Progress in IS

Klaus North
Ronald Maier
Oliver Haas *Editors*

Knowledge Management in Digital Change

New Findings and Practical Cases

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ISSN 2196-8705 ISSN 2196-8713 (electronic)
Progress in IS
ISBN 978-3-319-73545-0 ISBN 978-3-319-73546-7 (eBook)
https://doi.org/10.1007/978-3-319-73546-7

Library of Congress Control Number: 2017963289

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Digital is all about flows; the information flows, knowledge flows and minds flow.[1]

The disruptive power of digital change is a major challenge for knowledge-based value creation worldwide. The transformation toward a digitized economy and society deeply changes how we manage information and knowledge, how we connect, collaborate, learn, and decide within and across organizations. While digitalization offers new opportunities for disruptive renewal, knowledge workers, managers, and organizations will have to recreate their governance, leadership, innovation, knowledge, and learning processes and practices as well as their work organization. New business models and digitally enabled co-creation emerge, requiring new ways of managing knowledge. The “Knowledge ladder 4.0” is the guiding conceptual model of this publication.

Given the complexity of digital transformation at different levels, this book will not cover all aspects related to the subject. In particular, legal and governance issues are not covered by the contributions.

This book focusses on digitally enabled knowledge-intensive value creation. We offer cutting-edge contributions including case studies from practitioners and academics working on managing knowledge in transformational contexts, divided into the following four sections:

(1) Digital enrichment of resources to leverage human performance,
(2) Collaboration and networking,
(3) Leading and learning and, finally,
(4) New forms of digitally enabled knowledge-intensive value creation.

A glossary of key terms enriches the book.

This publication provides guidance to academics, managers, consultants, trainers, coaches, and those interested to learn about transforming organizations in a knowledge economy 4.0.

[1] http://futureofcio.blogspot.de/2014/11/knowledge-management-best-quotes.html.

Our thanks go to the contributors who furthered our insights into the topic and to Christian Rauscher; Executive Editor at Springer for actively supporting the book project.

We thank in particular Christopher Drodge for language editing and proof-reading of the book chapters and Christina Sarigianni for merging individual contributions into one consistent book format as well as compiling the glossary.

We wish inspiring reading and look forward to feedback.

Wiesbaden, Germany — Klaus North
Innsbruck, Austria — Ronald Maier
Bonn, Germany — Oliver Haas
Spring 2018

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Value Creation in the Digitally Enabled Knowledge Economy

Klaus North, Ronald Maier and Oliver Haas

Abstract This chapter discusses the critical question of how to manage knowledge for value creation in digitally enabled economies. We introduce the concept of "Knowledge 4.0" to set the developments of how companies and organisations use digital technologies for knowledge creation and sharing into a historic perspective. We explain the chain of activities that create value in the digitally enabled knowledge economy following the model of the "knowledge ladder 4.0". The model helps to relate enabling technologies to changes and new forms of managing knowledge and knowledge work. In addition, this introductory chapter summarises the key findings of the contributions presented in the subsequent chapters that we group into the four topic areas: (1) digital enrichment of resources to leverage human performance, (2) collaboration and networking, (3) leading and learning and, finally, (4) new forms of digitally enabled knowledge intensive value creation.

1 Towards Digitised Knowledge Societies

The move towards an increasingly digital world is rapidly changing the ways in which people and organisations create, use & share data, information and knowledge. A common definition of 'digital transformation' is the one coined by

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K. North et al. (eds.), *Knowledge Management in Digital Change*, Progress in IS,
https://doi.org/10.1007/978-3-319-73546-7_1

Bounfour (2016), namely 'the change associated with the application of digital technology in all aspects of human society'. The corresponding digitisation of previously analogue operations, tasks and managerial processes profoundly impacts companies and organisations (Iansiti and Lakhani 2014).

We are witnessing a development towards digitised knowledge societies on a global scale. What does this mean? Knowledge societies are dominated by professional experts and their scientific methods. Knowledge economies are marked by the expansion of knowledge-producing or knowledge-disseminating occupations (Burke 2000; see also Adolf and Stehr 2017). "Knowledge 4.0" refers to a societal stage where applications of digital technologies are pervasive in everyday life, leading to a "digital ubiquity" (Iansiti and Lakhani 2014), and also contribute a significant share to value creation. Researchers find that smart, connected products with their four capabilities of monitoring, control, optimisation and autonomy transform competition in the digitally-enabled knowledge economy (Porter and Heppelmann 2014). Thus, professional expertise is increasingly leveraged or "augmented" Davenport and Kirby (2016) by cognitive and networked systems. For example, McKinsey forecasts a potential economic impact of five to seven trillion US$ through the automation of knowledge work by 2025 (Manyika et al. 2013).

Figure 1 shows this development in a historic perspective (cf. Van Doren 1991; Burke 2000) starting with the *"Age of Reason" (Knowledge 1.0)*. Even though in ancient times there have been schools of philosophers reflecting about knowledge, at least in Europe, the sixteenth century is considered as the start of a systematic scientific exploration of nature and the development of a more widely accepted scientific method. From about 1700 it became possible to pursue an intellectual career not only as a teacher or writer but also as a salaried member of certain organisations dedicated to the accumulation of knowledge, notably the academies of science (Van Doren 1991, p. 27).

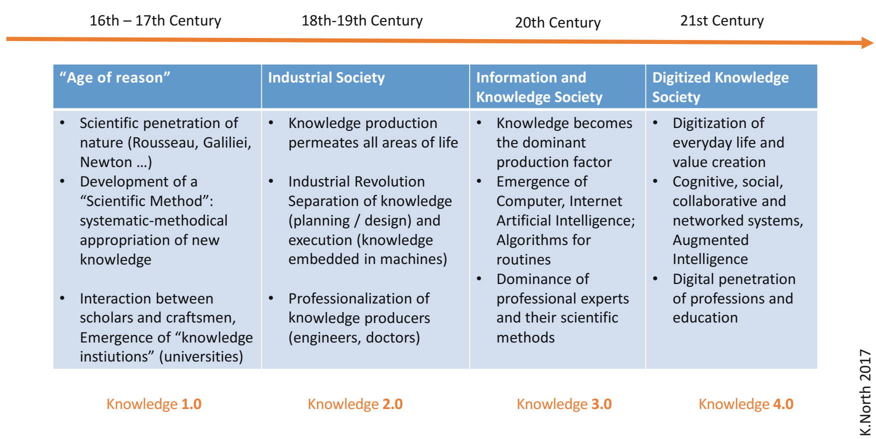

Fig. 1 Phases of knowledge production and dissemination

The insights gained in the “Age of Reason” enabled the development of an *“Industrial Society” (Knowledge 2.0)* in the eighteenth century. Knowledge was increasingly embedded in machines and production systems. Knowledge creation had been professionalised.

The twentieth century witnessed the upcoming of an *“Information and Knowledge Society” (Knowledge 3.0)*. Information and knowledge became dominant production factors. From an organisational perspective, researchers saw the way knowledge is handled as a source for competitive advantage advocated by the resource-based view (Grant 1991) and the knowledge-based theory of the firm (Kogut and Zander 1992; Spender 1996). Organisations address the need for constant communication and acquisition of knowledge dispersed among employees (Hayek 1945) by applying organisational and IT mechanisms to establish an environment supportive of knowledge work (Davis 2002), also called knowledge management systems (Alavi and Leidner 2001; Maier 2007; North and Kumta 2018). Professional expertise and scientific methods are pervasive in this “Knowledge 3.0” stage.

In the “*digitised knowledge society” (Knowledge 4.0)*, digital transformation strategies take on a different perspective and pursue different goals. From a business-centric perspective, they focus on the transformation of products, processes, business models and organisational aspects owing to new technologies (Manyika et al. 2013) such as big data (Mayer-Schönberger and Cukier 2013), business analytics (Chen et al. 2012), cloud computing (Martens et al. 2011), cognitive systems (Samulowitz et al. 2014), robots (Brynjolfsson and McAfee 2014), social software (Kaplan and Haenlein 2010) and the Internet of Things (Porter and Heppelmann 2014). From a human-centred perspective, knowledge management’s focus on collections of (documented) knowledge has been extended to comprise connections between people (Kaschig et al. 2016) and to embrace social relations with their corresponding technology support (Von Krogh 2012), also called social knowledge environments (Pawlowski et al. 2014).

Be it in business or in everyday life, digital transformation strategies have certain elements in common. These elements can be ascribed to four dimensions: *use of technologies*, *changes in value creation*, *structural changes*, and *financial aspects* (cf. Matt et al. 2015). The transformation of analogous assets into electronic representations is associated with new forms of cognition.

2 Understanding Value Creation: The Knowledge Ladder 4.0

Let us now have a closer look at how digital technologies enable value creation based on data, information and knowledge. We will explain the relationships following the model of the “knowledge ladder” (North 2005; North and Kumta 2018).

Value creation in a knowledge economy is a step by step process including many learning loops in which resources are enriched. The organisation of symbols into data represents the first step in the creation of value, which, in a next step, are given meaning to become information. Information serves as input for decision-making and actions, which requires the capability of selection, sensemaking and interpretation. From this perspective, knowledge is the result of information processed by the conscious mind. While information is organised data, knowledge refers to the tacit or explicit understanding about relationships among phenomena. It is embodied in routines or algorithms to perform activities, in organisational structures and processes. Knowledge is embedded in believes and behaviours, a large part of it is tacit. The value of knowledge becomes evident only if the "know-what" is converted into "know-how" which manifests as actions. The ability or capacity to act appropriately in a specific situation is known as competence. von Krogh and Roos (1996, p. 45) clarify the dynamics of competent acting: "… *we view competence as an event, rather than asset. This simply means that competencies do not exist in the way a car does; they exist only when the knowledge (and skill) meet the task*". This capacity to make an appropriate choice of actions depends upon a wide repertoire of action potentials which is based on experiences and expertise developed over time. Value is the result of the interplay between multiple competencies of a person, a group, a network, an intelligent system or an institution based on its unique information and knowledge resources (North and Gueldenberg 2011). From this perspective, competitiveness is the result of the capability to bundle competencies uniquely and to renew them to create a unique customer value (cf. Hamel and Prahalad 1994; Teece 2009).

How do digital technologies enable and change these value creation processes? To explore this, we have created a "knowledge ladder 4.0" shown in Fig. 2. It relates the steps of knowledge-based value creation to selected enabling technologies (found below the knowledge ladder in the lower part of Fig. 2) and to their effects on the digitally enabled enrichment of resources (displayed above the knowledge ladder in the upper part of Fig. 2).

We will explore the technological developments and the effects they have on knowledge-based value creation in two steps: Firstly we will move up the knowledge ladder linking technologies and repercussions on managing data, information and knowledge. Secondly, we will look into four application areas (digitally enabled enrichment of resources to leverage of human performance, collaboration and networking, leading and learning, digitally enabled value creation, see Sects. 3, 4, 5 and 6).

Let us now move up the digitally enabled knowledge ladder and look into some critical steps.

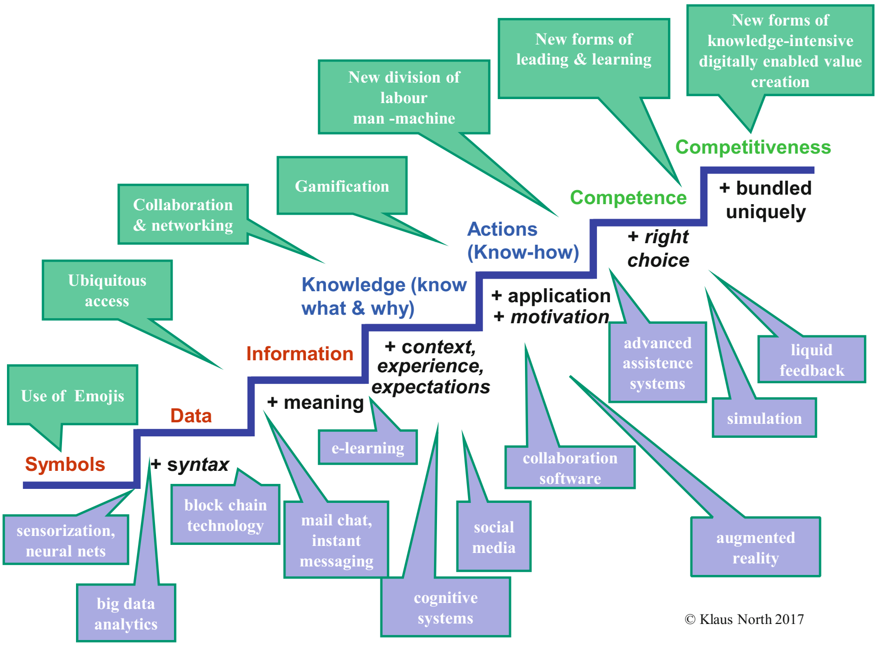

Fig. 2 Knowledge ladder 4.0: digital technologies for knowledge-based value creation

2.1 From Data to Information—Data & Surveillance Capitalism

Increasingly high-performance data analytics (HPDA) enables the acquisition and analysis of huge volumes of data and its subsequent transformation into information as a basis for actionable insights. Algorithms such as neural networks are able to interpret sensory data, recognise patterns, cluster and classify enormous amounts of data (e.g. face recognition of thousands of people).

Researchers from Google have used a deep-learning network to find and read the house numbers on many millions of Google Street View shots, even if they were rotated, tilted or uncommon. This served to locate the houses exactly on Google Maps. A team of people would have been involved with such a task for many years. The computer managed it in less than an hour. Source: Eberl (2016)

Such systems create actionable information but require humans with the knowledge to be able to act on the basis of that information. This means that the analytic capabilities of systems and the sensemaking capacity of humans and organisations have to match. Van der Aalst and Damiani (2015) argue that a major challenge is to relate massive amounts of event data to processes that are highly dynamic.

Researchers have associated the capabilities of big data analytics to a "data capitalism" which is "cashing in on our privacy" (Thornhill 2017). In this view, data has become an important source of monetisation as it enables the analysis of customer preferences and provide user-optimised advertising, products and services, and to further develop them.

Surveillance capitalism

Zuboff (2016) argues that we are entering a "surveillance capitalism" where the game is selling access to the real-time flow of our daily life –our reality—in order to directly influence and modify people's behaviour for profit: *"This is the gateway to a new universe of monetisation opportunities: restaurants who want to be your destination. Service vendors who want to fix your brake pads. Shops who will lure you like the fabled Sirens. The "various people" are anyone, and everyone who wants a piece of your behaviour for profit. Small wonder, then, that Google recently announced that its maps will not only provide the route you search but will also suggest a destination".*

As data and its presentation are a source of revenues they are increasingly "manipulated".

"Data curation" includes processes to create, maintain, and validate data to ensure the value of the data and present it under the perspective of generating revenues.

Hofmann (2017) reports on recent studies examining the data policies of digital platform providers. Although platform members increasingly produce, evaluate and circulate content, they rarely control the flow of information. The rise of new media channels also increases the power of the algorithms. Facebook, for example, currently categorises, filters and hierarchises approximately 500,000 comments per minute. This is done according to rules, which are not disclosed, but in fact decide about light and shadow in the communication flow. Digital platforms primarily "reward" those contributions with visibility in the news stream, which have the greatest prospects for further spread and thus promise not only attention, but also advertising revenues. This radical decoupling of quality and popularity of content, for example political news, explains why targeted misreporting (fake news) enjoys often the largest spread in the social networks. The algorithmically curated information flows (cf. Domingos 2015) or "newsfeeds" do not address people as political citizens, but as a data source whose presence should be held on the platform to gain continuous up-to-date information on their interaction behaviour (Urbinati 2014; Hofmann 2017). Summing up, there is a lot of debate about the major governance issue of how to deal with ownership and control of consumer data which manifests, among other forms, in the initiative towards a European Charter of Digital Fundamental Rights.[1]

Apart from the use of data for monetisation, there is a contrary movement towards open data which builds on the foundations laid by the highly visible and sustainable open source software initiatives and covers fields such as open content, open data, open government (OECD 2016), open innovation (Chesbrough 2006), open science (Le Dinh et al. 2015) or citizen science (Newman et al. 2012). These "open" movements advocate accessibility, collaboration and therefore the power of free or "democratised" innovation for digitised knowledge societies (Von Hippel and Von Krogh 2003; Von Hippel 2005, see also Pacheco et al.'s contribution on digital science in this book).

2.2 From Knowledge to Competence—The (R)evolution of Knowledge Work

At the centre of the knowledge ladder is the issue of how knowledge is put into action to create business value. *Enabling technologies* provide tools for agile communication and collaboration as well as intelligent systems leveraging human performance. Concepts such as "Augmented Intelligence" or "Advanced Artificial Intelligence" or "Cognitive Computing" describe systems that learn at scale, reason with purpose and interact with humans naturally (Kelly III 2015). "Cognitive" refers to the properties that the system integrates knowledge from diverse sources including current state and past experiences made by the system, "naturally" interacts with the user plus that the system generates and evaluates new hypotheses and capabilities (Samulowitz et al. 2014). What are the limits of these systems? (Davenport and Kirby 2016) argue that people are better able to interpret unstructured data, have the cognitive breadth to simultaneously act on different tasks as well as the judgment and flexibility that come with these basic advantages. Bostrom (2014) raises the questions what happens when machines surpass humans in general intelligence? Will there remain distinctive capabilities of humans if machine brains surpassed human brains in general intelligence?

The difference between artificial intelligence and cognitive computing
If your smartwatch had machine learning algorithms 'fed' inside it such that it can predict your health diagnosis by measuring your heart pulse: it might be a good example of AI—but a bad fit for cognitive computing, as it is still not interacting 'naturally' to humans. A Cognitive Computing system would rather have:

[1] https://digitalcharta.eu/wp-content/uploads/2016/12/Digital-Charta-EN.pdf.

1. taken your verbal command of ‘Hey AI Doctor, please tell me what is wrong with my health’;
2. and would have ‘arrived upon a plan’ to check your pulse. You as user did not ask to ‘check your pulse’—you only told that you were not feeling good—The agent arrived upon the plan to check your heart pulse itself using its intelligence. It could have arrived upon the plan to check your temperature using a thermometer as well.
3. and deduced the repercussions of what a low heart pulse would do once it was detected on your wrist. And would have explained the repercussions to you in ‘natural language’ much like how a human doctor would do.
4. A Cognitive Computing smartwatch would have memorised your health records from a time period and would have recorded the latest state or environment you are in, and would have given personalised recommendation based on that. So from its memory it would have memorised that you are a diabetic patient and you recently attended your son’s wedding and ended up eating lots of sweets—and its recommendation will take these two facts into account.

Source: adapted from[2]

While these technologies change everyday life, they have a particular influence on managing knowledge work. In the following we summarise major trends that will affect knowledge work in the future, as have been identified by a number of studies (cf. Intel 2014; BMAS 2015; Lehtiniemi et al. 2015; Telekom 2015). The issues summarised here will be discussed in further detail in Sects. 3, 4, 5 and 6.

New forms of interaction between humans and machines: Smart systems will emerge and collaborate with humans, changing the nature of work, and driving a re-imagination of work content and work process. Various forms will coexist in the future; from people who control machines, machines as people’s peers, to the merging of machine and human or the complete takeover of activities by intelligent systems. This will lead to a redefinition of expertise. If in the future expertise will be defined as human (expert) plus intelligent system, a major issue will be how people and machines will learn together? How will systems develop common sense and ethics (tacit knowledge).[3] Who will evaluate potential courses of action? How will systems weigh chances and risks? How will we appropriate the created value? Will humans remain capable of action if the assistance systems fail? Creative activities, for now, remain a domain for humans. Will intelligent systems become creative in the future? How will we escape the implied competition between

[2] https://www.quora.com/What-is-the-major-difference-between-Cognitive-Computing-and-Artificial-Intelligence.

[3] Compare: http://www.huffingtonpost.com/entry/ethics-and-creativity-in-artificial-intelligence-an_us_593047b4e4b09e93d7964848.

humans and machines? Concerning the latter, (Davenport and Kirby 2016) suggest to view the rising capabilities of machines not as threat and replacement for humans, but with a mindset of augmentation, that is to employ machines as partners and collaborators in creative problem solving.

Distributed value generation: The new world of work is characterised by networks. Standardised back-end processes are shared between companies, without being visible to customers or employees. This creates jobs without a clear organisational membership and products without a clear sender. Boundaries within and between organisations fade as work is organised in temporary projects done by people with temporary affiliations.

Work without borders: Highly qualified specialists work around the world as part of project work. Qualifications are globally transparent and comparable. The spatial location of the service provider is no longer relevant. For the first time, labour thus acquires the same mobility as capital. The traditional places and times of work dissolve. For employees, this results in new options, for example to improve the compatibility of family and work life, but also new burdens ("always on") (Mazmanian et al. 2013; Waizenegger et al. 2016). Offices will serve as temporary anchor points for human interaction rather than daily travel destinations. Office as a Service (OaaS) will become a strategic tool to connect employees in the right place, at the right time.

Crowdworking: Companies are increasingly focusing on customers instead of employees. Many (digitisable) services are offered by volunteers and free of charge, for example in open innovation contests a crowd submits ideas for innovations to a contest sponsor, usually hosted by an open innovation platform (Adamczyk et al. 2012; Boudreau and Lakhani 2013). Prosumerism blurs the boundaries between producers and consumers. Volunteered digital work complements or replaces professional employment. In addition, digital services are divided into ever smaller parts and delegated to "virtual labourers". Big data analytics can be used to assign value contributions to specific individual workers. Cloud- or clickworkers offer online services on a crowdsourcing platform such as Amazon MechanicalTurk, usually paid on a per-task basis for, for example, web research, text creation, tagging, categorisation and translation. In the foreseeable future, many of these activities will be fully digitised. While such developments certainly offer enormous opportunities for individuals, organisations and the society at large, some researchers have also described risks involved in this new form of global organisation of labour (e.g., Ettlinger 2016).

Self-management as a core competence: As traditional work relationships and processes are dissolved, knowledge workers have to learn self-management including self-organisation and self-control. Self-management means, amongst others, to organise work, to define or redefine work objectives, to choose adequate means and methods, to organise one´s own competence development as well as to find a sustainable work-life-balance.

Digital Leadership: The distribution of work in different locations is accompanied by a shift from a "presence culture" to a "result culture" ("do your work wherever you are"). Leaders need to learn to align individual interests of these dispersed workforces with organisational goals. The art is to build and maintain personal ties through impersonal channels enabled by information and communication technologies.

2.3 From Competence to Competitiveness

Moving up the knowledge ladder, the ultimate objective is to create unique customer value based on the capabilities of an organization. Unique knowledge in the form of a superior proprietary technology can lead to long-term market dominance, as we have seen in the case of Google's superior PageRank algorithms. Such proprietary technology can be the base for competitive advantage in a "winner takes all" manner due to the network effects created. However, as a result of disruptive technologies, the traditional boundaries for industries are being blurred and barriers for new entrants are lowered due to the pervasiveness of digitally enabled knowledge sharing and low equipment costs.

Switching costs as source of maintaining competitive advantage Switching costs might prevent customers from exchanging one service for another that might be functionally better, which might be more than offset by the cost of transfer to the new service or might (initially) offer inferior network advantages. Examples for such effects are social networks. "Switching cost is also essentially what makes Facebook so difficult to defeat: For a user, to move into another similar social medial platform implies the cost of building up a new «friends» base without any guarantees that his or her friends will do the same. The Google+ debacle is a powerful reminder of how resilient switching cost may be…."[4]

To retain and rebuild competitive advantage organisations need to develop capabilities for digital renewal and learn how to create and implement digital business strategies. The literature increasingly links digital transformation to the development of "dynamic capabilities" (Teece et al. 1997; Eisenhardt and Martin 2000; Yoo et al. 2012; Bharadwaj et al. 2013; Teece 2017). Dynamic capabilities have been defined by Teece et al. (1997) as an organisation's ability to integrate, create and reconfigure both internal and external competences to address changing environments. Karimi and Walter (2015) ascertain the role of dynamic capabilities in response to digital disruption. Their empirical results on the digital transformation of the newspaper industry suggest that dynamic capabilities are positively

[4](https://salvadorbaille.com/2017/02/07/so-you-think-you-have-a-competitive-advantage-i/).

associated with building digital platform capabilities, and that these capabilities impact the performance of a company's response to digital disruption.

Dynamic Capabilities and (Digital) Platform Lifecycles
To adopt a longer-term perspective on the competitive requirements of their platform-based business, managers should understand the dynamics of (digital) platforms: Managers should reflect on the four-stages—Birth, Expansion, Leadership, and Self-Renewal—of the platform lifecycle in terms of its dependence on the dynamic capability categories of sensing, seizing, and transforming. The requirements evolve from a heavy emphasis on generative sensing and planning-stage seizing in the birth phase, through greater emphasis on "seizing" activities and minor transformations as the platform, ideally, grows and stabilises. When platform renewal is called for, the emphasis returns to sensing future possibilities and generating new ideas for a platform and business model, developing them alongside the existing business, and eventually undertaking a major transformation to restart the platform lifecycle.
Source: Teece (2017)

The development of dynamic capabilities is closely linked to learning and managing knowledge acquisition, creation and sharing within and across organisations. Following Pavlou and El Sawy (2011)'s argument that dynamic capabilities are based on sensing, learning, integration and coordination, we will explore how these capabilities are related to managing knowledge in digital transformation and what are the specific challenges of coping with such turbulent and disruptive environments (North and Varvakis 2016). (Chap. 12)

Sensing capability: turbulent and disruptive environments require (1) receptiveness to weak signals, (2) a constant gathering of information on the business environment, market and technology trends, plus customer needs, followed by (3) the interpretation of this information with the available knowledge and (4) to draw conclusions. The challenge here is to effectively communicate internally across units and fields of knowledge what is changing and create a shared understanding of what this means for the organisation.

Learning capability: new business opportunities and threats to existing business arise from digitisation, which require new knowledge and skills to offer new or revised products, services or to change business models. The challenge here is to integrate quick learning loops into daily operations and business development.

Integration capability: integration focuses on overall sense-making and on building of a shared understanding throughout the organisation. Shared tacit knowledge is at the core of an integration capability. New or changed ways of doing business require the ability to combine individual knowledge into new operational processes and practices of a team or a business unit. The challenge here is to ensure that everybody understands and shares what digitisation means for the business and is enabled to assume their new role in the "digital game".

Coordination capability: coordination focuses on orchestrating individual tasks and activities. Organisations need to maintain an attitude that accepts change, establish monitoring systems and ensure the availability of financial and human resources. The challenge lies in empowering employees who need to develop the knowledge, skills and attitude needed to decide, monitor and act in an entrepreneurial spirit in a "work 4.0" environment.

The above described capabilities are a basis for **developing and implementing digital business strategies** (Mithas et al. 2013). Competence development needs to be aligned with a digital business strategy in order to create business value that differentiates a company from its competitors. (Bharadwaj et al. 2013) argue that a digital business strategy is different from traditional IT strategy in the sense that it is much more than a cross-functional strategy, and it transcends traditional functional areas and various IT-enabled business processes. Therefore, digital business strategy can be viewed as being inherently "transfunctional" (see also Koch and Windsperger 2017).

Yoo et al. (2010, p. 724) argue that pervasive digitisation gives birth to a new type of product architecture: "*The layered modular architecture extends the modular architecture of physical products by incorporating four loosely coupled layers of devices, networks, services, and contents created by digital technology.*" For example, as most subsystems of an automobile are becoming digitised and connected through vehicle-based software architectures, an automobile has become a computing platform on which other firms outside the automotive industry can develop and integrate new devices, networks, services, and content (Henfridsson and Lindgren 2010).

Along similar lines, Koch and Windsperger (2017, p. 2) propose a network-centric view, where firms may achieve competitive advantage by co-creating value with interconnected firms in the digital environment. They refer to a digital ecosystem as a network of companies and other institutions that is inter-linked by complementary interests to create and sustain value around a common digital platform. Therefore a digital business strategy extends the scope beyond firm boundaries and supply chains to dynamic ecosystems that can even cross traditional industry boundaries (Bharadwaj et al. 2013).

2.4 Implications for Managing Knowledge

In the past, organisations primarily engaged in knowledge management (KM) practices that focused on managing current knowledge and past experiences with a strong emphasis on documentation (Pawlowsky et al. 2011). KM has y been acknowledged as a factor that impacts on an organisation's performance (Zack et al. 2009) in an environment characterised by complexity and turbulence. A hypercompetitive "VUCA" environment (volatile, uncertain, complex, ambiguous), changed communication behaviours and the evolution towards knowledge work 4.0 set the scene for managing knowledge within and across organisations in the digitised society.

In analogy to the concept of "ambidexterity" (Tushman and O'Reilly 1996), KM has to support a number of conflicting knowledge activities such as "exploitation" and "exploration" (March 1991) or "sharing" and "protection" (Manhart et al. 2015; Loebbecke et al. 2016) at the same time in such VUCA settings. In the light of the ensuing conflict between stability and flexibility, KM stabilises the organisation's capabilities in a mode of protection and exploitation on the one hand and concurrently supports dynamic capabilities in a mode of exploration and sharing to enhance agility and renewal. An organisation's ability to manage such seemingly contradictory processes and practices increasingly gains importance with digital transformation. Let us look in more detail into these two functions of KM (North and Haas 2014).

Operational KM as stabiliser

Also in the future, operational KM will continue to aim at making the right knowledge available at the right time and place to support the employees of an organisation, plus the relevant stakeholders in the organisation's environment for day-to-day operations. The means and ways of how to achieve this ambitious objective, however, will change under a KM 4.0 perspective. Organisations can engage in the following activities to stabilise the portfolio of competencies in an organisation:

(1) **Facilitate ubiquitous and curated knowledge flows**: Quick, easy and ubiquitous access to the knowledge base of the organisation and across organisations gains importance and can be characterised by decentralized, and increasingly peer-networked repositories augmented by rapidly evolving machine intelligence. Murray and Wheaton (2016) argue that there is a need for "knowledge curation" as even advanced technologies such as machine-readable ontologies have not yet come close to being able to extract deep meaning or accurately organize content into proper contextual categories. Curation establishes, maintains and adds value to repositories of knowledge and helps to keep them relevant and up-to-date. In practice, curation could mean that an expert compiles a selection of links and shares them, adding a clear explanation of the selection criteria used to compile the list as well as brief introductions explaining why each link is relevant (Spiro 2017). However, the decisions necessary in such a process might also be augmented by machine intelligence, by a team or crowd who are engaged in the domain that is curated by the expert.

(2) **Enable collaboration**: The emphasis of KM has shifted from the support for collecting to connecting knowledge activities (Kaschig et al. 2016) that help to make collaboration work. Connecting knowledge activities are viewed comprehensively to comprise connections between people, that is joint knowledge creation, sharing and acquisition, and connections of knowledge both in an abstract and a manifest form—the integration of knowledge from diverse sources be it people,

documents or algorithms. KM needs to help people to develop the competencies needed for work 4.0, amongst which competencies for technology-mediated collaboration and collaboration with machines as "team mates" (Seeber et al. 2018) stand out.

(3) **Monitor and control augmented learning and decision-making**: As organisations increasingly develop and deploy algorithms to automate routine knowledge tasks and decisions plus provide decision support in known situations, such automated knowledge behaviour needs to be monitored and controlled to be not only efficient, but also compliant with an organisation's internal and external regulatory system. The corresponding experiences made need to be systematically reflected and interpreted in this respect, KM will have to ensure transparency of cognitive technologies, so that users will always be aware of how cognitive systems "think" and act. A particular challenge here is to identify and leverage the tacit knowledge of subject matter experts or communities and to provide the means for humans to keep up to date with the exponential growth of opportunities created by self-learning systems.

Strategic KM as catalyst

In an increasingly turbulent and complex environment, it is the responsibility of KM to critically examine knowledge and competencies of the organisation, a network or business ecosystem and identify its "blind spots". Here, KM takes on the role of an innovator and "irritates the system" by questioning past learning, established behaviours and practices (North and Haas 2014). KM must succeed in supporting the development of "dynamic capabilities" of organisations to reconfigure, realign and integrate core competencies with the help of external resources. Organisations can engage in the following activities to productively foster the growth of capabilities for improved organisational performance under shifting environmental conditions:

(1) **Identify critical knowledge**: KM needs to provide deep insight into the critical knowledge assets required to embark on the learning journey involved in the activities to pursue future organisational goals. Therefore, KM also questions current core competencies, intellectual property rights, market and industry comprehension, and customer understanding and expectations (MacMillan et al. 2017). KM should identify the pockets and islands of knowledge creation within and beyond the organisational boundaries that can be connected to acquire new core competencies that can be appropriated by the organisation. Hence, organisations need to integrate isolated knowledge on and views of the environment to make sense of information as a basis for seizing new opportunities and transforming the organisation. Strategic knowledge mapping helps to uncover and take an integral view on critical knowledge assets, providing the context for discovering the most promising digitalization strategies (MacMillan et al. 2017).

(2) **Facilitate sensemaking and shared understanding** as a basis to act: Klein et al. (2006) describe sensemaking as a way of understanding connections between people, places and events that occur now or occurred in the past, in order to

anticipate future trajectories and act accordingly. The ability to frame (set in context) and reframe problems and observations is particularly important when big data analytics seem to provide answers without adequate context knowledge (Madsbjerg 2017). Deep insights and shared understandings emerge through multiple discourses of people (Kurtz and Snowden 2003; Kolko 2010). The underlying mechanisms of meaning making can be seen as the essence of collaboration (Stahl et al. 2006) and highlight that negotiation processes are interactive, reciprocal and that meaning resides in the social realm and can be manifest in socio-technical systems (Dennerlein et al. 2016). Sensemaking is a shared and communal activity that produces knowledge appropriate for action, but biased heavily based on the individuals doing the sensemaking—that is, each group of people who have the various sensemaking conversations will "talk into existence" a very different set of situations, organisations, and environments (Weick et al. 2005). In this view sensemaking is a process that is highly collaborative, effective for organisational growth and planning in both the short and long-term, and highly dependent on interpretation.

The increasing complexity of work tasks intensifies the demand for collaboration, which in turn requires KM to support the creation of shared understanding among work groups (Bittner and Leimeister 2014). On the organisational level, shared understanding among organisations that collaborate in business ecosystems is vital for efficient knowledge creation in such ecosystems. Researchers found that at the beginning of business ecosystem formation, organisations need to share their capabilities, expertise, and knowledge and in particular make the tacit knowledge explicit in order to boost integration (Annanperä et al. 2016).

(3) **Encourage renewal, agile learning and reflection**: To ensure renewal in an ever changing and often disruptive environment, firms have to learn how to systematically develop new business models and non-profit organisations need to be capable of redesigning their missions in an accelerated manner (cf. Kotter 2014). KM can play a key role in these above described issues related to render organisations more dynamic in the future. In an environment that is characterised by unpredictability and various unanticipated crises, KM must support quick problem-solving, encourage constant experimenting, foster collaborative learning and facilitate professional reflection to learn from mistakes. For example, KM can be responsible for developing a "next practices" process in an organisation. Future developments in a business or technology area, or in a business model can be explored in cross-departmental workshops which include a range of stakeholders such as customers and the scientific community.

(4) **Build platforms for engagement**: In an era of information overload, human attention is a scarce resource. In order to attract heterogeneous and unexpected knowledge it is of strategic importance to build platforms that engage members in and beyond the organisational boundaries. Ghazawneh and Henfridsson (2010) point to the importance of governing third-party development through specific knowledge which they call "platform boundary resources". These include the design of technical boundary resources such as software development kits and application programming interfaces and social boundary resources such as

incentives, intellectual property rights, and control systems. KM's role is to build platforms that attract engagement of a wider community for the strategic development of organisational competencies, products and services.

After having clarified how digitalisation interrelates with managing knowledge in general we will now look into four application areas (digitally enabled enrichment of resources to leverage of human performance, collaboration and networking, leading and learning, digitally enabled value creation, see Sects. 3, 4, 5 and 6) and summarize the contributions of this book.

3 Digitally Enabled Enrichment of Resources to Leverage Human Performance

As we have explained above, the model of the knowledge ladder symbolises how resources such as data or information are connected, given meaning, related to contexts and thus enriched to enable value creation. The contributions which are grouped in this section have in common that they explore how this enrichment works, what are limitations and future perspectives. Particular emphasis is put on the interplay between smart systems and knowledge workers.

A key enabler for the enrichment of resources is the area of **Semantic Technologies**. While most semantic technologies originate from the vision of representing the existing Web in a machine-processable format, it's most notable success so far are large cross-domain "knowledge graphs". They are created by collaborative human modelling and linking of structured and semi-structured data. Rettinger et al. introduce the latest innovations in modelling knowledge using knowledge graphs and how those knowledge graphs enable value creation by making unstructured content, like text documents accessible by machines and humans, and finally how semantic technologies help to make hard- and software components in cyber physical systems interoperable.

An application of semantic technologies can be found in **clinical decision support systems (CDS)**. Healthcare professionals often make clinical decisions under time constraints within a highly complex patient situation. The aim of CDS, therefore, includes the improvement of clinical decisions by providing and applying evidence-based medical information at the right time of decision making. Amongst others, intelligent algorithms can detect specific patterns that are indicative of clinical conditions or diseases. Schnurr and colleagues explain the interplay of such "intelligent systems" and healthcare professionals and how knowledge is created and maintained through a collaborative process between knowledge engineers and clinicians. A major issue is how intelligent systems and users learn together, or from each other. The authors argue, that in future, we have to train and teach our computers. Maybe computers will have to pass exams and need to be certified to support humans in critical application domains.

Smart systems do not only provide guidance but increasingly support or interact with humans in physical tasks such as care robots in smart homes or smart robots within smart factories. Humans and machines will work side by side in so-called "hybrid teams." The success of future production or assistance concepts will strongly depend on the successful implementation of direct cooperation between humans and robots. As a step further, robots should be able to identify and adapt to individual strengths and weaknesses and take over the role of a workmate, helping to construct knowledge in social, teamwork-oriented processes.

In her contribution Anja Richert explores the interaction of **hybrid teams of humans and robots**. The empirical part researches if the appearance of the robot and its behaviour influence the perception of the robot as a partner as well as the human cooperation behaviour.

Kohlegger and Ploder take a further look into the **interplay between digital assistance systems and knowledge workers** to allow new, deep insights into phenomena and support business value creation. A model of data driven knowledge discovery is presented that describes how this interplay could look like and is critically discussed using real-world cases. The main conclusions are that it is crucial to (1) separate data-driven and expert-based analysis in knowledge discovery, (2) clearly describe the problem that should be solved by the analysis, (3) understand the particular domain that analysis is applied to, (4) complement data-driven with expert-based analysis, and (5) understand the relation of analysis and action implementation.

Digital change and Industry 4.0 concepts do not erase the need for human insight or experience. Experience plays an eminent role particularly in highly complex and automated digitised work environments. At the same time, digital transformation opens up new opportunities for implementing solutions for **advanced experience management** by automatically capturing, exchanging and preserving lessons learned and offer support that is both context-aware and situation-specific. These are based on key technologies such as information extraction from texts, process mining and text mining. Maier and Reimer discuss in their contribution various technological solutions for automating (parts of) capturing and providing experience-based knowledge:

- integrating knowledge provision into the work processes in a way that is both context-aware and specific to the situation
- using process mining to predict an employee's next activities and provide relevant knowledge
- extracting information from texts and text mining to identify good practices e.g. from discussions on social media.

The authors argue that the suggested approaches help to solve the dilemma that on the one hand companies deem experience and its transfer and exchange very important, while on the other hand well-known methods for capturing and preserving valuable experience within the company are rarely used due to the effort and time they require.