aspects of benefits is given in Table 4-4 (Shang & Seddon, 2000; Shang & Seddon, 2002). It contains five different groups of benefits: operational, managerial, strategic, IT infrastructure and organizational benefits. Operational benefits are covering the functional areas of primarily SCM and secondarily RPM. Managerial benefits are quite generic and apply to pretty much all functional areas. Strategic benefits are primarily focused on SMM, as expected. Then there are the IT infrastructure benefits which are the intrinsic ERP benefits, including interoperability, agility, and cost effectiveness. Finally, organizational benefits are primarily focused on ORM function. HRM and FSM are just touched under some sub-classifications, while FAM and CCM are not mentioned. It is an elaborate classification, which includes significant parts of 4 of the 8 functional areas presented here, and 2 more partially. It also mentions the intrinsic ERP benefits, but quite limited.

An ERP benefits framework that builds upon the previous one from (Shang & Seddon, 2000; Shang & Seddon, 2002), is the three-dimensional ERP benefit framework shown in Figure 4-1 (Eckartz, Daneva, Wieringa, & van Hillegersberg, 2009). They fold the 5 categories into 2 dimensions – operational, managerial and strategic benefits on one axis vs. IT infrastructure and organizational on the other axis. Then they add the third axis by taking balanced score-card areas (process, customer, finance and innovation) and adding the HR area. Folding benefits classification in multiple dimensions is a step in the right direction, but not quite the right way. As discussed in section 3, each functional area is used by all other areas giving us the 8-dimensional space of possible combinations. This is all in terms of enterprise ERP benefits. On each of those process combinations, a specific intrinsic ERP benefit can have an effect, and a specific functional enterprise ERP benefit can be present. This results in a much more complicated n-dimensional framework than proposed here.

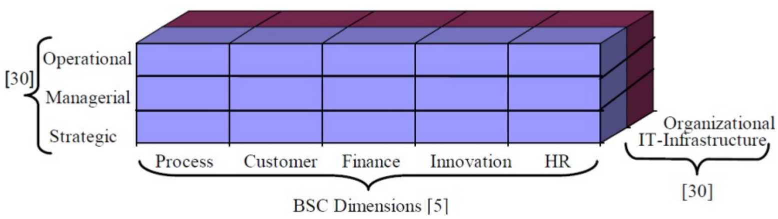

FIGURE 4-1 THREE-DIMENSIONAL ERP BENEFIT FRAMEWORK (ECKARTZ, DANEVA, WIERINGA, & VAN HILLEGERSBERG, 2009)

I.	Operational Benefits	Reference
1.1	Cost reduction in labor, inventory and administration expenses	SCM,RPM,ORM
1.2	Cycle time reductions in activities that support customers, employees and suppliers	SCM,HRM
1.3	Productivity improvement	SCM,RPM
1.4	Quality improvement through error rate reduction and improvements in data accuracy	ALL
1.5	Customer service improvement through ease of data access and inquiries	SCM
II.	**Managerial Benefits**	
2.1	Better resource management (assets, inventory, workforce)	HRM,FSM,SCM
2.2	Improved decision making and planning	ALL
2.3	Performance improvement in all levels (efficiency and effectiveness)	ALL
III.	**Strategic Benefits**	
3.1	Support business growth (improving capacity, capability and flexibility)	ALL
3.2	Support business alliance by consolidation, standardization and integration	SMM
3.3	Building business innovation (new markets, processes, products and services)	SMM,RPM
3.4	Building cost leadership by lean structure and resource sharing	ALL
3.5	Generating product differentiation by mass customization and lean production	SMM,RPM
3.6	Build external linkages with customers and suppliers	SMM,SCM
3.7	Worldwide expansion with centralization, global resource mgmt. and multicurrency	ALL
3.8	Attracting new customers or getting closer to customers through web integration	SMM,SCM
IV.	**IT Infrastructure Benefits**	
4.1	Building business flexibility by rapid response to internal and external changes	Agility
4.2	IT cost reduction in total cost (staff, maintenance, modification)	Cost-effectiveness
4.3	Increase IT infrastructure stability	Interoperability
V.	**Organizational Benefits**	
5.1	Coordination between interdisciplinary matters and interdepartmental processes	ORM
5.2	Facilitating business learning and broaden employee skills	HRM
5.3	Empowerment of employees (accountability, autonomy, proactiveness)	ORM,HRM
5.4	Building common visions	ORM
5.5	Customer, market, process and performance orientation	ORM,SMM
5.6	Increased employee morale and satisfaction	ORM

TABLE 4-4 ENTERPRISE SYSTEM BENEFIT FRAMEWORK SUMMARY (SHANG & SEDDON, 2002; SHANG & SEDDON, 2000)

A wider classification of benefits is given in Table 4-5 (Williams & Schubert, 2010). It covers benefits in the business areas of strategy and processes (SMM and ORM), resources (HRM, FSM and FAM), activities which they call “functions” (RPM and SCM) and the ERP system itself (the intrinsic ERP benefits). The only functional area that is missing is CCM, discussed for example in (Kumar, Pollanen, & Maheshwari, 2008). They even grouped the functional areas which were adjacent in the order they were presented in this thesis, just skipping the CCM function. This means that this classification can be easily reworked into the classification presented in this thesis, by grouping points 1 through 3 and dividing them up within the enterprise ERP benefits functional classification, and taking the point 4 as intrinsic ERP benefits. In terminology used in this thesis, listed intrinsic ERP benefits include integration, business functionality, agility (customization, stability), accessibility (usability, use), availability, transparency (complexity), and security (reliability). This is the closest classification found in the reviewed literature to the classification presented here.

	Business Area	**Description**	**REFERENCE**
1.	Business design (strategy and processes)	Strategy and business processes of a company. Typical criteria for this area are automation, transparency, complexity, effectiveness, and efficiency.	SMM, ORM
2.	Management (resources)	Resources of a company which are essential for running the business (financial, employees, information, products). Typical criteria for this area are cost, skills, productivity, satisfaction, time, and availability.	HRM, FSM, FAM
3.	Functional Areas (functions)	The business functions which relate to departments (marketing, procurement, manufacturing, sales). Examples of criteria for this area are transparency of the process, complexity, number of transactions, sales opportunities, and turnover.	RPM, SCM
4.	IT and infrastructure (technology components)	The actual enterprise systems landscape of the company (software, databases, systems and networks). Typical criteria for this area are integration issues, adequate functions or functionality, customization, usability, use, availability, complexity, flexibility, reliability, and stability.	

Table 4-5 Levels of ERP extended benefits framework (Williams & Schubert, 2010)

4.3 Conclusion

In this chapter it was shown that current ERP systems do in fact improve enterprise’s efficiency, both short and long-term, as evidenced in the difference in financial indicators between ERP adopters and non-adopters. The benefits an enterprise can have from an ERP system are numerous and there have been many attempts to classify those benefits. Here, the benefits have been split into enterprise ERP benefits and intrinsic ERP benefits. The summary list of both types of benefits of current ERP systems is provided in Table 4-6 (with no relationship along the lines in the table). Intrinsic ERP benefits are beneficial characteristics of the ERP system itself, referring to the internal working of the system and defining the capabilities of the ERP system. They serve all functional areas and form the architectural base for specifically included functionalities for distinct functional areas, which result in enterprise ERP benefits. Enterprise ERP benefits can be seen in the context of the functional areas defined in section 3 on functional requirements of an enterprise. In an ideal ERP system, each enterprise functional requirement would be completely satisfied in a process-oriented way, resulting in enterprise ERP benefits for every activity in every functional area. Unfortunately, what the next chapter is going to show is that these benefits are not always present at the necessary level to be called a benefit. In fact, they are often related to the problems with ERP systems that hinder their use in enterprise's processes.

Enterprise ERP Benefits	Intrinsic ERP Benefits
Strategy & Marketing Management	Integration
Organizational Resources Management	Agility
Human Resources Management	Accessibility
Fixed Assets Management	Reuse
Finance & Accounting Management	Business Functionality
Compliance & Control Management	Availability
Research & Production Management	Security

TABLE 4-6 ERP BENEFITS SUMMARY

5 PROBLEMS OF ERP SYSTEMS

This chapter analyzes the current state of ERP systems by looking into the encountered problems of the enterprises using or attempting to use the ERP systems. The problems of current ERP systems represent the minimal changes that the future ERP systems need to make. The question that this chapter answers is: *what are the ERP related problems encountered by adopting enterprises?* This chapter presents the literature review and discussion of published problems with ERP systems, divided into two parts – administrative and end users' problems. Administrative problems are related to the setup, implementation, maintenance, and change of ERP systems. End users' problems are related to the problems encountered while using the functionality of ERP systems.

Just as the research literature has documented ERP benefits, the ERP problems have been documented equally, or even more. The worst problem that an enterprise can have from ERP implementation is – its end of life. It is very rare, but there is a documented case of Foxmeyer who went bankrupt in 1996 after three years of unsuccessful implementation of SAP (Adam & O'Doherty, 2000). Less severely, it can be a significant loss of money (directly or indirectly) ranging into hundreds of millions of dollars. For example, "Mobil Europe spent hundreds of millions of dollars on its system only to abandon it when its merger partner objected" and "Dow Chemical spent seven years and close to half a billion dollars implementing a mainframe-based enterprise system [that it dropped for] a client-server version" (Davenport, 1998). Also, "Unisource Worldwide, Inc. wrote off US$ 168 million when the company abandoned nationwide implementation of SAP software" (Ehie & Madsen, 2005) and "Kmart in 2002 wrote off $130 million because of a failed ERP supply chain project" (Monk & Wagner, 2008). In addition to these examples of catastrophic failures, certain studies have found that 45% of enterprise found no improvements after implementing an ERP system (Adam & O'Doherty, 2000). Vice president at AMR research has been cited saying that only 35% of the enterprises are satisfied with the ERP they use (Johansson B. , 2009). Even the Chairman of the Supervisory Board of SAP and one of the cofounders, Hasso Plattner, said that they need to rebuild trust and make customers happy (Howlett, 2010), as he took back control of the company in 2010 due to declining performance.

5.1 Administrative Problems

Administrative problems are the problems encountered by the enterprise in its manipulation of the ERP system. This includes setup, implementation, maintenance, and change of the ERP system. They deal with interactions with the ERP system outside its use in the enterprise's processes by the end users performing their roles in the enterprise's operational processes. They are usually encountered by the management and the IT personnel. The following sections describe such problems.

5.1.1 Costs

From the examples in the introduction, it is obvious that ERP systems are expensive, ranging into hundreds of millions of dollars for large enterprises. The problem of costs that are too high has been noted by many researchers (Ferran & Salim, 2008; Rashid, Hossain, & Patrick, 2002; Scheer & Habermann, 2000; Adam & O'Doherty, 2000; Ehie & Madsen, 2005). In fact, "ERPs are the most expensive (in terms of financial and other resources) software that businesses have ever spent money on" (Ferran & Salim, 2008). However, as one might think, it is not the license (software) or the hardware (to run the software) that is the major part of their costs. Published research claims that the implementation of the ERP costs 5 times more than the purchase price (Scheer & Habermann, 2000), 5-7 times more (Adam & O'Doherty, 2000), and approximately 7 times more (Ehie & Madsen, 2005). It seems that they are all in the range of 5-7 to 1 ratio of the implementation costs, consisting primarily of consulting, dedicated employees working on the implementation and organizational change required (Davenport, 1998; Adam & O'Doherty, 2000). One of the reasons why they are so expensive is their complexity. The huge costs are especially a problem for small and medium enterprises (SMEs) and "until a new business model appears or we have a technological jump, they will continue to be" (Ferran & Salim, 2008).

5.1.2 Implementation Length

Besides being the most expensive part of ERP adoption, ERP implementation is also very time consuming (Rashid, Hossain, & Patrick, 2002; Yen, Chou, & Chang, 2002; Shehab, Sharp, Supramaniam, & Spedding, 2004; Ehie & Madsen, 2005). Implementation times range from several months to several years (Shehab, Sharp, Supramaniam, & Spedding, 2004; Ehie & Madsen, 2005). Even with the consultants and dedicated employees, enterprises still have considerable problems (Shehab, Sharp, Supramaniam, & Spedding, 2004). Implementation can slow down the current processes within an organization with changes (Yen, Chou, & Chang, 2002). During the implementation of ERP, usually a significant amount of business process re-engineering happens. Even Plattner of SAP acknowledges that the full implementation of all modules can take years, which also adds to the end price (Shah, 2010).

There are three sides to ERP implementation – the IT implementation side (software and hardware setup), the business implementation side (business process management) and the ERP vendor (the author of the software). The following example illustrates usual problems that arise when dealing with three sides:

> ***When Oracle sold Company D the software, they recommended an implementation partner. This is normal practice and a 'big six' consultancy firm such as Andersen or Price Waterhouse is usually recommended. Firms such as Andersen usually deal with the business process review***

> ***side and another firm of IT consultants is hired to deal with the configuration side. As a result, Company D was dealing with three separate organizations. This led to massive problems when the ERP system would not work. The software vendor and both consultants blamed each other for the problems and were not willing to take responsibility. (Skok & Legge, 2002)***

5.1.3 Complexity

Complexity is noted as the primary reason for lengthy and expensive implementation (Shehab, Sharp, Supramaniam, & Spedding, 2004; Ehie & Madsen, 2005; Adam & O'Doherty, 2000; Rashid, Hossain, & Patrick, 2002). Because it is an integrated system, “the whole (the ERP) is bigger, far more complex, more sensitive, and more expensive than the sum of the parts” (Ferran & Salim, 2008). Due to complexity, every step requires extensive verification, which takes time and costs money (Soffer, Golany, & Dori, 2005; Ferran & Salim, 2008). Researchers and ERP vendors alike acknowledge that the overall complexity of ERP systems keeps growing (Shah, 2010; Frank, 2009). Complexity also decreases efficiency, employee satisfaction and increases training costs. This is without even looking into integration of the ERP system with any existing software that has to remain in use, as discussed next.

5.1.4 Interoperability

When attempting to connect the ERP system with some previous software, whether it was purchased or custom developed, there is always a significant problem of interoperability. Modern ERP systems are required to support the technologies that evolved to relieve this problem, including enterprise application integration (EAI), extended markup language (XML), service oriented architecture (SOA) (Johansson & Bjorn-Andersen, 2007). However, SOA is not proving to be the silver bullet it was advertised as. The problem is that they are “only prescriptions for programmers, not finished solutions for users ... and there is still a heated discussion regarding the format of such services and even on the concept of SOA itself” (Ferran & Salim, 2008). A great explanation of the problems with these technologies is provided in:

> ***[S]ystems vendors propose new technologies as yet another panacea to solve the mentioned and further shortcomings. Whether enterprise application integration (EAI), componentization, or, more recently, service-oriented architectures (SOA), these proposed solutions emphasize technical concepts for developing software systems and do not adequately account for the organization as surrounding action systems in which enterprise systems are embedded (Sprott 2000; Fan et al. 2000). In particular, neither technology is based on (high-level business) concepts commonly used in enterprises such as invoice, customer, or product. Moreo-***

> ***ver, each technology addresses only specific issues with current ERP systems: EAI focuses on ex-post integration through middleware and data warehousing. Hence, metaphorically speaking, it is aimed at hiding the mess without removing it. SOA promotes the vision of "orchestrating" process-oriented information systems by selecting appropriate services, which are provided through standardized interfaces. It does not, however, account, e.g., for data integrity across services. Although these technologies deserve consideration as candidate solutions for future software infrastructures, their use does not provide a comprehensive conceptual foundation critical to future enterprise systems. (Frank, 2009)***

Another approach suggested is to make sure that the ERP system supports all the requirements before purchase, by at least middleware "add-on" facilities and 3rd party extended modules (Rashid, Hossain, & Patrick, 2002). However, this approach cannot guarantee long term satisfaction as business needs are constantly changing and might need something unsupported in the future.

5.1.5 Customization

Another problem related to the problems listed so far is customization. It is a source of significant costs and implementation delays, building upon complexity and caused by company needs for functionality and interoperability. For example, the world's leading computer retailer, Dell Computer, found that the SAP ERP they were trying to implement didn't fit their decentralized management model and decided to go with a custom solution (Davenport, 1998). This is an extreme response to the limitation of a standard ERP system. Usually companies opt for customizations in places where they find it necessary. Customization is different from configuration. Configuration "involves choosing from a range of inbuilt options and completing parameters and tables", while customization is "changing the software code so that the ERP processes operate differently from their original design" (Grant, Hall, Wailes, & Wright, 2006). Current leading ERP systems include "a catalogue of 8000–10,000 software templates from which the implementing organization [can] choose in order to create relevant functionality for their organization" (Wagner, Scott, & Galliers, 2006). If these configuration options don't cover the needs of the implementing enterprise, there are three options: to change the way the enterprise operates, to customize the ERP system, or to go with a different solution. It has been reported that configuration of an unmodified ERP system (also called vanilla software) is usually not enough (Wagner, Scott, & Galliers, 2006). Besides the Dell Computer example, the largest US retailer Wal-Mart has also chosen to write all its software in-house (Monk & Wagner, 2008). Their explanation is that the global strategic business process drives the technology, so they cannot be dependent on a generic ERP system that is not at the leading edge of the technology. The need for customization has also been linked to the regional conditions: compatibility with the local supply chain, local regulations, and local customs (Ferran & Salim, 2008).

Another argument for the need for customization is based on the competitive advantage compared to the main competitors (Johansson & Newman, 2010). As discussed in section 4.1, just having a standard ERP system does not imply having a competitive advantage (Johansson & Newman, 2010; Beard & Sumner, 2004). In fact, adopting a vanilla implementation and modifying all of enterprise's processes to fit the ERP system may eliminate the competitive advantage that the enterprise had, by destroying the features that made the enterprise unique and hard to imitate (Fosser, Leister, Moe, & Newman, 2008; Beard & Sumner, 2004; Davenport, 1998). So the current suggestion by ERP researchers is that the enterprise should decide before implementation which processes represent competitive advantage and are strategically important enough to be preserved. For those processes customization will be required, while other processes can be adapted to the ERP system. Unnecessary customizations result in additional costs and delays (Soffer, Golany, & Dori, 2005), so enterprise should choose carefully. This analysis and customization should be done before the actual implementation of the system, because it is easier to customize an empty system than the one that already has data entered (Monk & Wagner, 2008). Adjusting enterprise's processes to fit the ERP systems and customizing the ERP system to fit the required enterprise's processes is called "alignment". Unfortunately, "even if total alignment is achieved the success will still only be temporary due to the constant changes in business processes caused by the dynamic market environment in today's business world" (Johansson, Holst, & Henningsson, 2009). So in fact, modern enterprises are caught in a never ending circle of customizations, trying to keep up with the competitors. Also, when ERP vendors come up with new and improved versions of their ERP systems, ironically, customizations of ERP systems pose a significant problem for system upgrades, discussed separately.

Finally, the problem with current ERPs is that customizations can only be done on the programming level and usually require rewriting the whole form or module from scratch. This is because most current leading ERP systems are written in technology dating 20+ years back. They do not support code injection, overloading, inheritance, and other modern approaches. They do not support modeling and meta-modeling approaches. They do not allow database schema changes for ERP vendor's tables. All of this together is what makes customizations so expensive and lengthy.

5.1.6 Best Practice

ERP vendors and consultants claim that their vanilla systems embody the "best practices" in their processes and promote their use (Wagner, Scott, & Galliers, 2006). Best practices embed business models that are supposed to be the best possible at the time, including data, process models, and organizational structures (Van Stijn & Wensley, 2005). These best practices are developed and provided by the ERP vendors and consultants, and are supposed to be implemented in the ERP adopting enterprise in order to reduce implementation costs and improve enterprise's competitiveness (Van Stijn & Wensley, 2005). ERP research has been showing evidence that the best practices approach is flawed and should not be implemented unconditionally (Van Stijn & Wensley, 2005; Ferran & Salim, 2008). One of the problems with best practices is that they are not based on research and theory, but on practice, on what the ERP vendors and consultants encountered in their previous implementations (Ferran & Salim, 2008). As such, there is no guarantee that they are in fact the best. Another problem is the constant change in the business environment and the need for flexibility. As conditions change, there is no guarantee that the best practices are still the best (Shehab, Sharp, Supramaniam, & Spedding, 2004). So even though the ERP vendors and consultants promote and even pressure the implementing enterprise, often things don't work out the way they were advertised (Van Stijn & Wensley, 2005). This does not mean that all of the processes embedded in the best practices will not be good for the enterprise. In fact most of them might be just fine, but as discussed under the problem of customization, each enterprise needs to decide which processes will be adapted to the ERP system and which will be kept by customizing the ERP system instead (Davenport, 1998; Wagner, Scott, & Galliers, 2006)

5.1.7 Uniformity

Related to the problem of customization is the problem of uniformity. Most current ERP systems allow for just one way in which they operate. This represents a significant problem for regional requirements. Once the system is setup a certain way, it is not possible to have different ERP system operation in one business location from another business location (McAdam & Galloway, 2005). The main problem is that even though the system can operate the way each location needs, it cannot do so at the same time. If the regional units are not allowed to adjust to local customer requirements and regulations, they are likely to lose business to more flexible competitors (Davenport, 1998). A potential solution used by international enterprises is to deploy separate versions of the same system in each regional unit, instead of one global system. However, this results in significant increase of problems with integration, integrity, upgrades, costs, complexity and control. This is due to the fact that there are multiple ERP systems to setup, maintain, and integrate (which wasn't needed at all when there was only one system).

5.1.8 Upgrades

Upgrading current ERP systems is a challenging task. If there are any customizations present, all updates need to be rechecked and fixed (Soh, Kien, & Tay-Yap, 2000; Soffer, Golany, & Dori, 2005). As the data and operation of the ERP system changes, there is no guarantee that the customizations that were done will match the new ERP system. This is again a costly and time consuming process. In case of a global ERP with multiple local installations, it is even more complex, as it needs to be done for each location separately (Ferran & Salim, 2008). Sometimes even the core ERP functionality gets updated in a way which does not support backwards compatibility. This is another issue that needs to be resolved during the upgrade, but it is usually supported by the vendor. The difference in support comes from the fact that the vendor will be aware of this difference, while it has no knowledge of customizations in the specific implementation and cannot account for them. Then, if the new ERP processes are not in alignment with the enterprise's processes anymore, the enterprise needs to change its processes or new customizations need to be done. Finally, the users need to be retrained for any changes. All of these problems together, result in an expensive and time consuming process of upgrading an ERP system.

5.2 End Users' Problems

As opposed to the administrative problems, end users' problems are the problems faced by the people performing the enterprise's operational processes that are supported by the ERP system. These processes cut across the functional areas discussed in chapter 3, with employees or partners performing their roles as the functional experts. Frequently, the ERP system hinders their work, instead of helping. The following sections list and discuss such problems.

5.2.1 User Interface

User interface problems are usually connected to the problems with complexity and customizations. They represent the usability issues which significantly affect the productivity of ERP users. In an extreme example, users had to go through 26 screens in order to enter a single set of data (Wagner & Newell, 2004). Additionally they had to wait 5 minutes between each screen, but this is related to the problem of responsiveness, discussed next. The explanation for problems with user interfaces is that screens are usually designed according to program logic and not the user's process. The resulting damages to the enterprise include slow response requiring more staff, data entry errors, and high training costs (Markus, Petrie, & Axline, 2000). Another user interface problem is unwanted flexibility. For example, when users need to go through several screens without a predetermined path, the chances that they will take the wrong path are high (Soh, Sia, Boh, & Tang, 2003). This problem of user interface has been thoroughly discussed in role-based ERP research, whose goal is to improve the intuitiveness by tailoring it to the processes executed by the role that the user has (Johansson B. , 2009).

Other user interface problems reported include the missing ability to copy-cut-paste, missing on-line help, unfamiliar terminology, and unintuitive input (Shehab, Sharp, Supramaniam, & Spedding, 2004). Plattner of SAP noted that added complexity ultimately results in an unintuitive UI (Shah, 2010). However, in the context of modern technologies, such as Web 2.0, current ERP systems are not fully functionally integrated. They only share the data (in ideal situations, some ERP systems fail to even do that right), but do not support the related processes. For example, think of an item which has its usual code, description, price and quantity on any associated documents (like purchase order, quotation, invoice, and so on). Current ERP systems are so user-unfriendly that not only you cannot copy-paste and item from one document to another, but you cannot copy a document into another unless that specific action has been hardcoded into the system. Every time you need to reenter the same items, over and over again. That would be like after finding an interesting link on a website, instead of clicking it, you would have to type its URL in the address bar every single time. How much efficiency out of browsing would that take? They are also usually context insensitive. Instead of offering context sensitive menus based on user focus and situation, usually they offer just the same basic functions everywhere. This approach significantly reduces the utility of the system, as defined by the network effect. The network effect states that the more connections there are, the higher the utility of the system (Hendler & Golbeck, 2008), discussed in more detail under section 6.2.

5.2.2 Responsiveness

Problems with responsiveness of an ERP system refer to wait times between the start of an action and the returned result of an action in the ERP system. In the extreme example from user interface problem, users had to go through 26 screens and wait time between them was 5 minutes (Wagner & Newell, 2004). Waiting 5 minutes between each action is an extremely poor responsiveness. For efficient ERP system use, users should not have to wait more than a few seconds for an action to complete. Another example would be having to tell the customer to “please hold” while the system returns the information that the customer asked about (Markus, Petrie, & Axline, 2000). If this goes into the minutes range, then customer inquiries cannot be done in real-time. Instead customers need to be told that they will be called back, resulting in poor customer service. Common and frequent actions should be almost real-time, otherwise the efficiency of the entire enterprise decreases. Poor responsiveness also significantly decreases employee satisfaction. How would you feel about web-browsing if you had to wait 5 minutes for each webpage to load? Unfortunately current ERP systems, especially the big ones have rather poor responsiveness in activities. This gets even worse if the user requests a report or an analysis. Usually ERP systems take a long time to generate the requested information and present it to the user.

5.2.3 Information Availability

As a workaround for reporting responsiveness, current ERP systems are supplemented by business intelligence (BI) servers with their copy of the data in separate data warehouses (specialized databases). The problems with BI servers are duplicate data (prone to errors) and information delay, as it is not the real time data from the ERP system but periodically copied data (usually on a daily basis) (Yen, Chou, & Chang, 2002). There is even defined terminology that differentiates analysis and reporting from operational information. Online Transaction Processing (OLTP) is the processing of data in ERP actions, while Online Analytical Processing (OLAP) is the processing of data in analysis and reporting, usually done by the BI servers. Plattner of SAP has been reported to acknowledge that "one of the top challenges reported by SAP end-users is the inability to access real-time data in the transactional system" (Shah, 2010). In his research paper on a new database system that could improve information availability in the ERP systems he writes:

> ***I always believed the introduction of so-called data warehouses was a compromise. The flexibility and speed we gained had to be paid for with the additional management of extracting, and loading data, as well as controlling the redundancy. (Plattner, 2009)***

5.2.4 Control

The problem with ERP control is that it can be too restrictive for the enterprise's processes. It is something that most users of an ERP system have experienced – the feeling that the ERP is not letting them do their job efficiently. Sometimes it is justified and users are just not aware of the whole picture, but sometimes it is not justified. The problem of control has been studied in detail and it has been shown that an ERP system can take 5 different roles from the perspective of the user (Askenas & Westelius, 2000). The 5 roles with their definitions are illustrated in Figure 5-1 and listed in TABLE 5-1. They are: bureaucrat (when ERP is in control with a good fit with the enterprise process), manipulator (when ERP is in control with a poor fit), consultant (when user is in control with a good fit), administrative assistant (when user is in control with poor fit), and dismissed (not illustrated because the user refuses to use the ERP system). This narrows down our control problem to situations when the ERP system has taken the role of the manipulator, hindering the user in performing his role in the enterprise's processes.

Role	**Definition**
Bureaucrat	An ERP system given the role of a bureaucrat maintains the structure in the organization. It makes certain that the enactment of structure conforms to the existing rules. This may seem inflexible, however, unlike the manipulator, the structure it enforces is one accepted by its users.
Manipulator	The ERP system may be given the role of a manipulator if it is allowed to change or conserve work processes in ways not intended or wished by its users.
Consultant	An ERP system acting as a consultant provides the user with options and with solutions tailored to the situation. The use of the system follows the user's wishes and leaves the user in control.
Administrative assistant	An ERP system given the role of an administrative assistant is not used to the same extent as those acting as manipulators or bureaucrats. The information system administers and simplifies record keeping and dissemination of data, but does not affect (or indeed reflect) the processes

	and structures of the organization in any fundamental way.
Dismissed	The ERP that is dismissed becomes redundant. There may be many reasons for this but, to keep dismissing the system, the user will need good reasons or have a strong bargaining position.

TABLE 5-1 FIVE ROLES OF ERP (Askenas & Westelius, 2000)

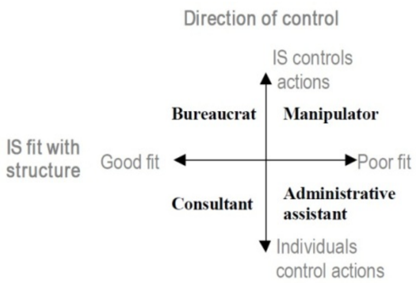

FIGURE 5-1 POSSIBLE ROLES OF ERP (ASKENAS & WESTELIUS, 2000)

5.2.5 Misfits

The problem of control is a result of a poor fit between the enterprises processes and the processes embedded in the ERP system. These differences in ERP's and enterprise's processes are called "misfits" in the ERP literature (Soh, Kien, & Tay-Yap, 2000). Misfits can happen from company-specific, industry/market-specific, or country-specific requirements that don't match the capabilities of the ERP system. This is closely related to the functional areas of CCM and ORM of this thesis. There are 3 types of ERP misfits: data, process and output misfits (Soh, Kien, & Tay-Yap, 2000). Data misfits are problems with the data format and the relationships in the underlying data model. Process misfits are functional misfits consisting of access misfits, control misfits and operational misfits. Output misfits are problems with information presentation or content. Relating those definitions to the problems presented here, they are mostly contained in the problems of user interface, information availability and control. They are also the cause of customization, indicators of unacceptable best practices processes and drivers of implementation length and costs.

5.3 Conclusion

The problems with ERP systems presented here can be related back to the ERP benefits, by realizing that most of the underlying problems are caused by the intrinsic ERP characteristics of the current ERP systems. Their cores are built on obsolete technologies and they come with significant restrictions on adjustments possible by the adopting enterprise. Whatever functionality they are missing in order to create the enterprise ERP benefits (for processes across the discussed functions in section 3), it is difficult to add because of their architecture. That is the underlying cause of ERP failures and adopters' dissatisfaction. It is the reason why the top performing companies (like Dell Computer and Wal-Mart from our examples in section 5.1.5) choose to go with custom-developed ERP systems. To go back to our comparison of an ERP with a website from section 4.1, it would be similar to many enterprises having the same structure and navigation of their website, distinguished from others only by their color scheme and by not including a certain page. If one wanted to add a custom product configurator for example, it would not be possible without extensive customization. Adopting enterprises would not be able to get much differentiation and competitive advantage from such websites, so competitive battles would be fought on other fields (like delivery times, item selection, stock levels and so on). That is exactly what is happening with the ERP and might even be acceptable in a way, as a leveled playing field. However, if there are other enterprises that have opted to make a custom website, which is better than the standard one used by most, they will have the competitive advantage in that field over the standardized enterprises. It is these well documented problems on both the administrative and the end users' side that need to be resolved by the future ERP systems. A lot of ERP requirements in the next chapter will be referring back to the problems documented in this chapter and summarized in Table 5-2 (with no relationship along the lines in the table).

Administrative Problems	**End Users' Problems**
Costs	User Interface
Implementation Length	Responsiveness
Complexity	Information Availability
Interoperability	Control
Customization	Misfits
Best Practice	
Uniformity	
Upgrades	

TABLE 5-2 ERP PROBLEMS SUMMARY

6 ERP 3.0 PROBLEM DOMAIN REQUIREMENTS

Before discussing the requirements of an ERP system, we need to define from what point of view they will be discussed. There are two possible points of view – what the adopting enterprise needs from the ERP system and what the ERP vendor needs to provide in order to satisfy the enterprise's needs. Those two different requirements are called the problem domain requirements and the solution domain requirements. Problem domain requirements are "stakeholder requirements that describe the capabilities which users expect from the new system ..., while requirements in the solution domain represent system features, which engineers implement to solve stakeholder requirements" (Adisa, Schubert, & Sudzina, 2010). As this thesis has been about the user side so far (functional requirements, the benefits for the adopting enterprises and the problems they have encountered) and as the section title suggest, this section covers problem domain requirements.

The requirements presented here will address the intrinsic ERP properties, which in turn support the functional requirements. They are meant to be as general as possible, applying to any and every ERP system that aims to provide the functionality required by the functional requirements from section 3. The requirements have been derived from the general functional requirements of an enterprise, the ERP benefits, and ERP problems, discussed in chapters 3, 4, and 5 respectively. Some of them are mostly satisfied by the current systems (resulting in ERP benefits), some are partially satisfied, and some are poorly satisfied (resulting in ERP problems). The goal of this section is to answer the question: *what does a modern enterprise need from an ERP system?* The grouping from ERP problems (administrative vs. end users') is also used here, with the addition of underlying general requirements that are essential for both groups.

6.1 Previously Published Requirements

Before starting with the requirements list, a quick overview of previous requirements in the published research will provide a quick reference point. In the context of ERP systems, there is a mention of general quality attributes of IT systems: availability, reliability, data quality, functional fit, information security, interoperability, modifiability, performance, safety, usability and user productivity (Gammelgard, Lindstrom, & Simonsson, 2006). This is equivalent to requirements because requirements are to have those qualities as high as possible. In the first summary table of this section, comparative requirements in TABLE 6-1 (Gil Gomez, A., M., O., & R., 2010) relate to the ERP problems in the previous section – lower cost, better interoperability, shorter implementation, easier customization and better functionality. These requirements represent the ways that the future ERP systems should be different from current ERP systems. Another list of comparative requirements is provided in TABLE 6-2 (Johansson & Bjorn-Andersen, 2007). It is similar to the first one, again correlating to the problems: lower costs, shorter implementation, easier customization, easier upgrades, better interoperability and better analysis. These lists are focused on the problem manifestation side and try to define the user requirements as solutions for the selected problems.

Characteristics of future ERPs
Lower license cost
Lower implementation cost
Compatibility between systems
Less consulting requirements in the implementation phase
Software with open code
Vertical growing

TABLE 6-1 CHARACTERISTICS OF FUTURE ERPS (Gil Gomez, A., M., O., & R., 2010)

Compared to existing ERP systems third generation of ERP systems for SMEs
may be distributed globally at relatively low costs
will be much easier to implement
will be easy to localize to different markets/industries/enterprises
will be easy to maintain/update when there are changes in the environment on the international, national, industry or enterprise level
will allow for collaboration between enterprises through easy integration with ERP systems of other enterprises in the value chains/value networks
will provide better business insight (data mining) for managing the enterprises

TABLE 6-2 KEY ATTRIBUTES OF THIRD GENERATION ERP (Johansson & Bjorn-Andersen, 2007)

Requirements in TABLE 6-3 (McGaughey & Gunasekaran, 2010) are more detailed and more focused on requirements that can resolve the ERP problems. The detailed requirements could be grouped in general requirements of interoperability, integration, simplicity, agility, responsiveness, and accessibility. Requirements in the last list in TABLE 6-4 (Frank, 2009) are the most general, focusing primarily on the user requirements of the ERP system architecture. They include the requirements of integration, flexibility, transparency, analysis, and reuse. The explanation of the requirements provided in this cited research is very thorough and this list was taken as the basis of the general problem domain requirements of ERP 3.0 presented in this thesis. References to this research will be used extensively in the following sections.

Desired future ERP capabilities
Supports interaction of supply chain partners and inter-organizational processes
A single corporate database to facilitate true functional system/module integration
An inter-organizational database to integrate supply chain partners--maybe supplied by an ASP
Any necessary data transfer among/integration of modules is smooth and consistent
Possesses flexibility to continuously support agile companies responding to dynamic business environment
Employs a fluid yet robust architecture reflective of evolving enterprise models and evolving technology
Support for transaction intensive applications and query intensive applications
Enterprise systems take into account partnering enterprise characteristics like culture, language, technology level, standards, information flows, and provide flexibility to adapt as partnering relationship changes
Solution vendors form global alliances with other vendors to better meet needs of clients in any country
Solution vendors embrace standards like XML and the Service Oriented Architecture

TABLE 6-3 DESIRED FUTURE ERP CAPABILITIES (McGaughey & Gunasekaran, 2010)

Future ERPs
Should feature high level of multi-dimensional integration
Should support safe and convenient flexibility
Should efficiently contributed to transparency
Should support decision makers with elaborate analysis methods
Should take advantage of software reuse

TABLE 6-4 FUTURE ERPS REQUIREMENTS (Frank, 2009)

6.2 General Requirements

The general ERP 3.0 problem domain requirements are the basic architectural requirements, that support the specific administrative and end users' requirements listed in the following sections. Four out of these five requirements have been discussed in (Frank, 2009), which is an excellent research on this topic and citations from it have been used in the following sections to relay the most important parts. The only difference made in the choice of requirements in this thesis is that the requirement of analysis support has been replaced with the requirement of automation. Additionally, the transparency requirement has been renamed to simplicity and the flexibility requirement to agility, for the purpose of more general terminology. In the following sections, the cited research is built upon by relating it to the previous chapters of this thesis, which have built the foundation for this discussion.

6.2.1 Integration

In the context of the functional requirements of modern enterprises, integration is crucial. It is primarily dealt with within the ORM function, or more specifically within the BPM sub-function. As the chapter 3 discussed, process integration across functions is required for efficient operation of the enterprise. *Integration is a requirement that we have seen mentioned in every chapter so far. In accordance with the enterprise's functional requirements, it is the fundamental requirement of an ERP system.* An elaborate definition of integration is provided in:

> ***In order to describe this requirement and to derive its implications, we first need a more elaborate conception of integration than the one suggested by its colloquial meaning – "unification into a whole". Within the context of information systems, integration is mainly a linguistic conception, i.e., it is accomplished through language and communication respectively. Integrating two components requires them to communicate, either directly or through some kind of mediator. Communication in turn implies the existence of common concepts that define the semantics of the linguistic artifacts that are subject of communication relationships. In other words: Integration requires the existence of a common semantic reference system. Examples for such reference systems are data types or database schemas. The level of integration can be conceptualized by referring to the semantics of the common concepts: The higher the level of semantics these concepts include, the higher the level of integration they allow for. Note that this concept of semantics corresponds to the concept of information content: The more possible interpretations are excluded by a concept, the higher its semantics. For example, the concept "Customer" is of higher semantics than the concept "String" (data type). A high level of integration offers definite benefits. The higher the level of semantics, the more focused and efficient information exchange will be. At the same time, a high level of semantics reduces the effort that is required for reconstructing the meaning of a message; hence, it also reduces the threat a message imposes to integrity. (Frank, 2009)***

From this definition we can take that integration is about bringing things together to work as one and that it can be done on different levels. Current ERP systems use the database schema to unify the data used by their components into one. The most recent ERP systems also use object-oriented programming to share high-level semantics within the code (customer vs. string example in the previous quote). For further elaboration, integration in the ERP context can be classified into four types: static, functional, dynamic and organizational integration. Definitions are provided in TABLE 6-5 (Frank, 2009). Static, functional and dynamic integration are more internal to the ERP system, relating to database and programming technologies. Organizational integration is the source of ERP misfits problems and the driver of customizations. So ERP 3.0 should have good integration across the entire system and all integration types or in other words “a high level of multi-dimensional integration” (Frank, 2009).

Integration Type	**Definition**
Static	Shared static structures. A typical example would be a common database schema used by a number of applications.
Functional	Linking applications by providing them with common functions, e.g., a common function library. It requires static integration to allow for common interfaces.
Dynamic	It is accomplished through common event types. Only if an event that is produced by software component corresponds to a common event type, another component (e.g., a workflow management system) can interpret it adequately and trigger the appropriate function – which presupposes functional integration.
Organizational	Integration of an information system with its surrounding action system. It includes overcoming the notorious cultural chasm between IT experts and business people. This kind of integration requires concepts that are shared by the organizational universe of discourse and the information system.

TABLE 6-5 ERP INTEGRATION TYPES (Frank, 2009)

A closely related term to integration is integrity. Integrity means consistency and in the context of ERP systems usually refers to data integrity. In databases a common term is referential integrity, which is the consistency between connected data (for example the same item that is on two different orders should always be the same item). Integrity is defined by integration, so higher level of integration results in higher level of integrity. As noted under section 5.1.4, the main problem with SOA is data integrity across services (Frank, 2009). Each service has its own copy of data with no guarantee of integrity, so integration based solely on SOA is not of high quality. The problem with multiple copies of data can be exemplified with an old saying: a man with one clock knows what time it is; a man with two clocks is never sure.

Speaking of integration as bringing things together, there is a documented need for merging of ERP with BI (McGaughey & Gunasekaran, 2010; Plattner, 2009; Howlett, 2010). ERP systems should not only execute transactions, but should also support users with elaborate analysis methods (Frank, 2009). There are several advantages of integrating BI functionalities (reporting and analysis) into the ERP system. First, users could get the necessary information within the ERP user interface exactly when and where needed to perform the desired action. They would not have to switch to BI software and enter all the parameters manually to get the information. Second, integrated BI could take advantage of the data model embedded in the ERP architecture and provide meaningful analysis and reporting out of the box. In current BI installations data modeling and data transformation (ETL – extract, transform, load) have to be done manually. Only the defined reports and analysis are available. ERP-integrated BI could offer any possible combination of data without manually defining it. Third, BI loading is usually done on a daily basis, so no real-time data analysis and reporting is possible. Fourth, transformed data could become corrupted or the ERP data can change without being reloaded into the BI data warehouse. This means that analyses and reports could be incorrect.

Integration can also be seen in the context of interoperability problems. In the future, data modeling tools and translation software are expected to be able "to move any amount of data in any format, and/or language, anywhere in near real-time" (Jacobs & Weston, 2007). Some even suggest a shared (global) database. It seems that the future of ERP is in connecting as many things together in an automatic way using as high as possible semantics. As mentioned earlier, the network effect (or Metcalfe's law) states that the more connections there are, the higher the utility of the system (Hendler & Golbeck, 2008). Current ERP systems have few manually programmed connection points between different functions of the ERP system. Ideally, users should be able to just plug in a new module and the system should configure itself, automatically connecting the new functionality to any meaningful functionality already in place (McGaughey & Gunasekaran, 2010). This would be like the plug-and-play hardware – the ultimate user friendly approach. For such integration to happen, a high semantic level would have to be achieved using the newest advances in modeling, but this is a topic in the solution domain. If everything was connected within the processes of an enterprise, then there is the challenge of the virtual enterprise – connecting different enterprises together through one global ERP system. That would truly take advantage of the network effect, creating an online business world, possibly a hybrid between the current online personal world of Facebook and the online trading world of EBay.

6.2.2 Agility

One of the most important functional requirements of the modern enterprises for long-term efficiency is innovation (as discussed in chapter 1.7). Innovation requires the ability of enterprise's processes to change easily, efficiently and timely. This includes the processes within the ERP system. As we have seen under the ERP problems section, lack of ERP flexibility is a commonly cited problem. It is a requirement that seems to be missing from the current ERP systems. But before we go into ERP flexibility and related issues, definition of the related terms will be discussed.

Research into the definition of flexibility, has found three terms that are closely related and often confused – flexibility, agility and responsiveness (Bernardes & Hanna, 2009). Based on their literature review, they have come up with the following definitions: flexibility is the "ability of a system to change status within an existing configuration (of pre-established parameters)"; agility is the "ability of the system to rapidly reconfigure (with a new parameter set)";

and responsiveness is the “propensity for purposeful and timely behavior change in the presence of modulating stimuli” (Bernardes & Hanna, 2009). This implies that responsiveness requires flexibility and agility to start with, and builds upon them. In the ERP systems context, flexibility already exists in current ERP systems, however the pre-established parameters are limited. This is the primary source of functional problems (misfits) with ERP systems. Agility is the source of customization problems and is at a very low level in current ERP systems. However, responsiveness of current ERP systems is virtually non-existent (in the sense of monitoring its usage and its environment, and automatically adjusting to it). It would require a significant level of semantic machine understanding and artificial intelligence in order for an ERP system to be called responsive at that level. This is due to the fact that in order to react to what users are doing, one needs to understand what they are doing, why they are doing it, and how can that be improved upon. Let’s say that for now responsiveness of an ERP system is beyond the reach of current technology.

Starting with flexibility, everyone seems to think of it as one of the key requirements of better ERP systems from the user’s perspective (Shehab, Sharp, Supramaniam, & Spedding, 2004; Tabatabaie, Paige, & Kimble, 2010; Adisa, Schubert, & Sudzina, 2010; Frank, 2009; Weber, Reichert, & Rinderle-Ma, 2008). However, according to the definitions cited, they seem to be talking more about agility than flexibility. “Supporting changes” (Tabatabaie, Paige, & Kimble, 2010), following “evolving business needs” (Adisa, Schubert, & Sudzina, 2010), and “evolving with the dynamic changes of a company” (Shehab, Sharp, Supramaniam, & Spedding, 2004) indicate new parameter sets instead of pre-established ones. Either way, let us look at this concept as one in the context of ERP systems, regardless of what it is called as it is very closely related. There have been two important sub-requirements identified for flexibility – that it should be safe and convenient (Frank, 2009). A great elaboration is provided in:

> ***Flexibility is a conception that incorporates three aspects. Firstly, it refers to the scope of additional requirements a system can be adapted to. Secondly, it refers to the effort it takes to perform adaptations. Thirdly, flexibility includes the (implicit) claim for safety, since software adaptations tend to jeopardize system integrity. Flexibility pertains to all dimensions of an [future ERPs]: the adaptation of static structures, of functions and of processes. The different aspects of flexibility are not independent. The highest level of adaptability would be to open the entire system code for manipulation. Apparently, this approach to flexibility would neither be convenient nor safe. More convenient approaches to adaptation, e.g. the modification of certain features in a class schema, imply the risk of producing side effects. The manipulation of tables that is sometimes used for the configuration of ERP systems is certainly not particularly convenient. It may be safe in a formal sense (depending on***

> ***the incorporated integrity constraints) – however, due to their rather cryptic representation, tables are a likely source of human errors. Against this background, we can express a more concrete demand for flexibility. An SRES should allow for adaptations within the scope of possible future changes. While this demand does not imply the ability of predicting the future, it suggests a thorough analysis of the respective domain that is aimed at identifying those parts that are likely to be invariant and others that may be subject to changes in respond of certain future scenarios. Convenient modifications require a representation of the relevant aspects of a system in a comprehensible manner, i.e., by concepts that correspond to domain-level terminology. Graphical depictions may further foster comprehensibility, because they often allow for a clearer representation of complex interrelations. For adaptations to be safe, the resulting changes should be clearly specified and mediated to those who perform the changes. Side effects are to be avoided. (Frank, 2009)***

In this quote we can see elements of both flexibility and agility, as per their definitions. What has been suggested is to try to predict the future needs and to accommodate for them now. This is implying that agility can be simulated by well-planned flexibility. However, without a higher level of semantics and extensible modeling approaches, it is not likely to be very long-lived. In fact, the answer to the requirements presented in the cited research lies in the modeling of the entire enterprise real-world system as the ERP core (Frank, 2009), however this is a solution domain topic. Another indicator of the need for flexibility is the rapid increase in use of BPM tools, also called the workflow management tools (Heili, Heraud, & France, 2006). They allow for safe and almost limitless flexibility by providing a controlled environment with powerful graphical tools to create the desired processes. In summary, *ERP 3.0 should support high level agility.* There is another problem aspect that shouldn't be forgotten. It is the problem of uniformity, where each location must be able to custom-adapt its processes within the same ERP. This requirement has been addressed by the newest release of one of the top 3 ERP vendors at this time – Microsoft Dynamics AX 2012. They call it the "model driven layered architecture" and it works similarly to object-oriented inheritance, with multiple layers of configurations inheriting and modifying the level above (Microsoft, 2011). ERP 3.0 should also satisfy such requirements.

6.2.3 Simplicity

Efficiency of an enterprise depends on its ability to understand its structure and its processes, so that the processes can be designed to be as efficient as possible. Understanding of the processes that have been adjusted to the ERP system is frequently lost in system's complexity and third party consulting. Also, even when understood, processes within the ERP system are frequently complex and inefficient (see section 5.2.1 for 26 screens example). In the ERP context, problem domain requirement simplicity is most closely related to the problems of complexity and user interface. As noted in section 5.1.3, the already complex ERP systems keep getting even more complex as their functionality is increased (Shah, 2010; Frank, 2009). Complexity that is difficult to comprehend is the underlying cause of many ERP problems. There are two ways to reduce the complexity that are contained in the simplicity requirement. First, complexity can be reduced by providing the users with as much understanding as possible of its architecture and functionalities, referred to as the transparency sub-requirement. Second, the complexity can be reduced by removing unnecessary, illogical, and unintuitive elements, which could be called the simplification sub-requirement. Together, *ERP 3.0 should support maximum simplicity*. A very good example is the success of Apple's iPhone which managed to significantly reduce the complexity of earlier smartphones, what other manufacturers failed to do. If something can be done in several ways, the designers of the ERP system should choose the one that will be most intuitive and understandable for the users. The simplicity requirement can be elaborated on as:

> ***An [ERP system] is an invisible artifact. Linguistic representations are our only chance to develop an appropriate understanding. In order to foster transparency, these representations should be restricted to those aspects that are significant for specific purposes and users. Taking into account that professional perspectives of those who deal with [ERP systems] vary to a great extent, this implies to provide representations of multiple perspectives. Graphical representations should be used where they foster transparency. (Frank, 2009)***

For the end users (employees executing enterprise's processes within the ERP system), a special approach has been getting increasing attention, called the role-based ERP. It has been documented in research literature first (Johansson B. , 2009) and recently adopted by some ERP vendors (Microsoft, 2011). The idea behind it is that unnecessary complexity should be hidden in a customized user interface, which is tailor made for the specific role that the user has in the processes supported by the ERP system. This is a requirement that relates to our example in section 5.2, where the users should not have to go through 26 different screens to perform a single action. Instead, the ERP system should be transparent and simple for them, meaning that they should have good understanding of what they are doing, and that it should be easy and intuitive for them to do it. An extension of that end-user requirement would be to support employees having multiple roles (Johansson B. , 2009).

Problems of end users with performing enterprise's processes within the ERP system are important for enterprise's short-term efficiency, but the other side of administrative problems has effects on enterprise's long term competitiveness. Simplicity requirement is very important for problems with customization, interoperability and upgrades. Better and easier understanding of the ERP system as a whole and each part can make a big difference in cost and time when trying to customize, upgrade or connect the ERP system. Being able to do it in a simple and intuitive way, makes the problems much easier to deal with. Compared to the original requirement of transparency (Frank, 2009), the replacement requirement of simplicity, used here, is the more general requirement. It combines transparency with simplification in order to reduce the complexity at its source and its representation at the same time, as discussed earlier in this section.

6.2.4 Reuse

An important component of efficient processes across all functions of an enterprise is reuse. Modern society is built upon this concept of reuse, dating back to the beginning of human evolution. If an enterprise wants to add or change a process, there is no point in reinventing the wheel (as the saying goes). If there are elements from other processes that can be reused within the new process, it is more efficient to reuse the old elements to create the new process, than to create the process from scratch. Same is true for processes within the ERP system (Frank, 2009). So, *ERP 3.0 should support reuse on all levels.* Better understanding of reuse in the context of ERP systems is provided in:

> ***The reuse of software artifacts allows for dramatic cost reduction through economics of scale. The benefit of reusing a software component depends on its semantics: The more semantics it includes (the more specific it is), the higher the benefit of using it. At the same time, however, the range of reuse is compromised by semantics: The more specific a component, the less likely it can be used in further systems. Therefore, it is required to develop an appropriate balance between reuse benefit and economics of scale, or – in other words – to find the appropriate level of semantics. The primary objective for accomplishing reuse that combines high benefit and low cost is to identify or construct commonalities that are shared by a large number of enterprises. In other words, there is need for abstractions (again: static, functional, dynamic) that are suited to fit many enterprises. (Frank, 2009)***

Requirement of reuse can be applied on many levels within the ERP system. First, from the user side, let's say that there exists a quotation that has been accepted and needs to be invoiced. Instead of entering the same information again in the invoice, it could be copied automatically into an invoice by the ERP system, therefore reusing the document information. Then, there could be a need for a new workflow that is similar to an already existing one. Instead of creating the new workflow from scratch, the user should be able to load the old workflow, adjust it, and save it as the new workflow. A new employee might need certain access rights within the ERP system. If he is going to be doing the same job as another employee that already exists in the ERP system, access rights should be easily copied over.

We can also go onto a higher level. If the new business unit needs to use the standard enterprise processes in everything but a few localized processes, ERP system should provide a way to extend the default configuration, and define only the changes instead of selecting each configuration from scratch. This inheritance or layered approach also means that if the standard processes on the enterprise level changes, each unit extending it will automatically inherit the change. It is a way of abstracting the common features on a higher level and allowing better reuse, while reducing complexity at the same time. Finally, if a certain customization or core ERP functionality is accessible through high levels of integration, agility, transparency and automation (i.e. modeling), it could be reused in a different place without having to write it again, by just connecting its inputs and outputs to the right connection points.

The cost-effectiveness side of the reuse requirement mentioned in the quote (Frank, 2009) can have a significant effect on the problems of ERP cost. The final, 5th level of SaaS (software-as-a-service) maturity model (Ried, 2008) could provide exactly that. It represents a flexible multi-tenant (same code used by many users) internet-based application. Instead of having multiple copies of code for each enterprise running on some server, it reuses the single copy of code to run everyone at the same time, but in different ways. In a way, current ERP systems are as if everyone had their version of Facebook running and exchanging information with other users' applications. Instead there is just one code running the Facebook for all users, but allowing each user to customize what they see and how they interact with the system. Of course, customizability of the ERP systems requires much more than the current personal SaaS instances, but if such code reuse could be accomplished, it would significantly lower ERP costs.

6.2.5 Automation

A significant trend of increasing automation is visible in the processes of modern enterprises. As discussed in section 3, automation includes machines and computers. In the context of ERP, automation of information manipulation by computers is very important. Humans are prone to errors in repetitive tasks and can process data much slower than modern computers. Current ERP systems support the automation of computations (for example, there has been no need for calculating computerized invoice totals by hand for decades), data entry (connecting with

B2B, B2G, B2C and B2E systems for automatic data exchange), control (access rights, workflow automation, and data validation), decisions (automatic credit approval), reporting (providing the right data at the right time to the right person), analysis (data mining in BI) and planning (statistical predictions based on historical data) (McGaughey & Gunasekaran, 2010; Baltzan & Phillips, 2008; Laudon & Laudon, 2012).

However, most of the current automation is done for the end users. It still has plenty of room for improvement, but what is really missing is the automation of the administrative side. There are some notable exceptions, such as the modern BPM tools which automate the creation of workflow automations (by allowing the administrator to graphically arrange high level elements and performing the necessary actions in the background). *ERP 3.0 should take the automation on a much higher level, on both administrative and end users' sides.* In a way, what is needed is the automation of automation. ERP systems should know what semantic information is contained in their data, and offer appropriate analysis for it automatically (Frank, 2009). It should not have to be manually programmed into a data model in a BI system. ERP systems should start understanding data and start suggesting business decisions based on that data, without being specifically programmed for a specific decision (Jacobs & Weston, 2007). They should automate customizations by safeguarding the changes. They should disallow a human from performing a conflicting customization and should automatically find all connection points. Helping the enterprise deal with the ERP system itself is the ultimate goal of automation for ERP 3.0.

In the context of the cited research by (Frank, 2009), the requirement of automation was added there, while the requirement of analysis support was dropped. This change of the previous requirements list was made because the automation is the more general requirement, while analysis is a sub-requirement in the end users' domain. As mentioned above, analysis should be automated by the system and present wherever and in whatever way it makes sense, based on the semantic meaning and relationships of the stored data. This has already been discussed under the integration requirement (section 6.2.1), as the integration of BI with ERP. Automation on the other hand is a more general and essential requirement that needs to be optimally satisfied by the ERP 3.0, supporting the rest of the requirements listed here.

6.3 Administrative Requirements

Administrative requirements relate to the same domain as the administrative problems from the previous chapter (section 5.1). They represent the necessary changes in the ERP 3.0 that could resolve the problems related to the setup, implementation, maintenance, and change of the ERP system.

6.3.1 Upgradeability

As discussed in the problems section, current ERP systems are difficult to upgrade. The biggest problem is the preservation of customizations through system upgrades. ERP vendors change parts of the ERP system to adjust for new functionality they have added between versions. If any of those changes make the ERP system incompatible with custom upgrades, customizations need to be redone. Also, if functionality changes in a way that does not fit the enterprise, new customizations are needed again. This is primarily because integration between custom functionality and the ERP system is done on the syntactic level of strings and integers in database fields. The system itself has no understanding of the higher semantic meaning of connections. For example, if the system knew that a customization added a home phone number to the customer model in the system, then if the upgrade was moving phone numbers in a different location (i.e. a sub-detail table in the database), it could adjust the connection point of the customization so that it doesn't stop working. For ERP adopting enterprises this would result in a significant reduction in costs and length of customizations across system upgrades.

New functionality added to the ERP systems is usually released in intervals of several months. Even when it's not added by the ERP vendors but customized by the enterprise, it is still usually done in separate releases in lengthy intervals. Supported by the general agility requirement, *ERP 3.0 should support safe and convenient upgrades.* Ideally it should support multiple versions of functionality at the same time and provide methods for testing and release without the need for big upgrades in long intervals. According to the definition of agility in section 6.2.2, this kind of ideally upgradable ERP could be called agile ERP. The difference in upgrading ERP functionality between current ERPs and the agile ERP is illustrated in Figure 6-1. Instead of the big jumps on upgrade dates, functionality is gradually added and used as soon as it is ready. This provides the enterprise with a competitive advantage over competitors that have to wait for months, until next system upgrade, before they can implement the latest industry innovation.

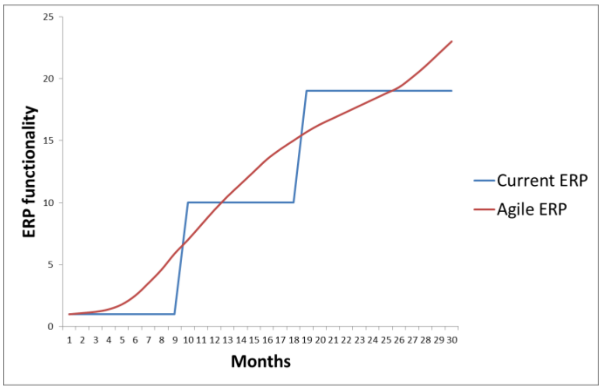

FIGURE 6-1 DIFFERENCE IN FUNCTIONALITY UPGRADES BETWEEN CURRENT ERPS AND AN AGILE ERP (OWN ILLUSTRATION)

6.3.2 Security

Security is an important factor in modern enterprises. Stolen passwords and credit card numbers are frequent news, resulting in serious damages for the affected enterprises. Within the functional requirements of an enterprise, the CCM function deals with control of security aspects. Enterprises processes within the ERP system need strong security from the ERP system. Within the context of ERP outsourcing (Application Service Providers in the cloud or Saas), studies found security as the number one issue (Saeed, Juell-Skielse, & Uppstrom, 2011; Frick & Schubert, 2008). In the context of ERP systems we are talking about data security. Through unauthorized access, data can be copied (like stolen credit cards), modified (like increasing the account balance), or deleted (like deleting the debt balance). This is an external threat. It can also be lost or corrupted internally through equipment failure, ERP system errors or accidental unwanted user actions. Data security can be divided into data storage security, data transmission security, application security, and security related to third-party resources (Saeed, Juell-Skielse, & Uppstrom, 2011).

Current ERP systems are quite strong in this requirement, so ERP 3.0 should at least maintain this level. However, there is one aspect that current ERP systems don't support, due to the design limitations of the underlying databases. That is the aspect of historical data. *ERP 3.0 should never delete any data.* It should be possible to go back to any point in time and see all the data exactly the way it was then (Stefansen, Simonsen, & Larsen, 2007). That is a strong requirement coming from the CCM function, particularly after the new laws regarding internal control like the SOX (see section 3.6 for more information). The way that it should work is the system should record when something was added and in what period it was valid. In the context of temporal databases research, those records are called transaction time and valid time (Mahmood, Burney, & Ahsan, 2010). ERP 3.0 should function the same way as the current ERP systems, until data is requested for a specific point in time. Ideally, at that point the whole system would respond with exactly the same forms and reports as they were at that time, extending this requirement further into ERP configuration and functionality history.

6.3.3 Templates

Since ERP systems are very complex, implementations require adjusting and customizing huge amounts of configurations and data. To define a new configuration from scratch would make the implementation time and costs prohibitive for most enterprises. That is why the current ERP systems come with preconfigured templates for specific industries and regions, which are supposed to be close to what the implementing enterprise needs (Jacobs & Weston, 2007). If this is true, then the implementation process is reduced to adjusting just the differences between the template and the actual enterprise's needs. This is an important requirement that cannot be lost in ERP 3.0. However, templates are connected to the problems of best practices and customization (sections 5.1.6 and 5.1.5). Even though the idea of templates is good, in combination with potentially flawed best practices and poor flexibility, it is not as good as it could be. Enterprises implementing the current ERP systems often find that even though the amount of necessary configurations and customizations is significantly reduced by templates, the remaining work is still very difficult, costly and time consuming. The better the general ERP requirements of integration, agility, transparency, reuse and automation are satisfied, the more utility will ERP templates provide. As templates provide the starting point of an implementation – *ERP 3.0 should support elaborate template creation*.

6.3.4 Simulation

A related requirement to planning (covered later under end users' requirements) is simulation. The simulation requirement refers to the simulation of ERP system changes. It means that *the system should be able to support multiple versions of configurations at the same time and allow interactions between test versions running simulations and the actual live version data up to a certain point in time.* This requirement can significantly reduce the difficulties of system modification, removing the need to copy the system to a test system, run tests, and then copy the modifications to the live system. Manual copying of modifications is prone to errors and requires system downtime (relating to the availability requirement discussed later). This requirement is in fact planning of the ERP system functionality, not just of the data stored in it.

6.3.5 Cost-efficiency

Final requirement from the administrative side is to make ERPs cost-efficient. Current ERP systems are prohibitively expensive for SMEs. We have seen that ERP license costs represent approximately 1/6th of the total ERP implementation costs, the rest going to consultants and related organizational costs. It has been suggested that smaller enterprises are less complex and therefore incur lower implementation costs, making the license cost relevant again (Adam & O'Doherty, 2000). The general requirements listed earlier can already contribute to cost reduction, but additional ways to reduce total ERP implementation and ownership costs should be sought.

6.4 End Users' Requirements

End users' requirements again relate to the end users' problems from the previous chapter (section 5.2). The goal of these requirements is to make the processes and functions supported by the ERP systems more fit with the business requirements of the enterprise and its people performing their roles. Instead of keeping the same effectiveness from manual or legacy software processes, or making it even worse (the ERP problems), ERP 3.0 should improve their effectiveness.

6.4.1 Responsiveness

One of the most important requirements of the ERP system from the end users' point of view is responsiveness. In the context of ERP requirements, we encountered the term "responsiveness" in the context of self-adjusting ERP systems, under the section 6.2.2 on agility. In this section, responsiveness is used in the same meaning as in section 5.2.2 and corresponding to the ERP responsiveness problems. There it was defined as the wait times between the start of an action and the returned result of an action in the ERP system. In the extreme example from that section, it took several minutes for a simple action within the system that had to be repeated 26 times for a single activity. *As a requirement of ERP 3.0, it could be stated that the system should respond with the result within a reasonable time.* Reasonable time depends on the activity and the expected result. For basic frequently recurring activities, it should be a few seconds. This includes quoting a customer or accessing his balance due. For complex reports that process significant amounts of data, even though ideally it should still be in seconds, users will likely find even a few minutes as a reasonable response time. In those cases it is important to provide the user with a progress indicator.

6.4.2 Accessibility

As enterprises exist in all countries in the world and are becoming increasingly global, it is important to provide accessibility. *The accessibility requirement refers to the ability of the ERP system to be used by as many enterprises and their users as possible.* As a verbal interface, it is important to support multi-lingual interfaces, preferably with built-in automatic translation assistance to promote inter-enterprise processes. It should also support different currencies and automatic conversions, just as with the languages. It should support as many access devices as possible. This includes the currently expanding mobile base (like smartphones and tablets) and any future technologies. It should include the most commonly used display technologies (like HTML5 is supposed to be). Finally, it should allow customizable user interface layouts in order to promote efficiency. That should also include left-to-right and right-to-text left, as well as color adjustments for color-blind people, and any other common accessibility features of software systems.

6.4.3 Availability

The availability requirement states that the ERP system should be available to its users at all times. There should be absolutely no nightly data processing or backups that block ERP use. There should be no system stops for upgrades. Ideally, the system should always be ready for use, doing everything in the background. This includes preparing changes on the live system in the background and making a seamless transition when ready. Current ERP systems cannot satisfy this requirement in the absolute level, but are usually considered satisfactory on this level. However, this is due to the fact that any system unavailability times are scheduled at night. The globalization trend is going to affect that in the future, as there is always somebody working somewhere (due to time zones across the globe). For a future global enterprise system downtime will not be an option.

6.4.4 Planning

Planning capabilities are becoming increasingly important for enterprises. Most enterprises perform some form of budgeting, at least in some basic format. This requirement can be used to support any function of the enterprise, however it is needed the most by the FAM function for budgeting and cash flow management. The plans could be created using automations such as statistical analysis for predictions of future data based on historical data, but planning requirement defined here can go further. These plans need to be also recorded, monitored and adjusted. Current ERP software allows (or even requires) planning, but makes it very difficult to change the plans as business conditions change. *ERP 3.0 should allow creation, recording, real-time comparison with actual data, adjustments of plans, and comparisons with previous plans.* In fact, it requires the same features of valid and transaction time needed by the security requirement for historical data. The system should be able to show what the plan looked like at a certain point in time and how it evolved by comparing it to some other point in time. This is a combination of future plans and historical data that can provide great functionality across all functions. A more detailed list of functions that could benefit from planning include “cost accounting, forecasting, capacity planning, order rate and response capacity planning, available to promise/capable to match, lead time, and supply network planning” (Jacobs & Weston, 2007).

6.4.5 Collaboration

The collaboration requirement in this context of ERP 3.0 can be linked to user generated content (UGC). UGC is a term for content created or produced by users rather than by paid professionals (Daugherty, Eastin, & Bright, 2008). It is commonly used for entertainment and information exchange, consisting of reviews, blogs and other social media. One of the noted shortcomings under the user interface problems (section 5.2.1) was lack of online help. *Primary use of collaboration (UGC) in ERP 3.0 could be for exchange of instructions, advice, tips, notes, and other helpful content between ERP end users, as well as administrators.* They could review 3rd party functionality and consulting service providers, providing valuable information for potential users. They could provide feedback to the ERP vendor on how to improve the system. This could be on the enterprise level, or in case of a multi-tenant SaaS ERP system on the global level. Requirement of collaboration could reduce training costs, improve efficiency and user satisfaction, and reduce customization costs and length.

The next step for collaboration within ERP 3.0 could be to build and maintain the semantic meaning on both the enterprise and the global level. Shared concepts and their relationships are called an ontology (Assmann, Zschaler, & Wagner, 2006; Kang, Lee, Choi, & Kim, 2010; O'Leary, 2010) and they provide the base for computer understanding and therefore automation. Allowing the user community to relate their enterprise concepts to the global concepts, paves the way for advanced ERP functionality, such as plug-and-play customization and automatic upgrades. Additionally, user community can provide continuous global ontology improvements, which only needs to be reviewed and accepted by the ERP vendor instead of creating it. UGC in this context provides a powerful source of high level semantics needed both by the ERP vendor and the ERP users. Hired professionals by the ERP vendor would cost a lot more (as UGC is virtually free) and would never be able to produce the same quantity of work. That is why *collaboration requirement through UGC in the context of semantic meaning is an important requirement for ERP 3.0*.

6.4.6 Business Functionality

Now that we have exhausted the intrinsic ERP requirements, we can look at the functionality requirements. As we have seen from the benefits classifications, an ideal ERP will satisfy all of the functional requirements of an enterprise (from section 3) and evolve with the enterprise's needs, providing any future functionality as needed. At this time there is no ERP system that provides all the functionality listed in chapter 2 and it is not likely that a single ERP vendor will be able to cover everything. So instead of specific functional requirements, an intrinsic ERP requirement for maximum business functionality variety is proposed here. This requirement translates to maximum satisfaction of the rest of the enterprise functionality requirements that are not satisfied by the intrinsic requirements listed so far, but are specific to enterprise's functional areas. For an ERP vendor to satisfy this requirement, it would be best to provide easy tools for 3rd party components and configuration packages, coupled with revenue sharing models. It should have something such as Apple's App Store or Google Apps Marketplace. Before App Store, each smartphone manufacturer was making its own applications and providing only standard functionality consisting of a browser, a media player, some games, and a few other applications. When Apple opened the functionality development to 3rd party providers, they revolutionized the market. Currently it is estimated that there are 500.000 different applications in the App Store. The same approach should be used for ERP 3.0 functionality, as a single ERP vendor will never be able to match the quantity and variety of functionality that 3rd party providers can offer. ERP 3.0 should come with some fundamental functionality of its own, but primary focus of ERP vendors should be on developing the ERP systems as a platform for other providers. Comparably, iPhone comes with just the standard browser, media player, email client, and a few other applications, leaving the rest for other providers and focusing on the quality of the iOS (the iPhone system that runs the 3rd party applications). For this requirement to be possible, the previously listed requirements need to be at the level where automatic plug-and-play functionality and automatic upgrades are possible.

6.5 Conclusion

This chapter builds upon the previous research in the area of ERP requirements and combines it with the previous chapters to define a more complete list of ERP 3.0 requirements. This list is designed to keep the current ERP benefits (chapter 4), improve upon them, eliminate the current ERP problems (chapter 5), and provide the maximum business functionality (chapter 3) needed by modern enterprises. Summary of the proposed requirements, grouped into general, administrative and end users' requirements, is provided in TABLE 6-6. If ERP 3.0 could satisfy all of the requirements, it would make a significant difference in both short and long-term effectiveness of the adopting enterprises.

General Requirements	**Administrative Requirements**	**End Users' Requirements**
Integration	Upgradeability	Responsiveness
Agility	Security	Accessibility
Simplicity	Templates	Availability
Reuse	Simulation	Planning
Automation	Cost-efficiency	Collaboration
		Business Functionality

TABLE 6-6 SUMMARY OF ERP 3.0 PROBLEM DOMAIN REQUIREMENTS

7 CONCLUSION AND FUTURE WORK

7.1 Summary of Thesis

The aim of this research was to define the user requirements of ERP 3.0 (future ERP systems). The motivation comes from the multitude of problems with current ERP systems that modern enterprises encounter, and the potential benefits that the new generation of ERP systems could bring. In the context of this thesis, ERP has been defined as a single software system that supports all of the functional requirements of a modern enterprise. These functional enterprise requirements integrated across enterprise's processes are needed for short and long-term efficiency of a modern enterprise. Evidence from reviewed literature indicates accelerating change in the business environment, due to technological advances that have globalized world markets. These changes demand increasing innovation, speed, and responsiveness of modern enterprises. Current best technology used to manage enterprise's functions and processes is the ERP system, as indicated by the measurable benefits they provide for enterprise's efficiency. However, current generation of ERPs can't keep up with changing functional requirements, due to inherent technological limitations. This causes significant problems for the enterprises, which have been well documented in the ERP literature. In order to provide the modern enterprises with a new generation of ERP (ERP 3.0), one must first define the requirements of such a system, which was the main goals of this research.

The starting point to ERP user requirements, are the requirements of a modern enterprise. What the enterprise needs to do defines what the ERP system needs to do. Chapter 3 defines 8 functional areas that a modern enterprise needs to engage in: strategy & marketing management (SMM), organizational resources management (ORM), human resources management (HRM), fixed asset management (FSM), finance & accounting management (FAM), compliance & control management (CCM), research & production management (RPM), and supply chain management (SCM). It has been shown in chapter 4 that current ERP systems do improve enterprise's relative efficiency by supporting the functional requirements from chapter 3. Underlying the enterprise ERP benefits are the intrinsic ERP benefits, which apply to all functions supported by the ERP system. The current intrinsic ERP characteristics, which sometimes result in intrinsic ERP benefits, are more frequently the causes of ERP problems, defined in chapter 5. ERP problems can be grouped into administrative problems and end users' problems, depending on whether they affect the use or the configuration of the ERP system. Enterprise's functional requirements, ERP benefits and ERP problems, represent the context and the foundation for main goal of ERP 3.0 requirements.

In chapter 6 the requirements of an ERP system have been defined. These intrinsic ERP requirements were defined from the problem domain side (what the enterprises need from the ERP system). Underlying general ERP requirements on the architectural level are integration, agility, simplicity, reuse, and automation. On the administrative side requirements include upgradeability, security, templates, simulation, and cost-efficiency. On the ERP end users' side requirements are responsiveness, accessibility, availability, planning, collaboration, and business functionality. An ERP system satisfying the requirements presented in this research could not only provide all of the functionality needed by current enterprises (as defined here), but could also easily and quickly adjust to any future requirements. As such it would be significantly more beneficial than the current ERP systems, allowing the enterprises to evolve further.

7.2 Contribution to Knowledge

This research provides an integrative understanding of the future ERP (ERP 3.0) requirements, by bringing unrelated lines of research together, and defining how they interact. It provides a thorough analysis of the first level of requirements (the enterprise), and relates them to the second level of requirements (problem domain ERP requirements) that can support the first level. In this process, necessary background and motivation evidence is provided from previous literature, to improve the understanding of this complex problem. As the final result, a list of categorized requirements is provided in section, which can be used as a starting point for solution domain requirements of ERP 3.0.

The first step was to define the current functional requirements of enterprises, resulting in a grouping of 8 major functional areas that need to be supported: strategy & marketing management (SMM), organizational resources management (ORM), human resources management (HRM), fixed asset management (FSM), finance & accounting management (FAM), compliance & control management (CCM), research & production management (RPM), and supply chain management (SCM). This list of major functional areas and their sub-areas was the contribution of chapter 3, which was supported by the business background, context, and terminology defined in chapter 2.

In the second step, benefits of the current ERP systems were defined in chapter 4. This contributes to the thesis findings with a systematic overview and classification of documented ERP benefits, which were shown to be related to the functional requirements from chapter 3 for the functional enterprise ERP benefits side. The other side identified in the previous research defines the intrinsic ERP benefits, which are beneficial characteristics of the ERP system itself, referring to the internal working of the system and defining the capabilities of the ERP system. These ERP benefits represent the foundation for ERP 3.0, as they represent what needs to be preserved and improved upon.

In the third step, problems with current ERP systems were defined in chapter 5. Similar to ERP benefits, contribution of this chapter is in the form of a systematic overview and classification of documented ERP problems. The reviewed problems have been grouped into two groups. The administrative problems are encountered by the enterprise in its manipulation of the ERP system, through setup, implementation, maintenance, and change of the ERP system. End users' problems are the problems faced by the people performing the enterprise's operational processes that are supported by the ERP system. These two groups of problems present very different aspects of the ERP system, translating to the same grouping of ERP 3.0 requirements in the following chapter.

In the fourth and final step, the main research question is answered. Chapter 6 defines the problem domain requirements of ERP 3.0, combining previous research with the previous chapters. Its contribution, as the most important contribution of this thesis, is the three groups of ERP 3.0 user requirements. They are the administrative requirements (relating to the administrative problems from chapter 5), the end users' requirements (relating to the end users' problems from chapter 5), and the general requirements. The general ERP 3.0 problem domain requirements are the basic architectural requirements, that support the specific administrative and end users' requirements.

7.3 Future Research Directions

The next logical step for future research is to define the solution domain requirements. It is "the domain of engineers (programmers) ... where problems outlined in the problem domain are solved" (Adisa, Schubert, & Sudzina, 2010). They can also be called system requirements. The following sections list the technical areas from computer-related lines of research, that could potentially satisfy the problem domain requirements defined here.

7.3.1 ERP Architecture

As suggested by the reviewed literature, future ERP architecture is most likely to be based on Software-as-a-Service (SaaS) architecture. However, there have been defined multiple levels of SaaS maturity. Based on the problem domain requirements, it would have to be the highest SaaS maturity level, called the "Dynamic business apps-as-a-service" in Figure 7-1. Relating it to the Web 3.0 line of research (Hendler, 2009; Hendler & Golbeck, 2008), future ERP should be a highly integrated Web 3.0 application. It could be an online business world which is real-time integrated with the existing social media applications such as PayPal, eBay, Amazon, Google, Facebook, LinkedIn, Twitter, YouTube, Wikipedia, and so on. This would result in a perfect integration with customers, employees, and suppliers over the internet. Network effect benefits would be enormous. And that is exactly what a modern enterprise needs.

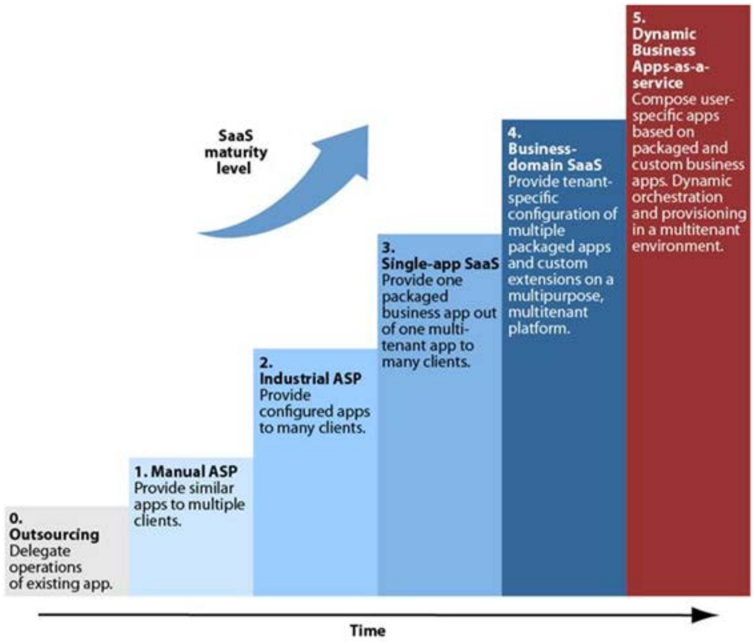

FIGURE 7-1 SAAS MATURITY LEVELS (RIED, 2008)

7.3.2 Modeling and Semantics

A rising line of research in information systems has been the area of conceptual modelling, semantics and ontologies. The Use of this technology as the basis for ERP 3.0 could enable the technological leap required to fully support the requirements that current ERP systems cannot. This line of research is probably the most important element of the solution domain requirements. Figure 7-2 provides the basis for a quick understanding of what it means and how it works. In the early days of computer programming, programmers would just write some code that does something according to the implicit model in their head. Then, certain advances in programming languages allowed deducting ("visualizing") some rough outlines of the model from the code. Then modelling tools like UML (Unified Modelling Language) were invented, and people started making models first and code second. However there was no connection between the manually maintained model and the code, requiring updates between changes ("roundtrip engineering" phase in the figure). Next, it was realized that a detailed model could be used to generate the code from it ("model programming" phase). This is where the current Model Driven Architecture (MDA) belongs. Finally, if the software was made intelligent enough, it could work directly with the model, without generating the code from it ("model only" phase). Current ERP systems are somewhere between the first and the third phase, depending on how old their cores are. Ideally, ERP 3.0 should take advantage of all the recent advancements in the modelling research and be implemented in the model-only way. This would allow for computer understanding, which in turn, combined with other requirements, could enable the key functionality of plug-and-play 3rd party functionality that could be automatically upgraded. This approach is already discussed by some research, the most interesting being the MEMO line of research (Frank, 2009; Frank, 2002; Frank, 2011)

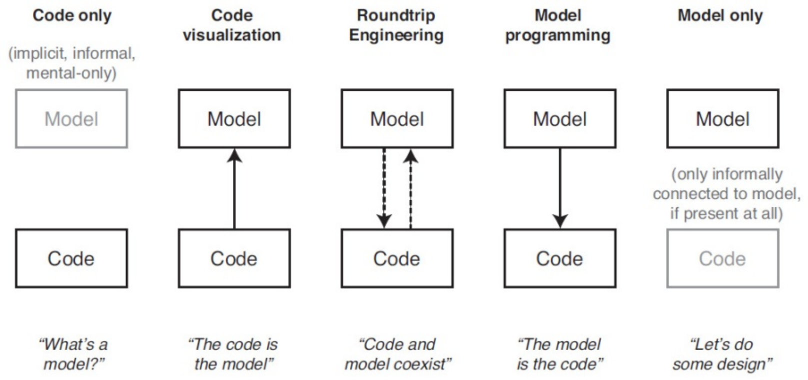

FIGURE 7-2 FROM CODE TO MODEL (LIDDLE, 2011)

7.3.3 Database Backend

One of the key features of current ERP systems is that they use a third party database backend for data storage and retrieval purposes. The current commercial and open-source databases have not evolved much over the last two decades. There are many requirements that the ERP 3.0 backend would have to satisfy in order to fulfil all of the problem domain requirements. One of the database requirements would have to be that it is distributed (as in cloud computing), due to the desired architecture of pure SaaS. This is something that current databases do support. However, the rest of the requirements are mostly not available outside of research versions.

First, to satisfy the data security and planning requirements, it would have to be a bi-temporal database. This means that it supports transaction and valid times (when was it entered for what period was it valid). Currently there is only one commercially available bi-temporal database (Snodgrass, 2010), but it does not support the requirement fully. It does not support temporal aspect of the schema versioning, thus simulation and historical view would not be supported. However, there is a line of research in that area that could resolve this issue (Roddick, 1996; Wei & Elmasri, 1999; Moreira & Edelweiss, 1999).

Second, databases were traditionally stored on hard disks, as they were much too big to fit in main memory (RAM). This is no longer true and according to Moore's law applied to memory growth rate (Laudon & Laudon, 2012) it will never be a problem again. That is why even SAP is working on a main-memory database they are supposed to release soon (Plattner, 2009). In combination with the new column-based order of data storage, main-memory database can satisfy the responsiveness requirement. Compared to disk-based database improvements in speed are in the order of magnitude.

Third, just as the database schemas are embedded in the database management system, so should the models from the previous section. Models define the data, its format and its relationships. Current approaches of conversion from models to schemas are the result of obsolete database technologies currently available. As part of integration and automation, models should become one with data storage representations. Additionally, for integrity purposes, this new database-model backend should support dynamic fields. For example, if the model says that there is an “invoice total” field and it is calculated in a certain way from other fields, it should be taken care of in the backend. In current databases it is necessary to enter this field with the other data or calculate it on-the-fly every single time it is needed by the system. First option can result in corrupted data if an item is updated without explicitly recalculating the “invoice total” field, and second option is slow. The ERP 3.0 backend should automatically update it with every change and have the field ready for any queries, because updates are very rare compared to queries of such calculated fields.

7.3.4 User Interface

As far as solution domain requirements for user interface go, they are not different from the problem domain requirements. It should be accessible (multi-lingual, multi-region, multi-device), simple (intuitive) and flexible (custom layout). A Primary candidate at this time for the technology to support the multi-device requirement is HTML5. However, this will change in the future, so the best option would be to support multiple user interface rendering technologies. When something better comes along, it can then be added to the system.

7.3.5 Applications and Services

Problem domain requirements of reuse and busienss functionality (need for the highest possible variety of enterprise’s functions supported), can be connected to the research on application production line (Krueger, 2006; Greenfield & Short, 2003). This research tries to “industrialize” the software development by making it possible to assemble it from already existing components. Instead of building a car from raw materials, car manufacturers assemble certain pre-fabricated and standardized parts, used in multiple car models. The same principle could possibly be applied to software production.

Combining 3rd party functionality development with SaaS architecture, requires thinking in the direction of Platform-as-a-Service (PaaS). PaaS refers to providing the computing platform and a software development stack as a combined service to application developers (Kourtesis, Kuttruff, & Paraskakis, 2011). As the ERP system should be a multi-tenant SaaS, any customizations should be coded directly in the system for testing and simulation purposes. Examples of current PaaS include Google Apps Engine and Microsoft Azure.

Finally, once the 3rd party functionality has been developed, it needs to be sold to the users. SaaS can offer great convenience of try-and-buy, as the system has full control over when to start charging or turn off the functionality at all times. This should be something similar to the Apple iOS App Store or Google Apps Marketplace. However, it should be connected to the global business ontology as a way to categorize the functionality and provide intuitive browsing and searching options. One of the main drawbacks of App Store is difficulty of finding something among the 500,000 applications it currently offers. This problem should be resolved within the ERP 3.0 application market.

As ERP systems require consulting services, it would be reasonable to support these in a marketplace as well. It should offer the functionality provided by current sites like Elance.com or Freelancer.com. An example would be the Google Apps Marketplace Professional Services.

7.3.6 Collaboration and C-Commerce

As a global multi-tenant SaaS, ERP 3.0 should take advantage of User Generated Content (Daugherty, Eastin, & Bright, 2008) and crowd sourcing (Huberman, Romero, & Wu, 2009). As discussed under the problem domain requirement of collaboration, ERP users should be able to use it as the current social media websites are used. They should be able to discuss, review, rate, ask, advise, comment, and do any other collaborative action about the ERP system and 3rd party applications and services, within and between enterprises. As also discussed, a primary use of crowd sourcing would be the creation and maintenance of a global ontology. Full semantic coverage is a prerequisite for fully automated 3rd party functionality integration.

Finally, this online business community could integrate in a similar way as the friend networks work on Facebook or LinkedIn. This could be further improved by listings, requests for quotations, bidding, advertising, and any number of related inter-enterprise activities. It should support the creation and evolution of a virtual enterprise, as a larger enterprise-level network on top of the individual person-level networks. This includes supporting all processes to go across the enterprise boundaries, whether choreographed or orchestrated (central or distributed process control). For example, a shared project should be visible in both enterprises. Such integration is a level above E-Commerce, called C-Commerce (or collaborative commerce). It can formally be defined as “collaborative, electronically enabled business interactions among an enterprise’s internal personnel, business partners and customers throughout a trading community” (Bond, Genovese, Miklovic, Wood, Zrimsek, & Rayner, 2000).

7.3.7 Revenue Model

As one of the biggest problems with ERP systems is their associated costs, there is the requirement of cost-efficiency. In order to make ERP accessible to SMEs, their ownership costs should decrease. This means that the revenue model of ERP 3.0 should be different from the current ERP vendors’ models. From all of the requirements listed in this thesis, there are several ways this price reduction could be achieved. First, as a pure SaaS, usage costs should not be fixed. There should be well defined and measured metrics that determine the month’s costs for each enterprise. Possible metrics could include the number of active users in the past month, current size of the data stored, amount of data transferred between users and SaaS servers, amount of CPU cycles used (increasing with frequency of running complex analyses and reports), used 3rd party functionalities, used 3rd party services, and so on. Depending on the actual use of the system, enterprises would get an objective and fair monthly bill. The larger the organization and the more the ERP is used, the higher will the bill be.

In order to further reduce the core ERP costs, a revenue sharing model with 3rd party functionality and service providers should be used. For example, Apple has a 30/70 revenue sharing model with their 3rd party application providers (30% going to Apple). Also, as a global SaaS, it could take advantage of targeted B2B advertising similar to Google Addwords or Facebook advertising. This can represent a significant source of revenue, allowing the ERP vendor to reduce the cost per metric, making it cheaper for SMEs to gain access.

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