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Rolf Dornberger *Editor*

Business Information Systems and Technology 4.0

New Trends in the Age of Digital Change

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Business Information Systems and Technology 4.0

New Trends in the Age of Digital Change

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Preface

It is said that we live in the digitalization age, or even in the age of digital change and digital transformation. What does this mean and where is it leading us?

These and further questions occupy our minds today—in our business and private lives as well as in our research. It starts with the word "digitalization", which, as often mentioned, originates from the word "digitization". However, whereas digitization outlines the process of transforming data and information from an analog format into its digital counterpart, digitalization describes how the worlds of business and society are changing due to the opportunities offered by digitization. The world itself, however, will not become digital: Not everything will be zero or one, black or white, head or tail; moreover, we are not heading for a binary future. Instead, we will have an increasing number of polymorphic solutions between zero and one, more grayscale and colorful solutions that will shape our future more intensively than ever before in human history.

This book has been written by a group of professors, lecturers, and researchers (including external colleagues) working in the field of Information Systems, Business Informatics, Computer Science, Business Administration, and Management at the School of Business of the University of Applied Sciences and Arts Northwestern Switzerland. As a university of applied sciences, our mission is to link academia and practical experience within our research and teaching activities. We focus our applied research and development on answering questions that arise from practice, and we transfer the research results to practical application. Thus, the style of the chapters of this book follows the philosophy of applied sciences by balancing the degree of profundity and rigor in our research with its translation into relevance in practice.

As the Institute for Information Systems is located at a business school, our original focus was on bridging the gap between business and IT, as well as aligning business and IT in the context of organizations. We have now broadened our focus to researching the impact of new IT-related technologies and IT-supported methods—including hot topics such as agile process management, artificial intelligence, robotics, management of complex systems, cybersecurity, machine ethics, digital

business transformation, etc. Furthermore, we are designing such smart systems, evaluating their interaction with humans and investigating their use in business and society.

This finally led to the idea of writing a book about our passion. We modestly named it "Business Information Systems and Technology 4.0—New Trends in the Age of Digital Change". In this book, we present the trends that we consider important in the age of digital change and their concrete use to boost the innovativeness and efficiency of organizations, discover new business opportunities, and, lastly, manage digital transformation in order to address the challenges within ever-changing business and societal environments. The first chapter is the key chapter, presenting our model of "Digitalization: Yesterday, today and tomorrow". It introduces the topics presented in this book and links them into one overarching theme.

Through the combination of application orientation and research depth, this book will be of interest and value to all who intend to leverage these trends to take their business beyond today's possibilities. As we contribute to the existing body of knowledge in the specific domains, this book will also be of interest and value to researchers. The future is not yet known, but it is waiting to be discovered by you, our readers.

As the editor of the book, I would like to express my gratitude to our employer, the University of Applied Sciences and Arts Northwestern Switzerland, and would particularly like to thank the School of Business for supporting the book by granting additional hours to the authors to write their chapters. Furthermore, my thanks go to all our authors, who made an excellent contribution to this work, providing insights into a variety of research fields, valuable research findings, and outstanding teaching content. Moreover, my special thanks go to Prof. Dr. Thomas Hanne and Prof. Dr. Uwe Leimstoll, who scientifically, thoroughly, and independently reviewed all the contributions, giving valuable, constructive feedback, and not hesitating to challenge us to make qualitative improvements to the content. Further, I would like to thank Vivienne Jia Zhong, who efficiently and competently coordinated the contributions of more than 30 authors, compiled in 18 chapters, and oversaw the progress of the book. My thanks also go to Christine Lorgé and Margaret Oertig, who carried out the proofreading of this book with diligence and commitment to language clarity. In addition, I would like to thank all our families for their enduring patience and great support.

Basel, Switzerland
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Prof. Dr. Rolf Dornberger

Contents

Digitalization: Yesterday, Today and Tomorrow

Rolf Dornberger, Terry Inglese, Safak Korkut and Vivienne Jia Zhong

Abstract The rapid development of digital technologies is making organizations rethink their business models and processes. This is resulting in a massive digital transformation of the economy and society. New trends are emerging at a fast pace and some of them might vanish soon. In order to investigate the opportunities and challenges behind these trends and make a sound prediction of their further development, it is necessary to understand the evolution of information and communication technology, which was and still is intended to provide support in the management of personal and business tasks. For this purpose, we present our model "Digitalization: Yesterday, today and tomorrow", which provides a brief summary of the development and rise of computational technology, resulting in changes in the interaction both of humans with computers and between humans and computers, and shows how individuals, business and the government have been adapting to these changes. We identified four streams of development: Early Information Systems, the E-Business Applications, the Web 2.0 Revolution and the renaissance of the Artificial Intelligence; a fifth stream remains unnamed, as we do not yet know where these fast-paced developments will lead us.

Keywords Digitalization · Information system · E-Business · Web 2.0
Artificial intelligence

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1 Introduction

The world is changing, probably faster today than ever before in human history. If we use a pattern to visualize this statement figuratively, the change might be described as follows: In early human imagination, the world was considered to be flat and assumed to be a kind of two-dimensional disk, where you can fall off its edge. Around 500 B.C., the Greek philosopher Aristotle spoke of the world as being a globe, the diameter of which Eratosthenes (approx. two centuries later) calculated very roughly and identified the earth as a three-dimensional shape without edges. However, it was not until 2,000 years later that Fernão de Magalhães was able to experimentally prove its globe shape by circumnavigating the earth at the beginning of the 16th century. Five hundred years later, in the course of globalization, Thomas Friedman declared that "The world is flat" (Friedman 2005), thus returning to the idea of an economically interconnected, but flat, two-dimensional world. Moreover, it is predicted today that "we live in exponential times" (Demirdjian 2015), suggesting that our world has shrunk to a one-dimensional exponential curve, where key issues are expanding at exponential speed and growth.

The pattern from a geographically 2D flat world via a 3D round globe back to an interconnected world economy and society (flat = 2D) ends up in an exponential 1D curve. Furthermore, the futurist Ray Kurzweil predicts that "the singularity is near" (Kurzweil 2005; Galeon and Reedy 2017) meaning that the point in time where machines are smarter than human beings thanks to advances in technology will soon be reached: Is the world shrinking to zero dimensions and vanishing?

We, my colleagues and I, are involved in teaching and research on such related topics, where digitalization aims to change the foundations, the mindset and the thinking about how people live and work—together and/or alone—in a world changing faster than ever before. New technologies, opportunities, business models and threats are emerging at a tremendous speed, only to vanish again as quickly as they appeared. To investigate this and to understand what is happening today and tomorrow, we have to understand the development of how information and communication technology (ICT), e.g. computers, software, the Internet etc., was intended to support the management of personal and business tasks.

To provide a common umbrella for the discussions in the following book chapters, we refer to our model "Digitalization: Yesterday, today and tomorrow" (see Fig. 1). This model provides a short summary of the development and rise of computational technology over the last decades, resulting in changes in the interaction both of humans with computers and between humans and computers, and shows how individuals, business and the government have been adapting to these changes. As depicted in Fig. 1, we identified that the literature about information systems generally proposes four streams of development: (early) Information Systems, E-Business Applications, Web 2.0 Revolution and (the renaissance of) Artificial Intelligence. Finally, but importantly, a fifth development stream is still written with a question mark, because we do not know where all this rapid development will lead us to and

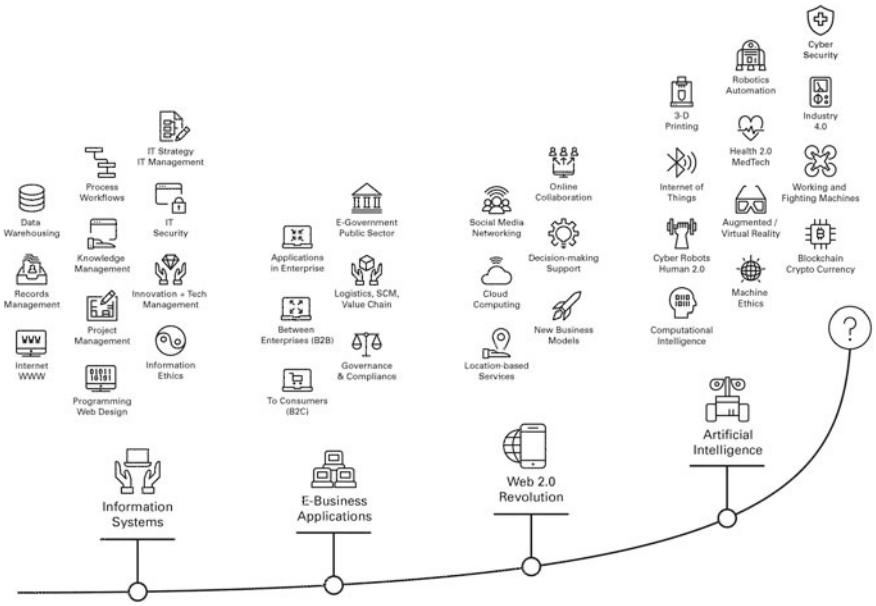

Fig. 1 Digitalization: Yesterday, today and tomorrow

what to call it. The question mark opens up new questions, which we—like everyone else—would love to answer as soon as possible.

In the following sections, we describe each of these streams. In particular, we elaborate the Artificial Intelligence stream in more detail, because the recent innovations we have been witnessing are heavily affected by it.

2 Information Systems

The first development stream is about the establishment of early information systems, which mainly affects corporate organizations. In the second half of the last century, computers were increasingly found to be useful in companies. An irony of history is that, in 1943, the former chairman and CEO of IBM, Thomas J. Watson, is claimed to have said that "there is a world market for maybe five computers" (Wikimedia Foundation, Inc. 2017). IBM went on to make a multi-billion dollar business out of it and now owns the most "intelligent" computer, called WATSON. Later on, in the 1970s, computers multiplied at the workplace, and with time were referred to as personal computers (PCs), thus indicating that everyone should have one. Computers attracted humans for private purposes, too, e.g. for writing letters and doing calculations, but mostly for gaming.

In the 1980s, computers were mainly used to enter, store, process and print data (data in the real sense of numbers and characters). Thanks to research in the field of information and knowledge management, we learned how to create and develop information and knowledge. The more computers there were on the market and at home, the more data were generated and processed and the more information and knowledge were piled up—theoretically. However, beforehand, data warehouses were needed to store all these data in databases, where, for example, records management is a small subtopic of a particular data handling issue in business. Process management was developed to manage the data flow effectively and to permit the sequencing of repetitive tasks using the data. A better understanding of workflow management ensures that the correct artefacts are found and processes are automatized.

Improvements to hardware and software, but also in project management, programming, the connection of computers to the Internet and to the World Wide Web (WWW), and the design of user interfaces brought us a new form of information systems, starting in the early 1990s. Furthermore, to integrate these powerful information systems into the context of work, companies needed a well-elaborated information technology (IT) strategy and strong IT management: IT became strategic. In order to bring in new ideas and technologies, innovation and technology management also became important. In parallel, IT security started to become a major issue to protect data and information—and to protect users and unaware, uninvolved people. Overall, information ethics was developed to assure the ethical use of information systems and the underlying technologies, data and processes.

3 E-Business Applications

Starting in the late 1990s, the business sector and the government developed their own usage of information systems. The concept of E-business emerged and attention was drawn to the development of IT applications that supported this concept. Companies then started developing business software such as enterprise resource planning systems and other enterprise applications, for the purpose of working more smoothly together, either internally within the organization, or interconnected with other enterprises (known as B2B, business-to-business), or with consumers (known as B2C, business-to-consumer). The intention was to promote the collaboration of enterprises with suppliers, customers and other organizations by managing and streamlining the data flow via electronically-supported processes. The idea was—to give an example—to extend classical logistics to supply chain management (SCM) and, even further, to overall value chain management.

In addition, governments from state level down to community level identified the potentialities of the IT, especially for providing citizens with a platform for all sorts of civic engagement, such as elections, electronic tax declaration systems and other types of civic participation. This became known as e-government.

In order to handle all these developments, the discipline of governance and compliance began its ascent, upgrading the legal issues and the so-called information ethics concept to standards of good and sensible conduct.

4 The Web 2.0 Revolution

In the early years of the 2000s, two new game-players made their appearance: the smartphone (first the iPhone in 2007 (The Telegraph 2017)) and social media (Kaplan and Haenlein 2010).

With the advent of smartphones came a major change in the instant availability of computing devices: It was now possible to carry our computers and our access to the Internet in our pockets; our computers were no longer sitting on our desks or stored in our bags. This change made new business models possible by applying new mobile commerce scenarios, such as mobile banking, online shopping, speed dating and so on. The scaling up of the business model to millions of users has led us to refer to platform capitalism (Lobo 2014), where globally accepted information ethics principles are urgently needed. Furthermore, constant access to the Internet provides organizations with the possibility to track our location to offer location-based services.

Moreover, with the Web 2.0, we are now not only consuming what is offered through the Internet; we are also simultaneously offering information to the Internet through a sort of non-negotiated and spontaneous online collaboration between all kinds of combinations of individuals, companies and organizations.

To facilitate collaboration, cloud computing was established as a solution. We neither need to concern ourselves with the physical storage of our data nor with the hosting of software required for running a business. Whatever we need, we can access it immediately from the Internet. We also do not need to bother about software updates. For instance, our mobile device is continuously being improved and enhanced in the background, and thus provides decision-making support for all kinds of situations (e.g. shopping suggestions, dining recommendations and leisure tips).

Social media provides the ultimate convergence of all types of networking, communication and collaboration in the digital scenarios already highlighted. Online users are becoming the producers and consumers of new types of content. Whether we want it or not, they are provoking new, rapid, social and societal transformations, through the interconnectedness of online networks.

5 Artificial Intelligence—The Renaissance of AI

Research in Artificial Intelligence (AI) already started in the second half of the last century, but led to disillusionment in the 1990s, because the theory predicted more

than computational power was able to prove. In the meantime, computational power is constantly increasing—still bravely following Moore's law (Denning and Lewis 2016)—speeding up algorithms and entire computer applications at an unknown pace. Thus, data can be quickly transferred, algorithms requiring immense computational power can be widely applied, information and knowledge can be quickly processed (mined) from any kind of data, and machines are starting to learn. This is the renaissance of AI! Below we comment on the meaningful developments within this stream.

Within this epoch, an important key concept is the Internet of Things (IoT), where everything is connected with everything. Every device, which needs electronic power will be linked to the Internet and—theoretically—the Internet will "know" about every device in the world connected to it. Moreover, people are connected too with their mobile devices. Consequently, the IoT is becoming the driving force for sensing data and information of all kinds, because more and more machines are being equipped with a vast number of sensors. They report all sorts of data to the Internet, e.g. acceleration, rotation, location, Wi-Fi connectivity, noise as well as spoken words, light intensity as well as camera pictures, and temperatures as well as sweat levels. For example, Industry 4.0 has the vision to connect all production machinery to the Internet (Federal Ministry of Education and Research n.d.). New value-added services, for instance, predictive maintenance, are just at the beginning. However, the constant connection of everything to the Internet is prone to cyber-attacks. Consequently, cyber security technologies play a more important role in sustaining business today than ever before.

Another important game changer has come on the scene, extending the possibilities of IoT and Industry 4.0 to robotics automation. In the past, computing machines were mainly stationary or, in the best case, carried around in our pockets like our smartphones. However, with the rise of mobile robots, they are now able to approach us—whether we want this or not. This phenomenon is known as the rise of the autonomous (Tan and Ng 2017; LaPlante 2017), where machines now approach humans—instead of the other way about. For example, self-driving cars identify their passengers on the pavement and pick them up (Hawkins 2017), pizza delivery drones bring food directly to the fifteenth floor of a skyscraper, knocking on the kitchen window (Reid 2016), police robots serve justice (Cellan-Jones 2017), and healthcare robots reassure us that they will take care of everything (Robinson et al. 2014). However, we do not have to worry at all. Such working machines are still our utopia, although turning working machines into fighting machines is our dystopia.

Another remarkable technology, 3D printing is emerging, with the potential to change the entire supply chain, because it opens up new possibilities for production by reshaping the distribution processes of goods. Within 3D printing scenarios, logistics processes are becoming local, because we are able to produce and print products instantly and locally, on the spot, where we want to receive them, for example, a nice T-shirt just after we get up, a delicious hamburger for lunch, a new leg after a severe car accident, etc.

Within a Health 2.0 scenario, we might use Medtech to print an artificial heart after a heart attack (Cohrs et al. 2017). Furthermore, a printed body part may lead

to human augmentation (Mann et al. 2016), offering the opportunity of using, for example, a third arm while doing all sorts of errands (e.g. two arms hold the heavy parcel, and the hand on the third arm rings the doorbell). Alternatively, we may print or actually breed our cyber robots. Are they already Human 2.0? Alternatively, are we the "Humans 2.0" and they go even beyond that?

Everything (and everyone) is becoming "cyber". The differences between the real and virtual world are diminishing: Augmented reality is enhancing our visual perception of the world by projecting fictive things in our field of vision. Virtual reality allows us to completely immerse ourselves into a virtual world. The role of cash as a payment method is decreasing, not even a credit card is hip anymore. The new trend is cryptocurrencies (Swan 2015; Luther 2016), where neither governmental institutions nor banks guarantee their value anymore, instead a new kind of trust information is stored in so-called blockchains (Swan 2015), decentralized somewhere in the Internet cloud.

Computing machines are becoming increasingly intelligent. This artificial machine intelligence is probably still different to human intelligence—however we define intelligence. Nevertheless, according to Nick Bostrom, machine intelligence is so powerful that it will outperform the human intelligence of all human brains already within this century (Bostrom 2014). Bostrom calls this effect superintelligence. The underlying methods and algorithms belong to artificial intelligence, perhaps to the field of computational intelligence, which uses nature-inspired methods to solve complex real-world problems (Hanne and Dornberger 2017).

We now return to the question mark in Fig. 1. We are equipping machines with an increasing number of AI methods and are still raising computational power, letting them connect via the IoT, granting them autonomous mobility, and thus making them more intelligent than us. What consequences superintelligence will have is completely unknown to us. As humans, we are good at creativity, empathy, designing, composing music and so on. We do not know when computers will achieve this kind of intelligence, but, based on Nick Bostrom, Ray Kurzweil and other thought leaders, we are quite sure that they will achieve superintelligence within the next few decades (Bostrom 2014; Kurzweil 2005; Galeon and Reedy 2017). What will happen then? We should definitely try to introduce machine ethics to computers and robots. However, will this work and will it be enough? The following example illustrates this concern: On August 21st, 2017, 113 leaders and CEOs of companies in robotics and informatics from all over the world presented a jointly signed letter to the United Nation commission to ask for the immediate regulation of "certain conventional weapons" without any kind of doubt about the potential threats in repurposing artificial intelligence and robotics from a societal benefit towards a third revolution in warfare. "*Once this Pandora's box is opened, it will be hard to close. We therefore implore the High Contracting Parties to find a way to protect us all from these dangers*" (University of New South Wales 2017; Future of Life Institute 2017). It seems that the request of these leaders and CEOs to the UNO commission should be discussed collectively and it should be addressed to all of us, where we can be part of a collective decision, which rewards "common sense" and respect for all sorts of creatures, humans as well as nonhumans.

The question mark at the end of the exponential curve of our model "Digitalization: Yesterday, today and tomorrow" (in Fig. 1) is perhaps an appropriate answer to the question about "tomorrow". We have it in our hands, today, to shape our "tomorrow" collectively and responsibly.

6 Organization of this Book

This book, named "Business Information Systems and Technology 4.0—New Trends in the Age of Digital Change", reflects on information systems, new technologies (which we summarize under the umbrella term Technology 4.0 in imitation of the term Industry 4.0) and on how digitalization is bringing about a change in business and society. The chapters are organized according to four meta-topics based on the sequence of Fig. 1 "Digitalization: Yesterday, today and tomorrow":

(a) Information Systems
(b) E-Business Applications
(c) Web 2.0 Revolution (and preliminary ending with)
(d) Artificial Intelligence.

Overall, the chapters address research topics such as digital transformation management, e-business, knowledge representation, the impact of digitalization on higher education, human computer interaction and computational intelligence. Finally, the book chapters are organized as follows:

(a) Information Systems

- "ERP Systems towards Digital Transformation": The new role of enterprise resource planning systems as a consequent extension of information systems.
- "Determining Information Relevance based on Personalization Techniques to Meet Specific User Needs": New solutions for information and knowledge management.
- "Case-based Reasoning for Process Experience": A new approach to integrated case-based reasoning for learning and experience management processes.
- "Road to Agile Requirements Engineering: Lessons Learned from a Web App Project": An explanation and best practices from agile requirements engineering embedded in project management.

(b) E-Business Applications

- "E-Business in the Era of Digital Transformation": The development of e-business over the years and its continuing great importance for understanding digitalization.
- "Digitalizing B2B Business Processes—The Learnings From E-Invoicing": Best practices of digitalizing complex business-to-business (B2B) processes based on the example of e-invoicing.

- "Marketing Automation: A Project Framework in Support of Digital Transformation": An overview of possibilities in marketing automation ranging from strategic considerations, customer journey analysis to use cases along with data management, content marketing and channel management.

(c) Web 2.0 Revolution

- "FHNW Maturity Models for Cloud and Enterprise IT": A new model to assess the digitalization readiness of enterprises and proposing the consequent next steps.
- "Digital Transformation Management and Digital Business Development": A new management concept for companies adapting their business to ongoing digital transformation.
- "Using Feedback Systems Thinking to Explore Theories of Digital Business for Medtech Companies": Supporting decision-making by applying feedback systems thinking to the example of Medtech companies.
- "Ontology-Based Metamodeling": A new method for decision making based on the same internal knowledge representation for humans and machines.

(d) Artificial Intelligence

- "Searching and Browsing in Historical Documents—State of the Art and Novel Approaches for Template-Based Keyword Spotting": Different state-of-the-art and novel approaches for keyword spotting (online, offline, without any a priori learning of a model, etc.) for the digitalization of handwritten documents.
- "How to Teach Blockchain in a Business School": The content and the preparation of teaching curricula related to the importance-gaining topic of blockchain.
- "Computational Intelligence in Modelling, Simulation, Optimization, and Control": Computational intelligence comprising nature-inspired AI methods with a focus on modelling, simulation and optimization in logistics and robotics.
- "Innovation Potential for Human Computer Interaction Domains in the Digital Enterprise": Innovative application scenarios of human computer interaction applying touch screen and natural language processing.
- "Prototype-Based Research on Immersive Virtual Reality and on Self-Replicating Robots": Summary and discussion of research topics in the field of virtual reality and self-replicating robots using gadgets and prototype-based research.
- "Co-Robots from an Ethical Perspective": Information and technology ethics, machine ethics and business ethics in the field of cooperation and collaboration robots.

Overall, the book offers a broad variety of topics on emerging trends in the age of digital change and illustrates concrete use cases for organizations to sustain their business in an ever-changing environment. We hope you will find our contributions inspiring.

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Part I
Information Systems

ERP Systems Towards Digital Transformation

Petra Maria Asprion, Bettina Schneider and Frank Grimberg

Abstract Enterprise Resource Planning (ERP) systems employ highly integrated business software solutions that have existed for many years. Being the base of the IT application landscape of most enterprises, ERP systems remain fairly commoditized and scarcely leave room for differentiation. In view of the major digital transformations currently taking place, the role of ERP systems needs to be reconsidered. Geoffrey Moore's concept of "Systems of Engagement" stresses the need for enterprise applications to become more user-oriented in order to support collaboration and to empower employees. Based on this understanding, we developed a model that classifies how ERP systems can evolve depending on its people-centricity focus and its level of integration.

Keywords ERP systems · Systems of engagement · Digital transformation

1 Introduction

The introductory section discusses the evolution of digital transformation and potential implications for ERP systems. It outlines the relevance, purpose and objectives of the study as well as the methodology applied.

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1.1 Digital Transformation and ERP Systems

The digital transformation of the economy and society can be seen as a revolution—with a similarly great impact as the Industrial Revolution of the nineteenth century. Originating in the 1960s with the introduction of the first computers, countless efforts were initiated to automate processes in nearly every industry, allowing for a further, accelerating step with the nascent internet and in particular the World Wide Web in the 1990s (Chalons and Dufft 2016). In short, digital transformation has been present ever since the 1960s and is very closely related to continuous technological innovations over time.

In the 1960s, with the release of mainframes, the management of huge amounts of data and automated calculations were made possible. In subsequent years, many other innovations such as client-server computing in the 1980s and ERP systems in the 1990s allowed for new productivity gains and significant transformations in the way enterprises and their employees work (Monk and Wagner 2013, p. 20 ff.).

During the 1990s and 2000s, the Third Industrial Revolution along with the dynamics of globalization transformed business and technology, manifesting itself via, for example, fully automated processes and web-based solutions (Lemke and Brenner 2015, p. 3 f.). During that period, the use of ERP systems expanded as evidenced by the rise of ERP vendors such as SAP, Oracle, JD Edwards, and others that permitted enterprises to automate and integrate complex processes (Mabert et al. 2001, p. 70; Kurbel 2013, p. 2). Since the beginning of the internet and other technical innovations, digitalization has no longer been limited to internal operations, but permits permanent and easy access through all supply chains and from all places with internet access (Venkatesh et al. 2012).

However, despite their incredible successes, it seems that ERP systems themselves are now in the age of digital transformation (as we will elaborate in Sect. 2.1) and that after a lifespan of more than 40 years, ERP systems have reached the end of their lifecycle. According to a study by Panorama Consulting (2016), there have been many indicators which have foreshadowed the "death" of ERP systems over the last decade. For example, current ERP software is available to enterprises of all sizes and industries with a wide variety of viable solutions. In respect of the operations, enterprises can decide between a multitude of options, e.g. web-based, cloud-based, on premise, mobile apps and a host of others (Bahssas et al. 2015). Nowadays, ERP systems are mature products that are vital for the companies' survival, but they offer hardly any opportunity to achieve competitive differentiation based on their use (Seddon 2005; Fosser et al. 2008; Moore 2011, p. 3).

Beyond this, ERP systems have a rather bad reputation. For example, despite their potential, many ERP implementations have failed or have not achieved the expected functionalities (Schwenk 2014, p. 42; Finger 2012, p. 7). Another issue is strong competitive pressure, leading to risk-averse enterprises with less tolerance for expensive and time-consuming ERP implementations (Stefanou 2014, p. 157).

For enterprises that want to lead their existing ERP system into the new digital age, it is recommended to define a smart strategic roadmap which considers (new)

technology and concentrates on people and processes (Panorama Consulting 2016). In particular, the focus on people, and especially the user, seems attractive. Based on their original purpose, ERP systems strongly optimize data and processes, whereas soft-factors like user-experience and user-engagement have not been developed with the same intensity. Therefore, we raise this topic as our focus of interest in this study.

We assume that enterprises will generally need to decide about their future ERP landscape sooner rather than later. The management should answer the question: "do we only aim for (simple) ERP implementation/consolidation, or is it/should it be a part of a digital transformation initiative?" In the first case, the consequence is to automate the status quo; in the latter, the decision is to aspire to innovative disruptive technologies, implying potential changes to the current business model or even adding a new business model (Laudon and Laudon 2016, p. 119).

1.2 Purpose and Objectives

The purpose of this study is to accumulate knowledge for practical application but also for the academic discipline of information systems (IS). Specifically, the objectives of this study are to (1) point out the relation between digital transformation and enterprises' ERP systems, (2) stress the future role of collaboration using Moore's concept of Systems of Engagement, (3) enhance the existing theory focused on ERP transformation, and (4) guide future research by developing recommendations and putting forward a research agenda.

This study argues that enterprises using or planning to implement/consolidate an ERP system need to decide about the future role of (their) ERP system(s). More precisely, enterprises have to define whether they wish to realize a (simple) ERP implementation/consolidation, or a digital transformation. A certain focus in this respect is on collaboration and people, in particular on the new generation of so-called digital natives, who tend to bring different expectations to their work environment and the way they work (Prensky 2001a, b; Roberts 2005; Koutropoulos 2011; Moore 2011, p. 2).

1.3 Methodology

In analyzing our focus of interest, we use as primary method the recommendations of Tranfield et al. (2003) as well as Benbasat and Zmud (1999) to conduct systematic literature reviews. In general, the literature search aims to identify the sources focused on the research topic, and in addition, seeks to prove the relevance and rigor of the research (vom Brocke et al. 2009). Relevance is achieved by ensuring that already known aspects of the research are not investigated twice (Baker 2000).

In order to contribute to the discussions around the role of ERP systems in the digital age, we set a clear focus on the potential of collaborative aspects. For this

reason, we base our study on the well-established concept of Systems of Engagement as described by Geoffrey Moore. This concept is referenced by both practitioners such as Forbes (Orosco 2015) or Hewlett Packard (Barkol et al. 2012) and academia, e.g. for a new IT consumerization theory (Niehaves et al. 2013; Köffer et al. 2014). We discuss selected aspects of Moore's concept to show the adaptability and relevance of his model in different business contexts (Sect. 2.3).

As a foundation, the Systems of Engagement concept will be used to design a straightforward model intended to support decision makers on ERP initiatives. We use a design science related approach. The approach supports our research objectives outlined above, with Hevner et al. (2004) providing seven guidelines for design science in IS, directing the research activities, especially regarding guideline 5 which addresses "research rigor".

Regarding our main method, we conducted a literature review with a search in the Web of Science (all journals) and in Google Scholar (top journals). Then, we enriched the matches from scientific literature by adapting practical knowledge from practitioner-oriented sources, for example the publications of Moore (2011, 2014). The search queries designed to select papers related to the topics "ERP systems", "ERP", "digital transformation", "digitalization", "digital business", "business age", "disruptive technologies" and "business technology".

The remainder of the paper is structured as follows. In the next section, we present a short explanation of the key concepts starting with disruptive technologies. Further, Moore's approach regarding Systems of Engagement and selected applications are introduced. In Sect. 3, the designed "ERP transformation model" is elaborated and in Sect. 4, we present a conclusion and an outlook of further research planned.

2 Key Concepts

In this section, the Systems of Engagement concept is described and aligned with ERP related perspectives. Based on exemplary cases the concept's broad field of potential applications is shown.

2.1 Disruptive Technologies

A wide discussion about the next disruptive industrial revolution started in recent years (Bauernhansl et al. 2014, V). In the German-speaking countries, the expression "Industry 4.0" (I4.0) emerged, following an initiative by the German government. High-income countries in particular need to exploit technological innovations in order to keep up with the competition and manage to stay ahead of the market. In order to achieve this goal, "cyber-physical systems" are required to merge the digital and the physical world (Sontow and Schürmeyer 2014, p. 19 f.). Related in this

respect are the drivers of the Fourth Industrial Revolution, e.g. Internet of Things (IoT), big data or augmented reality (Kaufmann 2015, p. 5).

Many publications related to I4.0 start their journey with an evaluation of technological advances followed by a future prospective on how I4.0 will change the world of business. For example, Kaufmann (2015) sets the focus on how IoT affects existing or new business models. Sendler (2013) describes intelligent, connected systems, which are difficult to integrate and challenging for many industries and their products. Andelfinger and Hänisch (2017) discuss how cyber-physical systems will influence working environments. Botthof and Hartmann (2015) evaluate the future role of labor in a digitalized world.

With many more examples available, there is no doubt that technology and the new opportunities around digitalization will change the business world enormously. In addition, digital natives are entering the job market with different mindsets and expectations, not least regarding how they want to learn and work (Roberts 2005; Koutropoulos 2011). Enterprises that aim to attract this generation as customers and employees need to investigate the appropriate composition of their future enterprise IT setup (Moore 2011, p. 2). Thus, in the future, both technology and people have to be considered in an integrative way.

Moore analyzed digital disruptive technologies and their impact on executives and business life and published the results in a widely-known publication called "Crossing the Chasm" (Moore 1991, revised 1999 and 2014), which has sold over one million copies. "Crossing the Chasm" became a metaphor applied to enterprises with complex products to explain their struggle in the transition from early adopters to mainstream markets.

Moore used and expanded the diffusion of innovation (DOI) theory introduced by Rogers (2005) and revealed a chasm between the early adopters of a product (the technology enthusiasts and visionaries) and the early majority (the pragmatists). Moore showed that visionaries and pragmatists have very different expectations, which he characterizes as a "chasm" which needs to be crossed. His model and the suggested techniques to cross the chasm have had a significant and lasting impact on product launches until now (Schwabel 2013). "Crossing the Chasm" is closely related to the "technology adoption lifecycle" model (Beal and Bohlen 1957). The model consists of five main segments, which are recognized as (1) innovators, (2) early adopters, (3) early majority, (4) late majority and (5) laggards. Moore's theories applicable for disruptive innovations align with digital transformation approaches which assume emerging opportunities, but also rapidly changing conditions such as the increasing power of the consumers (Lemke and Brenner 2015, p. 197 f.). At the latest, when the replacement of an outdated ERP system is pending, the enterprises' decision makers are confronted with Moore's chasm: They need to decide between implementing a more modern version of a classical ERP system or coping with the new approaches related to digital transformation.

2.2 Systems of Engagement

Closely related to the "crossing the chasm" model is Moore's concept of Systems of Engagement (SoE), a class of communication-focused and collaboration-focused systems, which are an essential component of a new people-centric era (Moore 2011, 3). In prior decades, IT innovations usually emerged within large enterprises or public institutes and then made their way to medium and small enterprises until they finally reached the consumer markets. This sequence has turned around: Today, children and students lead innovations, followed by adults as well as small and medium-sized enterprises (e.g. Prensky 2001a, b; Roberts 2005; Koutropoulos 2011). Eventually, large enterprises adopt the new IT trends and innovations (Moore 2011, p. 2).

Moore postulates the "consumerization of IT" as a highly relevant factor in today's business. Two significant aspects appear. The first aspect relates to societal changes. The upcoming generation, the digital natives, are the future employees and customers. They are used to communicating and collaborating via mobile devices and to actively taking part in the Web 2.0. Related to their working life, they aim for self-realization and they expect easy-to-use tools, receiving information right at the time they need it (Lemke and Brenner 2015, p. 76).

The second aspect relates to potential productivity gains. The consumerization of IT can serve as the next significant driver for business growth and prosperity. In the past, powerful IS with comprehensive data repositories enabled enormous economic expansion (Ganesh et al. 2014, p. 6 f.). ERP systems, with inherent exhaustive data repositories, are one of the most prominent examples of these innovations. Therefore, and according to Moore (2011, p. 3), ERP systems can be referred to as "Systems of Records" (SoR) that paved the way for the automation of processes and outsourcing and led to operating efficiency and tremendous cost savings.

In the last decade, SoRs have more or less turned into a commodity, requiring enterprises to concentrate their resources on particular core competences in order to differentiate and sharpen their strengths. Further, products or services are no longer a result of one enterprise's activities as there is a network of partners that operates as one unit—a "boundless enterprise" (Picot et al. 2009 cited in Lemke and Brenner 2015, p. 217).

In the (imminent) digital age, collaboration between employees, divisions, suppliers and other internal and external parties is regarded as a key success factor to achieve the next wave of productivity gains. By utilizing SoE, employees will be enabled to deliver the required conversion in view of the new ways of collaboration. With their strong focus on social interactions, the younger generation supports the sharing of ideas and is used to working with and through social media. Therefore, future employees will have the potential to elevate collaboration to a higher level. Significant breakthroughs will take place by applying collaboration tools, which promise easy and user-friendly access and use. The facilitation of the new way of working requires the support of various technical formats such as texts, images, audio and video (Moore 2011, p. 5). Nevertheless, it is crucial to understand that, according

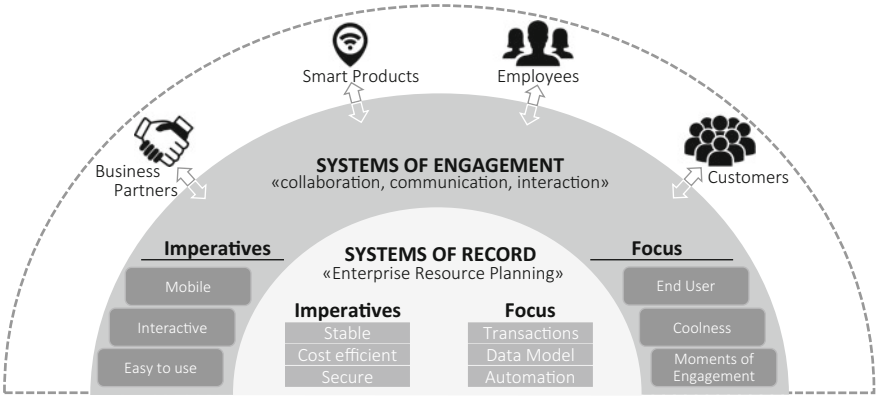

Fig. 1 Systems of engagement meets systems of records. (adopted from Corcoran 2013, p. 12; Matzke 2012; Lemke and Brenner 2015, p. 183)

to Moore, the "old" IS/ERP systems—the SoR—will not disappear. As such, SoE will enhance the existing enterprise IT landscape (Moore 2011, p. 6).

Figure 1 visualizes the relationship of both categories. The inner circle builds the SoR. This serves as the application backbone that automates essential business processes. SoR are required to run in a stable manner, to be cost effective and ensure high-level security and are built on a highly structured data model to support regular transactions. The SoE build a new layer, which is dedicated to interaction with users or smart services/products. SoE are designed to enable collaboration and focus on "Moments of Truth", the essential points during interactions. Hence, these systems have to be user-centric, focusing on mobile access and ease of use (Corcoran 2013, 12; Lemke and Brenner 2015, p. 183).

Enterprises that intend to incorporate SoE into their existing application landscape need to consider two things. First, more effort needs to be directed towards IT-enabled collaboration and people-centricity. Secondly, it is important to decide how SoE will be aligned with already existing SoR. The possibilities range from clear separation to full integration. We pick up both aspects in our model in Sect. 3.

2.3 Selective Applications

Moore (2011) discusses the concept of SoE using two perspectives. First, he makes recommendations for CIOs in B2B-oriented enterprises. The "Moments of Truth" appear in tasks such as holding meetings across different time zones as well as file sharing and recordings or solving complex business issues collaboratively. Suitable collaboration tools are mainly "Web 2.0 family" related, e.g. blogs or wikis, utilizing and combining the wisdom of experts and the crowd (Moore 2011, p. 7). Secondly, Moore turns to the CIOs working in B2C-oriented enterprises. In the past, con-

sumers fulfilled their demands by actively searching for desired products/services in the World Wide Web. In the near future, B2C-enterprises will need to foresee the (potential) requirements of their customers and provide accurate and tailored information in the right place and at the right time. Powerful algorithms that enable predictive analytics help to achieve this. Further, it is recommended that SoE is integrated with the well-known SoR to support customer contact throughout several channels (Moore 2011, p. 8 f.).

While Moore deals with SoE in a generic context of B2B and B2C, the concept has been applied in other situations. There are many cases in the literature in which the SoE model is adapted in certain industries with different technical approaches (e.g. Dey et al. 2014; Book et al. 2017). In the following, we discuss some selected examples.

Example 1: In the banking sector it is extremely important to guarantee confidence, security and regulatory compliance (Corcoran 2013, p. 4). However, banks may be forced to respond to changed customer behavior and demands (Corcoran 2013, p. 9). The study suggests that banks should reshape their application architecture, including the separation of IT systems into SoR (which is aligned to internal business processes) and SoE (which takes care of customer interactions). The latter focuses on customer expectations and is therefore designed from an "outside-in" perspective (Corcoran 2013, p. 14 f.). As SoE need to be agile and easy to use, the study raises the point that integration with SoR has to be considered carefully. In cases where customer interaction does not depend on real-time exchange with SoR, it is valid to keep the systems separated. In this way, risks resulting from frequent SoR-interface changes are avoided (Corcoran 2013, p. 22).

Example 2: The adoption of SoE in the context of I4.0 is described by Wehle and Dietel (2015, p. 211 f.). They show the application of SoE focused on production processes and the optimization of maintenance activities. The challenges of integrating components like SoR, shop floor machines, sensors and mobile devices are investigated, and as a solution, a cloud-based architecture is designed. One core element is a network of connected sensors measuring variables such as air humidity or temperature. The sensors are part of the SoE, receiving real-time data about the physical environments and transfer it via cloud services to the existing SoR. The SoR is relating the sensor data to the information stored for a specific work unit (e.g. capacity, maintenance schedule). A correlation of sensor and SoR data helps to evaluate how the air quality affects the quality of the produced product.

Example 3: Li et al. (2014) use Moore's concept to investigate software-defined environments. The result is a framework that visualizes the potential evolution and consolidation of SoE and SoR (see Fig. 2). The model consists of two axes. The Y-axis shows that a certain class of software systems relies on agility and therefore needs continuous updates. The platforms used for these systems have to be scalable and adaptive. Agility is the main requirement on this axis. The X-axis points out that some software products are heavily dependent on an efficient technological platform. They have to run in a stable manner while guaranteeing high performance and strong compliance-related controls, such as ERP systems. Efficiency is the main factor on this axis.